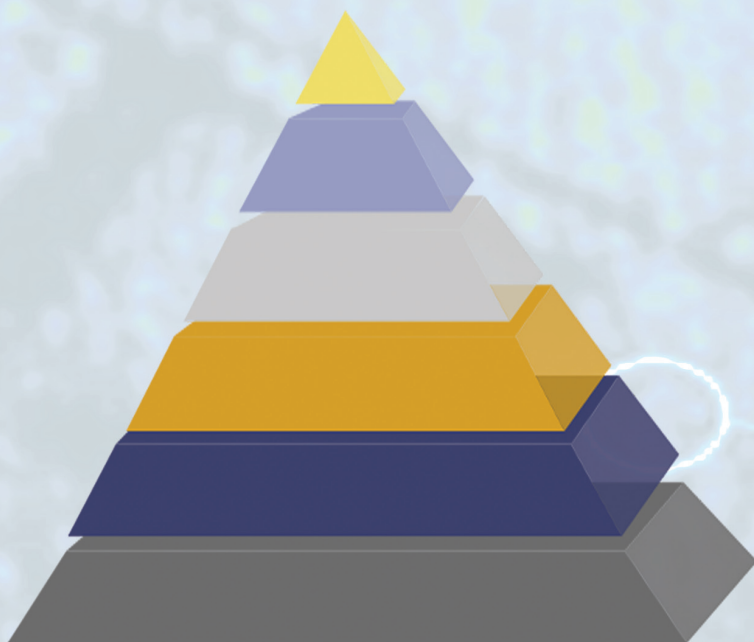


Jørn Braa • Sundeep Sahay

# INTEGRATED HEALTH INFORMATION ARCHITECTURE

Power to the Users

Design, Development and Use





Integrated Health  
Information Architecture  
Power to the Users



# Integrated Health Information Architecture Power to the Users

Design, Development and Use

Jørn Braa • Sundeep Sahay



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*Dedicated to  
Unni & Diego...  
and  
for a better world for all*



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# Preface

## HISP: Time, Space and Architectures

Chance brought together the radical Norwegian union based participatory design tradition, with grass root level anti-apartheid politics in 1994, when a Norwegian informatics researcher was invited to participate in South Africa's Reconstruction and Development Plan (RDP). This potent hybrid of traditions within this unique context of the fervour post-apartheid reform, led to the birth of Health Information Systems Pilot Project – HISPP. The Plan received external funding through Norwegian Agency for Development Cooperation (NORAD), to support pilot projects first in Western Province and then other provinces. Later, another Norwegian activist joined the team, contributing to the development of the first version of the District Health Information System (DHIS) on MS Office platform, which in 1998 was implemented in two provinces, and by 2000, became the de facto national standard. As the project scaled in momentum, the team dropped one 'P' from original HISPP and proclaimed it as the programme – HISP. This book is being written after about 15 years of the initial establishment of HISP, and its evolution as a 'network' involving different people, institutions, technologies and activities spreading across more than 20 countries. DHIS has now evolved into an architecture from just being a standalone software system. This journey – over time, space and technology – has provided the context and empirical experiences for our thoughts to evolve, and provides the basic foundation of this book. We describe in brief, this journey.

## The Origins: South Africa and Standalone DHIS (1995-2000)

HISP found its origins in South Africa, where HISP had learnt and created its own unique approach to 'Health Information Systems' (HIS). It was there, the term 'information for local action' was born and moved beyond rhetoric to actually having a grounded meaning and purpose. The notion of an 'integrated database' from the perspective of information flows in a district, converging to a central point in a district, was understood. This integration approach represents the essence of the data warehouse approach, something which many countries are trying to achieve today – 15 years on – with limited degrees of success. In this context, integration had a purpose – the political aim to rectify the 'bads' of apartheid in the health services which were inequitable, fragmented according to race, and centralised. Technology, the DHIS Version 1 (DHIS1), was one of the tools deployed for enabling this political integration. There were deliberately constructed features of flexibility and local control inscribed in the software design with the aim of empowering users. This process of design was not a one-time task of freezing requirements and development, but an ongoing process of

evolution in context. Given the background of the team members as social and political activists in the anti-apartheid struggle, the approach was grounded necessarily in the framework of a larger ‘learning through action’ and ‘empowerment’, especially political empowerment of both people and areas that had been systematically excluded during apartheid. This undoubtedly resonated with the African National Congress (ANC) government policy of reform and upliftment.

DHIS development was based on rapid prototyping with new ‘builds’ being sometimes released on a weekly or even daily basis. The informal mechanisms for reporting bugs and requesting new functionality – all tightly integrated with user support – proved popular and encouraged users to provide feedback to the development



team. This combined with the rapid deployment of new or corrected versions astounded many users, whose prior experience had involved long waits for responses to their requests, if they ever came. Requests for new functionalities were moderated by the HISP team depending on the number of users making requests and the team capacity, while recording all relevant requests. The methodology used was informal and to a certain degree, based on user improvisation. Thus, any proactive user, regardless of his or her place in the hierarchy, had full access to the development team representing

a meritocratic approach. This approach was arguably more effective than formal processes, given the formal and conflict-ridden operating environment which demanded hierarchy.

The important role that standards play in developing integrated systems, was another key learning from the South African experience. Apartheid was about fragmentation according to race, type of service, and the system of ‘homelands’. A consequence of this was that the absence of a comprehensive national standard for data collection, and each province used different datasets, definitions, and standards. The cornerstone of the strategy to address this challenge was to develop a HIS, including a system of national standards to measure and monitor the extent to which, this policy is being achieved while pinpointing the areas where more resources and efforts are needed. Implementing standards required an approach which did not try to make one shoe fit all, but there was a ‘hierarchy of standards’, where each level (for example, a province) had the freedom to define their own standards as long as they aligned with the standards of the level above. This hierarchy was implemented in the DHIS and used to prototype, negotiate, and implement provincial and national data standards. This approach helped lower tensions between various organisational units such as provinces and health programmes, as freedom to define their own information needs was granted to the locals, while the national level was satisfied by the universal compliance to their reporting requirements.

The social systems approach to Integrated Health Information Architecture (IHIA), which we argue for in this book, helps one to understand the marriage between the political and social climate of post-apartheid, providing the context for DHIS to be born and evolve into a national standard by the year, 2000. A sophisticated technical solution without compatibility with the political context – for example, being centralised rather than decentralised – would probably not have been as effective

a solution. A social systems approach emphasises the engagement of users in the process of technology design and development. While the participatory design helped in developing the DHIS software and getting the generic data models right, DHIS used as a tool for prototyping helped to get the wider information system right, such as the datasets, indicators, and reports. This could only be achieved by using the DHIS as LEGO bricks to build the system.

The seeds of the architectural approach, which we discuss in this book, were sown in South Africa during these formative years of the nineties. Some key concepts which took root were:

1. Principles of flexibility and user control are essential features of HIS.
2. Standards are the key to a national HIS, and the principle of hierarchy of standards provides an effective way of their implementation.
3. Principles of minimum and essential datasets are important in focusing the HIS on providing data on 'what is needed most', and not on what people believe may be important in future.
4. Integration of the information flows – involving convergence of all the local information flows into a central point in a district framework – is the key to an effective district-based health system.
5. Rapid prototyping is effective as a tool to build communication and interaction between the users and developers, and to ensure that strong public health related domain knowledge is inscribed in the software.

While DHIS was successfully launched within South Africa, the same principles of geographical scaling were attempted in other countries too. This presented various challenges, of which some issues are discussed here.

### Networking Efforts: HISP in South Africa and Beyond (2000-2006)

Scaling of both geographical and across areas of focus such as software and education, were the key efforts made from the year 2000 onwards. Growth of Masters programmes and involvement of PhD students became important and focal activities around which the scaling of HISP was attempted.

The intensive and evolutionary participatory development processes that HISP followed in South Africa, took DHIS from district pilots to a country-wide standard, involving increasingly refined prototypes being tested in close collaboration with the users whose focus was on using information for local action and management. The ANC government's reform goals of decentralisation and local empowerment were 'inscribed' into the design. For example, the hierarchy of standards and the use of Excel pivot tables, made drilling down and local use of information, easy. While the iterative design process produced a close fit with the needs for sweeping reform, the system accumulated both rigidities and a messy architecture overall. This proved problematic when it was subsequently introduced in countries such as Mozambique, India, Vietnam, and Cuba. A few anecdotes are presented.

In Cuba, HISP was initiated in October 2001, through the efforts of two Masters students working under the guidance of the Cuba's National Statistical Office. The Masters students, who had been trained in the Scandinavian tradition, had read about the success of the South African experience. They started their efforts in two pilot provinces

by attempting to develop minimum datasets while defining indicators to support local action. Minimum datasets and indicators for local action were alien concepts in Castro's centralised health system, where all indicator reports needed to be sent to Havana, even on a daily basis. The students' training efforts involving a participatory methodology was met by resistance at the national level, who expressed dislike for the concept of the local workers getting more skilled in the system than them. Institutionally, the HIS in Cuba was dominated by the statistical cadre, whose needs for information use were not so much to support local action, but statistical reporting. The statistical structure inspired by the Soviet legacy, encouraged centralisation, with data flowing to the national database for making prospective 5-year macro-level national



plans. Such a focus impeded processes to encourage local and active use of information, which required participation of local users.

Similarly, in India, where HISP efforts were initiated in the year 2000, breakthroughs in promoting the notions of 'information for local action' were difficult to achieve. Contributing to this was the very strong centralised mandate, at both the state and national levels, and also the extreme fragmentation and multiplicity of reporting channels. Institutional inertia was significant, with many reports that were

identified from the health programmes that were terminated long before. Attempts to try and deal with data redundancies in one state through the design of 'minimum datasets' was not allowed to go through by the state authorities who gave instructions that HISP should not be allowed to change anything. Many years later, in the year 2008, the situation did change as HISP became an active participant in the national level reform effort to redesign datasets, indicators, and information flows. The invitation to participate in these national level efforts, while coming largely through personal contacts (as is most always the case in India), helped open up opportunities to work at the local level in various states. An approach primarily focused on building grass root level participation, without the permissions from the top, would arguably have ended up in a failure in the Indian context.

In Mozambique, we found that the use of the 'learning by doing' approach, which had been so popular and effective in South Africa, to be relatively ineffective. The 'pivot table' based reporting approach, provides users with the flexibility to create the reports they locally require, and promotes a 'learning by doing' approach that potentially strengthens empowerment. Attempts to adopt the 'pivot table' approach was met with resistance as users wanted pre-designed reports, which could be generated with the click of a button and sent up the reporting hierarchy. The failure of the HISP team to provide such functionality in the application contributed significantly to the limited uptake of the systems in the three provinces, where HISP was piloting the project.

These different examples from varying contexts, helped to drive home the realisation, that context matters, and approaches to design and development of HIS must be broad-based and flexible enough to adapt. Scandinavian traditions of development, found a happy partner in post-apartheid South Africa, where the political focus was on local empowerment. In Cuba and India, local empowerment was largely a concept foreign to the culture, where the focus was on centralisation. This was a result of legacies of Soviet's statistics-based planning and the British bureaucracy, in the

respective countries. Politics was important, though there were apparent differences in how they played out on the ground. In both Cuba and India, the political buy-in was required, not as a form of user empowerment, but to get the permissions from the top to try out and scale things in the field. In hindsight, if permission had been obtained from Fidel Castro in Cuba and the Health Commissioner in India, the results could have been markedly different.

How does one deal with the limits of scaling efforts, both in terms of the technical systems and approaches to their development and implementation? HISP points to the solution in terms of consciously trying to cultivate networks within which, collaborative action can be fostered and shared, to address the twin problems of scale and sustainability. In the public health system, the normative goal is to provide equitable services to all. Hence, the problem of scale becomes a unique one of 'all or nothing', since data from limited sites will always be inadequate to the district manager, who needs data on the entire coverage of the catchment area, under the district including all its sub-units. However, if the HIS is not at a scale to be useful to the health system, then the managers will neither take ownership of the system nor invest resources, making the system unsustainable. A pilot will remain a pilot, and it would not scale if learning from the pilot is not linked to other facilities, systems, people and institutions to which it needs to scale. Without these inter-linkages, there will be no critical mass of interested people and resources, which will make the system unsustainable. Further, networks are never apolitical, and there are always negotiations around who gets included and who does not. A key agenda of HISP has been to work with marginalised contexts, and include them in the network.

HISP conceptualised as a 'network of action', comprises of various entities, including Universities, Ministries of Health, international agencies like WHO and NORAD, and in-country implementing agencies like HISP SA and HISP India. The network is never static and there are always new memberships, such as ongoing attempts by HISP, to forge partnerships with other open source software development groups such as OpenMRS and iHRIS. Network members play different roles from managing software development, co-ordinating educational linkages, or fund raising. Some nodes play co-ordinating and other implementing roles, influencing either local, national, or global levels depending on their interests, agendas, capacities and resources.

Reflecting back, as efforts were made over time to scale to different geographies, there was the encountering of very different time, space and cultural contexts, with significantly different politics (as compared to South Africa, which was our reference frame). As in the case of South Africa, there is always a deep and intimate relation between the politics, technology, and the user needs and pull. With respect to politics, in India and Cuba, HISP was not positioned 'high enough' in the hierarchy to get the required support to scale completely. With respect to the technology, the first version of the DHIS, which was used successfully in South Africa, had limits primarily because of a messy database architecture which had grown in a relatively ad hoc manner over time. It could not be scaled easily to other settings as evidenced by the difficulties faced initially in its internationalisation. Not being compatible with the web, provided another set of serious constraints to the technology, in how much it could be expanded.

While DHIS related project implementation was not so successful in the early 2000s, positive results were achieved by HISP in supporting the establishment of Masters programmes in Health Informatics (in Mozambique, South Africa, and so on), and

having more students engaged in PhD programmes from the South. From the social systems perspective, which was so integral to our thinking, we found out that the same was something which was not easily understood by students coming from more traditional engineering and medical backgrounds. Challenging their existing thinking, while incorporating a strong action research approach, which does not see a divide between action and research, are some of the struggles that we are grappling with, even today. Not being able to bridge this gap has adversely influenced implementation efforts in various settings such as in Ethiopia.

### Web-based Networking: Embracing a New Technological Paradigm (2006-2010)

The years following 2005, saw HISP or at least a large part of it embrace the new technological paradigm offered by the Web. In response to the demand for moving HISP to an Internet enabled web-based platform, the development of second version of the DHIS (DHIS2) was initiated. This development took place under the leadership



of the University of Oslo, but aimed at distributing development activities to a number of countries in the network, in order to bring software development closer to the contexts of use. A stack of 'bleeding edge' Java-based technologies was selected for DHIS2, and in parallel, a distributed development platform similar to those employed by many FOSS projects was set up. However, re-implementing DHIS as a modular web application proved quite difficult. Also, the radical break in technologies, as well as, an overemphasis on the new online communication platform presented a formidable obstacle to the

involvement of existing technical staff in various sites globally, such as in India, Ethiopia, and Vietnam.

It was only in January 2006, that the first instance of DHIS2 was deployed in Kerala, India; even at which point, many important functionalities were lacking. The system improved significantly through early use in India and Vietnam, and later in the Republic of Sierra Leone, as well as through the involvement of new software developers recruited locally. While engaging with the global source code, their main task was to support local implementations, in the process of bridging the divide between users and developers. Some of the principles of HIS learnt in South Africa were very relevant to the efforts in India and Sierra Leone. The technologies and the new web-based paradigm brought about important differences, for example in Republic of Sierra Leone.

Sierra Leone provides an interesting example in the making of architecture. While principles of intensive and rapid development of new functionalities required by the 'context of use' learnt in South Africa were relevant here; the DHIS2 was used as a 'plastic' to create the architecture, while allowing different groups of users with multiple views of data, transmitted through the Internet in ways that were relevant to them. The HMN Framework, which represented the global vision of the architecture, was instantiated through the DHIS2. An architecture, which is being developed by teams of

developers situated in their respective contexts of use, undoubtedly will have to deal with problems of coordination and synchronisation. When DHIS2 was first introduced in the field in the year 2006, the HISP India team members, who had several years of experience with DHIS1, found it hard to make it useable in their context. At the time, no report generation or graphing tools were in place and also DHIS1 was largely ill-equipped to process large amounts of data collected in India. Workarounds and ad hoc 'hacks' were used to produce the needed reports. In addition to this, the technology was changed to Java-based frameworks at the same time, which was not well known among the Indian team, leading to a knowledge gap between the global and Indian teams. For example, although the data model was quite similar to the DHIS1, DHIS2 had an additional data abstraction layer, thus using the Java Application Programming Interface (API) instead of directly accessing the database. The Indian team found this hard to comprehend. In addition, to achieve optimal speed, they chose to bypass the API and access the database directly, in order to get quick results and fill in the gaps in functionality in the DHIS2 application. This resulted in some 'hard-coded' but well performing reports.

Initially, the objective for the DHIS2 distributed development was to bring the design and development of the software closer to the users. Experience teaches us that the potential forking of branches and code bases is a complex problem to overcome. There is a significant advantage for developing countries to pool together resources and best practices, while developing a shared code base for DHIS2. But, the levels included in designing DHIS2 needs to be re-explored, starting with the distinction between software and system. In many ways, the DHIS2 development has seen a separation of the coding from the actual context of use. A team of 4-7 Java programmers in Vietnam have been a part of the global HISP network since 2006 and have become very proficient. The procedures being established now, is to centralise the core development and outsource (or what we call 'opensource') tasks to Vietnam, while strengthening the DHIS2 implementers in all the regions. These procedures ensure communication between implementers and 'coders' through the DHIS2 'gate keepers'.

The explicit change from stand-alone to networked user applications, within health systems in many developing countries, also signifies the increasing momentum in the use of open source technologies. While earlier, HISP spread through students and educational programmes, which are typically time and resource intensive, these new developments allowed countries to technically adopt systems or what we call 'HISP technologies', with limited prior preparation. For example, this was achieved by training and dissemination through regional workshops in West Africa with 8 participating countries. The shift in the networking dimension represents a fundamental challenge to locally focused participatory design approaches. Now, the landscape changes both technologically and in terms of geographical spread. While Microsoft-based technologies with its relative simplicity and more widespread use has enabled more direct participation of users, the web-based technologies undoubtedly place layers of complexity in between. Users, in the initial period, will not be able to directly engage with design issues, and their participation would need to be mediated by intermediaries such as HISP team members, who span the domains of both technology and use.



## Integrated Health Information Architecture: The Focus

While providing a broader aspect of the Integrated Health Information Architectures (IHIAs), the book's analysis is grounded concretely and deeply in the experiences of the HISP network and evolution of the DHIS2 over the last 15 years, in which both the authors have been personally involved.



The journey described so far has involved the birth of HISP in South Africa, the growth of participatory design and DHIS, and with it, the core ideas of the IHIA. While the DHIS was sufficient in the context of South Africa, technological and methodological limits were experienced as efforts were made to scale outside the country. The technological shifts that had emerged helped to provide the impetus for HISP and other global actors to co-operate on developing architecture of interoperable systems. Thanks to HMN and their HMN Framework; which

represents an overall country HIS Systems architecture design, integration of data using a data warehouse approach and interoperability between systems have helped to describe key features of such an architecture to a large extent.

Over the last year or so, and much accelerated in recent months, extensive focus was set on:

- Health information architecture and interoperability.
- Developments around expanding the scope of HIS.
- Include patient based systems such as OpenMRS, and human resource information systems such as iHRIS.

Discussions on how these systems should speak to each other, and the standards of data exchange are important contemporary topics. Thus, the HMN and WHO had taken a strong role in defining the Public Health Information Toolkit, consisting of a suite of applications and also the SDMX-HD standards for data exchange. With this move from individual to multiple systems, the nature and methods of the underlying approach to build them also need to be redefined. The book seeks to explore some of these issues in how architectures can be conceptualised, designed and used. The point of departure taken in this book is to focus on information needs, software applications, and data exchange, rather than just the technology that typical architecture discussions tend to focus on. At the level of information needs, the focus is on understanding what the users want, and then analyse from which system or part of the architecture, the information will feed in. The architecture approach thus helps to provide information of a greater granularity that individual users need, which also places the onus on the implementing staff to be capable of understanding the deep impact of the nature of decision making, information requirements, and the supporting systems that provide this.

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# Introduction

The effective management and use of health information is increasingly being recognised as a strategic resource for health reform initiatives in developing countries with key focus on decentralisation of service management and health delivery systems, integration of disparate health programmes, and most significantly, building the culture of evidence based decision making. This heightening recognition is contributing to bring in new institutional and technological actors into the arena of Health Information Systems (HIS), changing dramatically this landscape with every passing day. At the level of individual facilities, the degree of sophistication of systems are changing, for example district hospitals are attempting to move from manual-paper based systems and adopt electronic medical record systems as they seek to provide more comprehensive and continual care to their patients. Similarly, district health systems are trying to adopt diverse systems such as human resources that can monitor their workforce more effectively including individual service records, recruitments, trainings, and planning. For purposes of closer control, many health systems are attempting to use biometrics based applications to ensure their staff are available in the facilities when they are supposed to. Similarly, there are other systems mushrooming for managing drugs, logistics, procurement and other line areas. The supporting infrastructure for HIS are rapidly changing with the introduction of servers and cloud computing, use of mobile devices, and the combination of various media to cater to the uneven environments found in developing countries, where largely paper still dominates.

A definite trend in the changing landscape of HIS is the demand for more integrated and also specific and granular information. No longer are countries concerned only with standalone routine HIS dealing with aggregate statistics for purposes of upward reporting, but a whole range of diverse information including cross-cutting indicators taking inputs from multiple systems. The need to monitor Millennium Development Goals (MDGs), for example, requires such cross-cutting information. This entails integration of different types of systems (e.g. patient and facility based data), health programmes and their respective information systems (such as HIV and ANC programmes) which are being made possible by the use of technologies of data warehousing with powerful Business Intelligence (BI) capabilities such as mapping, and a stronger national and global mandate towards integration. The introduction of mobile technologies which enable data reporting from remote outreach areas previously not accessible for computerisation, and cloud computing which allows for a single central server based deployment for a province or a nation, are redefining both the demand and supply for integrated information, including of reporting practices, needs for capacity development, and also the cost-effectiveness of HIS deployments.

This book is an attempt to make sense of this changing landscape, and to present our perspective on IHAs, how they are designed, operationalised and used. This represents our efforts to abstract from more than 15 years of experience of active engagement in research, teaching and attempting to design, develop and implement HIS in more than 20 countries across the developing world. A common learning from these experiences has been that computer based HIS are complex, for both technical-institutional reasons, and have delivered far less than what promise and potential that has been attributed to them. While computerisation is arguably a necessary condition for strengthening management processes around information, their use does not naturally make it sufficient for making improvements in the HIS itself, and with it the basis they provide to making health services delivery improvements. This book attempts to try and build the bridge between HIS design and development and its impact on use, which arguably can help to enhance achievement of the untapped potential of HIS, especially in light of the changing landscape and arena of HIS.

Through various empirical examples in which we, the authors of this book, have been engaged in across the globe within the framework of the Health Information Systems Programme (HISP) research and development network, along with their various friends and colleagues, we attempt to sketch out the changing nature of the landscape of HIS in the developing world and describe the manner in which technology has been and can be harnessed to realise the vision(s) of health reforms. A key challenge we focus on is “how can systems can speak to each other – both technologically and institutionally” – in order to provide “power to the users” to use information to enable health systems improvements. While the technological and institutional domains are inextricably intertwined, they are most often been treated as independent islands, with adverse consequences. Without the institutional buy-in, even the best technological solutions for integration will not work on the ground, which has been the reason why the benefits of huge amounts of investment have gone unrealised. Integration requires a system of practically working and accepted standards for sharing data and their interoperability, and international agencies like the World Health Organisation (WHO) and various national governments are in the process of developing standards and frameworks. Making them work in practice is a much larger challenge than their design and development. Another key aim of this book is to put in perspective the various strategies being adopted towards integration and standardisation, approaches towards making them practically work on the ground, and how the information being generated can be effectively used.

While technological systems proliferate at a rapid rate, the institutional framework of most health systems lag far behind in their relevant utilisation, with adverse implications on the use of the information generated for supporting action aimed at making improvements in health care delivery. Why this is the case? The technical systems are not public health friendly enough, and thus not amenable to be used by the not so computer savvy health programme managers for their local purposes. The entire institutional culture of the health system which has historically been geared towards supporting a centralised system of upward reporting requires a radical reconfiguration where the local use of information is not resisted but also actively supported. This requires a mindset and cultural change and the building of trust and capacity, requiring years and not months to achieve. How to approach this complex socio-technical challenge of maturing use of information directed towards making health systems improvements is another key aim of this book.

Given this brief preview of some of the burning contemporary issues surrounding HIS in the context of the developing world, we have developed a framework of this book which is divided in three parts:

Part I – Good design – Our worldview on architecting

Part II – Implementing good design: Practical systems development

Part III – Maturing use: Impact of health information architectures

While the first part is concerned with presenting our *world view on the design* of integrated health information architectures (which we label IHIA) including the different components and principles it is constituted off (such as standards and principles of scaling), the second part deals with the *process* aspect, including systems development and capacity building, giving insights into how good design can be operationalized in practice. The third part of the book is concerned with the *impact* of making HIAs work on the ground – of how it is taken up by users through a process of maturing of capacity and information culture to make improvements in the HIS and its linkages with the policy domain along with practical impacts in health services delivery. Feedback from the use domain will go into making improvements in both domains of design and its operationalisation. In a simple way, this illustrates our systems thinking in the structuring of this book.

While the details of the chapters are provided at the introduction of the three parts of the book, we emphasise here that each chapter has largely a distinctly action focus, as also explicitly advocated by the verbs used designing, implementing and maturing. The aim thus is to try and challenge readers to reflect on how the ideas and approaches expressed in the different chapters can be made to practically work. A key medium to do this is the use of case studies and examples, most of which in we ourselves have been engaged in within the HISP framework. These examples are intertwined with concepts – explicitly and sometimes not so explicitly – so that there is a vehicle provided for the readers to try and generalise the empirical experiences to other settings and contexts.

Potentially, we believe this book would be useful to different groups of readers. These include:

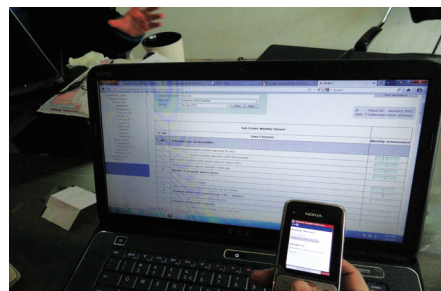
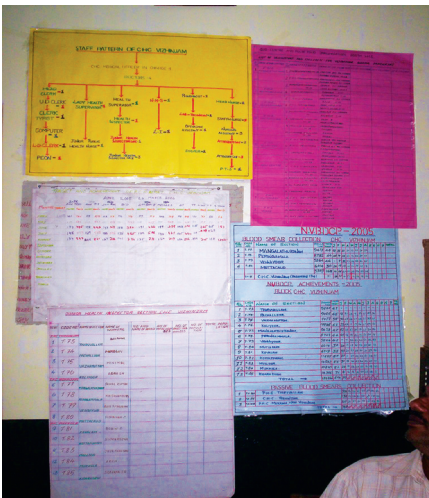
1. Policy makers and managers in countries that are engaged in deploying HIS to support their health systems reform processes.
2. Managers of international aid agencies that are supporting the deployment of health information systems in different countries.
3. Technologists involved in the design and development of architectures, related to public health domain specifically, but information systems more broadly.
4. District level managers – responsible for data systems and also for health programmes – who are engaged in making HIS more relevant and useful for supporting their everyday work.
5. Users of HIS, including field nurses, doctors, administrators and policy makers.
6. Masters level and Doctoral students who are pursuing graduate level studies in public health informatics.





# Good Design

- ⦿ Integrated Health Information Architectures – The Vision
  - ⦿ Integrated Health Information Architectures – Operationalising the Vision
- ⦿ Integration and Interoperability – Standardisation is the Key
- ⦿ Strategies for Scaling of Integrated Health Information Architectures

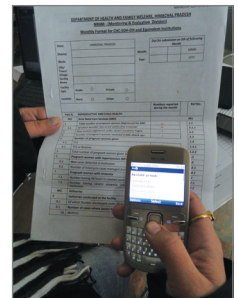




# Good Design: Our World View on Architecting

This introductory section of the book presents our world view on architecting, which we see as the foundation for good design. Like a clinician who understands the different organs of the body and the principles underlying their working and inter-linkages in the context of a human body, or a building architect who knows what are the different components of a house – the bricks and mortar – and the principles on how they work, we similarly see the role of a HIS architect to understand the different components of an IHIA, and the principles underlying their working within the context of a health system. With this background, this part is comprised of 4 chapters.

The first – “Integrated Health Information Architectures – the vision” describes what our conceptualisation of an architecture more generally, and an IHIA specifically. We emphasise our perspective of IHIA as a verb, something always in the making, rather than a finished product, a noun. A social systems perspective to understand an IHIA is a key building block of the vision. An IHIA is described over 3 levels comprising of the “social system”, “application” and “data.” Another key building block of the IHIA is the data warehouse, that helps to design the architecture in a scaleable manner – a fundamental prerequisite of an IHIA. As an example, we present the Health Metrics Network (HMN) concept of a data warehouse, and our point of departure of it with respect to its decentralisation and multiplicity in its reference.



The second chapter is on “Integrated Health Information Architectures: Operationalising the vision” seeks to discuss basic principles that can help to ground the vision to reality. The social systems perspective helps to emphasise a key purpose of the IHIA is to provide power to the users in terms of information for decision making. This has implications on



the approach to requirements analysis, which we argue should be based on *information needs* rather than the conservative and traditionally followed approach of automating existing work process and with it incorporating the installed base of techno-institutional elements. Principles to approach this process of understanding information needs is described in relation to the three levels of the IHIA – social system, application and data – articulated in Chapter 1.

The third chapter is titled “Integration and Interoperability – Standardisation is the key”, and focuses on standards which we describe as the glue that brings the different components of the IHIA together. Current debates on integration and interoperability are discussed in this chapter, and our perspectives on these two key issues are described. Standards are discussed in relation to these two concepts, again following the three level framework of IHIAs, along with general principles towards approaching standardisation. Case studies from South Africa and India are presented in this chapter to illustrate our general principles towards approaching standardisation.

The fourth chapter titled “Strategies for scaling of Integrated Health Information Architectures” concerns the fundamental characteristic of scale which architectures seek to achieve. General principles to understand the dimensions of scaling, including quantitative/qualitative or vertical/horizontal are described, along with different approaches to achieve it including those of improvisation, cultivation, and attractors. An example from Kenya is described to illustrate the potential of cloud computing on scaling, and from India to emphasise that scaling in the health sector of developing countries will necessarily involve planning for environments involving uneven infrastructures, rather than one where “one size may fit all.”



# 1

## Integrated Health Information Architectures – The Vision

**B**etter information, better decisions, better health' is the slogan of the Health Metrics Network (HMN). 'Global' consensus on the importance of information, combined with a likewise consensus, that current Health Information Systems (HIS) are fragmented and generally of poor quality, have contributed to the relative agreement on the need to strengthen HIS in most countries. As a result, reform of HIS is a key aspect of health restructuring agendas in most developing countries. One problem in this context, however, is that HIS has come to mean different things to varying groups of people. There are systems dealing with aggregate data around the everyday provision of services, typically referred to as 'Health Management Information Systems (HMIS)', and those that deal with patient level data in hospitals, often called 'Electronic Medical Records'. There are a variety of others dealing with specific functional areas, such as human resources, drugs and logistics, finance, inventory management, and others relating to specific diseases such as for HIV/AIDS, Tuberculosis and Malaria. Different technologies form a part of the infrastructure that is being used to support these various systems, such as stand-alone computers, networked servers, mobile phones, Personal Digital Assistants (PDAs), and so on. Taken together, we refer to these multiple systems as 'Health Information Systems'. As we move towards building bridges and standards for these different systems, and supporting infrastructures to communicate with each other, we contribute to the creation of an architecture, for systems of systems, which in this book we term as 'Integrated Health Information Architectures' abbreviated as IHIA.

Given this context of diversity and multiplicity of systems, the heart of the challenge facing policy makers, software developers, users and vendors is, 'How can we have these different systems to communicate to each other to get more integrated information?' Getting more integrated information helps managers to take more effective decisions, while data redundancies and duplications can be eliminated or minimised for the users and data providers. In this effort, international organisations like the World Health Organization (WHO), national ministries and software developers are all attempting to develop IHIA's, which represent a collection of various systems, with underlying procedures or standards that can enable 'interoperability' of data flow across these systems.

The term 'architecture' itself is not universally agreed on, and approaches to build them differ ranging from top-down blueprints to bottom-up and emerging collectives. In this chapter, we seek to provide an overview of the concept of architecture, and how we plan to use it in the context of HIS. Focusing on 'enterprise architecture' aimed at supporting health management and decision-making, we regard the 'data warehouse'

as a key integrating element. The focus is thus on management and use of information related to public health and health management, as in contrast to clinical information, which concerns individual patient care encounters. Further, our focus is on HIS, broader than the traditional HMIS, which are needed to inform decisions and management at facility, district, state and national levels. Defining architectures as 'systems of systems', we apply a social system perspective in order to better understand the social and other dynamics of systems and architectures. Finally, we describe the necessity of applying evolutionary bottom-up approaches in the development of such integrated architectures.

## 1.1 The Concept of Integrated Health Information Architecture

The first aim of this chapter is to present a coherent and integrated framework for HIS which we refer to as IHIA, with a focus on Use – the provision and use of data and information at all levels of the health services to support decision-making. This integrated framework includes various specialised components of the HIS, such as electronic medical records systems, laboratory systems, logistics systems and HMIS. These components need to interact by sharing data, including sending or receiving data from one or multiple systems, all according to a certain plan or design. It is within this overall design of an integrated framework that the various sub-systems and their interactions need to be 'located', assigned a role, and understood.

These various systems cannot be really understood without clarity on the supporting infrastructure, on which they are deployed and supported. For example, the rapid development of the Internet and mobile telephone infrastructures, have led to an increasing number of new HIS that were not even conceivable a few years ago. However, with these opportunities that the infrastructures provide, also comes the challenge of managing and synchronizing them. These challenges exponentially enhance the complexity of the systems, making it more and more difficult for health authorities to plan for the way forward. We argue that approaches to 'good design' within an integrated HIS framework, which can be operationalised through the concept of IHIA, represents a strategy that makes it easier to manage this increasing complexity. For example, a city planner needs architecture at different levels of detail to understand how all the various bits and pieces needed for a city to function well, should fit together and evolve. In the same way, health authorities need an architecture to understand how the various components of the HIS should work together and evolve within a flexible structure, while allowing future changes inherent in a health system to be seamlessly incorporated in the existing IHIA.

While a village would not need much of architecture for planning, city development would definitely need one. Development of mega-cities across the developing world including India, however, illustrate how the city's architectures and development plans are inadequate in solving or even coping with the problems in a dynamically evolving city environment. This rapidly changing environment is a result of influx of people, shifting demographics, changing lifestyles and new constructions. Most people would, however, agree that without efforts to draw up architecture for how the city should develop, the situation would have been even worse. Thus, architectures should not be viewed as an end-solution, as there is no perfect architecture, but should merely be seen as an approach to manage complexity. Similarly, in the context of HIS, architecture should be regarded as a process tool, which at any point would represent the current understanding and knowledge, which by definition will be inadequate

and incomplete, and while at the same time should enable the incorporation of new developments. Our point of departure, thus, is to conceptualise architecture as a verb – a collective; designing systems not a design of systems – always in the making – rather than a noun; representing an end solution.

The concept of architecture used in this book then aims at providing a map or compass and a form of direction for ‘good’ design of the overall IHIA as well as the phased implementation of its various sub-systems.

## 1.2 What is an Architecture?

### Architecture as system of systems

Architecture is formally defined by IEEE as representing the fundamental organisation of a system embodied in its components; their relationships to each other and to the environment; and the principles guiding its design and evolution. Our conceptualisation of architecture, as the organisation and evolution of a ‘system of systems,’ requires us to first understand the notion of a system. Very simply, a system represents a set of interacting or interdependent entities forming an integrated whole. A system can be described as set of components that are interconnected through processes of input, throughput, output and feedback. While we discuss the notion of a system in greater detail in Chapter 5; at this point, it will suffice to say, that a system is not something which exists in objective reality, but represents our conceptualisation of a certain phenomenon. For example, we may describe a hospital as a ‘hospital system’ because it consists of system with the characteristics of:

**Input:** Unwell patients entering the hospital.

**Throughput:** The different processes that the patient goes through in the hospital such as registration, billing, laboratory, Outpatient Department (OPD), Inpatient Department (IPD) and other more specialised ones such as blood bank and surgery.

**Output:** Cured patient leaving the hospital (as one of the outputs).

**Feedback:** This characteristic includes:

- Direct feedback: Patients’ opinion on the effectiveness of the hospital services, which may, then lead to either hiring of more specialist doctors (new inputs) or better management to improve the quality of services (throughput).
- Indirect feedback: The cure rates of the hospital is considered, which, if poorer than other hospitals, would lead to changes, such as, re-defining inputs (strengthening referral process to the hospital) or throughputs (establishing a stricter control on the quality and standards of care).
- While the above depiction of a system may seem rather simplistic and linear, it is done so deliberately for understanding. In practice, each part of the system can be expanded, and social dynamics added, to create a ‘rich picture’ of the system. Cybernetic systems, based on feedback, are complex and full of unintended consequences shaping system behaviour, and now being studied through theories like Complex Adaptive Systems.

Building on this conceptualisation of a system, an information system represents interconnected structures and processes, to enable the flows and use of information. In a



broad sense, the term information system is frequently used to refer to the interaction between people, processes, data and technology. The emphasis is not only on the Information and Communication Technologies (ICTs) that an organisation uses, but also, on the way in which people interact with these ICTs and use information to support their ongoing business processes. While an information system is often assumed to be computer-based, it need not always be. Like, a manual flow of information (such as the movement of a paper file in an office) involving an input, throughput and output, can also be conceptualised as an information system. In the health system of most developing countries, major part of the data is still registered and reported using paper, but they nonetheless represent (health) information systems. HIS are quite simply defined as information systems in the health sector.

### 1.2.1 A Social System Perspective to Health Information Systems

In the seventies and eighties, relatively in the early days of computing in organisations, computer systems were made to promise much by technologists, including the mastering of the human brain and the creation of expert systems for various domains, such as medicine and chess. Despite these promises, experiences of introducing computer-based applications in organisations were fraught with stories of failures. Surprisingly, research into understanding why computer systems did not deliver their potential led to the realisation that it was not the technology that was the primary reason. The research into failures rather revealed the reasons pertaining to the social, institutional and political conditions, such as the absence of top management support, lack of user involvement, and the centralisation of systems. This realisation starting from the eighties, contributed to the evolution of a 'social system' perspective to information systems, which emphasises the social context and its relation with the technical. One such perspective was labelled as the 'web model', (Kling and Scacchi, 1982) which described why and how large information systems tend to be tied to context through a complex web of associations. This was in opposition to a 'discrete-entity' model, representing the commonly held view that information systems are basically socially neutral technical systems.

A social systems perspective, is particularly relevant to understanding HIS in developing countries that are already situated and continue to evolve in a complex web of social, political, institutional and cultural relations, arising out of the involvement of technologies and various actors (such as international donors, ministry officials, vendors, infrastructure providers). HIS, which reflects the health system, is made-up of a number of more or less independent yet inter-linked institutions, living together in harmony and/or in conflict. Health Information Systems are made of a web of people, computers, paper, decision-making, management, procedures and institutions, with all the dynamics of a social system. Regarding HIS as being part of the social context, something much bigger and qualitatively different from the concept of a computer system or a technical system, makes it easier to understand the observed difficulties in changing or developing new systems. Changing and developing new information systems and HIS are in fact about organisational changes including organisational structures, procedures and the way people are working, which are all deeply implicated and intertwined in power relations.

Health Information Systems in developing countries comprise of many thousands of health workers, engaged in routine collecting, registering, collating, and reporting of data in a large number of formats. Data and information are analysed and used in a variety of ways by different people, to make informed decisions and to improve health

services delivery. These represent ‘good’ ways of applying information, which are being promoted in this book; or to only collect data to legitimate various positions, as some would claim. Since HIS are deeply embedded in the socially shaped work practices of staff in the health system, they can be seen as being barely separable from the social context of which they are a part. Seen from this perspective, HIS can be conceptualised as ‘human activity systems’, involving multiple activities around it, which constitute important parts of the institutional structures in organisations of the health care sector. Such routine work and repetitive activities across time and space have regularising consequences, including unintended ones for those engaged in the activities.

In this way, routine work related to information handling, represents processes of institutionalisation that are important in forming and maintaining the health institutions. While, there is a dominant tendency of institutions to constrain human action to following existing routines, the potential for change is always latent and existing, and comes to the fore through unintended consequences. As such, the argument goes that ‘structure is not to be equated with constraint, but is always both constraining and enabling’ (Giddens, 1984). This can be explained better in the following example in Box 1.1.

Box 1.1

Unintended consequences in mobile health project implementation in India

*Unintended consequences of a mHealth system – An example from India*

HISP India is involved with the implementation of a large-scale Mobile based HIS project, in a northern state of India. As part of this project, 5000 health workers have each been given mobile phones, to facilitate reporting of routine data. During the design of the application, the state first gave a list of about 150 data elements, which they wanted to be reported through SMS. They, however subsequently, expanded this list by 10 more data elements to be reported daily. The primary aim of this daily reporting from the state’s perspective was to try and strengthen control of the health workers’ activities, to know what they were doing on a daily basis.

However, when the implementation started, the HISP India team observed that the health workers were very resistant to the daily reporting and soon started to voice protests, including not sending both the daily and monthly reports. The matter escalated, with the ‘health worker union’ taking up the issue and providing written representations to the management. On exploring the reasons for this resistance, it was found that the health workers were providing particular services (relating to the daily data elements) only on a particular day of the week. They felt that this would lead to reports of non-zero numbers only on that day, while daily reports on the other days would most often show a zero. This, they felt the authorities might interpret, as them not doing their work.

Since the effectiveness of the entire mobile initiative was getting jeopardised by this ongoing protest, the state did away with daily reporting and switched to a weekly one. This is now planned to be merged with the monthly report.

This example illustrates how institutions seek to reinforce existing structures, in this case, related to control. However, humans always have the potential and capability to act otherwise, which leads to the creation of ‘unintended consequences’. Structures, thus, have the capabilities to both constrain and enable human action.

A social systems approach emphasises the inherent ‘messiness’ of things, and our state of incomplete knowledge, which makes HIS difficult to control. Technically too, new features tend to get added as extensions or changes of something already there, in the installed base. As the installed base grows, it becomes increasingly difficult to build systems from scratch and to implement substantial changes. If we combine the concept of HIS being part of information structures, with the concept of the very same systems being, in fact, social systems, it becomes clear that the installed base itself, is made up of a web of social systems. Social systems, made-up of social dynamics and politics, as they are, have considerable resistance to change, which explains why it has proven difficult to change HIS in countries; including developing new standard reporting formats, and building new systems from scratch.

### 1.2.2 Information Usage – For Decision-making or Power-making

Assumptions of rational decision-making seem to lie at the heart of Western progress, are characterised by the following principles:

- Better information helps make better decisions.
- Principles and logics of decision-making can be universally applied.
- Decision-makers are knowledgeable about all possible choices available.
- Choices are made, with the objective of maximising economic gains and efficiencies.

These assumptions of rationality have been shown through history of not being followed in practice and used often as a façade for how decisions are actually made. Going back to the Bay of Pigs, where fear was the key; to the very recent example of the decision of the US and UK to invade Iraq based on the argument of the presence of weapons of mass destruction. History has emphatically shown that information was intentionally misrepresented and manipulated based on political, economic and power-based compulsions to suit the needs of the US and UK governments. In family businesses, run in countries like India, the need to favour family members is often the guiding principle in making decisions rather than those of rationality. Power, fear, risk, incomplete knowledge, social dependencies and unintended consequences are all conditions that take us away from notions of economic rationality and encourage the adoption of a social systems approach, to understand the ‘local rationalities’ of how information is actually used. While we may make plans to demonstrate rationality, action is always situated and contingent.

Rationality assumptions have also inspired approaches to design and implement information systems, including HIS. Again, like the examples provided above, HIS have usage far beyond the rationale and best practice aims, for example, of improved health service delivery or creating universal coverage. Health Information Systems as social systems, cautions us that information may be used in many ways within a dynamic social context, not necessarily in line with a rational world view. For example, information may be used as part of a power struggle, or it may not be used at all.

Drawing from organisation research, information has been described to be used as ‘signal and symbol’, for which the following four different explanations have been provided (Feldman and March 1981):

Firstly, organisations provide incentives for gathering extra information, which are buried in conventional rules for organising, and the division of labour between information gathering and information. For example, it is generally agreed that much more data is reported than what would rationally be regarded as needed. In India, this fact was acknowledged in 2008, when the reporting requirements from the sub-district facilities were reduced by nearly 90%. The typical situation is, however, that when new data is needed, new forms are introduced without coordinating with the old, or without abolishing the old forms. As a consequence, multiple partly overlapping forms, providing a lot of irrelevant information are in use at the same time. Difficulties in changing the systems are due to inertias in the social system and the differences in perspective on information between information gatherers, reporters, and information users. Very often, for example, reported information is seen being used by the management, to control the workers; thus, ensuring the job is being done and vice versa (workers see data reports in order to confirm the work they have completed).

Secondly, much of the information in organisations is gathered and treated under a surveillance rather than decision supporting mode. The contemporary ideal of using information for decision-making, as part of rational management requires a proactive attitude to information and the information system. Particular targets need to be identified (for example, increase distribution of condoms to target groups), then specific indicators need to be defined, and routines for getting quality data that are used to calculate these indicators need to be ensured, (rates of condoms distributed by target group, data on target groups, data on condoms distributed to target groups), and finally, action needs to be taken according to how these indicators are developing over time. Contrary to this action-oriented modus, the typical use of information is to only act 'when something is wrong'. Thus, in order to avoid negative attention from superiors, the incentive is to make sure that the reports are not 'rocking the boat'.

Thirdly, much of the information in organisations is subject to strategic misrepresentations, for example, using information only after decisions are taken to legitimise them and selecting the information that support these decisions. A commonly held view is, that people in position often 'lie with statistics' by misinterpretations and by hiding and using information in opportunistic ways. During the controversy, on whether HIV led to AIDS in South Africa, both President Mbeki and those opposing him, used mortality statistics to prove their respective views, but with different interpretations. There are always "good" organisational reasons for "bad" record keeping.

Fourthly, information use symbolises a commitment to rational choice. In the contemporary world, politicians, managers and other decision makers need to show that their decisions are based on information, even though the information is used for other reasons. Information used only for the sake of appearance, represents only a symbol of rational decision-making.

A social systems inspired analysis of HIS, in most developing countries, will reveal that many routines of data collection and reporting that have been established at one point in time, for some purpose, still continue to be reproduced as a legacy, even though their purpose is no longer evident. An interesting anecdote narrated to us from India, was the example of a state still reporting on tobacco dispatches, a system set-up during British colonial rule to facilitate the dispatch of resources. While today, the

purpose was not there and no one used the information, the reporting structure was surprisingly difficult to abolish. A social systems perspective helps to understand that these reporting routines only help to reproduce and confirm existing social structures of the health workers through these reports, indicating they are doing their job and the management acknowledging the same through receiving the reports. The unintended consequences of the reporting system; reproducing the social structure, becomes the main purpose of the system, by dynamically providing the institutional glue. Changing this practice is not a trivial task as it would mean disrupting the existing power relations. An approach to change would need to first and foremost acknowledge this duality of the HIS, as a 'generator' of 'social order' as well as provider of information. We provide another example of unintended consequences of reporting, from South Africa. (See Box 1.2 and Figure 1.1)

## Box 1.2

## Unintended consequences of change: Example from South Africa

In the Day Hospital in Mitchell's Plain district, South Africa, the manager wanted to replace the data collection forms used in the wards with simple tally sheets (see Figure 1.1). While the old form included patient folder numbers and other scribbles, not used afterwards; the new tally sheet intentionally included only what was regarded useful information. The two forms (see next page) represented roughly the same amount of work carried out in the injection room on a particular day in 1995 and 1996, respectively. The old form had 59 entries, whereas the new form had 66. The health workers initially refused to use the tally sheet, because they felt that an anonymous tick did not reflect the amount of work it represented. The reporting system was, thus, seen as a way to legitimate their work. The old form contained text and figures representing real patients. Furthermore, it looked much 'busier' than the tick sheet, and it gave a certain personal touch in relation to each activity performed. The old form, therefore, represented a 'personalisation' of work, where a particular health worker dealt with particular patients. This was not seen as being represented by a tick in the new 'anonymous' form. In other words, the unintended consequences of the data reporting system, to confirm and re-enforce social contracts and existing power structures, were as important as the intended purposes of the system, to report on activities in the injection room. These dynamics needed to be understood in the social context, as the health system in South Africa was undergoing changes at the time, and many health workers feared losing their jobs. As they felt the new reporting forms did not sufficiently acknowledge the amount of work they did, they saw it as a threat to their job security. This example illustrates the way all reporting forms, data standards and procedures have similar origins of being embedded in daily reporting routines and work practices.

### 1.2.3 From Information Systems Back to Architecture

Seeing, IHAs as being made up by systems and subsystems, and applying the social systems perspective, we see IHAs as a socio-technical web, where social organisational structures, software applications and ICT infrastructures are all inter-related parts of the web. The complexity inherent in a IHIA, is undoubtedly enhanced, as the multiplicity of inter-relations is magnified as compared to an individual system.

The field of architecture is further complicated, as there are as many architecture models, as there are architects. We mainly stick to the term 'enterprise architecture', which is really not a new area in the broader IS domain, as it has been a focus of

DAY HOSPITALS DOCUMENTATION PHARMACEUTICAL ORGANISATION										DAY HOSPITALS									
Injection Room										DATE: 6/10/19									
Date: 26/10/19										Patient No.									
										E C B A									
										15 14 13 12 11 10 9 8 7 6 5 4 3 2 1									
										F O A									
PROCEEDURES: INJECTION ROOM																			
Injection																			
Total:																			
NEBS-0-5																			
Total:																			
6-12																			
Total:																			
Adult																			
Total:																			
Venesection																			
Total:																			
Pregnancy Test																			
Positive																			
Negative																			
Total:																			
HB																			
Total:																			
Swelling																			
Total:																			
ECG																			
Total:																			
Pap Smear																			
Total:																			
The Test																			
Total:																			
RSH																			
GBH																			
TBN																			
Somerset																			
Victoria																			
Joanna																			
K Bremer																			
Other																			
Total:																			
TOTAL:																			

Figure 1.1 Comparison of the new tally sheet in the injection room on the left with the old reporting form on the right. Each sheet reports 66 and 59 'events', respectively. Note the columns marked 'E'; 'C'; 'B' and 'A' in the old form, for European, Coloured, Black and Asian patients. These columns are not in use anymore, and the space is used for marking the categories of the events reported

attention, both in research and practice, for nearly two decades now. These systems gained attention to help handle the two-fold problem of the increasing complexity of IT systems, and the increasing problem of aligning these systems with the needs of a business or an organisation. The notion of architecture was, thus, extended to include the whole enterprise as a system, which constitutes multiple sub-systems. The term 'enterprise' is derived from that of a business entity and might at first seem

more concrete and grounded in objective realities than the term, system. At the time of business mergers, however, the term 'enterprise' was not necessarily so objective or 'physical' anymore, as the boundaries between a system and enterprise were becoming blurred, with the question of what comprises individual systems or enterprises. As for a system, one needs to define the enterprise, or in fact, a system, one tends to describe as an enterprise. We now discuss some of these issues and challenges, within the context of the health sector.

#### 1.2.4 IHIA – Transition from Standalone HMIS to Integrated Framework of Systems or Architecture

In the context of the health sector, there are multiple possible perspectives on how to 'circumscribe' the enterprise in question, when we discuss either a 'health system' more generally, or in a particular region/country, like the 'health system of India'. A hospital may be regarded as an enterprise or a business area, the system of district hospitals in a state, likewise, and the public health services in a state, may be regarded as an enterprise. In fact, each business area, or health services area, within the health system may be de-limited and defined as an enterprise, within an 'enterprise architecture' framework. The overall health system 'enterprise architecture', is therefore seen consisting of a number of enterprise architectures, each of them dealing with a particular business area such as drugs, logistics, management, laboratories, HIV/AIDS anti-retroviral treatment, and hospitals. Likewise, enterprises can be defined in relation to the multitude of organisational units that make-up the health system (such as dispensaries, sub centres, primary health care centres and district hospitals). Other forms of enterprise or systems can be based on service functions and logistics (laboratories, drug supply, or ambulance services), or across various administrative and managerial levels (health facility, sub-district, district, or state). Regarded as an enterprise, the health system is made up of multiple enterprises, and even enterprises of enterprises, or system of systems.

If we include everything in an enterprise-based analytical framework, how is it possible then to handle the complexity? Firstly, identifying and defining the perspective on the enterprise, the business or functional area, on which to focus. Second, by focusing on the information provided, and its use to support management within the health system. This way, we can obscure irrelevant areas, such as the various production systems. However, achieving such clarity in practice is both technically and institutionally complex, for historical reasons. A description of the multiplicity of systems relating to malaria control in Mozambique is depicted in Figure 1.2.

Traditionally, each part, sector or programme within the health sector has been developing their own information systems, tailored to serve their specific needs. The Figure 1.2 shows, how even within the same Malaria programme, there are four independent channels or systems of reporting; relating to notifiable diseases, laboratories, national HMIS and the malaria programme's own systems. These systems often are paper-based at the levels of data collection and reporting, and computerised at higher levels of the state/province or national levels. As there has been little or no coordination of these reporting systems and since most data originates from the local health services; health workers become overburdened by a plethora of reporting formats to fill in and report on every month. There are overlaps and inconsistencies between these reporting formats and the way data elements are named and defined,

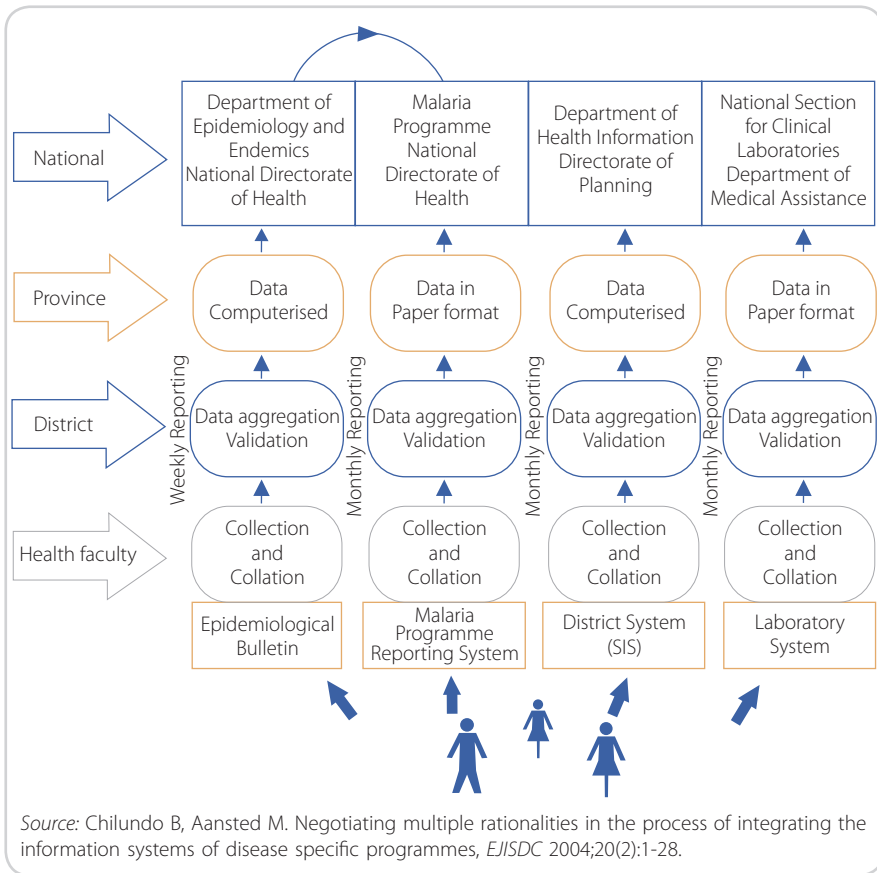


Figure 1.2 Multiple reporting systems for Malaria in Mozambique

resulting in the reporting of the same data several times in different formats, and sometimes in different ways under multiple names. Quality of data and efficiency of the systems are adversely affected, leading to a vicious cycle of data not been used, because of its poor quality. And the less it is used, the more the quality suffers.

### 1.2.5 Architecture to Support Decision-making and Management

Fragmentation and lack of coordination of HIS have been identified by various researchers and also managers, as the major problem shaping their use and utility. Each health service, health programme, project or initiative tends to organise their own reporting systems, often oblivious of what already exists, whether the data they require is already being collected under any other programme or a different name? Given that the main problems are fragmentation and lack of integration, how can then, a separate but still fragmented design and architectures for each of the sub-systems improve the situation? The simple answer is that separate architectures for each sub-system will not necessarily lead to integration between the sub-systems. A general problem with information system design methodologies, which are based on mapping current work-flows and information handling practices, which is to some



extent needed, is that they tend to focus on and conserve current practices and therefore do not necessarily enable innovation, that is support new ways to do the work, which new technologies necessarily enable. Therefore, what is needed is, to first, take the perspective of the whole and overall health system as a point of departure, and second, replicate this perspective at each level of the health services; from the national and state levels to the levels of district, sub-district, and health facilities. What is common for each administrative level is the need for information to inform decision-making and to support management. Key indicators and information more generally related to public health and health management at the particular level in question, is in contrast to clinical information related to individual patients. This information by definition needs to encompass at least the scope of management and decision-making, meaning that key information from all sub-areas are needed. While the national and state levels will mostly deal with policy-making and evaluation, the district is responsible for the operational management of health services delivery, including vertical health programmes in the district. This requires more of monitoring than evaluation related information. For example, while at the national level, one needs to know the overall state of immunisation coverage, to be able to evaluate the effectiveness of the immunisation programme; at the district level, one needs more detailed monitoring information such as information related to drop outs and vaccine supply and so on. Further, these services are implemented and delivered by various health facilities in the district. Translating this into the language of 'enterprise architecture', we may say that each business area identified for the architecture is that of management, co-ordination and decision-making. An IHIA should then be designed to meet these cross-cutting information needs.

The rapid developments of Internet and mobile infrastructure have led to new computerised and mobile-based information systems that have been planned for and implemented. The worry is, of course, that the current process of computerisation only replicates the former situation of fragmentation and poor co-ordination, though not casting it in stone, but wiring it up in the computer infrastructure. To guard against this, we propose an approach to design, based on information use. At all levels of management, for supporting processes of co-ordination and decision-making, key information is needed. This support could be leveraged from various data sources, including routine data collection, and other relevant areas; for example, from the census data and population based surveys of health status and utilisation of services. The approach to focus on information use, shares the generic characteristic of information for decision support across all administrative levels based on available and relevant data sources. This provides for the foundation, and a replication of design processes, both vertically (across administrative levels) and horizontally (across programmes at different levels) to establish the systems of systems – or in our words the 'IHIAs'.

In Table 1.1, we present as an example from India, the various data sources that could help in providing inputs to a IHIA.

### 1.3 Constructing IHIAs – The Data Warehouse Approach

#### Data Warehouse – Defining the Term

We have discussed how the architecture approach to design can help in developing an integrated and efficient roadmap for the way forward. In this section, to operationalise

Table 1.1 Various data sources to a IHIA in India

Sl. No.	Source Name	Data	Examples of Use – information	URL
1.	Census of India (conducted every ten years)	Demographic information	<ul style="list-style-type: none"> <li>Trends in demographic, population density.</li> <li>Social status and living conditions of different population groups.</li> </ul>	<a href="http://www.censusindia.gov.in/">http://www.censusindia.gov.in/</a>
2.	Sample registration system (conducted every six months)	Vital statistics	<ul style="list-style-type: none"> <li>Birth rate and death rate.</li> <li>Expected trends in population growth.</li> <li>Fertility and mortality indicators.</li> </ul>	<a href="http://www.censusindia.gov.in/">http://www.censusindia.gov.in/</a>
3.	National family health survey (multi-round survey, conducted every five years, latest 2005-06)	Vital statistics and utilisation rates, social health statistics	<ul style="list-style-type: none"> <li>Fertility rates.</li> <li>Infant and child mortality status.</li> <li>Family planning practices.</li> <li>Status of nutrition and anaemia in women and children.</li> <li>Reproductive and child health practices.</li> <li>Health service utilisation rates and quality of health.</li> </ul>	<a href="http://www.nfhsindia.org/">http://www.nfhsindia.org/</a>
4.	District level household survey (2 surveys conducted yet, latest by 2002-04)	District level demographic and vital statistics, mortality and morbidity statistics	<ul style="list-style-type: none"> <li>Coverage of ANC and immunisation.</li> <li>Extent of safe deliveries and contraceptive prevalence.</li> <li>Awareness about RTI/STI/HIV/AIDS.</li> <li>Utilisation of government health services and users' satisfaction.</li> </ul>	<a href="http://mohfw.nic.in/dlhs_2002.htm">http://mohfw.nic.in/dlhs_2002.htm</a>
5.	Central Bureau of Health Intelligence (compiles all information annually)	Health profile of India	<ul style="list-style-type: none"> <li>Socio-economic information.</li> <li>Disease wise morbidity and mortality.</li> <li>Expenditure and financing in health.</li> <li>Health infrastructure information.</li> </ul>	<a href="http://www.cbhidghs.nic.in/">http://www.cbhidghs.nic.in/</a>
6.	Bulletin on rural health statistics in India (updates information based on quarterly reports from all states)	Rural demographic profile	<ul style="list-style-type: none"> <li>Demographic trends in villages.</li> <li>Death and birth rates.</li> </ul>	<a href="http://mohfw.nic.in">http://mohfw.nic.in</a>
7.	National Rural Health Mission	Rural health profile	<ul style="list-style-type: none"> <li>Trends in rural health, mortality, morbidity, service utilisation.</li> </ul>	<a href="http://mohfw.nic.in/nrhm.htm">http://mohfw.nic.in/nrhm.htm</a>
8.	Other facility surveys at state or districts (for example, DRDA) or sub-districts (for example, Panchayat) levels	Demographic profile	Various health related information	Can be obtained from local governments office

this approach to design, we introduce the concept of a 'data warehouse.' In the information systems domain, this concept is not novel and emerged during the eighties and nineties from the earlier work on 'systems for decision-making', and even earlier in the seventies from the domain of expert systems. Interestingly, the term HMIS emerged in the late eighties and early nineties as a specific health-variety type of a 'system for decision-making'. This concept came in use when there were intensive efforts, more generally in the business world of the West, to introduce systems to support management's decision-making in organisations. Addressing private sector companies, the selling point was to provide decision support to the management with key data 'at the touch of a button' from across relevant data sources, such as currency rates, updated sales statistics from the company, stock market, oil prices, and so on. In health, a similar approach; for example, in a hospital would have been to provide key indicators on patient flows, by wards and diagnosis, finances, resource utilisation (staff, drugs, equipment), which is what we will advocate in this book. At that time, however, the typical clinical perspective dominated, and efforts were more directed towards supporting clinicians' decision-making in line with the diagnostic expert system approach. Within the public health systems in decision-making, the concept was still rather alien.

A data warehouse, which on the data input side, is loosely defined as a database which contains and manages data of different types from varying sources; and which on the data output side, is designed to process and present the data and provide a multiplicity of users with data, which is tailored for their specific needs. Simply put, it represents a 'warehouse of data' (database), compiled from different sources, with the tools for analysis and presentation, to support specific user needs. A data warehouse for health management will more generally contain, aggregate data and indicators from various production or transaction systems, for medical records, human resources, logistics, finances and laboratory. While the HMIS, as a concept, could be understood as a standalone system, the data warehouse typically represents a core database component of a framework of integrated systems. The sources of data for both, the data warehouse as well as the traditional HMIS, could be paper based. But where the HMIS would typically be represented by their own specific paper forms, the data warehouse would include data captured from a range of paper forms, also belonging to other health programmes, and thus, could be regarded as a shared resource to programmes and units contributing the information.

As an example of a data warehouse, the DHIS2, is currently being used for HMIS data in various states in India, and is slowly being expanded to include other data sources and integrate with other health programmes. The important difference from the concept of HMIS is that the data warehouse is more explicitly understood as being linked to different data sources, meaning that, in our context, the data warehouse is capable of importing aggregate data generated from patient records in hospitals or data from a human resource management system. The input to the DHIS2 can be captured directly or imported using different technologies such as from a mobile phone, a file to be imported from another system, or data captured directly from paper based data collection tools.

We may say that the development of these concepts had come full circle, when the HMN in Geneva, made from 2005, the concept of data warehouse; the centre piece in their technical framework. A simultaneous trend being, the increasing discredits of the term HMIS, due to its inherent problems of poor data quality and evidently poor use of

information. HMN chose to use the term 'data repository' instead of 'data warehouse', in order not to intimidate health authorities who may not understand. Despite their focus on analysis, presentation and use of data, which is evident from the HMN framework and concept, they use the term 'data warehouse' or 'data repository', instead of the more modern term 'business intelligence' (BI). Why? Probably for the same reason we do here, to emphasise the dual focus, integrating different data sources (core of the data warehouse concept) as well as, optimal analysis and use of data (where integrated access to data is a current key problem). In chapter 6, we apply the BI perspective and further develop the output side of the data warehouse further.

### The District Health Information System – An Example of a Data Warehouse

In this book, we use the development and application of the DHIS application in India and in many other countries, particularly in South Africa, to describe and discuss the gradual development of an IHIA; from a standalone HMIS to an integrated framework of interoperable information systems. The DHIS represents an instantiation of a data warehouse and a framework within which an IHIA can evolve. We first provide a brief description of the DHIS. A more detailed description is provided in Chapter 6.

#### What is the DHIS?

The DHIS is a software application for collection, validation, analysis, and presentation of aggregate statistical data; tailored (but not limited) to integrated health information management activities. It is designed to serve as a district-based country data warehouse, to address both local and national needs. DHIS is a generic tool rather than a pre-configured database application, with an open metadata model and a flexible user interface, which allows the user to design the contents of a specific information system without the need for programming. DHIS development has evolved over two versions. The first – DHIS1 – was developed in 1997 by HISP in South Africa, on MS Access, a platform selected because it was at that time the de facto standard in South Africa. The second – DHIS2 – is a modular web-based software package, built with free and open source Java frameworks, developed since 2004 and coordinated by the University of Oslo. The DHIS2 builds on the version 1 data model, and has over time created various enhancements towards making it a full-fledged data warehouse for statistical, aggregate, and anonymous data. The first prototype of DHIS2 was implemented in Kerala in 2006, and has been through numerous cycles of further development, since. It is now implemented in many states in India and various other countries in Asia and Africa.

On the data input side: DHIS can manage and integrate multiple datasets from different sources and types of data, including related to different health programmes and health services, population census, financial data, health and demographic survey data, human resources data, drug and logistics data, and so on. Data can be extracted and imported from varying electronic data sources (for example, a medical records database) directly to the DHIS by mobile telephones, captured from paper reports using online or offline web and the Internet – or using standalone desktop computer and e-mail attachments or memory sticks for reporting.

On the data output side: DHIS can combine, analyse and correlate data across datasets – and institutional boundaries; calculate indicators and present them in time series and/or across units, by comparing performance of facilities; evaluate quality

and significance of data using 'expert rules'. DHIS provides analysed data to the users according to their needs for management, decision-making, monitoring and evaluation, and health services provision. A variety of tools are used for dissemination and presentation of data; maps and Geographical Information Systems (GIS), charts, tables and pivot tables, using on-line (web) or off-line (desktop-warehouse) modes. Given the limitation in Internet connectivity in developing countries, the DHIS2 includes an automatically generating tool for downloading off-line data repository application using Excel pivot tables as a means for presentation.

On the throughput side: In the currently popular language of BI, the data input part is typically referred to as data warehouse, while the data output part is referred to as BI, because the 'metadata' design of this part of the DHIS and similar applications, is based on the elicitation and implementation of the 'business' knowledge and logic used for running and managing a business, or a health service, in our case, hence 'intelligence'. The definition of indicators, such as, immunisation coverage or infant mortality rate, the knowledge of how to validate data in relation to these indicators, and how to interpret and apply them, represent typical examples of this BI inscribed in and supported by DHIS.

We are endorsing the focus on information analysis and use, inherent in the term BI, but we are using the term 'data warehouse' to cover the input components of the data warehouse because we regard the process, or the verb 'data warehousing'; designing and developing the integrated HIS, as being integral to the building of the IHIA. The relevant institutions, organisations, departments and units are identified, and their information needs, by way of datasets and indicators, are defined. Typically, one starts with a sub-set of both participating departments and their datasets, and expands gradually, as institutions and users learn what works and what does not. The data flow, which is the data flowing back and forth from the various departments that are being integrated and gradually expanded by the DHIS data warehouse, are, in fact, instantiations of the enterprise architecture. Conversely, by depicting the data flows in the organisation or health system, the underlying structures and architecture, or lack, thereof, are being drawn up.

We illustrate the close relationship between the development of the enterprise architecture and the DHIS as a data warehouse, with an example from South Africa. In South Africa during apartheid, the health services as well as their HIS were extremely fragmented and there were no existing local democratic government structures. The new ANC government started out in 1994 to 'make right the wrongs of apartheid'. Establishing a system of strong decentralised health districts was regarded as a key intervention in order to both integrate health services and to empower the communities. Integration of information and information systems were regarded important in this process. In Figure 1.3a, which is from the ANC Strategic Plan for HIS, 1994, the data flows at the left depicts the 'past'; lack of local control and access to their own information, and one sees that all data flows are going out of the districts with no feedback. We would not call it an 'architecture', but, in fact, it is the conscious architecture of apartheid. The disenfranchised community was purposively kept ignorant of local integrated managerial structures, including access to their own information. It is therefore 'architecture' by design, the enterprise architecture of apartheid. The vision of the decentralised democratic structures of the new South Africa, the 'future', or in our language, the enterprise architecture of the new district structure (Figure 1.3b). Here, all data flows are passing through the district information office and data warehouse, for local analysis and use.

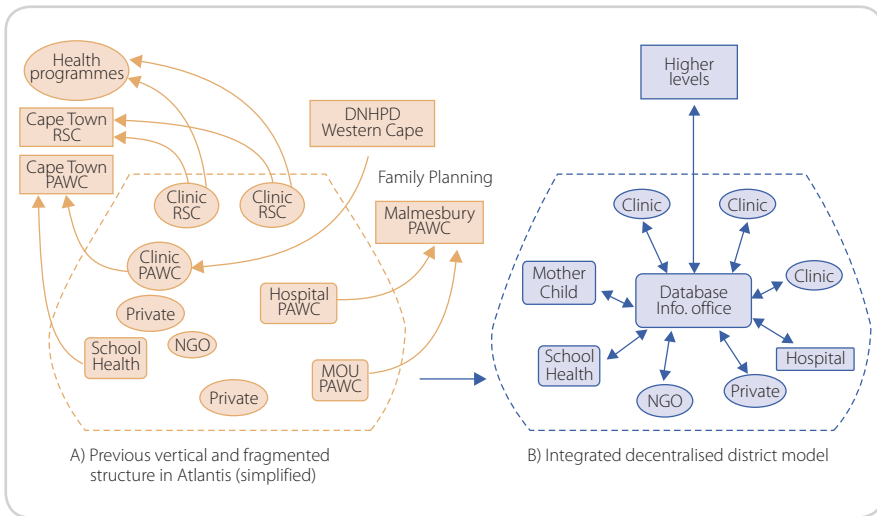


Figure 1.3 Information flows during apartheid and as they were envisioned in post-apartheid South Africa by 1994

However, only in 1997, when the DHIS was implemented together with a new unified data standard, was this vision of an enterprise architecture instantiated, or made real. Before its actual implementation, the process dragged on for years without much result. After having implemented the first version of the data standard and the DHIS, that is the architecture; however, the actors learnt that it was both useful and achievable. The architecture started to grow; new institutions joined in, datasets were added and extended – a process that continues to this day, 2012. Following the first prototype implementation of the DHIS in 1997, the vision of the Figure 1.3 was further developed, depicted in Figure 1.4. Here the design of what we call today, enterprise architecture for management and health services delivery at the district level, was drawn up, gradually implemented and enhanced through cycles of new versions of the DHIS, representing cycles of instantiations of the architecture.

This vision which South Africa articulated in 1994-97, has largely been achieved today and is what many countries are now undertaking, fifteen years on, with varying degrees of success. The important characteristic of this vision is its focus on the district level, and that all data passing through it enables integration with positive implications on data quality and information utilisation. Similar processes of integration need to be replicated at all levels of the health administration hierarchy. This is the crux of the design challenge of a IHIA. The lesson we draw is that, enterprise architecture, given the complex organisational and social structures and the degree of uncertainty, can only become real through its practical instantiations, and from there, it grows through a cyclic process of learning. That is, the continuous process of developing the enterprise architecture needs to be triggered, through concrete instantiations on the ground. Top-down blueprints of architecture with limited practical grounding, attempting 'big bang implementations', has little to no chance of succeeding.

After having discussed the key principles of a data warehouse, and illustrated, through the DHIS and its application, we discuss the HMN perspective on the data warehouse.

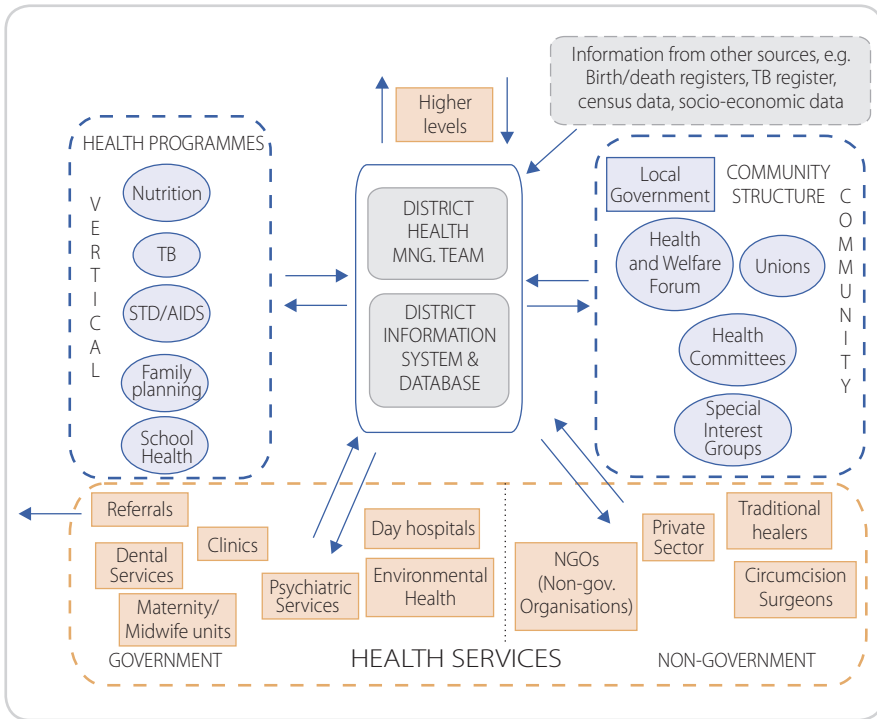


Figure 1.4 The data warehouse architecture. Vision and design of integrated health information management at district level, from South Africa, 1995

### 1.3.1 The HMN Concept of National Data Warehouse

The launch of the HMN in 2005, as an agency under the WHO, provided global leadership as well as a consensus-based strategy for the development of a national HIS. Consensus was that, countries should strive for interoperable subsystems within a national framework, where aggregated data from the sub-systems are integrated and made available in a national data repository. HMN initially used the term 'data warehouse', but subsequently changed it to 'data repository', in order not to intimidate users, who were oblivious to the fact that a data warehouse could easily be described as a database. Interoperability between systems is seen as a key feature of a data warehouse, as it helps to provide a pivotal component which enables the integration of data between the different subsystems. The linkage between a human resource management system and a medical records system, for example, is carried out indirectly when both systems export their data to the data warehouse, which will combine the data and calculate the rate of patients treated, per category of staff in hospitals. In Figure 1.5, a schematic description of the HMN data warehouse approach is provided.

The above framework leads us to identifying various data sources, summarised in Table 1.2. The data sources are divided into health services based (for example, medical records) and population-based (for example, census data).

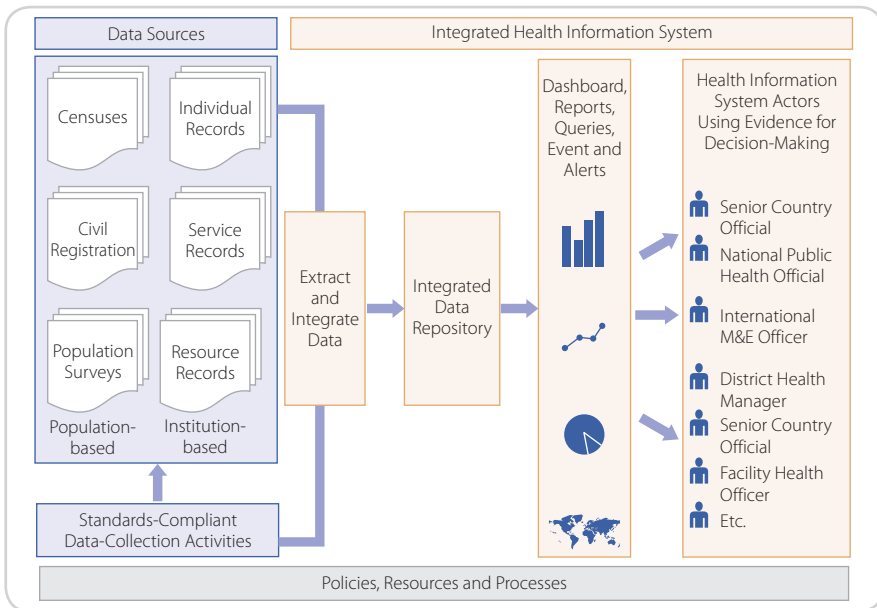


Figure 1.5 The HMN data warehouse concept

Table 1.2 The six data sources as defined by HMN

Principal data source categories for the National Data Warehouse

Health services based data sources

Individual records	All name based client and patient records, from register books for out-patients, or ANC (Antenatal Care) clients, to the registration and tracking of all pregnant women and Medical Record Systems in hospitals. The data warehouse imports and aggregates data from these primary data sources.
Resource records	Taken to mean that all other sources of health services data and records, ensures quality, availability and logistics of all inputs, in areas of human resources, drugs, health facilities and their services, laboratories, financial systems – budget /expenditures.
Service records	Includes data and records from across sectors like environmental health, insurance, police, and occupational health.

Population-based data sources

Census data	Population census is the primary source for the size of population, geographical distribution, target population for interventions, plus data on social and economic conditions.
Civil registration	Compulsory registration on birth, death and marriages provides both legal documents and important data sources in many countries. In many developing countries, such registration systems are relatively poor.
Population surveys	In developing countries, where civil registration is poor, health and demographic surveys are the most important source of population health status. For example, for HIV status, child and maternal mortality.



## 1.4 Our Point of Departure – Generalised and Decentralised HIAs

The HMN approach, to a national data warehouse or a 'data repository', as they term it, is all encompassing, since it does include all the principally relevant data sources in one data warehouse; thus, representing an ideal situation, where critical data can be technically and institutionally managed, in one national database. The point of departure taken in this book is that, within a national health system, there may be multiple data warehouses where there is more than one type or collection of datasets in each of the warehouses. A national data warehouse for aggregate hospital data, for example, may keep detailed data by sub-hospital level (e.g. wards) and/or by diagnosed diseases using ICD10 while only exporting summary data by hospital to the overall national data warehouse. We agree, however, in the HMN approach of a main national data warehouse framework, although we suggest changing its centralist emphasis, by labelling it a district-based data warehouse approach. In fact, we would argue that each administrative level of the health sector should have a data warehouse for their key information. The data managed by the national level data warehouse, will be a sub-set of this national framework of 'district-based data warehouses'. This design view is not changed by the fact that countries have a central web-based data warehouse. The lower administrative levels such as at the district would still have their 'views', as their data with lower levels requires more and granular data, than the higher levels. The district data warehouse, therefore, contains more detailed data than the national level 'view'.

It is our perspective that each administrative level will need a database, containing its key data, required for management. For example, in a hospital, the data warehouse for management will include aggregate data and indicator data, on patient flow, outcome by wards, services, diseases and patient groups; financial data, data on resources, laboratories and so on. This provides management indicators, for example, bed occupancy and average length of stay. We label such databases, focusing on management data, as 'data warehouses', even at local levels, such as in a hospital or district. It is therefore vital to release the 'data warehouse' concept, and its exclusive, all-encompassing, ideal features to turn it into a practical tool, for the stepwise development, targeting first the low-hanging fruit, and then gradually 'climbing higher up the tree'. This approach resonates with the decentralised 'district based' systems, advocated by WHO, since the Alma Ata declaration, which represented a 'bottom-up' evolutionary alternative to the 'top-down' national approach.

### Incremental Development of the Enterprise Architecture

In this book, we build upon the HMN framework, which helps to provide an overall architecture, context and with it tangible goals for national HIS development; and to design an architecture, which can include a multiplicity of data warehouses, with processes of interoperability in-built to facilitate the flow of data. This book, however, advocates a practical and more incremental approach to its design, development and implementation which is contrary to a comprehensive and a more all-encompassing one. For example, the first version of the data warehouse enterprise architecture in a country, like India, would typically start out from the existing systems of routine data, the HMIS would then gradually expand, by adding more data and datasets, like we described in the case of DHIS, in South Africa. First, for example, census data is added, then, data on resources in the health facilities, infrastructure, human resources, surveys and so forth, in an evolutionary approach. This step-by-step approach to building

the data warehouse architecture implies that the 'final' architecture is not there at the outset, not even as a finished design on paper; the architecture will always be in the making. In fact, the verb architecting or 'data warehousing' may be more useful to capture the essence of the architecture or the data warehouse as being always in the making.

Over time, users and institutions will learn more about the ICT based systems and their potentials and challenges, leading to changes in requirements and expectations. At the same time, it is important to keep in mind that, health systems, programmes, priorities, technology and infrastructures are ever-evolving, and precipitates ongoing transitions in requirements and potentials. Thus, in this ever-changing context, future requirements and predictions for systems development will always be characterised by a certain level of uncertainty, making incremental learning approaches necessary. That is, to start the systems development with what is achievable, learn from it and gradually expand, as users are maturing and infrastructure, technology and technical solutions are improving. 'Agile systems development', is a modern term for such approaches that are gaining popularity. Prototyping in system development has been used for decades, and is among the better used agile approaches. The incremental and ongoing approach to DHIS development represents a perspective, labelled arguably as agile architecting, with its emphasis on the need for flexibility, improvisation, responsiveness, and user participation in the evolutionary making of the architecture.

### Summary

Key concepts that can be taken from this chapter are summarised below:

1. Fragmentation and lack of co-ordination of HIS, is generally agreed to be the major problem, facing the similarly agreed objective of providing quality information to improve decision-making in the health sector. Furthermore, thanks to the efforts from HMN during 2005-2010, it is now 'globally' agreed that actors in health in a country or in a state, need to work together within an integrated framework for information management and use.
2. The strategy to approach the problem of institutional and information-wise fragmentation is within the integrated and co-operative design of HIS, which we label as 'enterprise architecture or IHIA,' which could in a simple way be defined as an approach to 'good design'.
3. The central approach in designing such architecture is to focus on information use for management, which then becomes the common theme across the various enterprises and systems, that comprise the health system.
4. We have, in line with HMN, advocated the need for making the data warehouse, a central component of the architecture. Furthermore, we have also advocated the need for an evolutionary, agile and participatory approach to the development of an architecture, which should not be regarded as a fixed or final product, as it will always be in the making and to be further improved. As users and institutions learn, health challenges changes, new requirements emerge and technologies develop, 'good design' or better architecture will always be something envisioned for 'tomorrow'.

5. Overall, we advocate a social systems perspective, that is the need to regard information systems – and architectures – as being a product of social dynamics, work processes and procedures as well as technical components. Seen from this perspective of a ‘web’, it becomes natural to understand that social inertia makes changes slower to implement, than if they had been mere technical systems.
6. The DHIS is described as an example of an instantiation of the architecture, which helps provide a framework for an architecture to evolve.

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# 2

## Integrated Health Information Architectures – Operationalising the Vision

At the conclusion of Chapter 1, we understood the challenge to conceptualise the linkages between a social system perspective and the technical parts of the architecture, such as the 'data warehouse'. In other words, the preceding chapter left us with the question of how to conceptualise a socio-technical architecture. Well, the answer describes the IHIA's, in three layers:

- The social system level or the user level, which includes users, business processes and information use.
- The application level, which includes the applications and systems.
- The data level, which includes processes of data interchange and interoperability.

The principle of layers (with each layer providing services to the layer above it), is beautifully demonstrated by the seven-layer Open System Interconnection (OSI) protocol model. The OSI model is a framework for implementing communication protocols for data exchange in layers, ranging from the physical layer of bits and cables to the application layer (7) communicating directly with the application. However, while the OSI model is a formal model of protocols for data exchange, our three-layered model is a conceptual model, which we place on top of the technical layer of cables and specific communication protocols. While the underlying technical layers, such as the seven-layer OSI model, are strictly concerned with the syntax of data flows, our lowest level, the data level, which builds on services from the technical layers, is where the semantics of the data is brought in.

Schematically, this three-level architecture is presented in Figure 2.1 and outlined in Table 2.1 and then further discussed.

### 2.1 Level 1 of the IHIA's: Users and Information Needs – Social System Level

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One of the first challenges arises when constructing a IHIA, which includes all subsystems, is identifying the key users and relative perspectives and vision. This requires a clear understanding of the work processes to be supported and the users' needs and requirements. We have therefore, labelled Level 1 as the social system comprising of the user and the institutional use of information. This characteristic is what makes this level undoubtedly, the defining level of the architecture.

To follow on all the users is meaningless, as it does not aid focus and vision. If you ask stakeholders, what the key components and focal points in a 'good' HIS are, you

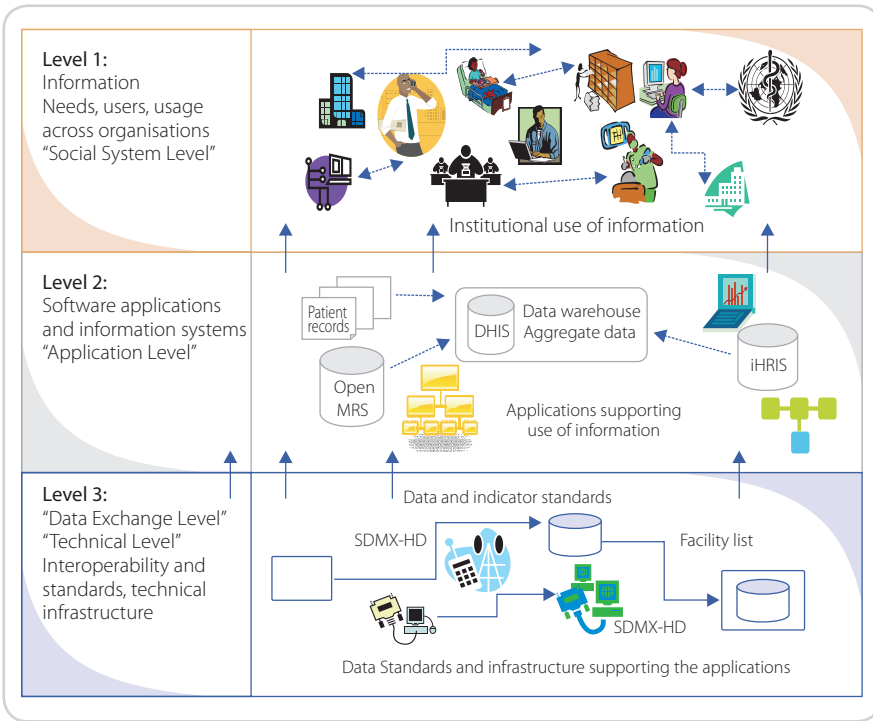


Figure 2.1 Three levels of enterprises architecture

Table 2.1 Three levels architecture	
Three Levels of the Health Information Architecture	
Level 1: Information needs, users and usage "Social System Level"	The users' information needs and actual usage of information; the business processes and functionalities to be supported by the HIS. Documented through users specifications and requirements within the context of the relevant business processes and organisational. The defining layer of the architecture!
Level 1 uses services from the level below (level 2)	
Level 2: Software applications and information systems "Application Level"	Applications and systems responding to the users' needs and providing the needed information and services to the users. Documented through SW application documentation, manuals, and actual implementations!
Level 2 uses services from the level below (level 3)	
Level 3: Data exchange, interoperability and standards "Data Level"	The technical level of data exchange and interoperability; the glue of it all, data and technical standards for interoperability of data between systems and applications, enabling data flow. Types of standards described differently, from formal standards for data exchange to data dictionaries of data standards and semantics.

will get different answers depending on the respondents' roles and 'locations'. A health technician in the hospital would emphasise medical records, a manager may emphasise information needed for decision-making, and an epidemiologist would point to population-based surveys, and so forth. Typically, public health practitioners and health managers tend to focus on HMIS type of systems; indicators and aggregate data supporting management and decision-making, whereas clinicians and medical practitioners, and IT technicians will tend to focus on electronic medical records. As argued earlier, the design focus of the IHIA is on information for management, decision-making to support effective health services delivery at all levels of the health system, related sectors, and institutions, as well as information dissemination to the general public.

Need for information, for decision-making and management may be described by the availability of essential information from across the sectors in appropriate formats, so that comparisons, trends, and correlation between areas, across sectors and over time can be carried out. Different levels of the health system will have varying needs, according to the role they play in the system and their scope or power of decision-making. The following types and areas of user needs are important:

- The need for integrated information, so that the information that originates from different areas is available at 'one point'.
- Different levels and types of management in the health sector have varying needs. For example, the lower levels need richer and more granular data, while the higher levels need less data in a more aggregated form.
- Information for action, where the focus needs to be on essential data and indicators, which are linked to targets and real usage.
- The form and presentation of the information, and how to access it. For example, reports, graphs, maps, statistics – real time and online using different media.

Each of the above principles are now elaborated.

### The Need for Integrated Information

Fragmentation is a major problem faced by HIS in most developing countries. Countries are typically saddled with historically institutionalised 'vertical' programmes, each collecting 'their individual' information independent of other programmes, with little regard to supporting the overall HIS. The result of this is excessive data, with great overlaps of the same data collected many times, and sometimes leaving large gaps in critical areas with no data at all. Furthermore, data and indicators are poorly standardised and represented in incompatible formats, making comparisons and analysis across programme areas, difficult. Some programmes such as HIV/AIDS are 'strong' and collect a lot of quality routine data, supported by regular surveys, whereas, other programmes such as environmental health are 'weak' and collect little or poor quality data. Here is an example from Zanzibar (Box 2.1).

The need for integration of information systems and to have information from different sources available at 'one point', as expressed here, are requirements that are expressed by many countries – a need to move from 'fragmentation to (more) order'. This is the aim of various national health reform efforts, advancing in various countries such as in India – to have information from different areas 'at one point' and at 'the press of a button'.

## Box 2.1

## An example of fragmentation in HIS from Zanzibar

*Fragmented HIS: An example from Zanzibar*

The situation in Zanzibar was as described above, characterised by fragmented and uncoordinated HIS. At a startup meeting of a project in 2006 to integrate and strengthen the national HIS, the Director of Health said:

“When I need to get an overview of the situation across different diseases and services areas, nowhere is that information available. I have to ask for information from a large number of programme offices – Malaria, HIV/AIDS, EPI, hospitals, and so forth. The resulting information is not easy to comprehend, compile and analyse, as each office tend to structure their information differently, and it is difficult to get exactly the information I need. ....

What I need is to have all the important data from all offices available at one point, in one office, so that I can get it here on my desk – on my computer. By the press of a button.”

– Ministry of Health, Zanzibar, 2006

### Varying Information Needs of Users and Administrative Levels

Data and information should support different work and management processes, at various levels of the health system; from patient management to the management of health facilities, and from districts, states and national levels. The management of patients and individual clients requires data on individual encounters with the health services; on diagnosis, procedures, laboratory tests, results, and so forth. The amount of data collected on each individual is significant and has implications both on the database and server capacity. Similarly, in a community setting, huge amounts of data are required to be collected to enable the registering and tracking of services to all pregnant women or children immunisation in a district, or in a hospital. In order to manage a health facility, aggregate data is required, for example, data such as the number of pregnant women taking part in the antenatal clinics, and the percentage of them that are not following up on their check-up schedule. In order to rectify a problem identified by a low percentage of women not coming for their check-ups, the level below – the outreach worker – would require a list of names and addresses of the pregnant women to be visited by health workers, at the health facility level. More generally, we may say that while patient management requires individual ‘name-based’ record systems, health facility management would need aggregate data and indicators on how the various programmes and activities are performed with respect to their targets. Most of this data can be aggregated from register books and individual records, all of which are either paper or computer-based.

If we move up from the outreach worker and the health facility, to the district, we see that the data and indicators needed for managing will be even less granular, requiring more limited amounts of data. The reason is that, while facility management is directly engaged in delivering services to clients and patients, the districts are located ‘one step up’ and require managing basically through the facilities in the district. The district, therefore, requires data on how each facility and health programme (not individual

patient) is performing, which will be the aggregate of the data generated at the facility. Moving from the district to higher levels of the state and national level, even lesser data of more minimal granularity is required. This principle of the data needs in all the levels and across, is presented in Figure 2.2:

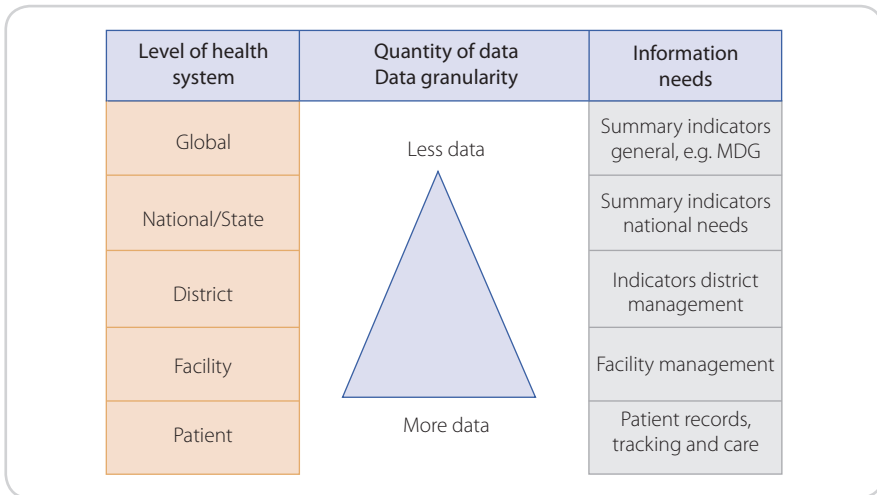


Figure 2.2 Data needs in all the levels and across

In line with the Figure 2.2, Table 2.2 outlines management functions and the corresponding information needs by the various levels in the health system.

Table 2.2 Information needs by level of the health system

Management functions	Information needs
Facility management in district health centre services delivery: <ul style="list-style-type: none"> <li>• First level curative care.</li> <li>• Antenatal care.</li> <li>• Deliveries.</li> <li>• Immunisation.</li> <li>• Under-5 care.</li> <li>• Chronic patient care and follow-up.</li> <li>• Outreach activities.</li> <li>• Community participation.</li> <li>• Drug and vaccines management.</li> </ul>	Health centre HIS: <ul style="list-style-type: none"> <li>• Aggregate data summary of all activities in the facility, by month; number of clients /patients by category.</li> <li>• Indicators linked to targets for immunisation, etc.</li> <li>• Community profile and target population information.</li> <li>• Patient /client records (registers) on all categories.</li> <li>• Tracking (as a minimum) of immunisation, pregnant women – deliveries, chronic patients.</li> </ul>
Hospital services and management: <ul style="list-style-type: none"> <li>• Curative (referral) care.</li> <li>• Outpatient.</li> <li>• Inpatient.</li> <li>• Surgery.</li> <li>• Laboratory.</li> <li>• X-ray.</li> <li>• Drugs.</li> <li>• Resources management; finances, staff, buildings and equipment.</li> </ul>	District hospital HIS: <ul style="list-style-type: none"> <li>• Aggregate data summary by month from all wards, specialties and services.</li> <li>• Indicators on death rates, average length of stay, bed occupancy, etc.</li> <li>• Financial data; consumption/income against budget.</li> <li>• Drugs; stock vs consumption.</li> <li>• Patient records system for quality and continuity of care.</li> </ul>



District level management: <ul style="list-style-type: none"> <li>• Manage health programmes; immunisation, antenatal care, nutritional activities, under-5 care, family planning, HIV/AIDS, etc.</li> <li>• Manage districts resources; human resources, finance, equipment/ buildings, etc.</li> <li>• Supervise health facilities in district and provide feedback.</li> </ul>	District HIS: <ul style="list-style-type: none"> <li>• Aggregate data summary on all activities and health programmes by month by facility.</li> <li>• Monitoring all key indicators.</li> <li>• Community profile and target populations – denominators.</li> <li>• District maps on demographics and health services.</li> <li>• Employee records and human resource summary data.</li> </ul>
<ul style="list-style-type: none"> <li>• Develop/evaluate annual work plan.</li> <li>• Organise health promotion in community and other activities.</li> <li>• Manage ambulance services, vehicles, transport and logistics.</li> </ul>	<ul style="list-style-type: none"> <li>• Financial data – summary; consumption against budgets.</li> </ul>
State (province, region) level: <ul style="list-style-type: none"> <li>• Co-ordinate and plan state and regional health services and programmes.</li> <li>• Manage resource allocation.</li> <li>• Supervision of districts.</li> <li>• Monitoring and evaluation of district and programme performances.</li> <li>• Logistical support.</li> <li>• Human capacity development – planning.</li> </ul>	State HIS: <ul style="list-style-type: none"> <li>• Monitoring all key indicators from health programmes and services in state.</li> <li>• Monitoring of budget utilisation with respect to programme performance.</li> <li>• Analysing inter district performance to identify which districts and programmes need more or less support.</li> <li>• Employee records and human resource summary data.</li> <li>• Financial data – summary; consumption against budgets.</li> </ul>
National level: <ul style="list-style-type: none"> <li>• Policy development.</li> <li>• National planning.</li> <li>• Evaluation and impact analysis of various programme evaluation.</li> <li>• Resource allocation.</li> <li>• Monitoring and evaluation – all programmes, services and health, demographic, and socioeconomic status.</li> <li>• Human capacity development – planning.</li> <li>• Epidemiological analysis.</li> <li>• Research agenda definition.</li> </ul>	National HIS: <ul style="list-style-type: none"> <li>• Monitoring all key indicators from health programmes and services across states.</li> <li>• Monitoring of budget utilisation with respect to programme performance.</li> <li>• Analysing inter state performance to identify which states and programmes need more or less support.</li> <li>• Employee records and human resource summary data.</li> <li>• Financial data – summary; consumption against budgets for states.</li> </ul>

In the context of various information needs by different levels in the health system, some important distinctions need to be understood.

Individual level data, from health programme registers (for example, Mother and Child register book) are represented either as individual record systems on paper, as rows in primary registers, or computer-based medical record systems. Clients registered in the register book during a month will typically be compiled at the end of the month to provide a total number of antenatal clients (ANC) as raw data.

Raw data are aggregations from individual data, to make sense in a particular context, representing the absolute achievements in a facility over a determined period. For example, a raw data form provides the data that 75 infants were given BCG vaccine, and 53 were given measles vaccine, in a particular PHC, in a month. From the raw data, it is difficult to make an inference of whether or not this is a good or poor achievement. Thus, it is vital to see how the data relates to the

target population; in this case, how many total children were expected to be given BCG or Measles vaccines.

Indicators are quantitative measurements to indicate/show particularly significant events or conditions, and to measure its changes, directly or indirectly. Indicators are typically based on processed data elements, and will generally include a numerator and a denominator. The numerator is a count of what is being measured and the denominator will typically be the size of the target population related to the count. Indicators are generated by calculating data according to a formula. While the rate of immunised children in a district represents a calculated indicator, the count of cases of maternal death may serve as a non-calculated indicator.

Information needed for management, decision-making and, monitoring and evaluation, will typically be indicator based, of which at least four types can be identified (Box 2.2).

Box 2.2

Four types of indicators<sup>1</sup>

### Types of Indicators

**Count indicators:** Measures the number of events without a denominator.

Example of count indicator = Number of recorded maternal deaths

**Proportion indicators:** Typically expressed as a percentage. The numerator is part of the denominator.

Example of proportion = 
$$\frac{\text{Number of first ANC visits within first trimester}}{\text{Total number of ANC visits including within first trimester}}$$
 indicator

**Rate indicators:** Measures the frequency of an event, during a specified time, in a specified population, usually expressed per 1,000, 10,000 or 100,000 population. Used to measure the probability or risk of, for example, infant mortality (typically per 1,000) or disease in a defined population.

Example of rate indicator = 
$$\frac{\text{Number of infant deaths}}{\text{Total number of live births}} \times 100$$

**Ratio indicators:** The numerator is not a part of the denominator.

Example of ratio indicator = 
$$\frac{\text{Number of female HIV positive}}{\text{Number of male HIV positive}} \times 100$$

<sup>1</sup> After Lippeveld, Sauerborn, Bodard, World Health Organization, 2000

## 2.1.1 Information for Decision-making and Focus on Essential Data

It was an academic trend in the early nineties that advocated decision-making systems to be rigid, especially on what information it includes in the scope of decision-making; for example, if you have no influence on a situation, you should not include data from that area. This principle translated into the influential Minimum Datasets (MDS) approach, developed in the post-apartheid era of South Africa. In the MDS approach, each level should define their most important data and indicators to satisfy what the levels below would need, to collect the specified data. When applying this approach

in other countries, however, there seemed a recurring problem of creating the MDS, because of the strong central mandate. This also led to the problem of the data being reported through the official HMIS to be narrow as it catered primarily to the needs of the national statistics division. Thus, health programmes had to initiate their own additional data reporting systems, which created overlapping and confusing structures of reporting. The more general strategy emanating from these experiences was to focus on involving various stakeholders in defining information needs, and within a more integrated framework.

Information needs for management and monitoring, are quite similar in type and areas of data, but data typically used for 'M & E' – monitoring and evaluation – often goes beyond the normal scope of decision-making for the health services. Here more comprehensive data, for example, on disease patterns, socio-economics, infant mortality, vulnerable groups and equity would be analysed and used despite not being directly applicable within the health services or the scope of power. However, if advocated correctly, such more comprehensive information could translate into political action. In this way, information from outside the scope of decision-making power may be turned into use. As a result, excess or overflow of data, poses a problem. This represents the design problem of creating a balance between a strictly action-led approach and a more comprehensive approach, allowing for richer and more overall information needs. An attempt to capture this dilemma, can be seen in Figure 2.3.

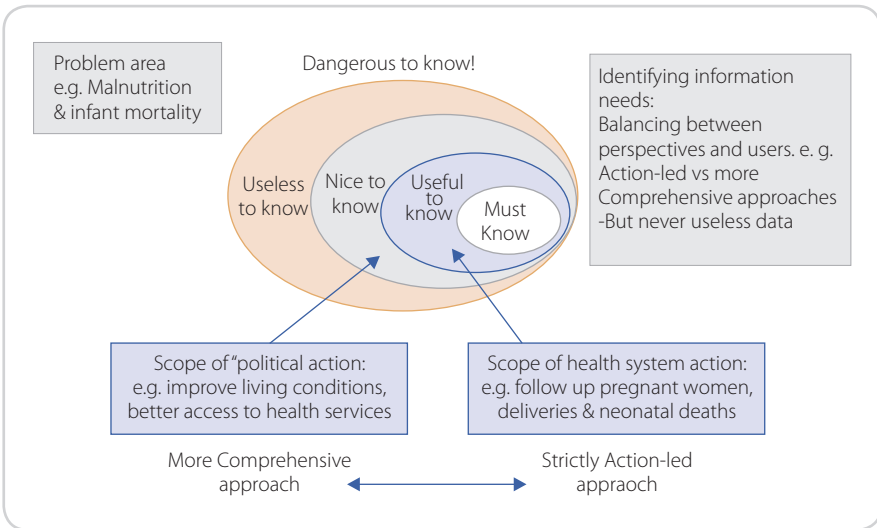


Figure 2.3 Balancing varying information needs

The HIS framework described above, depicts the different kinds of information in terms of its utility. For example, the essential information ('must know') for follow-up on health action, and the 'useful to know' information, that is required for public dissemination and advocacy. At the time of overflow of data and information, essential data and indicators are taken as information to address the needs of the user groups. For example, are indicators measuring achievements against relevant targets, rather than indiscriminate amounts of 'raw' data. This issue is further elaborated.

## 2.1.2 Information – For Purpose, For Action!

It is important to understand that all organisations, public and private, in both developed and developing countries collect more data than they actually use, for decision-making and action. Some data is used just as a control, to ensure the job is done, while some data collection is simply done to satisfy bureaucratic inertia. A review done in South Africa showed that more than 50% of the data submitted was neither looked at nor captured, but dumped. In most countries, where HIS are less mature, the percentage would be considerably higher.

The countries assessed as part of a HMN project to develop an assessment tool in 2005, showed similarly that a significant amount of data being collected was not analysed or used. Yet, there were encouraging aspects, particularly in South Africa and Thailand:

- In South Africa, individual provinces, districts and national programmes were systematically using information for action, with proven successful outcomes. For example, the health sector was in a major shift towards activity-based budgeting where information from the HMIS would be a deciding factor on resource allocation.
- In Thailand, there was a maturity around the use of information, which could be gauged from the fact that the information was being used to support the everyday working of the health department, as well as, national initiatives like 'Healthy Thailand', and the national insurance scheme.

Both countries, despite significant and increasing use of information for action, still collected more data than they used, and health staff continued to face major challenges in increasing analysis and use, especially at the district and local levels.

The HMN study reported that in most other countries, such as India and Vietnam, the relation between data collection and information use for action was severely mismatched.

- For example, in the Indian states of Andhra Pradesh and Karnataka, each Primary Health Centre (PHC), collected more than 1,000 data items on a monthly basis, including many duplicates and data from programmes that had been discontinued. Indicators were hardly used, and targets were uniform based on population figures rather than on programmes for action, which took account of inequities in population, social status and geography. The targets, mostly unrealistic and unreachable, were a constant source of manipulation as the health staff tended to 'doctor' figures to show that they had achieved the targets because the punishment for not reaching targets was way worse than the punishment for being caught lying. The strong culture of reprimand, which existed in the health sector, served as a strong deterrent for staff from reporting performance that may invite reprimand. Further, the numbers reported tended to be 'perfect', showing achievement of targets, indicating a non-believable character to the numbers.
- Vietnam too, had a centrally planned health service, and data was commonly manipulated to artificially achieve impossible targets, without any cross-checking from supervisors or top management.

One prevailing and important problem in most countries is the vicious cycle; of poor quality data not being used; and because it is not used, remains poor in quality. The poor quality is perpetuated by weak mechanisms for supervision, as well as the

multiple and outdated population figures that are used. Many clinics deal with multiple sets of population figures – of the health department, the revenue department, and figures compiled by household surveys conducted by independent agencies.

The ‘holy grail’ of promoting analysis and use of information, is clearly to link information to resource allocation (budgets), as well as develop indicator-driven short and medium-term planning. Linking HIS indicators to targets is in itself no guarantee for the collection of quality data or for its use in decision-making. Fulfilling targets can become a meaningless propaganda exercise, where everybody is making up data, but nobody wants to ‘rock the boat’. Concrete planning and targets are crucial, but plans and targets must be realistic and linked to resource allocation. Evaluation of the achievement of targets should focus on the entire process of the HIS, and not just the outputs. Evaluation should stimulate constructive suggestions on how to improve the process, rather than on providing reprimand and public shame.

## 2.2 Level 2 of the IHIA: Software Application and Information Systems – ‘Application Level’

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The information requirements for the HIS, for different administrative levels of the health services were outlined in the previous section. Key management needs that were identified – to have access to the essential data and indicators, integrated from across areas at one point, in one system to enable analysis, display and presentation of data using maps, graphs and tables. Further, it should be easy to design and customise reports locally, and more generally, the system should be easy to use. These requirements as we have argued are best addressed through a ‘data warehouse’ approach, whose software application level is now discussed.

A ‘data warehouse’ comprises of flows of data from various health services and programmes, health facilities, school health, and community. These flows are conceptually led through and managed by the district office and their part of the data warehouse, where data needs to be analysed; and feedback to those who have reported it, with a view to strengthen the management structures in the district and levels below. Further, there is an upward flow of reports that are required by the levels above. In the HMN description of the ‘data warehouse’, data of different types are imported from other computer-based systems such as, census, medical records, financial systems and so forth. In our context, however, in many settings the data collection, management and reporting at the local level will still be predominantly paper based. Data capturing from paper forms directly into the ‘data warehouse’, or the HMIS, is currently the typical situation. However, we are in the beginning of a process of substantial changes in this regard, where the primary management of data will also be computer-based. In other cases, we also see the use of mobile phones to send data into the warehouse through a SMS. While we see these winds of change in certain contexts, what we need to plan for, is a combination of environments, wherein paper, computer, and also other devices like mobiles where they are used. An example is provided from the state of Himachal Pradesh, India, reflecting an evolutionary approach to ‘data warehousing’ and HIS development (Box 2.3).

Here, paper-based systems are gradually being computerised and new types of data are being included in the ‘data warehouse’, with the point of departure being the current HMIS.

## Box 2.3

## Designing and implementing the data warehouse for Himachal Pradesh, India

*The Data Warehousing Approach – Example from Himachal Pradesh, India*

Himachal Pradesh is a state in Northern India, which is one of the more progressive states in the country with respect to its basic health indicators, for example, related to maternal and child health. Since the routine systems are relatively well-stabilised and institutionalised, the state has recently embarked upon a more sophisticated initiative of creating an IHIA with technical development being carried out through a national NGO called Health Information Systems Programmes (HISP), India.

This IHIA is comprised of a set of distinct information systems development processes, which are all integrated through the overall 'data warehouse' approach and 'glued' together through the application of standards. For example, the new WHO initiated, shared standard for data exchange and interoperability called SDMX-HD:

- *Building district and state data warehouse, based on the current routine HMIS:* The basic part of this data warehouse, is already in place with the HMIS database (based on DHIS2) for routine data, where the state carries out data entry at the sub-district level. The initiative in process, is to include more types of data and to extend the data structure of this 'data warehouse' by including data on the two lowest level facilities – the PHC and the Sub Centres reporting to this PHC – where till date this data was being aggregated and entered at the sub-district level of the block, which is a group of PHCs. Further, this system forms the framework within which the other projects, described in the following, are being integrated by feeding aggregate data to the 'data warehouse' and using data from it.
- *Mobile telephone reporting from Sub Centre and community levels:* Currently, the Sub Centres are reporting their data on a monthly basis, on a number of paper forms to the above HMIS system. Given the harsh winter, isolating many valleys in the state during the winters, the project is to use a mobile phone to report data directly and seamlessly to the 'data warehouse'. This mobile based Sub Centre reporting has been previously piloted in one block of the state, with positive results. Taking this many steps further, the mobile application is being extended both geographically and functionally. The geographical scaling plan involves extending from one block in one district to the complete district, and then to the other 12 districts in the state. The functional scaling is being done, by including all the formats that the field nurse [called the Auxiliary Nurse and Midwife (ANM)] has to report in a month (nearly 10 different formats) on to a mobile phone, in contrast to the earlier application, which only includes one dataset.
- *Name-based tracking of pregnant women, deliveries and children for immunisation – the DHIS Tracker system:* The government of India, has recently initiated a programme of name-based tracking, where all pregnant women would be tracked by names over the lifecycle of the services of antenatal,

delivery and postnatal care, and also all newborns over the lifecycle of their immunisation. The software to support this tracking (called DHIS Tracker) has been developed by the HISP network as a module in the DHIS2. The system is planned to be implemented in the state in a phased manner. From this system, the routine monthly reports on number of ANC visits, deliveries and immunisation will be aggregated, transformed into an adopted standard, and exported to the 'data warehouse.' Over time, the DHIS Tracker data would also be transmitted through a mobile phone application.

- Comprehensive hospital information system – integrating electronic medical record system and 'data warehouse' for hospital management: This project is two-folds.
- To develop an electronic medical record system for district hospitals, one which is easy to adapt to the needs and available resources, even in smaller hospitals. The system needs is flexible and has been scaled from initial admission and billing modules to a total of 10 modules and functionalities, as learning and human resources have also developed.
- Integrate the aggregate data from the medical record system with other types of data from the hospitals, needed for management, such as human and other resources, finances, laboratories, and drugs, in what we are labelling a 'data warehouse' of aggregate data for hospital management. Further, to extend this system, to include all patient related data, corresponding to services provided to individuals, in the setting up of 20 district hospitals in the state.

There are particular informational needs of hospital and facility management, which are not covered by medical records systems, since they primarily target patient management. The 'data warehouse' for hospital management can be understood, as in the district, by conceptualising wards and specialties as facilities in a district; organising aggregate data by wards and specialties; and correlating the data with the number of beds, staff and other services, thereby being able to analyse and present key hospital indicators, such as:

Bed occupancy: Number of patient days/nights divided by number of beds, typically provided by month; bed nights during a month divided by number of beds  $\times$  30.

Average length of stay: Number of patient nights divided by number of discharges, typically by month.

Death rate: Number of deaths divided by number of patients; by age, service and ward.

Infection rate: Hospital infections divided by number of patients; by ward, age and service.

- *Geographical Information System (GIS) – presentation of data using maps and other data representation tools:* The geographical co-ordinates on each health facility, and the borders of Districts and Sub Districts, have been included in the 'data

warehouse’, and the GIS module in the DHIS2 will enable the mapping of services, health and demographic status related to facilities, districts and other geographical boundaries.

The data presentation modules of the ‘data warehouses’, will more generally be developed further, to include a dashboard for easy access to graphical tools (bar charts), mapping, as described above and tabular and pivot enabled formats.

The next phase of the project will cover the creation of a *Human resource management information system*, which will include records of the employees in the health services. Aggregate data on number of staff and qualification by health facility, represents important information for managing hospitals, districts and more generally the health services in the state, and will be imported into the ‘data warehouse’. Human resource data by facility also represents important data for the mapping functionalities in the GIS.

#### *The IHIA – Integration of the Projects and HIS*

All the above initiatives, distinct projects and sub-systems of the HIS, are being integrated within the framework of the integrated ‘district-based’ state data warehouse, which may be conceptualised as a development and extension of the former HMIS, where the aggregate data from all hierarchical levels of the health administration come together. Data standards for exchange of aggregate data will be used to feed data from the various systems to the ‘HIS data warehouse’, which is being created at all levels of the administration; state, district – and to support management in the hospitals. The scheme for integration includes the following:

- The data reported by mobile telephones from the Sub Centres are being directly fed into the ‘data warehouse’, and will gradually make the reporting on paper and following data capture, obsolete.
- The name-based data tracking will, first, be dominantly reported on paper and captured in the DHIS Tracker database at block level; and second, gradually be registered and sent by mobile phones to the DHIS Tracker application. Aggregate data on pregnancies and ANC services, deliveries and immunisations will be fed into the data warehouse. The corresponding aggregate data currently being reported by paper and entered directly into the ‘data warehouse’ would be eliminated over time.
- Data from the hospital information system at the patient level, will be aggregated and exported directly into the ‘data warehouse’.
- All data and indicators will be available for presentation and analysis through the GIS and other reporting tools.

In this way, integrated data from different projects are being made available to a common set of reporting tools, for generating all required indicators to support management analysis and reporting at different levels of state, district, sub-district and hospital.



In the example of Himachal Pradesh, the 'data warehouse' represents an integrated framework – an 'umbrella', within which, the various systems and also data warehouses are gradually being plugged in and subsequently scaled. The existing HMIS and routine paper-based reporting, forms the backbone and point of departure. Here is a step-by-step process involved:

**First Step:** The data structure in the state data warehouse, previously called the HMIS database, is extended to include Sub Centres, which is important to strengthen data quality, data analysis and information use.

**Second Step:** It enables data reporting from Sub Centres, with the use of mobile phones. This is especially useful in the state, where parts of it are closed during winter as snow makes physical travel for data reporting problematic. The mobile network covers most of the state with all the Sub Centres having access, yet some may need to go to the nearest PHC, in order to submit their reports by SMS, or using the GPRS network.

**Third Step:** The electronic medical records in the district hospitals starts with patient admissions aggregate to developing management reports, such as for discharges and billing. Monthly hospital summary reports will be aggregated automatically by the electronic patient record system and transferred to the data warehouse.

**Fourth Step:** Registration of each pregnant woman and her follow-up until delivery, as well as, the registration of every individual infant and the doses of vaccines given to them, is a large undertaking as, initially, paper forms will be filled out in each Sub Centre and then submitted to the block, where the data is captured in the database. Later, mobile phones will be used for reporting data, a system currently being developed in one district. Aggregate reports from this system will automatically be generated every month, or at different intervals, and sent to the data warehouse in co-ordination with other Sub Centre reporting. Furthermore, reports and schedules of pregnant women for deliveries will be communicated to the relevant hospital, and data will be transferred to the hospital database.

**Fifth Step:** A human resource management information system will be developed within the same framework, to feed aggregate data on human resources into the data warehouse.

**Sixth Step:** GIS, analytical and reporting tools are encompassing data from all the different systems through the 'data warehouse'.

The planning and development of the IHIA in Himachal Pradesh, illustrates the benefits of a shared architecture and integrated framework, represented by the 'data warehouse'. Without that, the different components would have been easily developed as totally separate/independent entities, with little or no interconnectivity. For example, two separate mobile projects, one hospital project, one GIS project, one HMIS project and one human resource management project, which would have contributed to further fragmentation rather than to strengthen integration leading to more effective monitoring and decision-making, as is the case here.

In Figure 2.4, the 'data warehouse' design from the above example of Himachal Pradesh is schematically illustrated as the application level of the architecture. The 'data warehouse' scheme in this figure, replicates for each administrative level of health services, from the larger health facility – the hospital, and upwards to the district, state and national levels. Obviously, the data entry based on paper will be at the local level, as well as, the data imported from the medical records and human resource system.

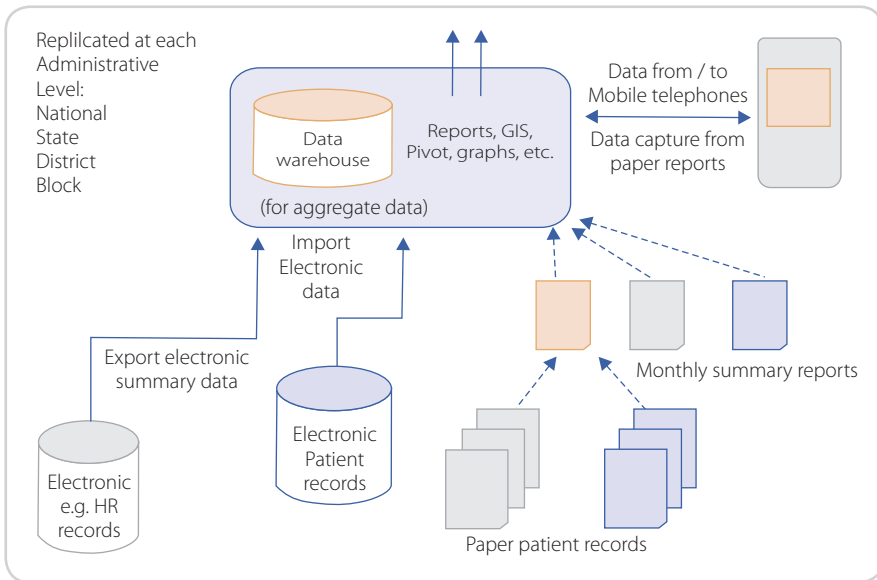


Figure 2.4 Conceptualising the Himachal Pradesh IHIA, and making it general

Generally, as pointed out earlier, the more local levels will need more granular data than the higher levels. Using a hospital as example, we see that a lot more data will be needed to manage the concrete local hospital, than needed at the state level; where 20 hospitals are being monitored.

### 2.2.1 Presentation and Dissemination of Information – The Purpose of the Data Warehouse!

Although discussions around data warehouses tend to be dominated by technical issues of data sources, and how to get the data into the warehouse, it is important to remember that the main purpose of this approach is to support the use of information; the output and Business Intelligence part of the data warehouse concept. This requires strong functionalities in the presentation and dissemination of information. Good presentation greatly enhances the use of information. While indicators as figures in a drawer are not very useful, displayed as graphs on the wall and updated every month, can make a difference. Some examples are now provided, of how the data warehouse should support different ways to present information – graphs, maps, charts and tables.

**Example 1:** This is the executive dashboard which provides the ‘birds’ eye view’ supported by the DHIS2 (Fig. 2.5). Using this functionality, the user can configure some key charts that he/she should see every time they log into DHIS2. For example, the user below has charts on immunisation, Malaria and ANC vs BCG coverage. Indicators of interest, thus, pops up for the user, giving a birds’ eye view every time on login.

**Example 2:** The Figure 2.6 shows how the GIS can be used to map indicators, in this case by Chiefdoms in Sierra Leone. The legend set, can be customised by the user, to define the ranges of display. The GIS package used here is the OpenHealthMapper –

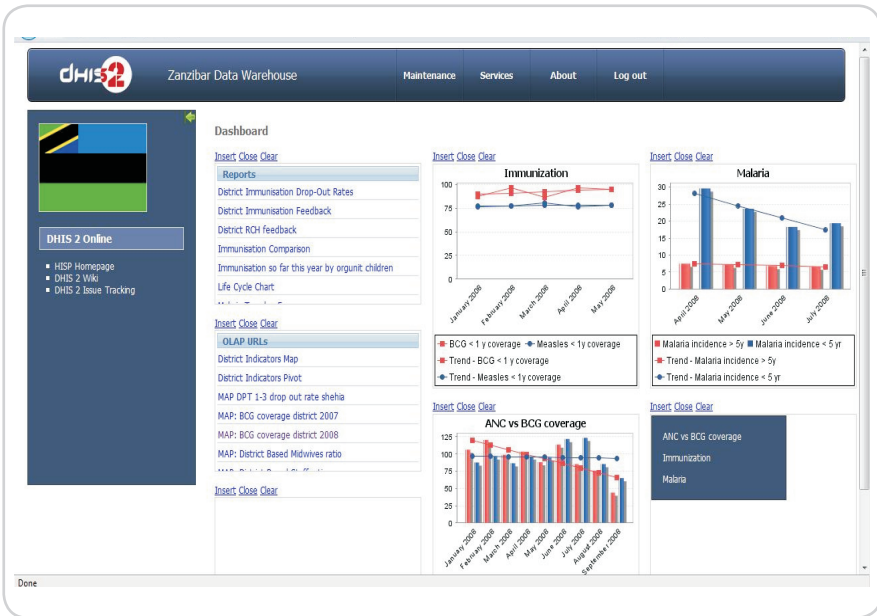


Figure 2.5 Bird's eye view through the DHIS2

the web-based version of the earlier version of WHO's Health Mapper. This GIS module is bundled in the DHIS2, which allows integration of the non-spatial data collected in the DHIS2 with the GIS shape files stored in the same database.

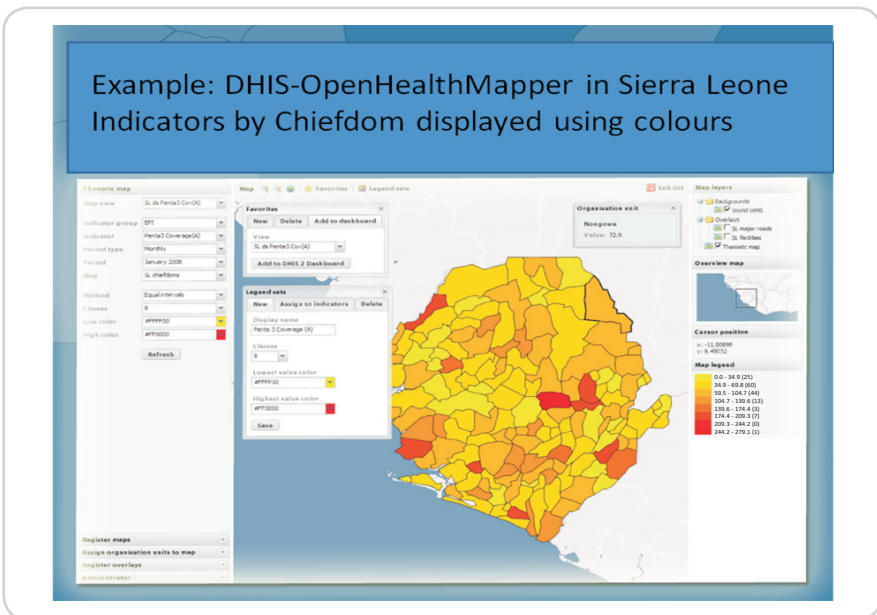


Figure 2.6 GIS presented indicators by Chiefdom in Sierra Leone

**Examples 3 and 4:** Presents two kinds of chart (Figs 2.7 & 2.8) representations, both taken from the DHIS2 deployment in India. The *first* chart compares ANCs first and third visit coverage, in the same graph for the different districts in the state. Seen together, these two graphs help to get an overview of the quality of ANC service care. The *second* graph compares home and institutional deliveries across districts in a state. Since, the sum of the two (home and institutional) must, by definition be 100%, seeing these figures in the same graph, helps to identify which districts; report high or low – home and institutional deliveries; and areas where intervention is required.

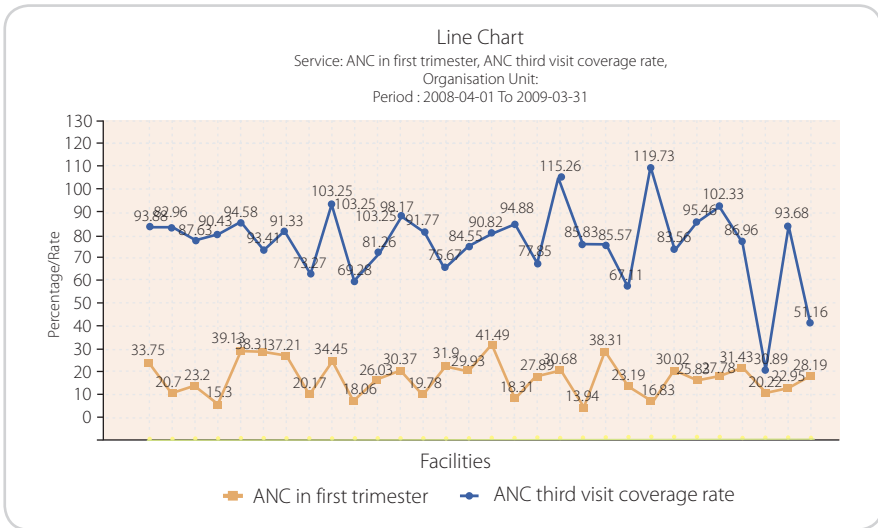


Figure 2.7 Line chart comparing ANC first trimester and third visit coverage

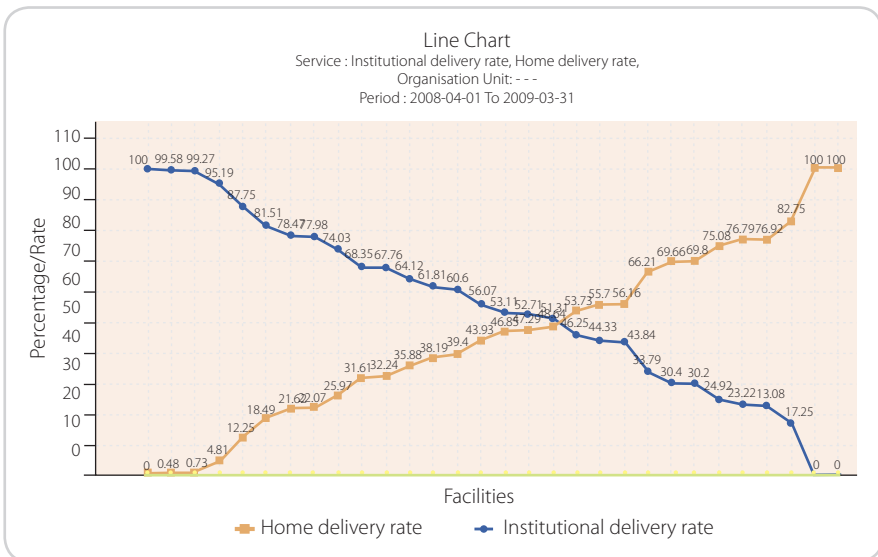


Figure 2.8 Line chart comparing home and institutional deliveries

Note: Names of the organisation units are kept anonymous in the above charts.

## 2.3 Level 3 of IHIA: Data Exchange, Interoperability and Standards – ‘Data Level’

While the Application level of the IHIA (level 2), may be depicted as consisting of a number of boxes, symbols and interconnecting lines, the data interchange (level 3) of the architecture, is mainly concerned with the lines connecting the applications, representing interoperability between the applications. In our context, interoperability refers to the ability of a system to use information or functionality of another system by adhering to common standards. According to the European interoperability framework (after Vernadat, 2005), interoperability can happen at three levels:

- *Technical level:* The ability of the ‘data warehouse’ to receive data from, for example, the medical record and human resource management system, and to exchange messages with these systems specifying which data to transfer. This is typically handled by technical protocols for data transfer. The effort of WHO to develop the SDMX-HD standard for data interchange is an important example in the contemporary public health context.
- *Semantic level:* This is linked to the definition, meaning and selection of the data to transfer between the systems. Data and indicator sets and definitions, data dictionaries, and the ICD 10 (International Classification of Diseases v10), illustrates semantic type standards used in our context.
- *Organisational level:* This is typically linked to the interaction of people and organisations, in order to define and decide which data and information should be shared and transferred, and the actual use of the data across organisational borders – interoperability between organisational units such as district and state hospitals.

While the technical and semantic levels of interoperability are both part of the third level, the data interchange level of the architecture model, interoperability at the organisational level is part of the first level, the level of use and users – the social system level. As interoperability refers to the ability to apply standards in a ‘practical way’, the three levels of interoperability are replicated in the world of standards. In the next chapter, we discuss notions of standards and standardisation, along these three levels in greater detail. Here, we focus on the two levels labelled technical and semantic interoperability, which together make up the third level of our architecture. In order for the different software applications to communicate and interoperate, there is a need for agreed standards; for what data to exchange; the format for exporting the data from one system; and importing the same data in another. This approach is further discussed.

### 2.3.1 Data Standards

Standards for health data, and other related data, will include both the definition of the data element; its content and meaning; and the name or reference. Table 2.3 is taken from the data and indicator dictionaries used in India, including the definition and rationale of two types of maternal health indicators, alongside the data elements needed to calculate them. To recall, data elements denote the disaggregated basic data elements, also called variables, counts and even indicators in other contexts, while indicators in most cases are calculations based on data elements alone or together, with demographic data, where the data elements are the numerators. Some examples of indicators are provided in Table 2.3.

Table 2.3 Example of Indicators

MATERNAL HEALTH INDICATORS – INDIA	
Indicator MH 1: Antenatal care first visit coverage rate A: ANC – First Visit B: ANC First Visit in first trimester C: ANC registered under Janani Suraksha Yojana (JSY)	
Definition	<ul style="list-style-type: none"> <li>Percentage of pregnant women who used Antenatal Care (ANC) provided by skilled health personnel, for reasons related to pregnancy, registered in first trimester of pregnancy.</li> <li>This indicator is also known as 'Any antenatal care visit'.</li> </ul>
Numerator	A: New registered/first ANC visit of a pregnant woman B: Pregnant women registered within first trimester C: New women registered under JSY
Denominator	A: Total expected pregnancies B,C: Total number of ANC registered
Rationale	<ul style="list-style-type: none"> <li>This first visit should be a 'registration' visit, with all the initial procedures, relating to assessing/preparing a woman for pregnancy and delivery. This should include history, examination, initial blood tests and immunisation.</li> <li>ANC care coverage is an indicator of access and use of health care, during pregnancy. All women should have at least three antenatal visits during a pregnancy.</li> <li>ANC should start as early in pregnancy as possible.</li> <li>ANC registration percentage in the first trimester shows early care and level of awareness.</li> <li>Percentage of women registered under JSY shows: Number of women entitled to benefits under JSY. This includes: (a) All women in Empowered Action Group (EAG) and Northeast (NE) states. (b) Only Below Poverty Line (BPL) and Scheduled Castes and Scheduled Tribes (SC/ST) women.</li> <li>Percentage of pregnant women receiving any ANC is a sensitive indicator of outreach.</li> </ul>
Data source	<ul style="list-style-type: none"> <li>Antenatal/pregnancy registers; maternal health cards.</li> <li>Household surveys.</li> <li>Population data – an estimate of the number of pregnant women is close to the number of children born (2.2 to 3.2% of population).</li> </ul>
Suggested level of use	National, state, district/block and Sub Centre.
Other useful indicators	<ul style="list-style-type: none"> <li>Risk and continuity indicators are important in ANC.</li> <li>Venereal Disease Research Laboratory (VDRL) test for syphilis and HIV testing coverage shows quality of care. This should be done in the first ANC visit.</li> <li>Haemoglobin testing and anaemia management rates.</li> <li>ANC referrals shows risk detection (and transport availability).</li> <li>Percentage of women getting third ANC shows, continuity of care, which is often related to perceived quality.</li> </ul>
Common problems	<ul style="list-style-type: none"> <li>Attendance for pregnancy test or simple registration without history and examination do NOT constitute antenatal care.</li> <li>Women who have started ANC elsewhere, but who come to your facility for follow-up should be counted as follow-up ANC and not first ANC.</li> </ul>

Actions to consider	Low coverage means either the strategy for providing ANC needs to be reviewed, to increase access, or the community should be approached to increase awareness through ASHA, VHSC, BCC and so on.
Indicator MH 4: ANC Anaemic and Hypertension testing and management rates A. % ANC moderately anaemic B. % ANC severely anaemic C. % ANC severely anaemic treated rate D. % ANC hypertension new case detection rate E. Eclampsia cases management rate	
Definition	<ul style="list-style-type: none"> <li>Percentage of pregnant women tested to be moderately anaemic (Hb level &lt;11 g).</li> <li>Percentage of severely anaemic pregnant women treated (Hb level &lt;7 g).</li> <li>Percentage of pregnant women tested with hypertension/high blood pressure (BP &gt;140/90).</li> </ul>
Numerator	<ul style="list-style-type: none"> <li>A. Pregnant women tested anaemic &lt;11 g.</li> <li>B. Severely anaemic pregnant women treated (Hb &lt;7 g).</li> <li>C. Pregnant women detected (BP &gt;140/90).</li> <li>D. Number of eclampsia cases managed during delivery.</li> </ul>
Denominator	<ul style="list-style-type: none"> <li>A, B &amp; C = Total ANC registration</li> <li>D = Total deliveries (home + institution)</li> </ul>
Rationale	<ul style="list-style-type: none"> <li>E. Testing for anaemia and hypertension is an indicator of quality of ANC services and also detection of important risks associated with preventable mortality.</li> <li>F. Hb &lt;7 g and BP &gt;140/90 is a danger sign for pregnant women and should be managed by, arranging for referral transport and informing the medical officer in-charge in advance.</li> </ul>
Data source	ANC/Pregnancy registers maintained by health workers.
Other useful indicators	<ul style="list-style-type: none"> <li>G. ANC hypertension management rate.</li> <li>H. LBW rate is common consequence of anaemia and hypertension.</li> <li>I. Still-birth rate/ PNM affected by anaemia.</li> <li>J. Maternal death due to excessive bleeding is more likely in an anaemic.</li> <li>K. Laboratory equipment availability rate.</li> </ul>
Suggested level of use	Sub Centre, Primous Health Centre, Community Health Centre.
Common problems	<ul style="list-style-type: none"> <li>L. BP is often not taken and Hb testing is not done.</li> <li>M. Health Sub Centres do not have BP apparatus and Hb kits.</li> <li>N. Sufficient stock of IFA tablets.</li> </ul>
Actions to consider	<ul style="list-style-type: none"> <li>O. Address supply side issues.</li> <li>P. Ensure quality of ANC.</li> <li>Q. Awareness generation among mothers to avail complete and quality ANC services.</li> </ul>

Three types of ANC coverage indicators are now described, each having a different data element used as numerator.

### ANC First Visit Coverage

*Numerator* is the data element 'First ANC visit', which is defined as the count of all first visits registered (because a count of first visits gives the total); *Denominator* is total number of pregnant women in the same area (which will be based on demographic estimates).

### ANC (First Visit in) First Trimester Coverage

*Numerator* is the data element 'First ANC visit', within the first 3 months of the pregnancy. This data element is a sub-set of the above 'First ANC visit'. *Denominator* is same as above; total number of pregnant women.

### ANC Registered Under Janani Suraksha Yojana (JSY) Coverage

JSY is an incentive scheme of the Government of India for pregnant women, in order for them to make use of the institutional health services. ([www.mohfw.nic.in/nrhm/rch/guideline/jsy-guideline](http://www.mohfw.nic.in/nrhm/rch/guideline/jsy-guideline))

*Numerator* is the data element 'First ANC visits', (or new women) registered under JSY. This data element is also a sub-set of the 'First ANC visit'. *Denominator* is same as the above ones, total number of pregnant women in the area.

Within our 'data warehouse' framework, the above three data elements represent data standards, whose values need to be reported from the local level for a required time period/periods, which is typically a month, and captured in the data warehouse. The recommended practice is to register 'atomic' values and data elements, that is to keep the data disaggregated. In this way, indicators and different levels of aggregation may be calculated based on the raw data.

Currently, the typical way to generate these three maternal health data elements is to extract them from the register books, used for recording ANC visits. Here, generally, there will be a column for 'First visits', making it easy to count the number of first visits, by month. As we have seen from the case of Himachal Pradesh, there are three different ways in which these data can be reported and included in the data warehouse:

- Data reported from the local unit and the source of the data on paper forms are captured directly into the 'DHIS2', at block level.
- Data reported on mobile phone using the SMS standard are automatically and 'seamlessly' imported into the data warehouse.
- The ANC registry and visits can be registered in an electronic register, using the DHIS Tracker system. From here the values of the three data elements can be aggregated from the ANC register, by the reporting health facility, and by a time period, to be included in a file of a particular format understood by DHIS, and sent (exported) to it where the data elements and values are imported.

In some countries, there will conventionally be a number of paper forms for data reporting, that will be 'owned' by different health programmes, which more or less overlap, with inconsistencies between them. The process of data standardisation is concerned with harmonising these reporting forms and requirements. The advisable approach to data standardisation is to focus on the needed indicators and on identifying the data elements required to calculate these indicators, as we have seen from the example of India. Ideally, the standardisation should result in a data and indicator dictionary, in line with the Indian example. Before it makes any sense to try



to export and import, or transfer data electronically between systems, such as the electronic ANC register and the data warehouse, the data standards and the definition of the data to be transferred, needs to be sorted out. This is a rather complex task, and in the next chapter, we explore further strategies for data standardisation. Here, we provide a snapshot view of technical standards, for data exchange.

### 2.3.2 Technical Standards for Data Exchange

Having agreed that standards are required for data to be exchanged between systems, for example, which data 'exactly' to send from the electronic ANC register to the 'data warehouse', the syntactic or technical formats then need to be agreed upon, and standardised. These formats are formally 'rigid' technical protocols, specifying exactly the form in which to transfer data, so that the meaning is not lost. Remember here, that it is not only the value and data element that needs to be transferred, but also the location, which is reporting health facility and time period, need to be specified. The unique identifier for all data element values in the 'data warehouse' is place, that is reporting health facility, time period, which can either be a particular month or week, and 'meaning', that is the data element.

A minimum of two applications involved, need to agree upon shared technical protocols of how the data and format could be written and described, from the side of the sender, so that the receiver of the data can comprehend it. The easiest and typical adhoc way to solve the data inter-change between two or more applications is for the systems wanting to inter-change data, to agree on a custom protocol serving, as a gateway between their systems only. The problem with this approach, however, is that it is very rigid and is difficult for new applications to be included, as they would need to adapt. And may be they would have their own way of doing things that is preferable to them. In a world where everybody uses their own standards; communication will be difficult. The agreed 'best practice' way to approach interoperability, is to apply standards shared by all involved systems. In the area of health information, however, there still are not any easy-to-use shared standards available. Fortunately, this is a situation that may change, as a project led by WHO, is currently developing a general standard for the interoperability between systems inter-changing health data called SDMX-HD (Health Data), which represents a general standard for data transfer. Although it is too early to know if SDMX-HD will become the agreed universal standard for exchange of statistical health data, we believe it is useful to provide a brief overview of this standard in the Box 2.4.

Box 2.4

An overview of SDMX-HD<sup>1</sup>

#### SDMX-HD – Standard Development

##### *Background*

The HMN Technical Framework provides a high-level architectural vision of how national HIS development might be implemented, and presupposes that such a HIS would consist of interoperating sub-systems, providing data to a national data repository or warehouse, and stops short of explicitly prescribing a data integration strategy. Three possibilities could be considered:

<sup>1</sup> Contributed by Bob Joliffe, one of the authors of the SDMX.HD standard and a core developer of DHIS2.

1. Homogeneous systems – If all of the services could be provided by a single software package, or by a suite of packages from the same vendor, then interoperability becomes an internal arrangement.
2. Gateways – It could have been possible to build gateways to perform translation and data-loading between the reporting sub-systems and the data warehouse system (for example, DHIS2).
3. Communication using an open data standard.

Each of these approaches present difficulties. The use of homogeneous systems in this context is rarely neither desirable nor possible. Besides the significant risk of creating vendor lock-in situations, the range of health service sub-domains is simply too varied to imagine a single product managing aggregate data, patient level data, HR data plus whatever future requirements that might materialise. Building gateways is certainly possible with one or two systems, but becomes more of a burden as the move to more comprehensive health system coverage exposes the need to build new gateways for each new system. The use of an open standard which can be mandated in procurement guidelines provides the best value proposition for the health system owner, in terms of protection against vendor lock-in and providing a 'plug-and-play' growth path in the future. The benefit of using open XML-based standards for interoperability between disparate systems, is well understood, both in terms of economy and efficiency, as well as broader political and developmental considerations related to state procurement of ICT systems in developing countries. We use the term 'open standard' to indicate standards which are not encumbered with intellectual property constraints and which enjoy legitimacy through open, fair and participatory development and maintenance arrangements by a not-for profit agency. The problem was that, up until 2009/2010, there had been no agreed upon standard for exchange of aggregate health data between systems.

In 2010, the WHO published a standard for exchange of data and metadata, for aggregate health information. The new standard, SDMX-HD,<sup>2</sup> is an implementation of the ISO SDMX standard (TC154, 2005). SDMX is a mature XML-based standard which has found use in a number of domains for international reporting of statistical data. SDMX-HD is a health domain specific dialect of SDMX, which is specialised to represent health indicators. It is important to understand that before two applications can meaningfully exchange a data item, they must (i) have established a common understanding of metadata, and (ii) use a data format which is commonly understood by both parties. SDMX-HD provides formal rules to facilitate this exchange. This is best understood by a simple example. Note that the example simplifies some of the XML for the purpose of instruction.

#### *Example*

An electronic medical record system might collect data on immunisations, which take place during clinical encounters at a facility. The facility might be required to report a monthly aggregate data item called 'Total immunisations', broken down by age group (for example, under 1 year old and over 1 year old), and gender (male and female), to the District HIS.

For this exchange to take place, the HIS needs to define and communicate the metadata for the communication to take place. It does this in SDMX-HD, by producing

<sup>2</sup> Further information about the SDMX-HD standard is available at <http://www.sdmx-hd.org>.

what is called a Data Structure Definition (DSD) message. The DSD is an xml file or a package of xml files in more complex cases, which defines:

Codelists for items such as data elements and disaggregations. In this simple case, 3 codelists would be required for data elements, gender and age, as well as, an additional codelist for health facilities. An example of the gender codelist might look like:

```
<CodeList id="CL_CATEGORY_SEX" agencyID="SL-MOHS"
version="1.0" isFinal="false">
<Name xml:lang="en">Sex</Name>
<Code value="1">
<Description xml:lang="en">Female</Description>
</Code>
<Code value="2">
<Description xml:lang="en">Male</Description>
</Code>
</CodeList>
```

The Codelist is a generic structure used to represent any coded item in SDMX-HD. The other codelists are not shown here.

KeyFamilies which indicate the way in which data values are grouped and disaggregated. So for example, data items like the example above would be represented in a KeyFamily, which indicates the need for age and gender disaggregation. A simplified KeyFamily for this might look like:

```
<KeyFamily id="KF_419035" agencyID="SL-MOHS" version="1.0"
isFinal="false">
<Name xml:lang="en">KeyFamily for categorycombo sex+ age
group</Name>
<Description xml:lang="en"/>
<Components>
<Dimension crossSectionalAttachGroup="true" conceptRef="FREQ"
conceptSchemeRef="CS_COMMON" conceptVersion="1.0"
conceptSchemeAgency="SDMX-HD" isFrequencyDimension="true" >
</Dimension>
<Dimension crossSectionalAttachObservation="true" conceptRef=
"DATAELEMENT" conceptSchemeRef="CS_COMMON" conceptVersion="1.0"
conceptSchemeAgency="SDMX-HD" codelist="CL_DATAELEMENTS"
codelistVersion="1.0" codelistAgency="SL-MOHS"/>
<Dimension crossSectionalAttachObservation="true" crossSectiona
lAttachGroup="true" conceptRef="FACILITY" conceptSchemeRef="CS_
DIMENSION" conceptVersion="1.0" conceptSchemeAgency="SL-
MOHS" codelist="CL_FACILITY" codelistVersion="1.0"
codelistAgency="SL-MOHS"/>
<Dimension crossSectionalAttachObservation="tru
e" conceptRef="SEX" conceptSchemeRef="CS_DIMENSIONS"
conceptVersion="1.0" conceptSchemeAgency="SDMX-
HD" codelist="CL_CATEGORY_SEX" codelistVersion="1.0"
codelistAgency="SL-MOHS"/>
<Dimension crossSectionalAttachObservation="tru
e" conceptRef="AGE" conceptSchemeRef="CS_DIMENSIONS"
```

```

conceptVersion="1.0" conceptSchemeAgency="SDMX-
HD" codelist="CL_CATEGORY_AGE" codelistVersion="1.0"
codelistAgency="SL-MOHS"/>

<TimeDimension crossSectionalAttachGroup="true
" conceptRef="TIME_PERIOD" conceptSchemeRef="CS_COMMON"
conceptVersion="1.0" conceptSchemeAgency="SDMX-HD">

<TextFormat textType="ObservationalTimePeriod"/>

</TimeDimension>

<PrimaryMeasure conceptRef="OBS_VALUE" conceptSchemeRef="CS_
COMMON" conceptVersion="1.0" conceptSchemeAgency="SDMX-HD">

<TextFormat textType="Decimal"/>

</PrimaryMeasure>

</Components>

</KeyFamily>

```

The XML formatting is quite verbose and not easily consumable by a human reader. But the strict conventions used, are quite easy for a programme (such as the electronic medical record system in the example), to use this set of metadata definitions to codify and produce data element values, which can be exported to the district HIS. The metadata defined in the DSD message, would typically represent the reporting requirements within a national HIS. Human management users would not ever interact with the data at this level, and would define the data elements and codelists within the more comfortable context of a user friendly HIS. The DSD is generated from that system.

The data values for the elements to be reported by the electronic medical record system are formatted using a separate type of data message. There are a number of variants on this format, mostly XML, also including CSV. A typical snippet from a data message for which uses the SDMX-HD cross-sectional data format might look like:

```

<DataSet reportingBeginDate="2010-02-01"
reportingEndDate="2010-02-28"

datasetID="OMRS_export" dataProviderID="34">

<Group TIME_PERIOD="2010-02" FREQ="M">

<Section>

<OBS_VALUE AGE="1" SEX="1" value="20" FACILITY="21"
DATAELEMENT="8"/>

<OBS_VALUE AGE="1" SEX="0" value="13" FACILITY="21"
DATAELEMENT="8"/>

.. etc

</Section>

</Group>

<DataSet>

```

The coded values used, are the values from the codelists which were exchanged in the DSD.

### *Conclusion and Onwards*

SDMX-HD represents a distillation of compromise and best practices, both from the information science as well as the HIS domains. It continues to be developed on an iterative basis, with the experience of implementation being fed back into the standard development process. The formal aspect of structuring metadata and data messages, has matured to a point that it has been successfully implemented in a number of independent health information software packages. The longer term goal of the WHO and the national implementation efforts are, to rationalise common codelists to be used across and within countries, and to build tools for better governance of such metadata. Metadata governance, refers to the human processes around publication and revision of code lists, key families, facility lists, that ensure the functionality and flexibility of the HIS over time.

The first concrete application of this standard has been to ensure the interoperability between the following three applications:

- *DHIS2*: Database or data warehouse application of aggregate data.
- *OpenMRS*: Medical records database.
- *iHRIS*: Human resource management system containing records on all the employees.

The interoperability in this case, is to aggregate data in OpenMRS and iHRIS, and to export this to the DHIS2. Though, it would have been easier to implement custom protocols between DHIS2 and OpenMRS and between DHIS2 and iHRIS; the decision was early on, to make use of the emerging standard, SDMX-HD, for this purpose. While the initial implementation is more challenging, using the emerging standard, we ensure its ease, to link with other similar standard-compliant systems in the future. The SDMX-HD is ideally planned to be a general standard used for data transfers and interoperability of aggregate data between software applications, in the health domain. In the case of the integrated 'data warehouse' framework and IHIA, the SDMX-HD will serve as a 'plug-in' functionality, enabling an evolutionary development, where new systems and modules are plugged into the 'data warehouse' using the SDMX-HD standard.

Here we have used the SDMX-HD to illustrate the role and importance of standards for data exchange when developing information systems within an integrated architecture framework where interoperability is a key building block. In reality, however, developing new standards are complicated processes and at this point, it is far from sure that the SDMX-HD exercise will develop into a widely accepted standard.

### Summary

Key concepts that can be taken from this chapter are summarised below:

1. The framework for IHIA, includes three levels:

- The social system level
- The application level
- The data level

These levels represent our approach to operationalising the vision of a IHIA conceptualised in Chapter 1.

2. Each level of the HIA, draws upon the services provided by the level(s) below.
3. The social system level, is defining to the whole IHIA, given our focus on the information needs for decision; being the 'raison d'être' or reason for existence of a IHIA.
4. Users' needs, integrated and not fragmented information (as is typically the case), vary with levels and purpose. Information when collected must have a purpose, which is to support action.
5. The application level of the IHIA is best approached through the 'data warehouse', which represents a data repository that can manage data from multiple sources and application domains, as illustrated in the case of Himachal Pradesh.
6. The SDMX.HD represents a current global effort towards developing interoperability data standards.

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# 3

## Integration and Interoperability – Standardisation is the Key

In this chapter, we engage in the ongoing debate in the global HIS field, around issues of integration and interoperability – how these are different, how they may complement each other, and how integration and interoperability, respectively, could be achieved. We argue that, standardisation is the key to understand and to achieve integration and interoperability in HIS, and information systems more broadly. Furthermore, we argue that within the perspective of the management-oriented enterprise architecture, we develop in this book; the IHIA – as we have labelled it, makes it crucial for data standards.

In this chapter, we first position the debate(s) around integration and interoperability in HIS, taking examples from the development of the DHIS2 and its integration and/or interoperability with medical records and human resource management systems. After discussing concepts of vertical and horizontal integration, in the last part of the chapter, data standardisation is linked to cases of development of the DHIS2 'data warehouse'.

### 3.1 Integration and Interoperability – Current Debate

Integration is a term with different meanings in different contexts – from being a very precise term in mathematics, as the art of calculating integrals, to a more ambiguous term in social sciences and everyday speech, as in cultural, ethnic, or religious integration. Similarly, in our field of HIS, meanings of integration will vary according to 'who you are', your role in the organisation, your relation to the health sector, and the perspectives on the HIS. While managers and health services providers would think that integration of information and routines are needed to perform certain tasks; ICT staff, software developers and more technically-oriented personnel would think that co-ordination of the software applications and protocols for communication are needed to achieve that.

During an electronic forum debate on integration, in the RHINO network meeting in Mexico, 2009, it turned out that, while some saw integration strictly as a technical term related to collating several software applications into 'one system,' regarded as a negative and an old fashioned approach; others used integration to describe approaches to get health programmes to collaborate and unify their data collection forms and routines. Those who understood the term integration as referring to a technical approach to make 'one big system,' were against the notion of integration understood in this way. They would rather go for the concept of interoperability,

as they saw it more useful to make different systems to interoperate rather than to collapse them into one big system. In our view, however, integration, even at the level of software applications, cannot be reduced to an aim of constructing one big system. The definition of integration in the organisational context, takes the users needs of the HIS, the purpose of the systems, and the wider organisational perspectives as points of departure, and relate those to goals of better efficiency, effectiveness and co-ordination in organisations and enterprises. In such a perspective, interoperability is one of the means to achieve such ends – integration.

Interoperability is, contrary to integration, a term which may be given a more formal definition. In our context, interoperability refers to the ability of a system to use and share information or functionality, of another system by adhering to common standards. Without agreed standards shared by at least two systems, processes or other actors which are aiming at interoperability, interoperability is not possible.

In the last chapter, we described the example of the SDMX-HD standard for exchange of data. Two ‘levels’ of standards are needed in order to exchange data; a shared format or protocol, for example the SDMX-HD, and then, of course, one needs to agree on what data including their definition and meaning should be transferred. Later in this chapter, we discuss the distinction between syntactic and semantic standards, and elaborate on the challenges of developing data standards. But for now, we use the example of SDMX-HD to describe the essence of interoperability.

**Box 3.1****An example from Sierra Leone***Building Interoperability*

In late 2009, WHO had initiated a process to develop a data exchange standard for health metadata and statistics, building on an existing standard for financial transactions. This new protocol, SDMX-HD, was still not implemented by any application, far less in any real use-case setting by early 2010. Nevertheless, HMN, MoH in Sierra Leone and HISP, decided to initiate a pilot system that could both track patients on Antiretroviral Therapy (ART) and share this data with the data warehouse running on DHIS2, as stipulated in the original strategic plan for the country. OpenMRS, a medical record application, was set up in the main hospital in Freetown, the capital. Weeks before this took place in February 2010, major advancements were made to SDMX-HD, spurred by the fact that it was about to be implemented in two ‘live’ applications. The main idea was that OpenMRS has the functionalities needed for doctors and nurses to track patients over time, while the aggregate data from this system is used for general health management at hospital, district, and national levels. This two-level use applies to other domains and applications also, such as logistics management, human resource management, lab systems, health finances, and so on. With SDMX-HD set to go live in Sierra Leone at the given date, developers behind DHIS2 and OpenMRS not only pushed development forward by implementing this standard in the respective applications, they also contributed the necessary use-case to solve outstanding issues. The development of SDMX-HD made the HIS architecture of various applications for different business domains, a reality; anyone able to share data on this protocol could now be ‘plugged in’ in a country HIS.



While HMN and HISP were collaborating in Sierra Leone; *CapacityPlus*, a partner of HISP and HMN, specialising in strengthening health workforce information systems, was partnering with the West Africa Health Organisation (WAHO), to pilot open source human resource management software called iHRIS, in Ghana. Learning about the 'Sierra Leone architecture', WAHO took the initiative to include also the iHRIS suite of applications for human resource management in this architecture, which provided further impetus to the iHRIS implementation of SDMX-HD. These initiatives, together with the fact that many countries in the West African region were in the process of introducing the DHIS2 and/or the iHRIS, led to the organisation of a workshop on training in both these applications in Accra, Ghana, September 2010. This workshop was jointly supported by WAHO, HMN, WHO, *CapacityPlus* and HISP. The WHO organised a 'Connectathon' meeting for the SDMX-HD in parallel with the workshop. At the end of the workshop, the SDMX-HD standard was officially launched and implemented in the DHIS2, the iHRIS, OpenMRS, and the WHO Indicator Measurement Registry (IMR) integrated framework. This initiative was further consolidated in November 2010, where HIS staff from all the 15 WAHO member states were present. There, it was decided that HMN, WAHO, HISP, and *CapacityPlus* should collaborate to develop a centre of excellence at WAHO, for supporting member countries in adopting the interoperable solutions which had grown out of Sierra Leone.

Figure 3.1 depicts the three applications being part of piloting the SDMX-HD standard, depicting the relationship between integration and interoperability.

**Interoperability** is the ability to exchange data between two or more systems. In Figure 3.1, we see exchange of data:

- Between DHIS2 and OpenMRS.
- Between DHIS2 and iHRIS.

This is where, we have interoperability between, in this case, two systems. There is no interoperability between OpenMRS and IHRIS.

**Integration** here, can be understood as the process of joining distinct systems in such a way, that they appear as being a whole in a particular perspective. In this case, we see that patient data from OpenMRS and human resource data from iHRIS are 'joined' and integrated in the DHIS2 'data warehouse'. OpenMRS and iHRIS are integrated, but there is no interoperability between them. DHIS2 is interoperable with both OpenMRS and iHRIS.

Figure 3.1 emphasises a technically biased perspective on interoperability, since it is seen strictly as an interaction between two software applications. Such a technical perspective is quite usual and may seem the reason why the concept of interoperability has been mostly used and promoted by those with more technical and/or clinical medical backgrounds, who view the term as being mostly related to a medical records system. However, if we 'unpack' the SDMX-HD interoperability arrow in Figure 3.1, we see that it includes both the SDMX-HD standard for data exchange and the data which is to be exchanged. We may regard these two components and their internal relationship as being similar to the messenger and the message; the container and the content; and between syntax and semantics.

In Figure 3.2, we have depicted the overall integrated 'data warehouse' and the architecture concept: Integration across health programmes and services and across technologies. With Figure 3.1 and its discussion, we have extended the interoperability

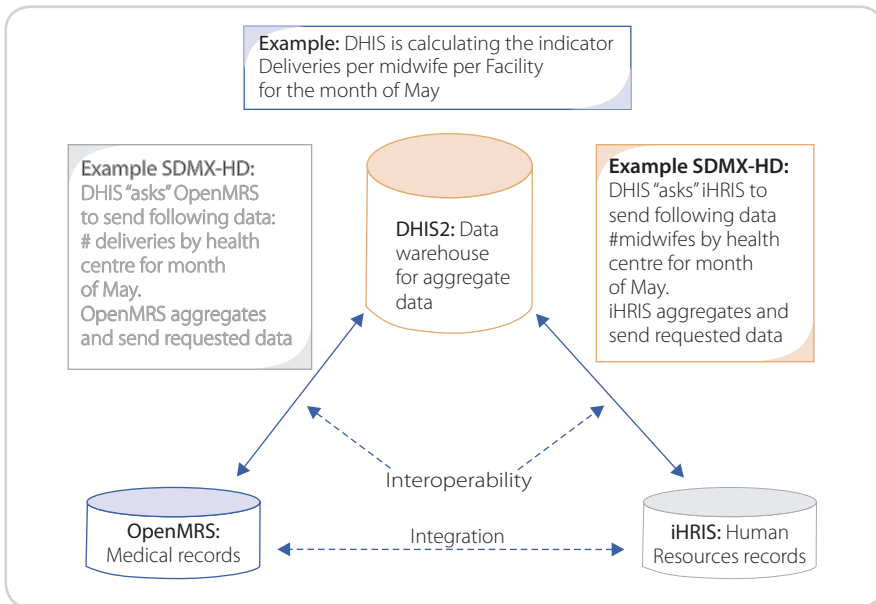


Figure 3.1 Examples of interoperability and integration

and integration concepts to also include the traditional routine HMIS data reporting, which may be paper-based or computer-based. Data may be reported using the Internet, USB memory sticks, as paper reports, or by mobile phones. The means of data transfer, whether it uses paper or electronic format, physical transport or the Internet, does not affect the use of the terms, as interoperability is not limited to exchange between computer-based systems. Figure 3.2 illustrates that data exchanged between the DHIS 'data warehouse', a range of health programmes and services, and data reported from different types of systems. For example, data generated and transferred from computer-based systems such as medical record systems, human resource management systems, logistics and drug management systems and vital registration; and data generated from paper-based systems such as register books used by health programmes, such as Expanded Programme on Immunisation (EPI), Reproductive and Child Health (RCH), and typically, from Outpatient Department (OPD). While some data is exchanged using SDMX-HD, other data are exchanged using paper-based reporting forms. In principle, however, the data standard remains the same, regardless of the means of exchange; electronic or paper-based. Distinguishing the technical level of data transfer from the data itself is therefore important, when using the concept of interoperability. Furthermore, Figure 3.2 also illustrates that interoperability and data exchange is also as much between people and organisational actors. Thus, the social system dimension is particularly relevant to the understanding of interoperability.

Given the many-faceted picture of interoperability, as discussed in Chapter 2, we have the three levels of organisational, semantic and technical which is analogous to our three local architecture framework.

Looking at the relationship between interoperability and integration, interoperability is a sub-set of integration, and more concrete and directly operational, than what is

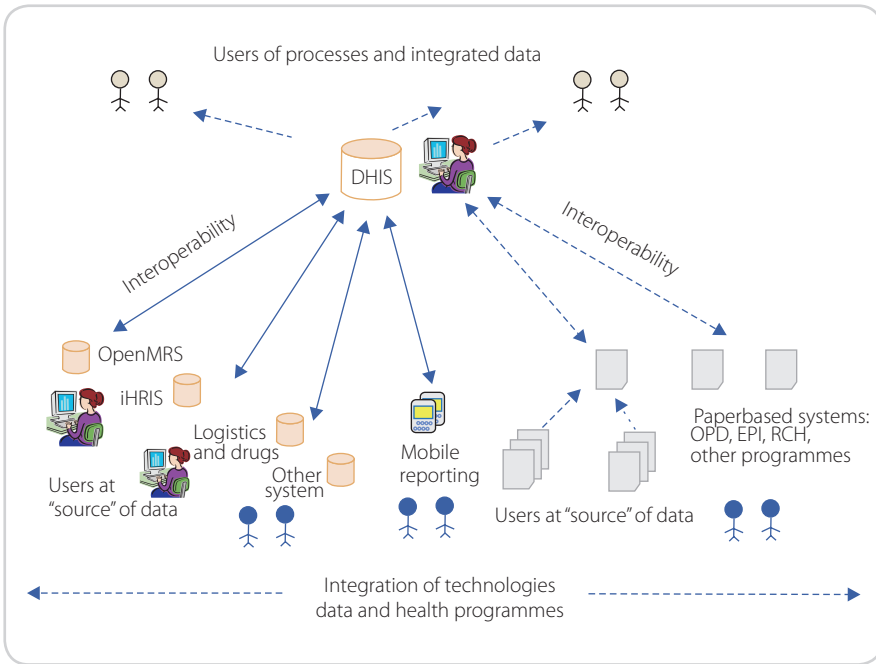


Figure 3.2 Using integrated data

often understood by the more open term of integration. The fact that integration may mean everything also covered by the term interoperability, and that it is also used in such overlapping ways, is a source for confusion. However, if we are explicit about what we mean, or want to achieve, when dealing with concrete system design and development, these differences between professional traditions should not be problematic to sort out.

### 3.2 Enterprise Integration

In this section, we approach the term integration from the view of the enterprise, and relate it to the overall view of enterprise architecture. *Enterprise integration*, is a topic of research and practice in the sphere of business schools, with many issues relevant to our enterprise architecture debate. For example, information systems and HIS practitioners and researchers will tend to see fragmented and uncoordinated computer-based systems as their problem domain, and integration as the solution through an approach to bring these systems together. At the same time, the Enterprise Integration folks would take the need for better co-ordination of the units and domains of the enterprise as their point of departure, and see integration as an approach to increase co-ordination and efficiency of the enterprise. Then, of course, with the needs of the enterprise as their point of departure, they would address the need for integration at the software application and technical level. These two perspectives might or might not be compatible, or even the same. The key issue is who is defining the integration needs; the 'business users' in the language of Enterprise approaches, or, as we have argued earlier in this book, that in our context would be the health

managers and service providers, who really need to define the integration needs, and not the IT people!

The networked enterprise facing global competition, operating in a context of changing economic conditions, mergers and new business strategies, is the model on which the enterprise integration approach is developing their concepts. The emerging strategy then, is towards enabling the flexibility needed by a networked enterprise or a network of enterprises, characterised by distributed control, inter-organisational business processes, shared information and knowledge, where nodes can be added or removed. For the enterprise then, integration means the development of a coherent information architecture, where the various administrative, business processes and systems are integrated, so that they appear in the most seamless way possible to the users, irrespective of where they are located.

The enterprise architecture model may as well be adapted to the organisational structures, objectives and 'business logic' of the health sector, as it aims for co-ordination, interoperability and efficiency. Since in the enterprise model, the health sector may be seen as being made up of a vast number of more or less interoperable units and sub-hierarchies, or by more or less independent enterprises, networks of enterprises, or sub-enterprises. Furthermore, and importantly, the health sector, as the typical enterprise, abounds in more or less uncoordinated information systems.

### 3.3 Horizontal and Vertical Integration

The two terms, horizontal and vertical integration, the contrast and the interdependence between them, are frequently used concepts in the Enterprise Integration domain, that are highly relevant for understanding integration in the health sector. *Horizontal integration* refers to integration across the various domains or business areas of an organisation, or across organisations. *Vertical integration* is integration typically 'military style' along the line of command from the top to bottom, in the hierarchy of an organisation, or the line of business from its top management down to operational levels. While our objective of developing an integrated architecture across the different health programmes and services, is by definition a quest for horizontal integration; our objective to enable a seamless flow of data between the patient and facility level and higher administrative levels is by definition vertical integration. At both the horizontal and vertical levels, we can employ strategies of *tight* or *loose* integration. A tight integration involves closely coupled systems, using a shared resource, where the failure of one could lead to the failure of the other. In a loose framework, there is more buffer and leeway between the systems, and the failure of one may not directly bring down the other.

*Vertical integration* is often labelled 'silos', thus emphasising the contrast or even opposition to horizontal integration, as in the HMN slogan 'From silos to integrated HIS', which advocates horizontal integration. Independent and uncoordinated silos, following a vertical integration approach, is the classic way to organise data reporting and information management in health programmes, according to donor agencies' requirements. 'Too much' vertical integration is, thereby, often seen as the main reason for the fragmented HIS in the health sector, as each health programme tends to focus on building their own HIS as silos with little or no interaction horizontally. While acknowledging these negative connotations, in our context, however, vertical integration is predominantly linked to the goal of achieving the most 'seamless' possible

flow of data between the local data sources. For example, the patient-health facility encounter and the various administrative levels above in the health administrative hierarchy. The Sierra Leone SDMX-HD is a perfect example of interoperability and integration, where the OpenMRS database for AIDS patients on ART and the DHIS2 enables a relatively seamless electronic flow of HIV/AIDS data and indicators from the patient and hospital level, to the national level, and further as national reports to WHO in Geneva.

Today, data management at the local facility is conventionally paper-based. In India, the reporting from the Sub Centres and PHCs is currently in the process of change, from paper to electronic reporting, and in some cases enabled through the use of mobile phones from Sub Centres and in others, by accessing the web-based application from the health facilities. In most developing countries, however, reporting from the facilities is currently typically paper-based. The paper-computer interface is therefore important in achieving 'seamless' vertical integration.

At a more general level, vertical integration may also be seen as being parallel to the aggregation of data from the patient or production or transaction levels, for information systems, where further up in the hierarchy of usage and management, only particular sub-sets of the information produced at the local and transaction levels of information hierarchy are useful, or make sense. At the local and operational levels, more granular information is needed for patient management and services delivery, while at higher managerial levels, less granular information or sub-sets of information 'produced' locally, would be needed. The smooth flow, or availability, of information between these levels of granularity is an important characteristic of vertical integration. The following Figure 3.3 contrasts vertical and horizontal integration.

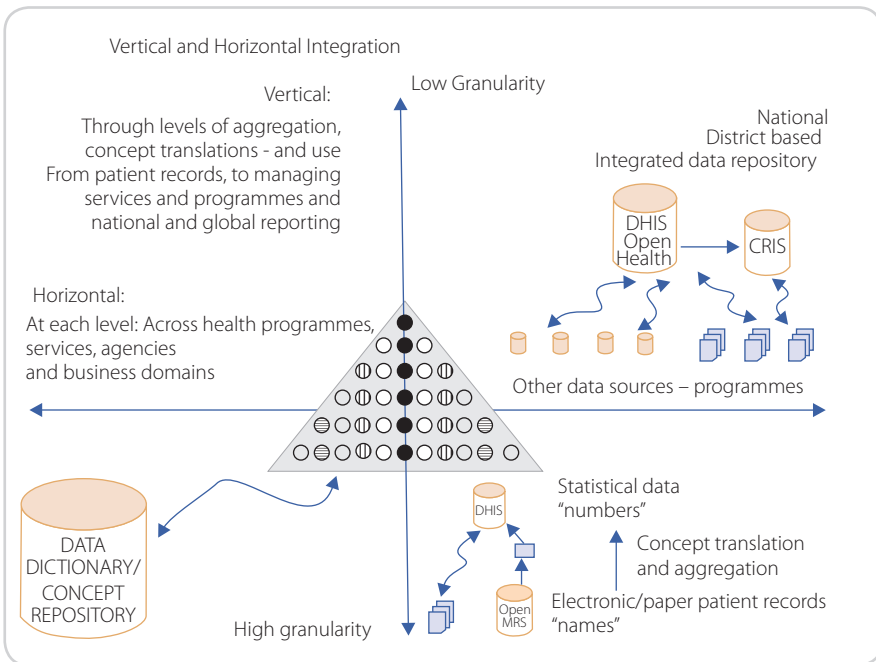


Figure 3.3 Vertical and Horizontal integration

## Horizontal Integration

Horizontal integration is understood as the integration of the various domains or business areas of an enterprise, or as in our case, the health sector – between the enterprise or the health sector and its environment and wider context of partners, community or public sector. In the health sector, horizontal integration would involve the co-ordination of information flows and information systems across the different health programmes, health services and other relevant data sources, so that all data can be accessed and analysed at ‘one point’. The ‘data warehouse’ approach represents a typical horizontal integration, by the level of hierarchy; national, state, district and facility. The ‘data warehouse’ enables a horizontal view across the various sectors at each level, where again each sector is part of a vertical flow and integration of data, thus, manifesting a dynamic relationship between vertical and horizontal integration – up, down and sideways in the hierarchy. The Table 3.1 links the concepts of integration within the three-layered structure of the IHIA.

Such a three-layered perspective on integration, will help us guard against the view that integration can be easily achieved. Research points to the contrary – that most

Table 3.1 Horizontal and vertical integration in the health information architectures framework

<i>Three-level Architecture – Horizontal and Vertical Integration</i>	
<b>Level 1:</b> The organisational, political level of information needs, users and usage	<b>Horizontal Integration</b> <ul style="list-style-type: none"> <li>Health management’s need for information from across different health programmes and health services and health resources (for example, human resources), available at ‘one point’ of access, for co-ordinated management, M &amp; E, correlation and analysis.</li> <li>Hospital management’s need for information from across wards, specialties, finances, and so on are available at one point.</li> </ul>
	<b>Vertical Integration</b> <ul style="list-style-type: none"> <li>Managers, at all levels, need for ‘seamless’ flow of information between the peripheral levels of the hierarchy, the source of information, for example, patient-facility encounters, and district, state/province, national and even global levels.</li> </ul>
<i>Level 1 uses services from the level below (level 2)</i>	
<b>Level 2:</b> Software applications and information systems	<b>Horizontal Integration</b> <ul style="list-style-type: none"> <li>Data warehouse for aggregate data and indicators, such as the DHIS2, integrating and managing data from different health programmes and service areas. Data imported electronically from other systems, or captured directly from paper reports.</li> <li>Integrating patient-based medical records between different systems, typically using shared repository.</li> </ul>
	<b>Vertical Integration</b> <ul style="list-style-type: none"> <li>Extracting aggregate data and indicators from medical record systems and loading them into the ‘data warehouse’ for aggregate data, as illustrated by the integration between OpenMRS and DHIS2, and the flow of these data upward, through the levels of the system.</li> <li>The still dominant paper-based reporting routines, where aggregate data is extracted from register books and reported upwards through the levels of the health system.</li> </ul>

Level 2 uses services from the level below (level 3)	
Level 3: Data exchange and interoperability standards	<p><i>Horizontal Integration</i></p> <ul style="list-style-type: none"> <li>• Shared data standards prerequisite for capturing data from paper or importing data electronically to the 'data warehouse'. Harmonisation of datasets between health programmes and services to solve overlaps, inconsistencies and gaps is the first step.</li> <li>• Shared data standards, for example, SDMX-HD, represents a technical standard used for transferring aggregate and indicator data between systems.</li> </ul>
	<p><i>Vertical Integration</i></p> <ul style="list-style-type: none"> <li>• Shared data standards prerequisite for the flow of aggregate data reported up through the levels. Extracting aggregate data from medical record systems such as OpenMRS and loading them into the 'data warehouse', such as DHIS is based on the shared data standards and converted into the SDMX-HD technical standard for import into DHIS2.</li> </ul>

integration efforts in the domain of HIS in developing countries do not often work, and the reason for this is mostly institutional. For example, donor projects often lead to the development of small fragmented systems, and when the donors leave, legacy of their systems remain. Donors and other stakeholders tend to be reluctant to integrate their systems with anything else, leaving an unhealthy trail of unintegrat(able) systems.

Integration, interoperability and standardisation are intimately linked. In the next section, we illustrate this through cases of developing data standards involving varying approaches. We will argue that standardisation of data and indicators is a pivotal part, and in fact, a precondition of integration efforts.

### 3.4 Standardisation and its Relation to Interoperability and Integration

Integration and interoperability both build on the use of standards. The alternative to shared standards is to build a custom gateway between each of the systems involved, while being of course possible, gets too complex as more systems are included and existing systems are replaced. Because, each new system will need to connect with all the other systems, and in total requires  $n*(n-1)/2$  connecting gateways to be established and maintained. Looking above the level of technical standards for interoperability to the level of data standards, there is no alternative to shared standards. Or more precisely put, the alternative is *chaos* – fragmentation of systems and lack of co-ordination. Obviously therefore, data standards play a crucial role in HIS development generally, and in an architecture particularly.

We discuss here, the concepts of standards, and the process of standardisation as related to the integrated IHIA. In the example and Figure 3.2, standards of different types enabled the flow of data:

- The SDMX-HD enabled the technical exchange of data between systems.
- Data standards ensured that the sender and the receiver both understood the data being transferred.
- Finally, we may say that the standard institutional procedures and legislation ensured that data were collected, processed and reported.

Thus, the three types or levels of data are in line with the levels of interoperability listed above.

We can compare these three levels of standards with a cellular telephone system. The technical standards of transmission and handheld devices enable us to hear the sound of the voice at the other end, the one you are communicating with, and vice versa. The data and semantic standards is about, the meaning of what is being transferred; which can be likened with a telephonic dialogue, where if one speaks Hindi and the other Chinese, and none understands the others, language, not much would come out of the conversation. Therefore, it does not help if the technical standards are working well, unless there are standards for joint understanding, which we call semantic standards – a shared language, in the case of the telephonic conversation. And finally, we will also need standards for agreed procedures of communication and data sharing, at the organisational level. If, for example, two people understand each other perfectly well and are provided with a technically excellent telephone line, it does not help much if they do not want to talk, or have nothing to talk about. Similarly between two information systems, for example, the hospital system and the DHIS2 data warehouse, technical and data standards will not help much if the two organisational structures do not want to share and interchange data.

In Figure 3.4, the three levels of standards are depicted.

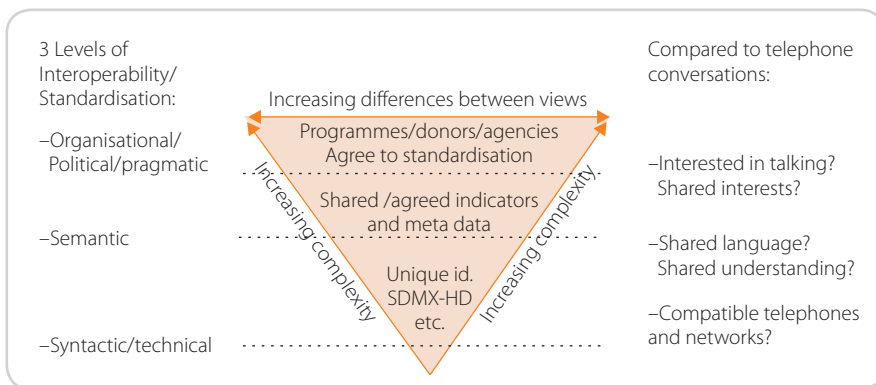


Figure 3.4 Three levels of standardisation of the increasing differences and complexities

The inverted triangular model describes the three levels of standardisation and interoperability, adapted from Carlile (2004), who developed his model in the area of knowledge management to help conceptualise the management of knowledge across boundaries. In our context, the boundary is between those needing to share the standard; and who are engaged in negotiations on agreeing on the standard. The three levels are relating to what type of standards and agreements would be needed. At the syntactic and technical level, they need to agree on technical means of data exchange, as in the SDMX-HD example. At the semantic data level, they need to create shared understanding and agreement on the data to exchange, the datasets and concrete definitions. Finally, at the level of the social system and organisational politics, agreement is needed to share data and to change routines, systems and even ownership and control of data and information. The point with increasing differences



between views, as one move up through the levels, to arrive at a shared understanding and partial agreement, is only at the top level, the world of politics; with social and organisational dynamics. Having reached an agreement at this level, it would be easier to agree on some shared data standards and procedures for exchange. And having agreed on the need to share data and the data to be shared, it becomes relatively less complex to sort out how it can be carried out in practice technically.

Related to the three progressively, more complex boundaries of differences described above – syntactic, semantic and social customs boundaries, there are three progressively, more complex processes of managing these differences. And these processes, in our context, include implementing standards such as for transfer, translation and transformation. We summarise the levels of boundaries and processes needed to overcome them.

### 3.4.1 Syntactic-Technical Level

Data transfer and interoperability. This level is part of both paper and computer-based systems, and any combination, thereof. The technical level is relatively easy to comprehend. The SDMX-HD standard, enables an example of a syntactic description of data to be transferred, so that it can be understood both by the sender and the receiver. Paper-based systems and standards are often understood as something completely different. It is, therefore, important to note that in a manual system, paper-based registers and data reporting formats are representing the same syntactic level; the paper form is also a 'grammar' for coding the data to be transferred, so that the sender and the receiver understand it in a similar way. Also note, however, that the practical difficulties in changing paper-based reporting forms make up an important driving factor in the fragmentation of HIS and the problems faced by data standardisation. While data standards (like SDMX-HD) are *Software* based, and enables data transfer, implying that it is easy to change data standards, the paper formats are *Hardware*, or not changeable, and will need to be replaced!

*At the syntactic-technical level:* The process of agreeing on a shared 'grammar', or in our context 'protocols', as we call it, to able transfer of data and information. But, the meaning of what is being transferred is not in question here.

### 3.4.2 Data-Semantic Level

Meaning and shared understanding. This is the level of standards for data and indicators, data dictionaries and metadata; for example, on procedures for calculating indicators, health facility lists, and coding schemes like ICD10. Data standardisation is the focal point in most standardisation efforts, and in our context of integrated 'data warehouse' architecture.

*At the data-semantic level:* Processes of translation of interests and views, are involved in reaching shared meaning and understanding; for example, between different health programmes, on what should be the important and shared data and indicators.

### 3.4.3 Social System – Organisational-Political Level

This is the level of decision-making, using the power to decide standards at, mainly, the semantic level: the data and indicator standards. The standards for interoperability at the syntactic and semantic levels will also be reflected by 'softer' standards at the

inter-organisational level, in terms of procedures, mandates, responsibilities and job-descriptions needed in order to effectuate the other standards.

*At the social system and organisational level:* Processes of transformation of, in fact, social and organisational structures, in order to align the interests between the actors, and in its' process; so as to accommodate new ways of sharing information across organisational boundaries, implementing new systems and new routines, and shared by several health programmes.

Boundary objects can be used by both sides of the boundary of differences, as a means of negotiating, arriving at, communicating and maintaining shared understanding. For example, they can mediate between two health programmes, working on developing shared routines for collecting and using information. In our context, the various information systems resources, such as the DHIS2, shared by different parts of the health system represents such a boundary object. The example of developing the SDMX-HD standard illustrates the role of DHIS as a boundary object. Demonstrating that data could be shared between DHIS2 'data warehouse' and the iHRIS human resource management system, allows the actors to agree on useful data and indicators to be shared; for example, the provision of indicators on number of patients served by staff for different services and areas. Concrete examples like this, again, make it possible for the different departments and health programmes to explore modes of collaboration, such as between the human resource department of WAHO and the general information unit there.

This example brings us to the most important part of the proposed framework, the need for processes of iterative cycling through the levels, to step-by-step develop a common understanding and alignment of interests. In the example of SDMX-HD, the first cycle has only been on the piloting stage, and for very limited datasets. Numerous cycles will be needed for standards, interoperability and integration in the area of information systems, shared between human resource management and the overall management of health services. And when segments of the interoperability have matured and become 'common sense', there will be new frontiers of piloting and development. Generally, repetitive cycles are needed because consequences cannot be seen and addressed with one try. New agreements and changes are developed through a process. Shared artefacts and methods play an important role as boundary objects, in providing the capacity to negotiate interests and transform knowledge. By cycling through the levels, the aim is to gradually negotiate and solve differences in interests and shared understanding, at the different levels.

An important characteristic with this cyclic prototyping approach is that, generally, problems at the 'higher' semantic and pragmatic levels will need solutions at the levels below in order to be solved. Adapting this strategy of 'cyclic evolution' of standards in the health sector, we may say that the differences in interests between, for example, two health programmes on content of data reporting and ownership to information can be addressed. This will involve the need to negotiate the particular data and indicators to be shared, and include it in the standard setting, at the semantic level, based on practical implementations of how to actually do it at the technical/syntactic level. To take the SDMX-HD example; the ability to solve the interoperability problem, caused the action of defining the data and indicators to be shared at the 'higher' data-semantic level, which triggered the processes of transformation at the 'highest' organisational level, and so the cycles continue.

This cycling between levels is illustrated through an example from Malawi (see Box 3.2). In Malawi, for quite some time, the Expanded Programme on Immunisation (EPI) and the Ministry of Health, were aware of the significant discrepancies in data quality and actual values, for immunised children between their two data collection systems. At the organisational level, they were eager to find a solution, but had no practical way to join or collaborate the systems. The first approach was only to regard the data from EPI to be of best quality, and therefore to be used for official purposes. Only when a practical solution was found for standardisation and co-ordination at the syntactic-technical level, which included the shared data warehouse,

## Box 3.2

## Designing and implementing an integrated HIS in Malawi

*Standardising EPI datasets in Malawi*

During 2000–2002, Malawi went through a HMIS reform, where, following the South African learning, the integration efforts focused on developing minimal datasets consisting of the most important data elements from all health programmes. Paper-based data collection forms were designed for reporting from the health facilities to the districts, and in the districts, the DHIS1.3, was implemented for data capturing and onwards reporting to the national level. Data collection forms and software were implemented country wide from 2002. Given the poor infrastructure in Malawi, data was only reported from the health facilities on a quarterly basis. However, since monthly frequency is regarded to be a better option in order to ensure data quality, the quarterly reports contained the data for each of the three months.

When the reformed HMIS was implemented, it was a good match between both the perceived and the real needs of the users and the information provided by the HMIS. As time passed by, however, the needs of the health programmes developed or changed, while the HMIS stood still, as if cast in stone. They could not adapt to changes over time, where new requirements were not included from users as the needs of the health programmes changed over time. The inability to 'change with the tide' caused users to regard the HMIS, as not fulfilling their needs.

The EPI, for example, re-established their own separate reporting system, as they claimed that the HMIS did not provide them the information they needed. While the HMIS collected only a sub-set of the vaccines provided, for example, DPT1 and DPT3, and not DPT2, the EPI collected all. While HMIS reported data on a quarterly basis, EPI did it on a monthly basis. Furthermore, the data reported through the two channels, EPI and HMIS, differed. While EPI was well resourced with staff and vehicles, and had established their own procedures for data collection from all points of vaccination including outreach clinics in their catchment area each month; the HMIS was less resourced and relied upon the health facilities own reporting, including of the outreach clinics, to the districts, every quarter. The HMIS routines for collecting vaccine data was, thus, less 'thorough' than those of the EPI. Consequently, EPI statistics showed better coverage of their data collection, with 'more data, higher values'. The variations between the figures reported by HMIS and those reported by EPI Programme, together, with the general assumption that the EPI data was of higher quality, resulted in the general sentiments expressed by a range of users, that the data quality was better in the vertical programmes on reporting structures of the EPI, than that of the HMIS.

joint data collection, paper forms and data capture. Only after this solution, could they arrive at shared information management, including the data, indicators and immunisation, which represented standardisation and co-ordination at the semantic level. Finally, co-ordinated and shared management of the information at the semantic level, enabled further co-ordination and sharing at the organisational level. This co-ordination manifested through shared and integrated procedures for various aspects of data collection, information management and shared co-ordination of the official immunisation statistics, for Malawi.

This example from Malawi indicates that practical and flexible solutions at the technical-syntactic level greatly enable harmonisation and standardisation of data, indicators and general information management at the semantic level, which again enable the harmonisation of organisational information procedures. The cycling between these three levels also represents a process of learning by doing.

### General Aspects of Standardisation

The evolutionary 'rule of nature' approach to standardisation, advocated through this cyclic model, is in line with contemporary research on how standards actually develop. Standards are generally seen to evolve through use and by solutions, that over time become 'attractors,' that is, gaining momentum by attracting more and more users, and becoming more and more of 'global' standards. Bureaucratic committee based standard-making, is more or less futile, because the process is too slow, while the world is changing rapidly. Besides, emphasis is on organisational-political considerations rather than the flexibility of use. Standards need to be flexible, in order to adapt to a changing world, to remain 'attractors'.

Flexibility allows for standards to be useful, to gain momentum, to grow and to endure. Flexibility can be understood across two-dimensions, termed, use-flexibility and change-flexibility. How can a standard be flexible, is not a standard something that is fixed? Yes and No. For example, the new European Union standard requires all chargers for mobile phones to be interchangeable, that is to be similar in all practical ways, same plugs, connectors, cables, voltage, and so on, and would be regarded as a standard; fixed and rigid. While it has a high level of use-flexibility for all mobile phone users in all contexts; its change-flexibility is nil! In this case, the change-flexibility is low and its use-flexibility is high. In other cases, it may be the high change-flexibility that makes a standard and also, flexible to use. The SDMX-HD standard, for example, which provides the interoperability between the various systems and the data warehouse in our IHIA, is only useful for this purpose, because of its ease to change and adapt to variety of data standards needed to be transmitted or reported, from various systems. If we compare data standards for electronic reporting of data, with the traditional standard for data reporting; the paper form, the difference in terms of change-flexibility becomes obvious. The paper form is like 'cast in stone', in that it is form and content combined, the actual data and the view of the data tied together in the 'pen and the ink' and it is impossible to change. Contrary to the paper form, in the SDMX-HD standard (or any XML format really) the data is represented separate from any representation of it. Therefore, it is flexible in terms of changes in the data to be transferred, contrary to the paper form.

In the next section, we describe cases and practical approaches to data standardisation, using what we have labelled the 'data warehouse' approach.

### 3.5 Data Standardisation, Principles and Cases – A Pivotal Part of the Integrated Health Information Architectures

Developing data and indicator standards in health and related areas, represents complicated processes, as different areas of health services, health programmes, donors and governmental structures, such as states and provinces, will by definition have different views and interests. Standardisation seems to indicate more or less by default, more control being handed over to those higher up in the hierarchy, leaving less flexibility for those situated in the lower levels to pursue their own interests and views. Similarly, the push for integration will tend to imply increased co-ordination, and as for standardisation, more control to those higher up and less independence, for example, the individual health programmes.

The principle of *Hierarchy of Standards*, to be described next, represents an effort to address both:

- *The Paradox of Standardisation*: How to provide simultaneously both the flexibility and control needed to guide the standardisation processes.
- and
- *The Paradox of Integration*: How to provide both co-ordination and independence between actors, such as health programmes.

The rationale for the principle of *Hierarchy of Standards* is, that in the area of health data and information, the lower levels of the health services will generally need more detailed data – that is, larger datasets or longer ‘lists’ of data – in order to support their day-to-day work, than higher levels, in order to support their needs for co-ordination and overall management. For example, while the health facility needs a register of local Tuberculosis patients to ensure proper treatment of each individual patient, the district will only need, say, the number and percentage of patients fully cured or treatment defaulters, in their overall management of the Tuberculosis programme. The principle of the *Hierarchy of Standards*, schematically depicted in the Figure 3.5, as a pyramid, implies the lowest point of entry requires additional and more granular data (most disaggregated), whereas higher the level, more aggregated or lesser granular data.

The pyramid depicting the hierarchy of standards, also represents horizontal and vertical integration, as described in the earlier section on integration. While vertically, the levels of the pyramid represent a sub-set of the levels below and thereby illustrate vertical integration; horizontally, the pyramid consists of distinct datasets that maintain their independence, at the same time are (horizontally) integrated in a shared framework.

We describe the development of this hierarchy principle in practice, from our seminal experience in South Africa. This was developed by the HISP team, as a part of this process of developing the district-based HIS and the DHIS software application. The hierarchy principle is key, to the design on which the DHIS is also based and the general data warehouse design, described in this book. Flexibility is ensured by allowing for ‘freedom’ horizontally in the health system hierarchy, as long as standards are maintained vertically. The central core of the pyramid shows, the ‘essential data and indicators’ required by the national and global levels which all levels below must report, and more generally, every level below has the freedom to add to that core representing their local needs. Horizontally in the hierarchy, multiple domains of data, or datasets, may be envisioned. So, while a state can add some data, they cannot

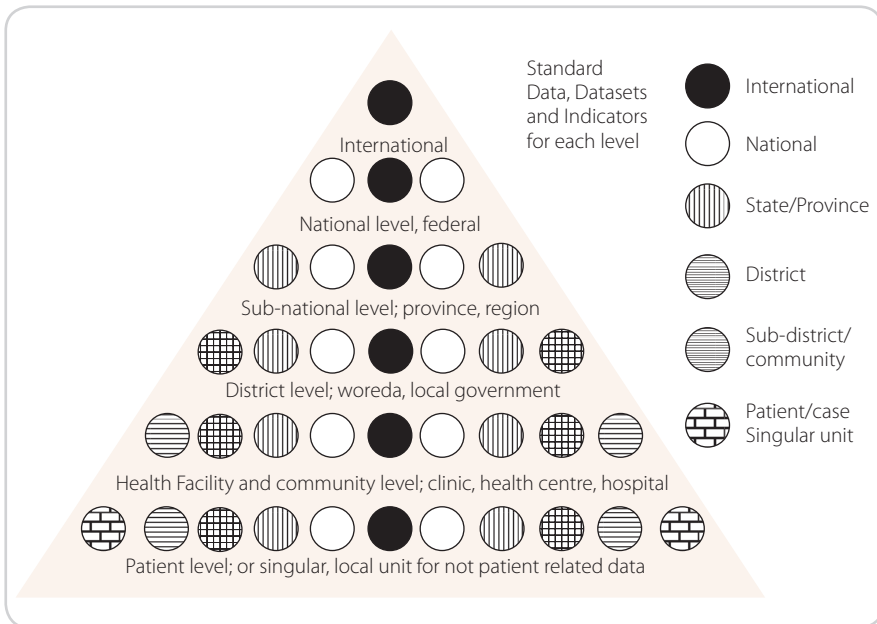


Figure 3.5 Hierarchy of standards

delete what the national level needs, and the added data need not be sent to the national level, but only used for state specific purposes. Similarly, the level below the State (the district) must report on what the State and National levels wants, and in addition can incorporate other data, essential to the local needs. Similar logic holds for the levels below. This approach of 'flexible standards', allows for standards to evolve in a locally relevant manner. This mechanism for local empowerment enables users to view the HIS, as not a tool for top-down control facilitating upward reporting, but as a tool to facilitate local relevance and action. Following this principle, horizontal integration is enabled by, for example, multiple health programmes that can maintain their independence, while at the same time are integrated through the shared management of their datasets in the data warehouse and/or co-ordinating upward reporting.

### Case Study 1: The South African Example

In 1994, as a legacy of apartheid, the new South Africa inherited one of the least equitable health care systems in the world, where 60% of the resources were used by the private sector; serving only about 20% of the population. In order to rectify the wrongs of the past, the new government launched the Reconstruction and Development Programme (RDP), with a title that clearly expresses its intent – The reconstruction and development of communities that suffered under apartheid. The restructuring of the health sector is based on a decentralised system of health districts. Development of a new HIS, to support the restructuring of the health sector was part of this plan.

During apartheid (1948–1993), the health services were extremely fragmented by race, type of service, and the system of 'homelands'. Until May 1994, there were 14 departments of health at the central level: the 'general' Department of National Health

and Population Development, 3 specific 'white,' 'Asian,' and 'coloured' administrations, and 10 for 'blacks,' 'homelands,' and 'self-governing states'.

As a consequence of this fragmentation, there were no comprehensive national standards for data collection, and each province used different datasets, definitions, and standards. Furthermore, apartheid was characterised by extreme inequity in health services provision and health status, between populations and racial groups. Equity in health services provision and health status had therefore become a major political target, in post-apartheid South Africa. The important issue, in this case, was the striving for equity between geographical areas and racial groups, required a system of national standards to measure and monitor the extent to which this policy was achieved, to pinpoint areas where more resources and efforts were needed.

The Health Information Systems Programme (HISP), was initiated as part of the RDP in 1995, with the aim to develop integrated district-based information systems, supporting the new emerging decentralised structures in South Africa. Starting in 3 pilot districts in Cape Town, the focus was on strategising development of shared data standards as a way to counteract the extreme fragmentation of health services and health programmes, serving different population groups that made up the legacy of apartheid. Figure 3.6 illustrates the typical situation in a district in South Africa, where a multitude of different services, all reported to different head offices outside the district, with no information shared or co-ordinated within the district.

The strategy for moving from a fragmented centralised to a decentralised integrated information and management system, is depicted in Figure 3.7, from Atlantis sub-district outside Cape Town; creating a repository for all information being reported

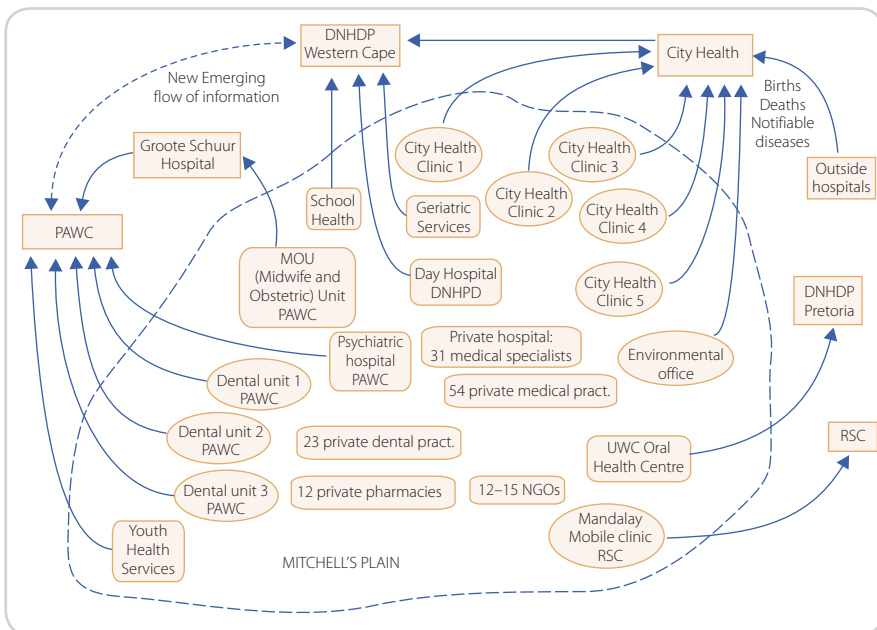


Figure 3.6 Legacy of apartheid; fragmented and centralised data flows, Mitchell's plain district in Cape Town. The figure featured in the document proposing to establish HISP written by the Western Cape Strategic Management Committee, 1994.

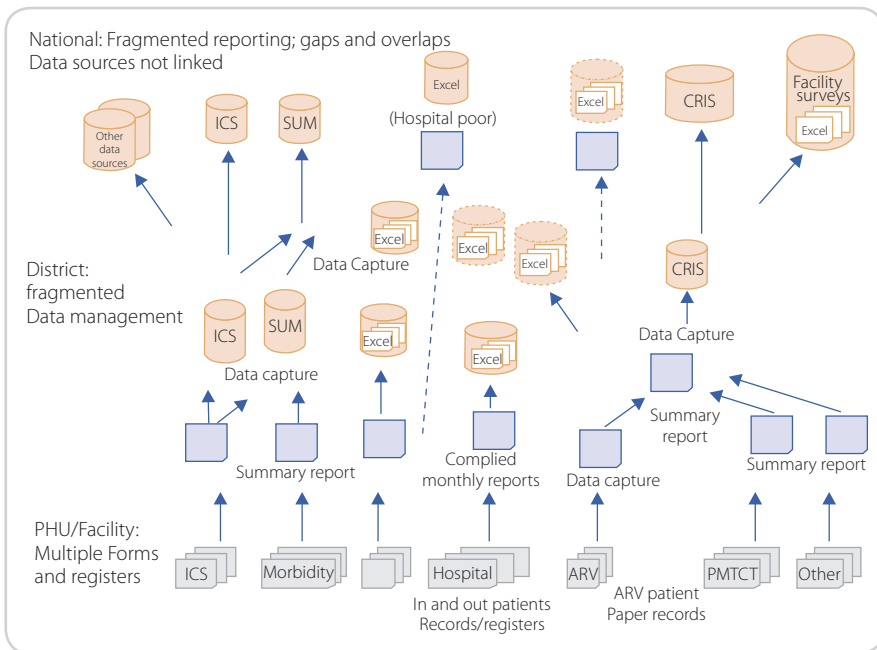


Figure 3.7 Prior to interventions, fragmented health information systems in Sierra Leone

from the district within the district, and shared so that it could be used by all the stakeholders. In this book, we label this as the 'data warehouse strategy'.

HISP was responsible for efforts towards standardisation and software development. Standardisation efforts aimed at developing minimal datasets – a uniform and minimal set of data elements (a dataset), with clear definitions to be reported by all health facilities, using simple paper reporting forms. These were essential so that the data elements could cover the key information needs across, and calculate the most important indicators. Implicit in this approach, was the reporting on minimal dataset to be established, in addition to the data already being collected by the various health programmes and organisational structures. Software development and prototyping efforts led to the creation of the first version of DHIS application, which supported the implementation and use of the minimum datasets.

In order to reach consensus on datasets, widespread negotiations and consultations with different health programmes and services were carried out, starting from the Western Cape Province. After about 9 months of intensive negotiations, driven by local managers in collaboration with the HISP team, the first essential dataset was implemented in all the local government health facilities in the Cape Metropole, in May 1997, and later in the whole of Western Cape. The first version of the DHIS was implemented and used, to capture and analyse monthly data at district, regional, and provincial levels, in Western Cape, from 1998. Simultaneously, in the Eastern Cape Province, a unified monthly minimal dataset was implemented as from January 1998, in all primary health care centres. The DHIS software application was used to manage the new minimum datasets in the two provinces. Interestingly, the two minimum



datasets resulted from two different processes in two different provinces, and were very different with only about 50% overlap. The DHIS had already, at that time, incorporated a flexible metadata structure, that could be used to manage multiple datasets; where the data elements that were the same in both datasets, could be seen as a 'shared' core dataset. The standards that were specific to each province could be seen as a locally defined extension of the shared core, and the concept of organising the datasets in a hierarchy, was born.

In the situation, where there were no shared national standards, and in provinces; no shared provincial standards, the two provinces had developed their own shared standards, followed similar approaches and were managed by the same software application, appearing to be a significant success. From 1999, the DHIS and HISP approaches, were endorsed as official national approaches, and projects to establish provincial datasets and agreed processes were started in all provinces. The first national essential dataset was agreed upon in June 2000. While all the provinces maintained their own extended datasets, the national dataset made up the shared core, where all the provinces needed to collect and report on. This dataset was revised several times since then. Over time, additional data elements were added, either as a process of expanding an existing programme dataset, or to accommodate new vertical programmes (for example, HIV/AIDS programmes). By 2005, it was expanded to become a National Indicator Dataset (NIDS), reflecting the increased focus on the use of indicators, as compared to the earlier focus on data elements.

While some health programmes, such as, within the HIV/AIDS segment, maintained their own full-fledged systems and only provided extracts to the NIDS, and was managed by the DHIS; others, such as the EPI, was fully included in the essential dataset and DHIS2 routines.

In 2000, EPI was collecting 44 data elements through their own system, whereas 5 data elements were collected through the minimal dataset. They then realised that the completeness and overall data quality was much higher for the few data elements being collected through the national 'minimal' system and DHIS, than for the much larger dataset they collected themselves. As a consequence, the EPI reduced their data elements from 44 to 13, and included them in the national reporting system. In this way, the national system grew in strength and quality, and was able to provide to 'everybody' with better data than they had, when each one of them maintained their own system.

### Case Study 2: The Indian Example

From around 2000, the South African approach to integration by using unified dataset and reporting tools, was applied in other countries, typically ones with smaller scale settings. The example of India illustrates how these bottom-up approaches need to be modified and adapted to a more stable and entrenched bureaucratic structure, over a much larger geographical scope.

The HISP initiative from South Africa was adopted first in India, in December 1999, in the state of Andhra Pradesh in the South. Initially, the HISP team, inspired by the South African experience, and may be a little naïve about the 'heavy hand' of the Indian centre, tried to develop minimum datasets following a situation analysis of 12 pilot clinics in one district of the State. However, these attempts were largely unsuccessful as the national mandated datasets could not be modified by the levels below. Even

though health is a state subject in India, historically, the data collection formats have been largely governed by nationally defined vertical health programmes, in which international donors have a significant influence. Unable to make a dent in this process of modification, HISP India then adopted an approach of automating existing formats on an 'as is' basis, hoping that once HISP and DHIS is more deeply entrenched, they may have some leeway in influencing the design of the datasets.

However, the above opportunity did not come through easily, and after 5 years of struggle, HISP was terminated, as the state government in Andhra Pradesh had changed following the elections which also had the fall out of a change in the bureaucratic structures. HISP moved first to Kerala state, and then other states such as Gujarat, Jharkhand, and Madhya Pradesh. In each of the states, it was found that while the state health secretaries agreed to the logic of the 'Minimum Dataset' approach, when it actually came to making concrete changes in what data gets collected and why, they would back off saying that 'we cannot change as the national level wants this data.' So, in all the cases invariably, HISP India designed the respective state applications on a 'as is' basis implying the collection of nearly 2500–3000 data elements on a monthly basis. However, by making data from across programme areas and for the whole state available for analysis, through the DHIS application, important lessons on data quality and the eventual usefulness of the various data were drawn by a multitude of stakeholders; lessons that later provided valuable input in the national reform process.

In response to the grim state in the country of public health indicators, despite the achievements in the economic growth sphere, in 2005 the National Rural Health Mission (NRHM) was launched. The NRHM had the explicit aim of bringing about architectural corrections, within a health systems framework, in order to make health care, especially to the marginalised poor – more equitable, affordable and accountable. Amongst the health systems identified for introducing these architectural corrections was the area of HIS, including making these systems more integrated, decentralised and supporting of evidence-based decision-making.

While there had been previously (prior to 2008) various attempts both through the national level and various states to carry out HIS related reforms, systems remained fragmented and data driven. In 2008, another initiative was taken on re-design, which took technical inputs from the HISP India team, and also another public health expert who had been deeply involved in the HISP process in South Africa. The re-design started with a situation analysis of the HMIS of 4 to 5 states to identify the existing systemic problems. This analysis led to an inductively derived set of design principles, which could be applied to HIS re-design including to datasets, reporting formats, indicator lists, and feedback cycles, as well as, the DHIS 'data warehouse' application.

In carrying out the situation analysis, HMIS data from some states was analysed for 2007–2008. The problems identified across these states were quite uniform; a very high number of data elements being collected, of which a high number of zeros or blanks were reported (ranging from 50 to 60%). While a lot of data elements were being routinely collected, less than 5% of them were actually being used for the generation of indicators, reflecting very poor utilisation of information for action. Further, a lot of disaggregated data was being collected (for example, each data element being broken up by caste groups – Schedule Castes, Schedule Tribes, and Others) on a routine basis, which would arguably be better off being collected on an

annual basis through surveys. Another systemic challenge which existed in the HMIS, was the historical practice, of field nurses collecting 'area-based data', which involved them going to the houses and collecting information, such as, if a delivery has taken place, and recording it even though it may have taken place in a facility (like at a hospital or medical college) that may even be outside the jurisdiction of the nurse. A problem of duplication would then arise, as the same delivery noted by the nurse, would have also been recorded by the hospital or medical college, where the delivery physically took place.

To address these identified problems at a systemic level, HMIS guiding principles were inductively derived to help design, based on the overall philosophy of developing a HMIS that could support the broader NRHM agenda of decentralisation, integration and use of information for action. These principles included reducing duplication of reporting, use of surveys for collecting data not used routinely, build the HMIS on indicators rather than raw numbers, and establish a hierarchy of indicators for the different levels, as in South Africa.

After a long period of intensive negotiation across the different divisions, in the Ministry of Health, some decisions on re-design were taken, which led to a nearly 80 to 90% reduction of data elements to what existed earlier. Two of the national programmes (Immunisation and Blindness Control) were integrated into the existing routine HMIS. With other national programmes (for example, Tuberculosis and Malaria) basically adopted the strategy of 'wait and watch' to see how the new HMIS would fare, before deciding whether or not they would agree to integrate. Till then, it was decided to adopt a strategy of 'reverse integration', where the core indicators required from the disease programmes would be imported from their systems, electronically or manually, as the case may be into the national HMIS.

In this way, the national HMIS was re-designed with the aim of simplification, integration and also decentralisation. *Simplification* came in the form of reduction of data elements, the creation of facility specific datasets, and clearly distinguishing between recording and reporting formats. *Integration* came with the incorporation of datasets from two of the existing vertical programmes into the routine HMIS, and agreeing on a phased strategy for the other programmes. *Decentralisation* was designed by reducing the workload of field workers, with respect to the amount of data they had to collect; and setting up an environment where they could focus more on how they could use indicators to manage their everyday processes. The entire set of new recording and reporting formats were then under signature from the then Mission Director, NRHM, sent to all the states with the instructions that they should immediately switch over to the new formats, and all the existing formats (except those disease specific programmes, not yet integrated in the HMIS), would need to be discontinued with immediate effect.

The Indian example, in contrast to the South African case, was a top-down national level driven initiative. While in South Africa, the climate and political will was to create 'new systems'; in India, it was an attempt to make changes within a deeply entrenched system, in which various stakeholders preferred the 'status quo'. Standards established in India included the data elements, datasets, reporting formats and reporting relationships – a mix of technical and practice related. The case of standardisation in South Africa, and to some extent also in the case of India, emphasised flexibility in standard setting *vertically* in the hierarchy, analogue to what we have labelled vertical integration. For example, integrating the line of management from the policy setting and managerial

levels, to the peripheral operational levels. In the standard setting, you are free to add your own standards, for your own domain, which may include levels below, as long as you adhere to the standards of the level above. Vertical integration is very much about managing levels of granularity and levels of aggregation. In the India case, what could not be effectively agreed was on the hierarchy of information, with the national statistics division insisting on receiving all the data that was being collected at the facility level. This insistence on receiving 'monitoring' instead of 'evaluation' data, which by design could not be useful to convert to action.

### Case Study 3: The Sierra Leone case

In 2002, the civil war that had raged Sierra Leone since 1990 was declared over. Having cost 50,000 lives, and made many more refugees, the war had a devastating impact on the small West African country, which is currently ranked among the *last* on the United Nation's development index.

Sierra Leone is the HMN pilot country, for HMIS. The HMN formed a strong partnership with the Ministry of Health in 2005, thus, forming a solid political base for the integration project. After an initial HIS assessment revealed substantial challenges in relation to a myriad of data reporting structures, and weak ministerial data management, HISP got involved in developing a detailed plan of action during the last half of 2007, the implementation of which commenced in early 2008. Two efforts to integrate data reporting, had been carried out the previous two years, each of them consisted of the development of a new paper reporting form that included parts of other forms and datasets; and a computer database, to capture the data. The most recent integration effort was from early 2007, which focused on Mother and Child Health and immunisation services, and came with a customised database application based on EpiInfo. It was partly overlapping the preceding integration effort, which also included disease data, still in use, with the database application. In addition, came several other forms overlapping both of the initiatives. Numerous errors and inconsistencies were identified, but the developers had left the country, and the effort had no more funds. Furthermore, the UNAIDS CRIS application for HIV/AIDS data was implemented in all districts, but also overlapped with other systems on Mother and Child Health data.

The situation by early 2008 was, thus, that in a typical district information office, there were three software applications in little use, each capturing datasets overlapping with all the others, no communication between the applications, and many more data collection forms not captured by any software. 'Isn't it possible to get all this data into one database? Can DHIS do that?' were the initial questions, we were asked by the Ministry of Health, when we started the planning in 2007. In order to respond to this request, we started to set up the DHIS, as a data warehouse to be used at the district level, which could extract and load data from the three other systems. This rather complex approach, given the state of the technical infrastructure at the district level, was selected, in order not to offend the various system owners. However, as things developed during 2008, it turned out, that most districts stopped using the HIV/AIDS system CRIS; the HIV/AIDS staff employed by UNAIDS got on several occasions, the salary of the information officers, who then did not want to enter the data themselves; 'why do not they do it themselves, they do not have that much work to do!', was a statement made by one information officer. Also the EpiInfo project ran out of funding and stopped. As a consequence, the decision was taken to replace all applications with the DHIS2, as it was rolled out to the districts.

Given the fragmented, overlapping and inconsistent character of the existing datasets, a major effort went into designing a data structure in the DHIS2, that enabled the capturing of all the data from the paper forms in use through a computer user interface mimicking each of the forms, while at the same time solving the inconsistencies behind the scene, in the database. Overlapping data that had been entered for one paper form using the corresponding 'computer form' would then show up in the other computer forms it belonged to, without having to be entered into the database again. A consistent maximum dataset had been derived from the multitude of overlapping forms.

Following a 2 times 3 weeks training, of all district and national information officers in May and June, 2008, a major effort was directed to get all the data captured in the district, to be reported electronically to the national database. The most important result had been the documentation of the quality of data including the completeness. The most advanced district information officers were instrumental in spreading the lesson that, 'we can get all the data from all the forms into one database, why do we still have all these overlapping and complicated paper forms?' For the first time, all the data collected were available in one database, which again convinced all stakeholders that it was actually possible to harmonise and integrate the data reporting from all programmes. A revised set of data collection forms was drafted and circulated among stakeholders for feedback; alongside a drafted list of indicators with definitions of the data, needed to calculate them. In January 2009, a workshop with all the important stakeholders, programme managers and district representatives, agreed on revised and integrated data collection tools and data and indicator sets. Given that there were some refinements to these collection tools, and the time it took to print and distribute them, these new forms were in effect in all facilities, from January 2010.

As the new data collection forms were developed over the summer of 2009, the project started to approach the various international agencies, involved in health service delivery in Sierra Leone. The districts, which for the first time not just had most of their data available in one data warehouse, but also had electronic tools to ease the analysis and dissemination of this data, had been given extensive training in the use of information. Some best performing districts had started to engage civil society to improve their health indicators, a process that was fuelled by the national level publishing league tables, ranking the districts on key indicators. UNICEF was the first major international organisation that pledged to support the data warehouse structure, and drop their own parallel reporting systems, with others also following suit. This integration at the organisational level was only made possible by creating an attractor; a system that had proven results in data completeness and quality. By the second quarter of 2009, the percentage of facilities that had reported the main data collection form, reached above 90% for 7 out of 13 districts, up from 4 districts the quarter before. It was exactly this proven ability to increase data completeness that convinced the health development partners to support the DHIS2. This was not just the software by itself that increased completeness, it was supported by the whole enabling structure of capacity building, information products, and quite aggressive dissemination of feedback to districts to create an environment of friendly competition and peer pressure. All these efforts contributed to making the health development partners to accept the standards implemented in the software.

The Sierra Leone example shows the power of the whole 'data warehouse' approach to develop data standards in practice. With firstly, enabling the pulling in of all data

from different sources into the DHIS2, and then using its analytical capabilities to make visible the problems of redundancies and gaps; a stronger motivation and buy in, for the stakeholders to agree on data standards.

The three cases; all demonstrate that defining and implementing standards is a socio-political process, far from being a neat technical exercise. Standards cannot be dropped down from the top, but need to emerge in and through practice. The most effective form of practice seems to be the ability to make visible the problems, and allow the stakeholders themselves to come to an agreement on the need to standardise. This allows for ownership to develop, which is essential for the standards to get embedded in practice.

### Summary

Key concepts that can be taken from this chapter are summarised below:

1. Integration is not about creating one big technical system, as user perspectives will always vary. The definition of integration in the organisational context, takes the users needs of the HIS, the purposes of the HIS, and the wider organisational perspectives as points of departure, and relate those to goals of better efficiency, effectiveness and co-ordination in organisations and enterprises. In such a perspective, interoperability is one of the means to achieve such ends – integration.
2. Interoperability, contrary to integration, is a term with a more formal definition. In our context, interoperability refers to the ability of a system to use and share information or functionality, of another system by adhering to common standards.
3. The SDMX-HD standard being carried forward by WHO describes the essence of interoperability. Sharing data requires two 'levels' of standards, a shared format or protocol and data definition and meaning. SDMX.HD provides the protocols for sharing data.
4. A 'data warehouse' will enable both integration and interoperability of data. iHRIS and OpenMRS data interoperate with DHIS2, and the DHIS2 enables the integration of iHRIS and OpenMRS, by providing a common platform to join their data.
5. The European interoperability framework is described over three levels: Organisational, Semantic and Technical.
6. Integration can be conceptualised across horizontal and vertical dimensions. While horizontal involves integrating further business domains, vertical is concerned with levels of hierarchy.
7. Standardisation is fundamental and a pre-condition to both integration and interoperability.
8. Standardisation is a technical-institutional process, which takes place in everyday practice.
9. The principle of hierarchy of standards, provides a practical framework in which, standards can be created in the context of diversity, and provides a means of flexibility, as against central control, which standards imply.

## Reference

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# 4

## Strategies for Scaling of Integrated Health Information Architectures

In the earlier chapters, we presented concepts, principles and components of an IHIA, as a framework within which HIS may be designed, developed and implemented. Building on this discussion, here, in this chapter we address the next step – strategies, whereby these systems and architectures may be spread out and taken into use, in a country or a state, successively in all districts in a state, in all facilities in a district, and in all hospitals in a state or country, covering different user groups and technologies. We call this scaling.

The chapter is divided into four key sections. In the first, we describe the principles for scaling of IHIAs, arguing that this is more about the scaling of design principles than of ‘boxes.’ Since the IHIA is not ‘fixed’ and pre-defined at the outset, it needs to expand and develop organically in a paced manner, according to the local context and the opportunities available. The design principles outlined will help to understand how this scaling challenge can be approached.

The second section, describes the dimensions of scaling. Conceptually, we distinguish between vertical and horizontal processes. Vertically is ‘down’ the health hierarchy, from national and state to district, and the various sub-district levels of the health facilities and communities, and finally to the level of the patient or a beneficiary of a particular health programme. These different levels are associated with different granularities of data and information needs, and also the comprehensiveness of the solutions provided. The horizontal processes refers to the ‘scope’ of services and functional areas, included in the IHIA, as well as, the geographical scope of coverage; for example, from one pilot hospital, or pilot districts to all hospitals and districts in the state, or successively to include new programmes. Horizontal processes also include the incorporation of different technologies, as the IHIA increases in scope and functionalities.

The third section, describes the particular challenges of scaling ICT based solutions in developing countries, where the technical infrastructure and human resources are unevenly developed across various dimensions, such as urban and rural, rich and poor, politically advantaged and marginalised, and well funded and neglected health programmes. Such dichotomies, which are inherent in the context of developing countries, in general, and the health system in particular, makes scaling of uniform ICT solutions impossible and emphasises the need for context sensitive scaling approaches.

Finally, the fourth section focuses on strategies for scaling, describing the importance of creating attractors, for change as part of an evolutionary approach. This involves the creation of initial success and its demonstration, in order to rally scarce resources and



political support for the process, and thereby to create more success and strengthen the attractor further. Case examples are provided to demonstrate the practical benefits of such an approach.

## 4.1 Scaling of IHIA – Scaling of Design Principles, Not Boxes

Scaling is often conceptualised in a rather static and stand-alone manner, concerning how a system used in one location can be replicated in other settings. We see such an approach to focus on the ‘boxes’ or the technologies being used, rather than the underlying processes through which such circulation takes place or not. Our focus in conceptualising scaling, is on the processes underlying the spreading out and expanding of the IHIA around the different dimensions of technology and institutional use of information. This will include aspects of the three layers of the IHIA, such as organisational work practices; for example, training materials and approaches, datasets and data collection tools, software applications, and other components of the HIS including the technologies and the capacities to use them. Scaling is generally used to denote the quantitative and mechanical expansion of the system in scope, size and number of users. However, we will, in line with our three levels IHIA, distinguish between the quantitative, structural and mechanical dimensions on the one hand and the more people centred qualitative, process-oriented and social system dimensions of scaling, on the other hand.

**Quantitative, Mechanical, Structural Dimensions of Scaling:** Here, we not only include the traditional expansion of the system in scope, size and number of users, but also the expansion of the system down in the hierarchy of the health system. Also, the inclusion of increasing number of health programmes and systems, in granularity of data, and in comprehensiveness of the architecture and systems taken into use.

**Qualitative, Social System, Process-Oriented Dimension of Scaling:** Here, we include the increase and expansion of quality of the use of information, the extent to which individual and institutional users are taking part in the development of the system, maturity of the users, and their feelings and sense of ownership to the system.

### 4.1.1 Cultivation of Social Systems and Improvisation

The concept of cultivation, in contrast to construction, denotes a way of shaping technology that is fundamentally different from rational planning, engineering methods and the construction of technology. A rational process will assume linearity in how system requirements are first frozen and then developed. In reality, requirements can never be frozen – they always change – and thus, need to be ‘cultivated’. Cultivation is about interfering with, supporting and controlling natural organic processes that are in material; as the seeds sprout, they must be provided with proper cultivation; the soil must be prepared and the saplings cared for, nourished, watered and given appropriate sunlight. The term cultivation covers these processes of, and in our case, spreading the principles, tools and basic set-ups of the IHIA to a new place, and then help them to grow into place within the local social system of work practices and technologies, through processes of learning. The IHIA, may thus, be regarded as a socio-technical system, or an organism, with a life of its own, with its ability to learn and grow. The spread of technology is, therefore, better understood as a process of

technology learning, rather than ‘technology transfer’, which metaphorically represents a ‘design from nowhere’. Technology, like institutions, are also shaped through such processes of learning and growing into place. Methodologically, cultivation is characterised by incremental and evolutionary approaches, described in terms of ‘piecemeal engineering’.

The ‘bricoleur’ or ‘tinkerer’ are alternatives to the rational engineer in shaping the design and change processes, following a cultivation approach. Typically, the engineer starts out by defining and specifying his or her goal, then choosing and constructing his tools in order to reach this goal. However, the bricoleur will take the possibilities given by the available tools, situation and other possessions, as the point of departure, and define the goals and way forward, according to that. The bricoleur will improvise out of the possibilities given, by what is in hand and the results might look like patchwork. Particular tools will be used for many purposes. The bricoleur thinks in association to concrete observable things, which helps to remember, while the engineer builds on abstract mathematics and technical drawings. The engineer builds abstractions on abstractions, where the bricoleur builds abstractions on observations. In developing the HIS and the IHIA, a bricolage approach allows and encourages tinkering by people close to the operational level, that is by combining and applying known tools and routines at hand to solve new problems. The value of tinkering lies in keeping the development, or ‘cultivation’ of the information system and the IHIA, close to the competencies of the organisation and its ongoing fluctuations in local practices. Evolutionary and participatory approaches have a bricolage approach, inherent by their flexibility and multiple ways to address cultivation and user participation. The bricoleur is the roadside ‘bush’ mechanic you meet in Africa who gets the car going by the way of ‘magic’ or by whatever is at hand in an improvised way. Due to contextual constraints, bricolage is particularly appropriate in developing countries, where local resources and potentials form the point of departure.

Given the extreme heterogeneity of the technical and human resource infrastructure in developing countries, scaling approaches need to be flexible and allow for different paces, according to the socio-technical and institutional contexts available. We argue against a perspective, which regards scaling as a property of complex systems, in which one part of the system reproduces the same structure and patterns that appear in other parts of the system. Broccoli is used as an example here, of scaling, in a natural system as branches and sub-branches have the same structure as the whole plant. This perspective on scaling is limited to the replication of the same, which implies in our context, a fully standardised package being replicated in a fully standardised context; consisting then of the same infrastructure, human resources situation, and sociocultural conditions across the various settings, in which scaling is taking place. Such replication is not possible.

#### 4.1.2 Scaling and Poor Infrastructure

There are particular challenges related to the scaling of systems, in developing countries. The fact that technical infrastructure is very unevenly distributed between, for example, rural and urban areas, poses a particular challenge when scaling computer-based and networked solutions, for uniform implementation in a country. For example, currently while planning for the use of a General Packet Radio Service (GPRS) based mobile application in Himachal Pradesh in India, we had to consider, some of those remote districts that would not receive the GPRS connectivity, to then have the

state application to cater to both GPRS and SMS based solutions. Similarly, when the HMN Technical Framework, advises countries to implement a central data repository; receiving data electronically from subsystems and the peripheral levels, it presupposes both uniform access to the Internet and that sub-systems are computer-based. This assumption is rarely valid, since data sources are often paper-based, as is the dominant tendency in Africa and even in various parts of India. Therefore, new ICT based solutions need to be established and interoperability created based on the available infrastructure, which ranges from a complete lack of power and connectivity through portable data systems, such as USB memory sticks all the way to mobile networks and the Internet. We give below, an example from a northern state in India.

Box 4.1 also emphasises the need to take a process perspective on scaling, rather than, treating it as a one time event of expansion. In this case, scaling decisions and outcomes were shaped by the institutionalisation of existing processes (such as the stability of existing reporting system), availability of infrastructure, and the intentions of the state to access disaggregated data. At another level, the hilly terrains of the state and the challenges of both physical and electronic access had an important bearing on shaping the scaling processes.

Box 4.1

Addressing the challenge of scaling in a context of uneven infrastructure

#### *Uttarakhand – Scaling and Uneven Infrastructure*

Uttarakhand is a state in Northern India, which has various districts nesting in the foothills of the Himalayas, making access, both physically and electronically, a challenge. The state started to implement DHIS2 for their state HMIS, in December 2008, initially based on a district model. This implied that each district would get their different facilities to submit on paper their monthly reports, to the district HMIS officer, who was then responsible for manually aggregating the report for the district, and then entering it into the DHIS2, which was deployed over the state server.

After about six months as the district-based process of reporting was stabilised, the state took the next step of scaling, by getting sub-district (called Block) based data. The list of all the blocks by districts was provided and these details were included in the organisation unit hierarchy in the database. Now, we had all the districts and within each, all the blocks were included. In the next step, each block now made a block consolidated report for the month (including all the data from the Primary Health Centres and Sub Centres in the block) on paper and sent it to the district office, where data was now entered electronically at the district level, but by blocks. The district consolidated report was generated electronically by the DHIS2, and in this way the state and district managers could drill down to the blocks, to identify performance issues.

Once this process was stabilised, the state took the bold decision to now scale the systems one step further: by now getting data disaggregated by particular facilities in the block. For this, it was important to do the data entry at the block itself, otherwise the load of data entry at the district, would be huge. However, while computers were available in the block level, internet connectivity did not allow online data entry at the block level. To deal with this, offline installations of DHIS2 were made for each of the 88 blocks in the state, which had the particular hierarchies (PHCs and Sub Centres)

preconfigured in the installers for each block. These installers were then installed in the respective block computers, training was provided to the staff on how to enter data by their respective facilities and export the monthly data into a file, which would either be saved on a USB stick and sent physically to the corresponding district, or by e-mail using a dial-up connection. At the district office, this data would be imported into the online application, which would then be hosted on the server.

The possibility to drill down to the facility level helps to set in place various other processes, such as examining of data quality by facilities, establishing and strengthening of feedback and supervisory processes, and also allowing for the analysis of health status indicators by the facilities. This requires the maturing of user capabilities, and simultaneously, the scaling of the processes of capacity building – both in terms of the geographical coverage and the content of training. And as the state develops confidence in their HMIS related processes, they may consider including additional datasets in the application that would cater to the state reporting requirements in the future, in addition to the existing national reporting datasets currently included in the HMIS.

In this way, the challenge of very uneven ICT infrastructure, even within the same district and block, could be addressed using a mix of varying technological solutions, and synchronising it with different institutional practices to match these revised technical configurations.

So the challenge in front, is how to scale a ‘whole’ integrated architecture, the IHIA, in a setting that is characterised by differences in technical and human infrastructure, and where scaling of uniform solutions is not possible. The answer is, by focusing on the scaling of architecture, in terms of the underlying principles and not the boxes. If we combine scalability and comprehensiveness, meaning a long-term vision of the integrated architecture to be in place from the outset, it must allow for stepwise development that does not compromise further expansion. Therefore, the architecture is not cast in stone, it is never a finished product, it needs to develop according to institutional learning and changes in technologies and needs, and be open to leverage on opportunistic conditions. The need for scalable strategies applies also to the comprehensiveness of solutions. The pace of expanding the architecture along the vertical and horizontal axes, on one hand, will depend upon the combination of the evolving maturity and readiness of the ‘target’ system in terms of human resources, institutional learning and infrastructure. While, on the other hand, the development of the overall architecture, in terms of the design, particular open source components being used, and the more general technological development strategies being used.

The architecture will, in most cases, not develop uniformly in all areas and across the different dimensions. There will always be lead examples and best practices paving the way, but due to various constraints, the others may not be able to follow. For example, the HIV/AIDS area will typically take the lead on medical records, paving the way for other patient groups segments to be implemented later. However, HIV/AIDS programmes are usually better resourced, than others, such as, TB and Malaria control. Integrated datasets, and national and district data warehouses, will start with essential indicators on some, but not all relevant areas; geographical and administrative regions may develop at different paces depending on infrastructure

and maturity. The key issue, however, is that the various scaling processes need to develop within an interoperable and integrated framework, which underlies the IHIA. The heart of this strategy is to not limit the focus of scaling to singular independent solutions, but on the design principles of the architecture and their embodiment, in simple but concrete instances. Based on our empirical experiences, we inductively propose design principles both around the two-dimensions of the IHIA, outlined in the beginning of this section. These are summarised in Box 4.2.

Box 4.2

Design principles for a scalable IHIA – quantitative and qualitative dimensions

*Structure, Technical System, Quantitative Dimension: Components of the Scalable IHIA*

- Agreed data standards and integrated data and indicator sets, represent the primary building block of the IHIA. Data standards need to develop, according to the user's needs and be flexible to adapt to a changing context, and expanded and changed with the addition of new data and datasets.
- Develop based on a data warehouse framework, or data repository for aggregate data, which provides the means to manage the data and integrate the various datasets and sub-systems. The data warehouse needs to be expandable and flexible, and cater to both data management and information usage.
- Integrate and manage datasets as they are emerging, changing and developing.
- Present and make data available according to domain knowledge and 'business intelligence', as user needs are developing and emerging.
- Establishing interoperability and data exchange using standards, and through the provision of gateways between the data warehouse and the sources of data, whether they are based on paper, computer or other electronic means. One such standard to enable data exchange is SDMX-HD, which helps to provide a 'plug-in' to sub-systems and data sources.
- Designing for modularity; since complexity is managed by enabling sub-systems and data sources to plug-in (or out) of the data warehouse, through the use of appropriately designed datasets and means for data exchange (paper or computer-based).
- The use of Free and Open Source Software (FOSS) and Open Standards. It is important that the system development is based on the use of mature FOSS components, and supports both web-based and offline deployments. FOSS contributes to the scalability; as there are no license transaction cost; and 'small letters', it makes for the threshold to: test, try and eventually implement the components. 'Open standards' are devoid of intellectual property constraints, and which enjoy legitimacy through open, fair and participatory development and maintenance arrangements, by not-for profit agencies.
- While the spread of replicable processes is enabled by standards; standards also constrain, as same solutions cannot easily be implemented uniformly across unevenly developed infrastructure in developing countries.

*Process, Social System, Qualitative Dimension: Scaling and Cultivation Approaches*

- User participation, learning and local empowerment. To get users at all levels committed, and foster a sense of ownership to information and system.
- 'Radical change through small steps.' Adopt an evolutionary strategy, start small and grow big(ger) as users learn and see the potentials.
- Going first, for the lower hanging fruits which are easy to reach, before moving up the tree. Getting bogged down with complicated problems from the outset will reduce user confidence.
- Scale the architecture gradually along the vertical and horizontal axes, depending on users, and institutional readiness and learning, according to available infrastructure.
- Create 'attractors' by establishing initial success, which serves as the best way to enroll more actors and user organisations, and thereby rallying scarce resources to increase the success. Focus on solving specific large problems shared by many, rather than addressing 'all problems,' or specific problems which do not affect many.
- Flexibility: Data standards, data warehouse and means of data exchange need to be flexible; to enable change according to redefinition of needs, infrastructure and overall context.
- The architecture can never be developed (or constructed) right from scratch, the existing installed base needs to be nurtured and cultivated, so that it evolves and scales over time taking advantage of existing capabilities.

## 4.2 Scaling as Horizontal Spreading of Replicable Vertical Processes

While in the last section, we presented a model of scaling of the IHIA, as the scaling of principles rather than boxes, in this section, we take this model one step further and present scaling, as the horizontal and vertical translation of replicable processes and the cultivation of these principles. We distinguish between scaling the architecture through the hierarchy of the health system and geography, on one hand, and scaling as increasing the comprehensiveness of the architecture and its technical solutions, on the other.

- *Scaling the Architecture Through Geography and Health Structures:* While horizontal denotes diffusion to new places at the same level of the hierarchy, vertical denotes the process of cultivating the principles and architecture components by growing vertically, translating them into context and creating the need of a complete social system present at one location. Vertical also illustrates, the movement down the hierarchy to new levels of the health system, such as from districts to sub-districts, where the horizontal and vertical processes are repeated; and the movement upwards, through the processes from facilities to sub-districts and districts.
- *Scaling as Increasing the Scope and Comprehensiveness of the Architecture and its Technical Solutions:* Horizontal and vertical scaling also represents a good model for increasing the comprehensiveness of the technical solutions of the architecture.

While vertical denotes increased granularity of the data being managed, such as, adding medical records and interoperability where before only aggregate data was reported; horizontal denotes the expansion of the systems horizontally, by including more health programmes and health services, or by simply, expanding the datasets. Scaling of technical solutions also involves development of new functionality to already existing data sources, such as, new analytical modules like GIS or data integrity checks.

- *Scaling as Increasing the Depth and Grounding of the System:* This involves increasing the quality of use of information – cultivating the system in the context of use. This is first about the appropriation of the system amongst users and grounding; to form it in the context of use. This can only be achieved through user participation and the creation of a sense of ownership to the information and the system, by the users. These processes, of translating the technical aspects of the IHIA into the dynamics of the social context of use; are the concrete local instances of translation, following the horizontal scaling from locality to locality. We focus on one dimension of this local translation – the quality of use. Here we apply the TALI tool (See Annexure 1), which helps to distinguish 3 levels of quality of information use:

*Level 1:* Achieve basic technical functionalities at each level of the system; if data flows, including feedback, are working; and, data quality and data completeness are acceptable.

*Level 2:* Achieve active analysis, use and dissemination of data. Graphs, reports, maps, and so on, presenting data is used; for example, on the walls in facilities and in meetings.

*Level 3:* Data used to influence decision-making, planning and evaluation of the performance.

#### 4.2.1 Debating Dimensions of Scaling

Metaphorically, the vertical and horizontal expansions of the systems are taken from historic battlefields; where armies would expand into territories 'horizontally', and dig down to consolidate 'vertically'. Another way to look at this dichotomy, is to regard the horizontal movement as expansion in quantity, or width, and the vertical movement, in quality, or depth. The usefulness and relevance of using this dichotomy of horizontal – vertical, or quantity – quality, or width – depth dimensions, is to emphasise on the point that an expansion in scope will always need to be followed by efforts to sustain the system, through improved quality of use and heightened capacity development. When scaling an IHIA in scope, to new domains of use (for example, to include human resource management or logistics in the IHIA), or to new geographical or physical locations (for example, to new states, districts, facilities or wards in a hospital), consolidation and gradual improvement of the system will always need to be part of the overall process. Furthermore, improved quality of use, which also implies more use and increased learning about the potentials and limitations of the current system, will lead to gradual improvements and further expansion of the system. Along the qualitative social system axis, the key part of the vertical scaling is, therefore, through cultivation: to ground the system among the users, create a sense of ownership to the system, and to improve the quality of use of data.

There is also, however, a quantitative and technical dimension of vertical scaling. Vertical scaling also denotes an expansion of the systems, literally downwards in the hierarchy of the health system, for example, in India the first computer-based HMIS was introduced at the state level, then successively in districts, sub-districts, PHCs, and finally, in the Sub Centres, as we included mobile phone reporting as part of the computer-based HMIS, or IHIA. Furthermore, vertical scaling of computer-based resources is also the movement down, the 'data hierarchy' of the IHIA, from aggregate data to individual or case based 'disaggregate' data; from aggregate data reporting to medical records systems, which is increased granularity of data managed in the databases.

It is important to note, however, that technical scaling, vertically in the health system hierarchy, is most of all about users' learning, capacity building and increased quality in data use. For example, vertical scaling is provided from the district to the Sub Centre, and in the data hierarchy, from aggregate HMIS data to medical records system. When a system is introduced, data quality and data use will generally be at the basic level, and a key part of the efforts to strengthen the system, will be directed towards improving quality and use. Capacity building and support, are the key issues in efforts to improve information usage, and will always make up the major part of budgets and resources, needed for scaling systems. What is important to note here, is that scaling a system vertically 'down' the hierarchy, exponentially increases the number of users, and with it the demand for training and capacity building. The key part of vertical scaling, is to ground the system among the users, create a sense of ownership to the system, and improve the quality of data use.

If the key components and design principles are in place, such as agreed datasets, FOSS based tools and procedures for collection or extraction of data, standards such as the SDMX-HD, ad hoc gateways to enable data exchange, and a data warehouse to support data management; the boxes or sub-systems may 'grow' from paper registers to electronic systems, and new boxes 'plug in' to grow into place. As an example of such a scaling strategy, the initial HMIS for routine data reporting serves as a starting point, or the backbone from which the architecture may expand both horizontally and vertically. The HMIS typically includes a number of data elements to be reported, which are organised into datasets, such as outpatient data, immunisation data, reproductive and child health data. Datasets are implemented in the data warehouse, like the DHIS2, which serves as an umbrella or framework, to further expand the architecture. Each one of the included datasets may start out as being relatively limited where the data sources will typically be paper-based registers. Scaling will involve the expansion of these datasets, using more robust technological solutions, and increasing the usability of datasets to a larger community of users.

Expansions of this basic architecture may be illustrated in the following way:

First, a new dataset on human resources is added, made-up by number and categories of staff. This dataset is customised in the DHIS2, and is also reported on paper. We call this the expansion of scope, as more datasets representing a horizontal scaling of the IHIA, are included.

Second, a human resource management database application is established, using the iHRIS software, which facilitates the management of data based on individual records.



Furthermore, a summary of human resource data is exported, using for example, the SDMX-HD standard, to the DHIS2 based data warehouse. We call this the 'downward' expansion of the architecture for vertical scaling; as computer-based management of human resource data is expanded one level down from only being based on aggregate data to also include individual data, making the data more granular and providing the service area (human resources management) with a more comprehensive solution. Introduction of medical records, for example, starting with HIV/AIDS and TB patients, and expanding it to more patient groups, will represent a similar horizontal/vertical scaling of the architecture, as will the introduction of new systems for logistics, drugs management, and laboratories.

In Box 4.3, we summarise the dimensions of scaling discussed.

Box 4.3

Horizontal and vertical scaling as involving processes of translation and cultivation

*Scaling Dimension*

Scaling is summarised, as taking place over horizontal and vertical dimensions – two complementary, yet contrasting 'directions' of the expansion.

*Horizontal Scaling*

*Scaling in Geographical Scope:* Scaling from state to state, from one district to more and all districts, from one hospital to all hospitals in a state, expands the system to all facilities in an area. For example, introducing mobile reporting to all outreach centres in a district. Components of the system, software and standards are also scaled from country to country – from India to Bangladesh, from Sierra Leone to other countries in West Africa.

Horizontal scaling will always involve local adaptation and translation of the specifics of the system and standards, to the local context. Within one district and one state, most systems may be standardised, and more of the same may be replicated. But when scaling to a new state, however, more changes will be necessary; and when moving to a new country, even more.

Standards are crucial, in scaling from one place to another (as without standards, there would have been nothing to replicate), but they will always have to be adapted and translated to the local conditions. The farther away from its origin; administratively, culturally, technically and work-flow-wise, the more changes will be necessary through translation of the new context.

*Scaling in Scope of Services and Functionalities:* Expanding the scope of integrated HIS and architectures, to include more health programmes or service areas, including TB, HIV/AIDS, and other disease specific programmes, in an integrated approach. And expanding the IHIA to include laboratory systems, drug logistics systems, financial systems and human resource management systems. In terms of medical records and name based registries, typical in many countries, starting with key patient groups, such as, AIDS patients on ART and TB patients, expanding to other groups of patients and clients or services. In India, in some states, processes are ongoingly expanding the architecture, to include medical records for hospitals, registration of pregnant women and the newborn for immunisation.

Typically in many countries, there already exists, different health programmes, which have their own existing systems that are not co-ordinated and integrated with other programme-specific systems. Initiatives to introduce integrated HIS and architectures, will ideally start with some core health programmes, such as Mother and Child Health and Vaccination, to gradually include more programme areas.

#### *Vertical Scaling*

*Vertically 'Down' the Hierarchy of the Health System:* A typical vertical scaling of HIS, is to first introduce a database system at a sub-national level in the hierarchy, to capture data submitted on the paper forms aggregated by the level below; for example, systems at the state level, in India capturing data by the district, and in Tanzania and Ethiopia, at the regional level. Thereafter, introducing the system at lower levels in the hierarchy, down to the peripheral unit and health facility, for example, to a ward within the hospital. What's important to note here, is that the number of users and the need for training and support, increases ten-folds for each level, as the system scales down the hierarchy.

*Increasing Comprehensiveness of the System:* Comprehensive refers to the need to provide solutions that meet the needs of each service area and level of the health system; from medical records for patient management, to aggregated data and indicator repositories supporting sub-district, district and higher level management, as well as, national and global monitoring and evaluation.

*Increasing Data Granularity:* Scaling to make database and system management increasingly disaggregated and granular, available to users. The typical situation is that at the global level (for example, WHO), data is analysed and used by the country, at the country level by the state, at the state by the district level, at the district level by the facility, and at the facility, data is managed by patients. Scaling, according to increased granularity is classically then, to ensure data management in the HIS by the facility (and wards in hospitals), and then integrate 'seamlessly' transacting systems (for example, medical records, lab system) in the IHIA, as source of data for the HIS.

More data is needed at (more) local levels than at (more) central levels. The data at local levels is more granular and more disaggregated than at the central level. Data is generated through transaction systems, paper or electronic, at the local level, at the source of data. At higher levels in the hierarchy, more and more aggregated data is required and used.

*Increasing the Depth and Grounding of the System by Increasing Quality of Use of Information and Users' Sense of Ownership to the System:* Scaling as the appropriation of the system amongst the users and grounding the information system 'vertically' in the social system and forming it in the context of use. This can only be achieved through user participation and the creation of a sense of ownership to the information and the system by the users. The TALI tool (see later section) helps to measure the level of quality of information usage, which may be likened to the 'depth' and quality of the information system in the social system.

## Box 4.4

## Scaling in Himachal Pradesh

*Scaling in Himachal Pradesh, India*

The state of Himachal Pradesh signed an agreement with HISP India to design, develop and implement a hospital management system in all their district hospitals (20 in number) in the state. Ten modules were identified (Registration, Billing, Laboratory, Radiology, Outpatient Department (OPD), Inpatient Department (IPD), Finance, Blood Bank, Inventory and Pharmacy) as forming the core set of modules, to be included in the hospital management system. The plan was to design, develop and implement the system first in one hospital (in the state capital), stabilise it and then gradually also scale the system to the other 19 hospitals in the state. This involved scaling along different dimensions.

First, there was module-by-module scaling. HISP first developed the registration and billing modules, deployed it in the hospital, and started getting feedback through use, while simultaneously, worked on the development of other modules. Over a period of about 9 months, all the modules were deployed. This process of expansion can be understood as horizontal scaling, as the system gradually expanded in scope.

Second, a DHIS2 instance for the hospital was established to capture all the hospital semi-permanent data, such as infrastructure, human resources and government norms on infrastructure, human resources and equipment. Data captured through the patient level transactions (such as in registration, OPD and IPD encounters) would then be needed to be aggregated and exported to the DHIS2 hospital based data warehouse using the SDMX-HD standard. By combining the aggregated patient level data with the semi-permanent data hosted in DHIS2, allowed for the generation of indicators such relating to bed occupancy rates, hospital infection rates and other management indicators. Moving from the patient level data to its aggregated form, plugging into the data warehouse, processing and combining this data, can be conceptualised as a form of vertical scaling. The vertical expansion is represented by more comprehensive solutions for the hospital, increased granularity of the data and expansion of the architecture further down the hierarchy first, within the hospital itself, and subsequently the health system, as selected summary data would need to be exported from the hospital server to the state server that would host data for all the 20 hospitals. In the process described, the new datasets inscribed in the different modules in the hospital, represented horizontal expansion, while the development of the medical records system for the hospitals, from where the aggregate data for the hospital datasets were extracted, represented vertical expansion of the architecture.

Third, the scaling process involved a geographical expansion from one hospital to the others, in the state. The system developed in the first hospital serves as a frame of reference, or, the core standards, against which the systems for the other hospitals need to be developed. For example, the fields of data being captured in the hospital were listed down in a checklist, and form the basis of the requirements study in the other hospitals. The state agreed on the core standards being what the state wanted data on, and if other hospitals needed to collect any other data they could, but were not allowed to delete any item from the list of core standards. This process of requirement analysis was used, to scope out the system for each of the other hospitals, and for development to be carried out. The plan was to first try this scaling process in one nearby hospital, to test the process of customising the application to another setting; and to scope out the context free and context dependent elements of the application. Once the process was carried out in one hospital, it was possible to scale out to more than one hospital at a time (say a group of hospitals from adjoining districts).

This process of expansion represents a geographical scaling, which can also be labelled as horizontal scaling. That is, spreading particular solutions, as parts of the architecture, so that they cover a whole district and a whole state. Together, the horizontal and vertical scaling, make up a dialectic relationship where, first, a solution is scaled so that it covers the whole hospital, and then gradually spread to all hospitals in the state, and possibly to other states wanting to adopt the solution. For each administrative unit or location, the architecture is established as a result of horizontal scaling processes of vertical downward expansion.

We take the example of implementation of a hospital management system in Himachal Pradesh, to describe the horizontal and vertical processes of scaling, and how scaling is cultivated bottom up, but at the same time plugged into the 'top-down' vision of the IHIA (Box 4.4). There is a constant and mutual interaction between these bottom up and top down processes that help to ground the IHIA in reality, while giving it the flexibility to evolve as per the constantly changing realities.

As described in the example in Chapter 1, the development and spread of a hospital information system, or the IHIA including the OpenMRS for patient related transactions and the DHIS2 as a data warehouse for aggregate data, is one of the five applications, being implemented in the state, representing the overall IHIA. Vertical scaling with reference to increased granularity of data is illustrated by the gradual inclusion of medical and name-based records systems in the IHIA, and the registration of pregnancies and children for immunisation; first, in one hospital, and then more hospitals. Such expansions of the architecture vertically, in depth, lead to the management of increasingly granular data, providing an appropriate design; the ability to 'drill down' in the data from the district, to the facility to the individual. In each of the places or areas of use, where the new system or functionality was introduced, it needed for it to expand vertically in the hierarchy of the health system. For example, the new system had to expand vertically from the state to the districts, from the districts to the blocks, from the blocks to the PHCs, and finally to the Sub Centre.

Expansions of the IHIA along the vertical and horizontal axes are far from being mere mechanical or quantitative processes of development. However, as described above, as the IHIA is scaled horizontally, processes of translation are needed to 'ground' it, in the local context. Obviously, the 'further' the IHIA is scaled horizontally, the more the context would change; and if the context is changing, standards will need to change; and the more the change in standards, the more profound will be the required processes of translation. The further the IHIA is being scaled along the horizontal axis, the more the changes in the data standards and metadata, broadly speaking, as they would differ. Hence, there is the need for flexible standards. Changes in standards, however, are not only required when moving from one country to another; there are differences between even states and provinces within a country, and a local adaptation would be needed when moving even between districts within a state.

As the need for information, the reason that the IHIA is being evolved, data standards must be regarded as the most important part of the IHIA. In this perspective, the IHIA is a machinery being put in place, to serve the needs for information. The design principles described in the beginning of this chapter, take the data standards as a point of departure. In India, while the central data standards are shared by all states, each state has its own additional data standards and specific requirements. Scaling the IHIA

in India, will therefore be based on a core of data standards shared by all states, with each state, having its adaptation by the way of additional or expanded datasets. If we 'move' beyond India, to Bangladesh, or to countries in Africa, the requirements will be very different. Focusing on the data, we see that the data standards and datasets are also different. But are they so different that we would need to develop a totally new IHIA as we scale further along the horizontal axis, or is it 'more or less the same'?

The integrated architecture framework focusing on management needs, called IHIA, presented in this book, is being developed over about 15 years through practical trials, errors and learnings in numerous countries in Africa and Asia. This varied nature (over geography and time) of inscribed experience, makes the framework robust and well grounded. There are two general reasons for this robustness. First, the context of global health is to some degree standardised across countries, among other things, due to the influence of and from international agencies such as the WHO. Second, the IHIA, while building on these standardised aspects of global health, provides design principles and a framework, rather than technical solutions. While the data warehouse, the DHIS2 in our case, is a technical solution in its various concrete instances and installations; at the outset, it simply is an empty shell that includes a toolkit with which building the metadata and functionalities of the data warehouse is possible, playing an essential part in the IHIA. In fact, the DHIS is, the toolkit and drawing board with which the IHIA is being evolved through successive cyclic instances in multiple countries over the last 15 years.

Scaling the IHIA within a country, state or district, will not involve many 'mechanical' changes in data standards as such. However, the differences in social, economic, cultural and other contexts will be significant. Continuous translation, rather than mere replication, will be needed on both, the horizontal axis of diffusion and the vertical axis of appropriation. In each location or node, as being part of the horizontal scaling, the IHIA will need to adapt to the local context and the users needs, to appropriate the system and build a sense of ownership, for development. This scaling, in scope and depth, are both required to reach the goals of using quality information to inform health management and strengthen service delivery.

### 4.3 Scaling Across Uneven Infrastructure and Heterogeneity

The need for scalable strategies, applies to the differences in infrastructure, and relate to the comprehensiveness of the architecture and solutions. For example, the recently mandated registration of all pregnant women and immunised children in India will only gradually be covered by computerised electronic records for tracking, as states and districts, rural and urban areas, will develop at different paces depending on their infrastructure and otherwise readiness. The pregnancy and immunisation register, for example, is starting universally as a paper-based registration system, but is gradually becoming computerised – with paper forms captured in the database, and primary registration of services also on mobile phones or other mobile devices, sending data to the database, will be able to access the database directly. The scaling model implies that the architecture and particular solutions need to be able to grow with time; from one to more places, from one level of the health system to the other levels (from district to the facility and then community level), to generally become more granular and comprehensive. This scaling process can be depicted as involving the following processes (See Figure 4.1).

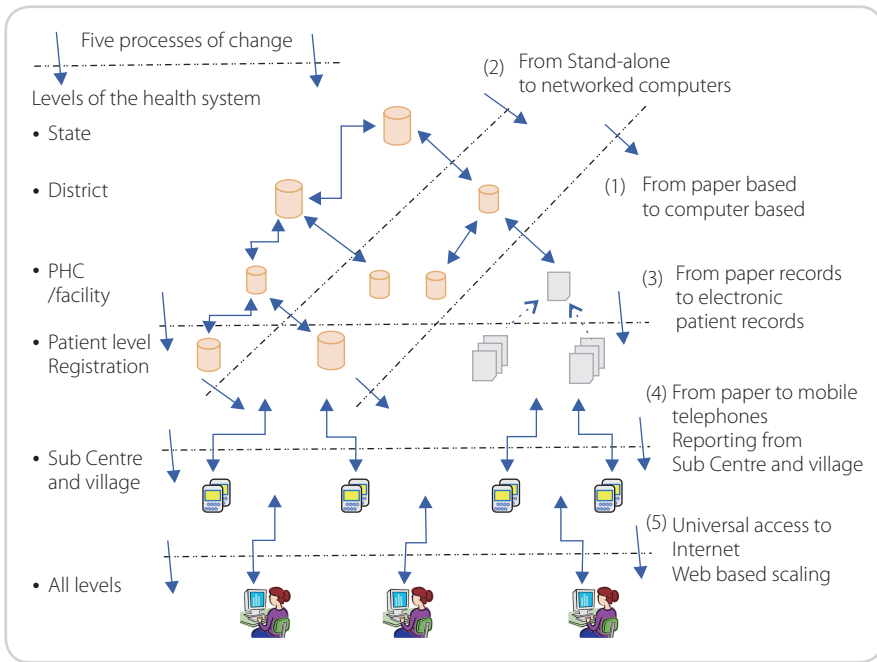


Figure 4.1 Scaling across different infrastructural contexts

**Process 1 – From Paper to Computer:** This is a general process that has been ongoing for a long-time, where paper-based registers and reporting procedures are gradually being computerised. Still, however, health workers all over the developing world are using large numbers of register books, typically one for each health programme, to register all activities related to individual patients and clients. These registers are yet far from being uniformly replaced by electronic record systems. In India, various states have taken significant steps towards computerisation with different paces. While nearly all are computerised at the district level and a high percentage also at the sub-district level of the Block, there are others (such as, Kerala, Karnataka, Gujarat and Tamil Nadu) also capturing data at the facility level of the PHC. In African countries, data capturing is, very often, limited to the district level.

**Process 2 – From Stand-alone Computers to Internet and Networked Computers:** In the beginning, all computerised HMIS systems were stand-alone, with for example, a database application installed in each district and using discs and later memory sticks for reporting upwards. Then, with Internet, data could be transferred as e-mail attachments, and finally, web-based systems are used in India and gradually also in various African countries. Taking the example of India, all states are networked at the district level, and a quarter of them at the sub-district level and may be a third of that at the facility level. In India, the transition from multiple installations reporting their data as e-mail attachments (networked, but not web-based), to direct access to a central server, has taken place just recently. As the network availability is enhanced, levels below the district are gradually being included in the network.

**Process 3 – From Paper-based Patient Records to Electronic Medical Record Systems and Patient-based Tracking Systems:** Introducing medical records systems in all health

facilities and for all patient groups is a tremendous task and most developing countries have only just started, and then typically in hospitals and for priority patient groups, such as HIV/AIDS patients on Antiretroviral Treatment. In India, while initially, only a couple of states had initiated processes for introducing electronic patient records in district hospitals, other states like Himachal Pradesh, are starting similar projects. Success of this will potentially lead to a larger process of adoption in other states, since the application is being built on open source platforms which do not have license restrictions. The national Ministry of Health in India has now mandated all states to register, all cases of pregnancy and immunisation by names, which is being universally implemented on paper forms, but some states are initiating electronic community and name-based tracking systems. This registration scheme may trigger more rapid scaling of electronic patient or name-based registers.

*Process 4 – From Paper-based Reporting to Reporting on Mobile Phones:* As the mobile telephone network has been expanding to reach out to all corners of the world, the use of mobile telephones for data reporting and dissemination is gaining momentum. In India, some states such as Punjab, have initiated state-wide implementations of Sub Centre wise reporting of routine data, using a mobile phone application, directly to the DHIS2, being used in the state as the HMIS backbone. The mobile phone is small and makes it difficult to handle large datasets because of interface limitations. The paradox may be that the Sub Centres using mobile phones will be better networked than the larger PHCs, as, the much larger datasets reported by the PHCs are not well-suited for mobile phones. Through such efforts, the mobile applications are now a part of the IHIA. However, there is also a more negative trend in evidence, which is to establish vertical mobile reporting projects that are not part of the IHIA, but based on software services provided by mobile network providers. This may lead to disruptions in the architecture.

*Process 5 – Web-based Scaling:* Universal access to the Internet from multiple installations to central servers. While in India, the scaling of the IHIA as from 2009–2010 has been web-based with web access at the district, the block and the PHCs depending on the states; in Africa, scaling has been carried out on stand-alone installations, although typically with Internet access for submission of data. The scaling of the DHIS2 in India would not have been possible without web access to central servers, as support and maintenance of thousands of stand-alone applications would not have been possible. In Kenya, access is being enabled countrywide through mobile internet.

This brief overview of ongoing and often simultaneous processes, gives an idea of the various dimensions and aspects which are involved in scaling, including paper artefacts, computer terminals, servers and networks, mobile phone and mobile internet, and of course the various institutional conditions and practices that constitute the system and its use. This collective, which comprises the IHIA, is depicted in Figure 4.1.

Approaches for scaling of electronic patient records, from relatively simple name-based tracking systems to more comprehensive medical records systems, are being eagerly debated in many countries and within many agencies. A recurrent dichotomy is between those arguing that scaling of medical records will make the traditional HMIS approach superfluous, and those arguing that medical records systems will not scale fully in a foreseeable future in, for example, Africa, and therefore should not be prioritised. The Ministry of Health and Social Welfare in Tanzania once posed the question – Should we go for medical records systems or should we focus on the

HMIS? As argued in the first chapter of this book, this is a 'wrong' question. Within an enterprise architecture perspective, both medical records and information for decision-making and Monitoring and Evaluation (M & E) are part of the enterprise architecture for the health system. Within a scaling perspective, however, we may be more precise; for example, in Tanzania, it will take time to scale electronic patient record systems covering all patient and client groups to all the literally thousands of health facilities in the country. If the aim is to get full coverage data health programmes performance for management and M & E at different levels of the health system, it will not work to wait for full coverage of patient records. And the approach needs to be based on the IHIA data warehouse framework argued for in this book, where there are electronic patient records systems aggregated data needs to be generated and fed into the data warehouse, where there are no such systems, paper-based records must be used as the data source. The same holds for data on human resources, drug logistics, laboratories, and so on. More generic we may regard the IHIA as consisting, on the one hand, of more or less fine grained, paper-based or electronic transaction systems where patient-health service encounters are registered, staff recorded, lab tests registered, drug stocks updated, and so on; and on the other hand, the data warehouse where processed aggregate data from these primary data sources are managed.

The case of Himachal Pradesh described in Chapter 2, details how an integrated architecture approach enables a 'seamless' gradual scaling of the architecture, such as from paper records to electronic medical records first, then more hospitals and the similarly gradual expansion of the electronic tracking system for pregnancies and newborn. The key advantage with an enterprise architecture following a data warehouse approach in a scaling perspective is that it provides a framework within which computerisation, that is, new software applications, within all the various sub-areas may be scaled. When a new system for tracking pregnancies and immunisation is introduced in a facility, the data previously reported on paper will now be generated electronically and loaded into the data warehouse. New software solutions are 'plugged into' the architecture – the data warehouse – using, for example, the SDMX-HD. In this way, the data warehouse and IHIA are enabling smooth scaling of, for example, medical records systems.

#### 4.4 Scaling Through Central Servers and 'Cloud Computing' – Universal Solutions in Heterogenic Infrastructure

Scaling of IHIA in developing countries has so far been seriously hampered by poor Internet. While in industrialised countries, a HIS data warehouse may be installed at a central server with one support team and made accessible for all users in a country; in developing countries, until now, the HIS data warehouse application would need to be installed in literally hundreds of locations, data would need to be manually transferred and synchronised and a large number of skilled people would be needed to run and maintain the system. Data management in a system consisting of hundreds of stand alone databases with manual data flows to the central database is extremely complex and the maintenance and update of all the installations likewise. Scaling of such 'stand alone' systems in countries like Tanzania is difficult.

Given the improvements of the mobile telephone network, the 'standalone' problem may be overcome by using the mobile telephone to submit and receive data. In Punjab, India, a large project including 5000 Auxiliary Nurse and Midwives (ANMs)



## Box 4.5

## Scaling of mobile based health information systems in India

*Scaling Using Mobile Telephones in Punjab, India*

The first effort towards the use of mobile phones for supporting of reporting from the peripheral facilities was initiated in 2008, when the National Rural Health Mission (NRHM) started a pilot in 5 Blocks of 5 States in India covering a total of about 200 field nurses. HISP India developed the application for this based on GSM technology through which the report would be sent via SMS to the DHIS2 application (used as the HMIS data warehouse application in the 5 pilot states) installed at three levels of the Block (Sub-district), District and State. In addition to building the application on a free and open source model, HISP India provided the required capacity building and support to the health workers on whose phones the application was installed. In this pilot, focused on Sub Centre reporting, the dataset included 77 data elements covering Antenatal Care (ANC), Child Immunisation and Family Planning. The pilot was evaluated as a success, and Punjab was one of the states that decided to go for a state wide implementation, covering 5000 health workers who would be given mobile phones from the state, and also CUG connections.

This initiative was a scaling challenge on various dimensions including functionality, geography and user support. With respect to functionality, while the initial application covered only 77 data elements, the State wanted to extend that to also include the reporting of mortality and morbidity details and other financial reports along with the basic Sub Centre report. This extended the data elements list to about 150, and these then needed to be split into 2 datasets as one was too long to be sent in a single SMS and resulted in memory errors. Further, the state also wanted to use the phone to carry out health services monitoring on a daily basis, and 10 data elements were identified in this dataset which mainly covered activities of a health worker on daily basis. From one dataset of 77 data elements, in this case the application was scaled to 160 data elements, which were then divided into 3 datasets – two monthly and one daily.

In terms of geography, while in the pilot only the field nurses from one Block (or sub-district facility) was covered in each of the 5 pilot sites (about 30 nurses each), the project now covered 5000 nurses from about 2500 Sub Centres covering the whole state (20 districts). To deal with this massive expansion in scale, a shift was made in the model of reporting. Now all SMSs were only to be sent to a central server where the state DHIS2 application was hosted. This meant that the SMS would now also be sent to the Block and District databases, and users from this level would need to access the data from the state server. However, this raised challenges at the server end, especially in the use of the GSM modems for receiving the SMS, and for also sending out the acknowledgements back to the users whose SMS had been received. There were extreme challenges in managing this SMS traffic, especially the daily report covering 5000 messages. To deal with this, first the number of modems were increased to 3, where 2 were used for receiving the messages and one was exclusively dedicated to acknowledgements. Further, a change was also made to the queuing algorithm, wherein messages were processed in a batch mode rather than sequentially.

In terms of implementation support, HISP India had to enhance its team both in numbers and the mix of skills. While in the pilot phase, after the initial phase of training, the technical person would visit the sites may be once in 3 months for support, and the rest of the time remote support was provided. However, in Punjab given the scale of operations a total team strength of 10 members was created to

cover all the training, and following that a team of 5 were based permanently in the State for 9 months to provide continuous support. The team now needed to include a dedicated server technician who needed to be at hand to deal with the constant problems related to the server and modem. Two of the five members were software developers who needed to be continuously engaged in making improvements to the existing application, but also create new enhancements as the demands of the state grew with time. For example, the state demanded a feature of Mass SMS to health workers in order to obtain feedback from health workers regarding any service, programme, stock requirement or grievance report. For example, the state wanted to be able to send a SMS to all 5000 health workers to get a confirmation whether or not their monthly stock of IFA or Iron tablets had been received. This facility of enabling 2 way communication scaled the use of the phone from not just reporting but to also co-ordination and communication.

The scaling of the Punjab state mobile project makes it, by far the largest implementation in the health sector in the world. It is interesting to also point out to how other states are in process of further developing pushing the boundaries of scaling. For example, the states of Himachal Pradesh and Orissa wants to scale the mobile based reporting for disease surveillance and control programme covering diseases like Polio, Malaria, HIV/AIDS, TB and other chronic diseases.

Various other states are planning to use the phone not only for number based reporting but also for reporting on names for tracking of pregnant woman care and child immunisation in order to provide timely care and monitoring. Further, though the application had only been used for reporting from Sub Centres, some other states also want to use it for reporting from PHCs and CHCs, where the datasets are much larger (about 150 data elements). This they plan to do because of the extremely poor internet connectivity, bad power situation, and also the difficult geography which makes travel complex.

using their telephones to report their routine databased on an application using SMS, is a good example of how the basic mobile network may be used to report data over distance to a central server. See Box 4.5 for details on this project.

Many projects in the developing world are exploring similar ways, or using the upgraded GPRS protocol, to use mobile phones for remote data reporting and communication. The global mobile network, however, is also opening up for new business models of 'software-based services', and what may be feared, the outsourcing of ICT and software services business from Africa to the West. What is happening in many countries in Africa now is that international mobile network providers are targeting donor funded health programmes and projects working in remote areas, typically in Africa, and providing end-to-end infrastructure and software solutions for data capturing, data management, and analysis at a cost, paid by the rich donor, and typically not integrated within a national Health Information Systems framework.

A typical example is a project by Pfizer and Vodafone in the Gambia, where Pfizer wants to monitor stock and distribution of Malaria drugs in the dispensaries and Vodafone is providing the entire infrastructure; SIM cards if needed (users have their own telephones), mobile network, air time, data management in their servers in the 'cloud' and provision of the data to the users. DHIS2 is running as the national HIS in the country and is including similar data. We have tried to argue the need for an integrated architecture approach, and suggested to feed the data reported by the

Vodafone mobiles into the DHIS2, that is the national HIS. We have also argued the need for pooling together the limited resources available for HIS in the Gambia. These efforts to integrate the approaches, however, have been in vain. Vodafone argued quite frankly that such integration efforts could only be included 'if there is a place for them in the value chain'.

It is our general view that business models that are locating value chains derived from Africa, outside Africa, are of no use for Africa. But more specifically, we will argue that the outsourcing of what may be labelled the 'ICT learning and innovation chain' from Africa to the West, as illustrated by the example of Vodafone and Pfizer, may be even more harmful.

The new situation of improved Internet connectivity and 'cloud computing', that is the availability of software and Internet-based services from anywhere in the world, represents, apart from some threats of further fragmentation of the HIS as illustrated above, and at the same time drastically improved opportunities for implementing and scaling integrated architectures. The rapid scaling of the IHIA in India has to a large extent been made possible by web-based access to the DHIS2 data warehouse, installed on central servers in each state. India does not have universal Internet access, but the network in most cases is extended to the block (sub-district) level. In most states, data is therefore captured at the block level, and in some states directly from the sub-block level of the PHCs. Experience from the previous stand-alone installations of DHIS2 in India, have shown that it is very complicated to support, maintain, update, and to some extent also synchronise hundreds of separate installations in PHCs, blocks and districts. This is of course following from the large scale of implementation in India. The case from Kerala in Box 4.6 describes the gradual transition from stand-alone installations to a central server solution and how that has enabled the scaling process.

## Box 4.6

## Scaling of DHIS2 in Kerala, India

*Scaling of DHIS2 in Kerala – From Stand-alone to Central Server and Web Access*

The very first instance of the DHIS2 started with a deployment in one Community Health Centre (CHC) in Trivandrum district of Kerala state in India. A CHC represents a sub-district level health unit in the state, and has below it PHCs and below which there are Sub Centres. A CHC caters to about 200,000 population. Kerala is the most advanced state in India with respect to public health indicators, which ranks with the best in the world. Furthermore, with its very high levels of literacy, Kerala was declared a 'Fully Literate State' in 1991, it becomes a very fertile and receptive place to initiate new innovations in the rural work force. And to the advantage of DHIS2, Kerala state has an explicit policy to promote the use of FOSS in the public sector, which provided us with the argument for this effort. Historically, the state has had a strong legacy of a left government which makes decentralisation a key political agenda, which was another argument made for deploying DHIS2 in a clinic level rather than within a centralised model.

HISP India, with whom the state has a technical partnership since 2005 and a formal MOU since 2008 is responsible for the DHIS2 deployment, and organising all processes of technical support and training. Since the stack of technologies used in DHIS2 was new to the HISP team (with prior experience in the Access-based DHIS1.4) and the DHIS2 itself was in a very nascent stage, it was an intensive and

continuous period of learning for the team. There were constant requests for re-installation (due to virus attacks), more functionalities, and ongoing hand holding and support. The clinic was about 15 km away from the HISP office, and the field co-ordinators would go sometimes once or twice in a day to deal with these field problems. After about 3 months, the HISP team could demonstrate concrete results to the district and state office, and they gave the permission to extend the DHIS2 deployment to the 18 CHCs in the district. For this, the HISP team purchased the required hardware and got it installed in the CHCs through the vendor who were responsible for the hardware maintenance activities.

Extending to 18 CHCs started to expose the HISP team to the challenges of scaling. Now there were 18 such installations that we needed to take care of, and hence 8 field co-ordinators were hired and trained with each of them being made responsible for two to three CHCs for providing field level technical support. There were more technical problems to deal with, more training to be provided, and furthermore more databases to synchronise. For this, at the end of every month, all the paper-based data from all the facilities would be sent to the CHC data operators, who would consolidate that manually into a CHC wise aggregated report and enter it into the DHIS2. After the entry was done, the data would be exported into a file on a flash drive or CD, and this would manually be carried to the district office, where it would be imported into the district database to create the consolidated reports.

These scaling related challenges were only a preview of what the HISP team would need to do next, as the state was satisfied with the progress made by HISP in establishing the district systems and entered into a Memorandum of Understanding (MoU) with them to implement the DHIS2 across the state. The level of deployment was the PHC (a level below the CHC) and there were 858 such facilities in the state. This time around, the state procured the necessary hardware (computers, printers, UPS), and through the MoU required 2 of the HISP co-ordinators to be placed in each district (there are 14 districts in the state) for 1 year, and have an additional 2 in the second year to strengthen hand holding support. In this model, the entry at the PHC was to be done by each Sub Centre, and at the end of the month the PHC consolidated data (sum of the PHC and Sub Centre facilities data) would be aggregated and exported, and then sent manually to the CHC from where there would be internet access. Thus, the CHC would import their data PHC wise, plus enter data on services provided by their facility into the DHIS2 now deployed on a server hosted at the state IT centre.

*Scaling challenges came across multiple dimensions which are briefly summarised:*

The database had to be scaled to be able to handle data from 5391 Sub Centres, 858 PHCs, 181 CHCs, 86 District and Sub District hospitals, and also private institutions.

Server performance had to be constantly monitored and fine tuned to ensure, it could handle the load of may be 1000–1500 simultaneous users entering data in the last week of the month.

Capacity building programmes had to be carried out for more than 12,000 staff to ensure data entry and data quality management was done by the data collectors/compilers, that is the health staff themselves.

During the first year of statewide implementation all PHCs and CHCs were not provided with internet connection. Therefore, in PHCs and CHCs offline version of

DHIS2 had to be maintained. This involved ensuring stable installation and continuous trouble shooting in 858 PHCs, 181 CHCs and 86 Hospitals. The installations were quite a challenge and took about two to three months.

Data synchronisation every month involved the Sub Centres entering their data every month at the PHC from where data was exported manually or electronically where possible to the CHC where it was imported. At the CHC then sent up the data to the District. This way each of the 14 districts in the state had their respective database located at the district headquarters. This was a huge institutional and technical undertaking.

Providing technical handholding support to all the facilities in the state with the team of 56 co-ordinators and the state team.

With intensive implementation support, the HISP team was able to demonstrate very positive results, leading Kerala state to be ranked No. 1 in the country with respect to HMIS. The next phase of the scaling challenge came when the state now wanted the PHCs to access the server directly and carry out online entry. However, it was agreed that the data entry would be carried out for PHC consolidated (PHC plus Sub Centre data) rather than including data also by individual Sub Centres. This of course was good, in that now the problem of export-import which was being carried out manually would be stopped, but it led to serious performance issues with the server. There were constant crisis calls to the DHIS2 development team, especially at the end of the month, for trying to improve both server and DHIS2 performance. Slowly, this process was also stabilised.

A final challenge on scaling came when the state also wanted all Sub Centre data by individual facilities to be also placed on the server to enable the state and district officials to be able to drill down to the lowest level data when required. The HISP team tried to argue against this move saying that why should the state want to keep Sub Centre data and overload the server when for their planning and action, district and CHC level data would be sufficient. Instead, we could make the Sub Centre data available to them in an offline installation, and they could access that when necessary. However, the state was adamant on this, and insisted this was done. This was then done, providing huge amount of additional pressure on the server. This required again serious improvements to be made to the DHIS2, especially to improve the time taken in the loading of the screen. Simultaneously, the HISP team kept pointing out to the state the names of particular facilities where improvements in infrastructure needed to be carried. This process is now well-stabilised.

At this point, the HISP team with a great deal of pride can say that these scaling challenges have to a large extent been successfully dealt with, and significant improvements have been made in terms of data quality, data coverage and timeliness of reporting. In the next phase of the MoU, currently being negotiated between the State and HISP, the focus is shifting on strengthening processes of improving the use of information for local action, and improving the overall state ownership of systems.

The problem of maintaining numerous stand-alone installations represents a formidable obstacle for scaling the IHIA not only in India, but also in various countries in Africa. In Africa, the Internet has not been, and is still not perceived as robust or reliable enough to support web-based data warehouse solutions for routine data reporting. The norm, until today has been to capture routine data in stand-alone databases, and

to report data electronically by e-mail attachments or physically to the level above. Significant human capacity on database, data management and system support is needed, in order to manage a national HIS based on numerous stand-alone database applications with fragile flows of data between them. Problems of data reporting, completeness and the maintenance of numerous stand-alone applications across the country, make it very complicated.

Building the IHIA on a web-based data warehouse on a central server is much simpler technically, in terms of data and database management. In terms of human resources too, ironically, it would be more appropriate for Africa, than their current reliance on stand-alone database applications. The paradox is that, currently, in Africa, more resources are needed to sustain a national data warehouse solution than, for example, in Europe, even though the resources required are fewer. The key challenge, therefore, is to explore how Africa may be able to optimise the use of Internet, including developing the required power back-up infrastructure on generators, since during power cuts, the fixed line Internet connectivity will typically be down. Internet over the mobile network is spreading rapidly, and may be a solution here, both as a back-up to fixed lines and as a solution on its own.

DHIS2 has been rolled out in 2011 in Kenya, based on a central server solution. The long-awaited sea cable has arrived in Mombasa, at the coast, and Internet over the mobile network is now covering the country. Kenya has become the first country in Africa implementing an online national data warehouse for universal capturing and use of routine data. In Chapter 6, we describe these new opportunities of online computing Kenya and Africa more generally and how offline data entry using the new HTML 5 standard may help managing the rather poor Internet connectivity found many places. Offline data analysis and use is another innovative approach developed to manage poor Internet connectivity; a small 'super lightweight DHIS2' application installed locally is used to download and update a 'datamart' including user specified data and indicators, which is then used to generate Excel pivot tables used for data analysis. Reports, charts and maps are generated when 'online' and downloaded in PDF format and archived in the offline application. As the Excel pivot tables are not easy to update, or 'refresh', online regardless of bandwidth, the offline local datamart is actually representing an improvement in some functionalities as compared with the web browsing.

The innovative approach to address the rather fragile Internet situation in Kenya illustrates how innovations are generated through implementation, use and problem solving. Innovation may thus be seen as being an embedded part of the scaling process. Furthermore, by using open source and shared software applications and enabling collaborative networks where countries and institutions share learning, best practices and solutions, innovations in Kenya is fed back to the entire community. The DHIS2 functionalities developed to enable the 'semi-offline' approach in Kenya have been included in the global core and thereby made available for everybody. As a next step, therefore, the semi-offline functionalities, including the ability to download data-marts and reports and to generate Excel pivot tables locally, are made available for users also in Kerala and other parts of the world.

Scaling may, therefore, be understood as a dialectic process that is enabling innovation; it is not the diffusion of the 'same', as the system and its components is changing and improving through the participative processes involved with implementation and use.

In scaling, while new things are gained, there are also always old things being lost representing a dialectical process of expansion. Feedback cycles are then bringing the innovations from one context, such as Kenya, to other contexts, such as Kerala, where new user interactions may lead to further innovations and improvements. In a next cycle then, the solutions may come back to Kenya, further improved. The FOSS approach is important in such a dialectic cycle of innovations as it enables free circulation of new solutions.

## 4.5 Attractors for Change – Drivers of Scaling Processes

Complex adaptive systems (CAS) is a research tradition, concerned with studying the dynamics with which complex systems, made up by other systems, networks and actors, evolve through adaptation. The health system illustrates not a singular but a complex system, made up of numerous more or less independent systems, organisations, structures and actors of different types. It typically is, not even 'one' system, and can be regarded differently, depending on what perspective and view point one is using to define the system, its components, or its point of gravity. Analogue to the health system, CAS is seen as being made up of semi-autonomous agents, with the inherent ability to change and adapt in response to other agents and the environment. It is important to understand how order within such systems is created without a 'designer', but out of emergence. Attractors are seen as 'points of gravity', which enable the emergence of order amongst processes that are divergent and apparently in a state of chaos. For example, in a situation where different health programmes, health authorities and other actors, are unable to come to agreement on the new shared data standards, an attractor in practical terms, would be the implementation of a simple but useful standard, which works; and on demonstrating its 'success', attracts attention and more followers, thereby enabling the implementation of even more effective data standards. Our case materials provides empirical evidence implying that such standard making attractors is the typical way in which new data standards can emerge and grow in use and importance, through attracting more followers.

### Example of South Africa

In South Africa, as also discussed in Chapter 2, numerous actors, health programmes and health authorities were for a long period, after the liberation, unable to agree on shared data standards, basically because, as it turned out, they were unable to see practical ways of achieving it. A major problem that seemed difficult to overcome was the fact that the federal constitution made each province 'free' to make their own data standards, making it all the more difficult to see practical ways in unifying all these actors. The breakthrough came, when the HISP team finally managed both, to create and implement a minimal essential dataset and manage it close to the users through the first version of the DHIS application, at first one province, and then at a second. The third component in this package, in addition to the datasets and the DHIS application, was the principle of the hierarchy of standards, which was implemented in the DHIS. Important here, was that despite the fact that the two datasets were different, they shared only about 50% of the data elements, and were managed within the same unified framework. The DHIS framework used, was the early version of the IHIA discussed in this book. The DHIS, despite its simplicity in design, turned out to be quite powerful as a key attractor, driving the process of scaling along both the

horizontal and vertical axis for many years in South Africa. When the various actors saw that the principles were working in two provinces, they understood that, they could be made to work in other provinces and the whole country, as well, motivating and driving cross country scaling. Since its emergence in the late 90s, the DHIS has been growing in strength and depth, and is today institutionalised as the national standard in South Africa.

### Example of India

In India, the development of the new integrated health data standards, including data elements, indicators and reporting formats, was carried out within the framework of the NRHM, starting early 2008. Unlike in South Africa, where the development of standards took place through a bottom up process, or even in Himachal, where the hospital standards development has started from one hospital to be incrementally taken to other facilities; the NRHM was largely a top down and centralised process. In this top down process, the NRHM in consultation with the heads of different health programme divisions (like Child Health and Maternal Health), at the Ministry of Health and Family Welfare in Delhi, defined the standards and diffused them into the states for implementation. The probable arguments for adopting this top down rather than a bottom up (by states and districts) approach, could be as follows:

- The design was not being done from scratch but was modifying something already existing. It could thus, be argued that the requirements were already known.
- In a historically existing hierarchical and centralised structure, states will not take the initiative to re-design unless it has been mandated from the centre to do so.
- Given the large-scale and diversity of the different states in the country, a centralised and top down approach offers time and logistics expedencies.
- Since a number of the health programmes being implemented in the states are centrally driven, in terms of budgets and information systems, the states would not have the mandate to make any changes in design – and must comply to national directives.
- The problem on creation of standards was largely to streamline and reduce, rather than add new, so these decisions were best taken at the 'top' rather than by states who would not have the overall picture.

So, there were certain merits to the adoption of a top down process for the definition of standards and its scaling to the states. This approach was compatible to the existing context. The entire process of re-design of the national HMIS has been described in detail in Chapter 5, but in this section we describe the key features of the scaling strategies adopted. These are summarised in Box 4.7.

#### Box 4.7

#### Characteristics of scaling strategies

##### *Characteristics of Scaling Strategies – India*

1. The focus of the re-design process was to create the core standards, on what data should be reported by all districts, and all its facilities to the national level. In addition, the states had the freedom to add further local requirements, but they did not have the right to delete anything from the national core.



2. A set of design principles were created – rather than boxes of technologies and applications and these principles were scalable. The principles were articulated in a way such that was simple, based on common sense, was easily understood by all, and was accepted as being useful to address the common problems currently being faced. Examples of the design principles were:
  - a. Data will only be entered on one format, and not more than one (to address the problem of duplication).
  - b. Data will only be reported on the services provided by the facility (to address the problem of confusion between facility reporting and area based reporting).
  - c. Only that data will be collected, which contributes the generation of at least one indicator (to improve the action ability of the HMIS).
  - d. Disaggregations of data (for example, break ups by Scheduled Castes and Scheduled Tribes to be captured through surveys rather than routine data).
3. The revised datasets were designed in a scalable manner, which were flexible to adapt. For example, private hospitals could report using the CHC dataset as they were seen as equivalent facilities in terms of services being provided.
4. There was flexibility to add new datasets as new programmes were integrated into the HMIS dataset. In 2008, the immunisation data had been integrated. So, an incremental and flexible strategy was adopted, making it scalable.

Through this re-design process based on principles elaborated above, close to a 90% reduction on data elements to be collected was carried out. For the states that had agreed to adopt the DHIS2 as their state system, all the datasets, data entry screens and reporting formats were customised. Furthermore, many of the states requested for their local data elements or indicators to be added. These additions could easily be done in the DHIS2, which helped it become an attractor, since the users felt a sense of control over it and something they could tweak for their local ends. Another feature of the DHIS2 which helped make it a strong attractor, was the capability to customise organisational unit hierarchy to the sub-district level, if the user wanted it. This indeed helped to empower the users and enhance local control, something that was then absent in the existing national portal, which was based only on district level data entry and reporting. Further, DHIS2 was typically hosted on a local state server that implied easy accessibility to its users, which again was difficult with the 'black boxed' ministry portal, as it served primarily as a gateway for national, and not state reporting.

#### 4.5.1 SDMX in Sierra Leone and West Africa

In this example from Sierra Leone and West Africa, we illustrate how attractors may drive scaling processes in one country, across countries; and in the scope of the IHIA, by including more components. We call this the creation of 'network of networks'. In the second chapter, we were told the story of how the IHIA was developed and scaled, in Sierra Leone, through initial success that created an attractor, which further led more health programmes and agencies to align their interests and join the scaling process. This is a development quite similar to what happened in South Africa.

Sierra Leone has been one of the HMN pilot countries, and by far the most successful. As HMN needed a success story, they have promoted Sierra Leone as that. While the success of the new IHIA in Sierra Leone has been real, it is clear that being declared a success by HMN and being published as a success several times in the HMN weekly bulletin, has significantly added to the reputation and knowledge of the project in Sierra Leone. Sierra Leone has thus, become an attractor for IHIA in particularly the West African region. In 2009, The Gambia started implementing DHIS2 on their agreed data standards, which previously had been implemented using Excel spreadsheets. Furthermore, during 2010, Burkina Faso, Ghana, Liberia and other countries in West Africa, have also decided to go for DHIS2, as the embodiment of the IHIA. Today, the West African Health Organization (WAHO) is co-ordinating technical support on DHIS2 to all West African countries.

In late 2009, WHO had initiated a process to develop a data exchange standard for health metadata and aggregate data, SDMX-HD. By early 2010, HISP and HMN, decided to pilot the standard in Sierra Leone by implementing the OpenMRS medical record system to track patients on Antiretroviral Therapy (ART), and to share this data with the DHIS2 data warehouse. This was the first implementation of the standard, and major advancements were made to SDMX-HD, spurred by the fact that it was now being implemented for real in two applications. The seemingly successful implementation of SDMX-HD for medical records data triggered interest among the many actors dealing with human resource management. While medical records system are slow in scaling, as health facility and patient groups need to be implemented one by one; human resource records are different, as in it the employees and salary registers are more centralised and complete. In fact, the problem in many African countries is that, employees and salary registers tend to be more than complete, sometimes containing unknown numbers of ghost workers. The integration and interoperability between the DHIS2 data warehouse and human resource records system was therefore seen as very attractive; as the number of staff by category could be analysed by facility and compared with other data on resource utilisation and consumption.

The development of SDMX-HD, made the IHIA architecture include 'any' application from different business domains, a reality. Anyone able to share data using the SDMX-HD could now be 'plugged in', in a country IHIA. In addition, as this development was associated with Sierra Leone, its perceived success accumulated, and, further events triggered. While HMN and HISP were collaborating in Sierra Leone, *CapacityPlus*, a partner of HISP and HMN specialising in strengthening health workforce information systems, was partnering with WAHO, to pilot the open source iHRIS application for human resource management in Ghana. Given the success of what was now seen as the 'integrated Sierra Leone architecture' in West Africa, WAHO organised a workshop in Accra, Ghana, in partnership with HMN, *CapacityPlus* and HISP, to promote the integrated architecture, and conduct training in DHIS2 and iHRIS. At the end of the Accra workshop, SDMX-HD implemented for interoperability of DHIS2, iHRIS, OpenMRS, was officially launched by a WHO representative pointing out the appropriateness of it being taken up among countries adopting the standard-supporting applications. In November 2010, WAHO invited HISP, *CapacityPlus*, and HMN to the first annual WAHO HIS strengthening workshop in Dakar, where HIS staff from all 15 WAHO member states were present. Here, it was decided that HMN, WAHO, HISP, and *CapacityPlus* should form a partnership to develop a centre of excellence at WAHO, for supporting member countries in adopting the IHIA, which had grown out of Sierra Leone.

The above discussion highlights the important role attractors play in enabling processes of scaling. In South Africa, the DHIS2 which enabled the implementation of the data standards and principle of hierarchy, served as an important attractor for other provinces who saw its value and took it up. In India, the principles developed for the re-design of the datasets, became an attractor in creating uniform standards, which could be scaled across geography and programmes. While in Sierra Leone, the DHIS2 which served as the IHIA became the attractor and the focal point, to expand the HIS to interoperate with human resources and patient based data. The IHIA initially represented by the DHIS2 and the supporting network, became the attractor to coalesce other networks – the OpenMRS and iHRIS – in both its technological and institutional constituents, leading to scaling through ‘network of networks’. Thus, attractors are not only technological in nature, but well involve organisational and institutional constituents.

### Summary

Key concepts that can be taken from this chapter are summarised below:

1. We emphasise that scaling should focus on design principles rather than on technological artefacts referred to as ‘boxes’.
2. Scaling is around two sets of processes:
  - a. Quantitative, mechanical, structural dimensions of scaling.
  - b. Qualitative, social system, process-oriented dimension of scaling.
3. Scaling takes place across interrelated dimensions of vertical and horizontal axes representing depth and scope, respectively.
4. Scaling of systems involves processes of cultivation and improvisation.
5. Scaling in developing countries will always involve expanding across uneven and heterogeneous architectures.
6. Improving Internet and mobile networks are making it possible to scale universal solutions despite heterogenic infrastructures – through web and mobile access to central servers.
7. Scaling represents a dialectic process, where something is simultaneously lost and gained during the process of expansion.
8. Scaling along the vertical and horizontal dimensions goes hand in hand with the sustainability of the system.
9. Attractors – technical and institutional – are drivers for processes of change.
10. A current strategy for scaling is the creation of ‘network of networks’.

# Implementing Good Design

- ⦿ Practical Design Guidelines
- ⦿ District Health Information Software –What it is
  - ⦿ How to Set-up DHIS2 in a New Context?
  - ⦿ Building Capacity – The Power of Networks





# Implementing Good Design: Practical Systems Development

If the first part is about identifying the components, principles and inter-linkages of an IHIA, the second concerns the process dimension, of how by using this toolkit, an architect can start to build the IHIA and make it work on the ground. Primarily, two sets of processes are important – systems development and capacity building. Further, the DHIS (District Health Information System), the software being developed and evolved within the HISP network, is used as a concrete example to illustrate how these processes can be materialised in practice. With this background, the part is structured as a set of 4 chapters.

The first in this part, Chapter 5, “Practical design guidelines”, firstly zooms down from the macro level of the IHIA to the micro level of the system, and how these can be developed and gradually evolved to a “system of systems” or a IHIA. The example of systems thinking, fundamental to this chapter, is provided through a hospital information system. The link between design and practical materialisation is systems development, and more closely the design and development are intertwined, there is a sounder basis for the IHIA. A key focus of these design principles is on Participatory design, and how through the engagement and ownership of users, more appropriate systems can be developed, can help foster local control and ownership and to develop a sense of empowerment amongst users. An incremental approach to design and development is another design principle, exemplified through an example from India involving the reform of the national HIS.

Chapter 6, the second in this set, describes in detail the technical components of the DHIS2, which provides us a concrete tool,



basis, and a set of building blocks to operationalise an IHIA in practice. The DHIS2 is conceptualised both as an instantiation of an IHIA, and also a platform which can facilitate the evolution of architectures. Corresponding to the 3 level architecture articulated in Chapter 1, the DHIS 2 is described at the level of data (standards of interoperability and the data model), the application (the underlying business logic of indicators), and the user with respect to features and functionalities of carrying out Business Intelligence through the Dashboard and Geographic Information Systems modules.



Taking a look into the future, we describe some priority areas for further development and enhancement of the DHIS2. DHIS2 is discussed as a platform which can help foster innovation.

Chapter 7, the third in this set is titled “How to set up DHIS2 in a new context?” and provides practical multi-country cases on how to set up and scale DHIS2 in a new country. Cases from Botswana, Burkina Faso, Bangladesh, Tajikistan, and Sierra Leone are described to illustrate how each country is different in terms of opportunities to use technology, the political environment around which negotiations can take place to define datasets and indicators, and the existing installed base of paper forms and legacy systems. The combination of these conditions helps to define particular strategies for the introduction of DHIS2, in a way that can satisfy both the technical and institutional challenges.

The last chapter of this set, 8, focuses on the other key process element of systems development – capacity building, and is titled “Building capacity – the power of networks”.

Networks and networking is described as the central underlying principle for building capacity at both the individual and institutional levels. The Oslo/HISP model of multi-level capacity building including PhD, Masters, and in-service training, is described as a successful model of building capacity in a network framework. Strategies for building capacity into formal institutional measures and hand holding implementation support are described in this chapter using examples from Sierra Leone, India and Ethiopia.



# 5

## Practical Design Guidelines

Part I of this book focused on design principles at the architecture level, including related to concepts of architecture, standards, integration, interoperability and scaling models. In this chapter, we zoom down from this macro-level of the architecture to the relatively micro-level when we need to start make practical design choices at the level of an information system – for example, a system for routine health data collection and analysis or a patient-based medical record system. As discussed in our conceptualisation of the IHIA, these two systems and others, need to speak to each other; for example, the aggregates from the patient system need to be interoperable with the facility system, implying the data should be exported from one and imported into the other. Together, building such inter-linkages between these different information systems helps to initiate the creation of the IHIA. As other systems such as ones for human resources or finance feeds data related to human resources and finance respectively into the facility system, the architecture or the system of systems starts to gradually evolve. For this evolution to take place effectively, we need to adhere to principles of architecture discussed in the previous chapters, especially related to standards, interoperability and scalability.

The guidelines discussed in this chapter will help in practically approaching the design of individual systems within the framework of the larger IHIA being evolved. This also then illustrates and supports our approach to architecture as a verb – an activity in process, involving bottom up designing, making small things work in practical settings, slowly linking individual systems with others, within a broad template of how we want the architecture to evolve. This approach is in contrast with a top down view of an architecture – the grand master plan, which is pre-defined, and implemented as one monolithic structure. Our approach emphasises a modular strategy, involving the creation of small bits, which can plug into others, or plugged out as the case may be. We have described the evolution of a IHIA as a process, evolving over time, in an incremental and iterative manner. At the heart of this approach is the social systems thinking, which we have emphasised earlier, but discuss it in context of information systems design.

### 5.1 Systems Thinking

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At the micro-level, a system can be conceptualised as a set of interacting or interdependent entities forming an integrated whole. In simple terms, a system can be described as a set of components that are interconnected through processes of input, throughput, output and feedback. A system can be described to have a



structure, defined by the various parts in it and their inter-relations. In the example of the hospital system described in Chapter 1, the structure is represented by the different wards, the allocation of doctors to Outpatient Department, forms of registration, billing and laboratory examination. A system exhibits 'behaviour', with respect to their inputs, processing and outputs of material, energy or information. For example, behaviour could reflect how patients are registered, the mechanisms used to define bed allocation to Inpatient Department patients, the manner in which examinations are carried out and how nurses are recruited. A system inherently has interconnectivity with its various components having functional as well as structural relationships with each other. For example, the quality of the throughput (standard of patient care) will have direct implications on the quality of the outputs (percentage of patients achieving cured status). Similarly, the level of inputs (for example, the bed capacity of the hospital) will influence the quality of the output in bed occupancy rates.

### 5.1.1 The Hospital – Architecture at the Local Level

An information system represents a system that relates to the flow and use of information. In a broad sense, an information system refers to our conceptualisation of the interaction between people, processes, data and technology. It refers not only to the ICTs that an organisation uses to enable the flow of information, but also to the way in which people interact with this technology.

We will use hospital to illustrate both the concept of system and information system, and how they relate. A hospital is a complex 'system', which may be regarded as containing input, throughput and output at multiple levels. In our perspective of an integrated enterprise architecture, we may distinguish two key overall 'systems', related to patient care and management respectively. At the level of patient care, the individual patients are admitted to the hospital, they are provided care through a number of services, and they leave the hospital, alive or dead either being discharged or they die. At the level of hospital management, the whole 'machinery' making up the hospital is the area of concern:

- The 'input' is not limited to the patients, but includes the entire support structure of specific services, human resources, money, policies and equipment.
- The management of the above resources for optimal patient care represents the throughput.
- The results in terms of treated patients and their costs of treatment may be regarded as the output.

The hospital is a micro-version of the overall health system and most of the general and specific health system support structures are found as subsystems within the hospital system: human resource management, patient care, laboratory, X-ray department, surgery, pharmacy, and facility maintenance. In a management information perspective, the hospital is comparable to a district. In a district, management is responsible for services delivered at all the health facilities in the district as well as the performance of the health programmes and specific services. In the hospital, the management is responsible for all the services provided by the different wards and departments in the hospital.

While in the previous chapters, we have described the IHIA mostly at the level of a state or a district; however, in this section, we translate these principles of IHIA design to the level of the hospital, and more generally to the level of an individual health facility. For the district and higher levels, the data warehouse and IHIA approach described in this book is well aligned with views and strategies put forward by most actors within global health. Access to essential data and indicators from across health programmes and services, in a district or in a country, is generally regarded as crucial for management, decision-making and monitoring and evaluation. Here we will extend these design principles to the hospital and the health facility; integrated essential indicators targeting management needs are as important in the context of hospital as in the context of district and health programme management and monitoring and evaluation. Given that roughly an estimated 60% of the health budgets in developing countries are going to the hospital sector, one would assume that global and national health communities would prioritise the strengthening of the currently generally very poor hospital management information systems in countries. However, strangely enough, very little co-ordinated efforts and resources from the global donor community are directed to this sector. As the direction of efforts to strengthen information systems is following the money, the topic of hospital information systems in developing countries is also a neglected area in the HIS community. Donors will always tend to direct their funds to disease or service specific areas, where results may seem to be easier to achieve, and document. To strengthen the district hospital sector in Africa, including human resources, equipment, transport, buildings, maintenance, and so on, may appear as too massive a task to embark on. As a hospital is more like a living organism along various interconnected dimensions, it is difficult to single out a particular sub-area for targeted vertical support from a donor organisation, although the maternity wards in hospitals are crucial to the MDGs on maternal health. It is difficult to support the maternity services in a dilapidated hospital with limited ambulance services without targeting such shortcomings. The scale and complexity of the problem is probably the main reason why donors are not much interested in the hospital sector, despite its key role in the MDGs of reducing maternal mortality. The WHO likewise; while having special programmes and offices directed towards numerous specific diseases and service areas, seems to have no coordinated efforts, not even an 'office', concerned with addressing the plight of the hospitals in developing countries.

Any effort to improve the hospital sector in developing countries will depend on the quality of information targeting areas where quality, efficiency and management can be improved. Providing high quality and timely data, effective monitoring of a few key indicators may have considerable impact. Mortality rates, for example, perinatal (still births + deaths under one week), under one year and maternal mortality, are regarded as the most effective quality indicators for comparing performance between hospitals regardless of the level of sophistication of the hospital sector. In England, for example, the under one year mortality rate is found to be the most effective way to compare quality across the facilities in the hospital sector. Despite the differences in quality between England and Africa, mortality rates may be used as an 'universal' indicator for comparing quality across the hospital sectors in the different contexts.

In addition to the quality of services, the efficiency of services delivered represent key target areas for hospital management. Also in this area, there are essential and 'universal' indicators that need to be included in any hospital information system. These are indicators used to measure patient 'throughput' and the optimal utilisation

of resources: While 'average length of stay' by patient group and/or service and/or diagnosis is the most effective way to measure patient throughput, 'bed occupancy rate' is the most effective way to measure to what extent resources are optimally utilised.

We use these three types of indicators to illustrate that relatively simple indicators can be turned into powerful tools for hospital management. By 'simple' we mean that the data needed to calculate the death rates are relatively easy to collect. For example, within the actual group of patients for the actual time period, mortality rate is calculated:

$$\text{Mortality Rate} = \frac{\text{Number of Deaths}}{\text{Number of Patients}} \%$$

Of course, the indicators can be refined in order to single out causes of deaths due to poor ambulance services or referral system. Infection rate is another key quality indicator, also based on data that is relatively easy to collect. For the bed occupancy rate or average length of stay, the following formula is used:

$$\text{Hospital Bed Occupancy Rate} = \frac{\text{Number of Inpatients days}}{\text{Number of Active Beds}} \%$$

Note: The number of inpatient days is also referred as bed-nights when the number of days are one more than the number of nights,

$$\text{Average Length of Stay} = \frac{\text{Number of Inpatients days}}{\text{Total Number of Patients}} \%$$

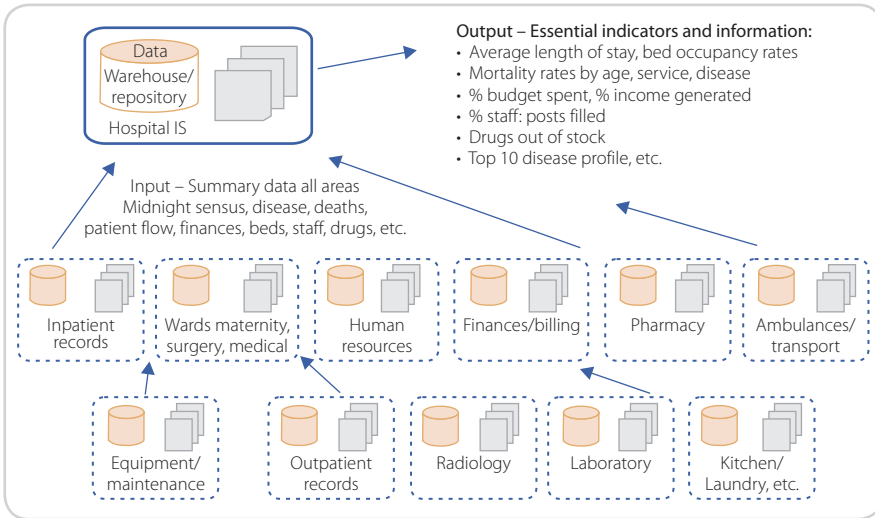
We see that the data are of different types and have different sources; number of active beds categorised as 'semi-permanent data' in the DHIS terminology, and will typically be collected and updated regularly or on change; inpatient days are traditionally collected by midnight census, but can also be derived from a complete patient record system. In Table 5.1, we summarise some key indicators that can be used for hospital management.

	Indicator	Numerator	Denominator
Inpatients			
Activity	Bed occupancy rate (Bed utilisation rate)	Inpatient days	Active beds
	Average length of stay	Inpatient days	Discharges + Deaths + Transfers out
	Percentage of TB patient days	TB patient days	Total inpatient days
Deaths	Crude death rate	Number of deaths in hospital	Total hospital admissions
	Infant mortality rate	Still births + deaths in first week	Total births

	Perinatal mortality rate	Maternal deaths	Total deliveries
	Maternal mortality rate	Total deaths audited	Total deaths
	Death audit rate	Total deaths audited	Total deaths
Nutrition	Percentage of severe childhood malnutrition	Number of children with severe malnutrition	Number of children < 5 years that are admitted
Gynaecology	Number of termination of pregnancies performed	Number of termination of pregnancies performed	N/A
Obstetrics	Low birth weight rate	Number of live babies with birth weight <2,500 g	Total live births
	Percentage of deliveries with WR recorded (tested for syphilis)	Percentage of deliveries with WR recorded	Total deliveries
	Percentage of assisted deliveries	Percentage of assisted deliveries	Total deliveries
	Caesarean section rate	Number of caesarean sections	Total deliveries
	Teenage delivery rate	Deliveries to women <18 years	Total deliveries
Outpatients			
OPD	Percentage of referrals from clinics	Patients with clinic referral letter	OPD + casualty headcount
	Percentage of trauma	Motor vehicle accidents + interpersonal violence	OPD + casualty headcount
Support			
	Percentage of stores items out of stock	Number of store items out of stock	Number of items should be in stock
Pharmacy	Percentage of EDL items out of stock (Essential drug list)	Number of essential drugs list items out of stock	Number of items that should be in stock
	Items per script	Number of items prescribed	Number of prescriptions
Financial			
	Cost per patient day equivalent	Total amount spent in last calendar month	Patient day equivalent
	Percentage of budget spent to date	Expenditure to date this year	Budget for the year

Despite being crucial for hospital management, the data and indicators described above are not easily available in many developing countries. Routine reporting from hospital are very often of poor quality and not well-integrated within the district, state and national systems. When hospital systems are being developed, the first priority is often patient billing because it has importance for the hospital administrative operations, and the essential indicator approach is often neglected.

In Figure 5.1, a schematic description of the hospital information system is provided. A hospital is comprised of a number of modules or sub-systems including medical records, laboratory, billing, pharmacy, outpatient, and inpatient. The above schematic of a hospital information system depicts it in the perspective of the management and enterprise perspective of the IHIA.



**Figure 5.1** Data warehouse based architecture at the hospital level. Summary data from all sub-systems are fed into the data warehouse, where essential management indicators can be calculated and disseminated

We have taken the architecture perspective and applied it to the hospital. Compared to a health district, we may say that the various health facilities and specific programmes and services, in this design, are replaced by wards and hospital services and resources. In developing countries, and particularly in African countries, hospital information systems are basically paper-based, which is accommodated in the scalable architecture depicted in Figure 5.1. According to the suggested design of hospital information systems, the hospital data warehouse for management information should be part of the first phase of any project. Whether the hospital system is totally paper-based, or whether it is a medical record system, or a more simple billing system, the data warehouse should be established. While in the beginning, the data sources will typically be paper-based, new computer-based systems or modules may be 'plugged in', integrated and made interoperable with the data warehouse as they are introduced or expanded.

From the discussion above on key indicators for hospital management, it appeared that the number of inpatient days, or bed-nights, as they may also be called, is of particular importance. From Figure 5.1, both average length of stay and bed-occupancy rate is being calculated. Traditionally, these numbers are collected through midnight census in each ward. If a medical record system is in place, or a billing system, which are typically made in order to keep track of how long time the patient has spent in the hospital, inpatient days may be generated from the patient records. However, often, also in advanced hospitals, the old-fashioned manual counting at midnight is being

upheld, because of the complexity of keeping track of the movements of patients between wards. It is a bit like the manual counting of passengers in an airplane before take off. They have computer-based sources, but due to a certain complexity that is inherent they want to be sure and resort to manual counting.

The key quality and management indicators are very useful when comparing performances across all hospitals in a state or country. Therefore, it is important to ensure that each hospital is reporting to the state or country-wise hospital data warehouse, and that they are well integrated in the national health information system framework. As mentioned above, that is not always the case, as information reported from hospitals is often of poor quality and poorly integrated within a national HIS framework.

### 5.1.2 Health Information Systems – A Broader Perspective

At a broader level, HIS is focused on supporting management processes within the health domain. For example, it can be used to support the monitoring of how a country is progressing on the achievement of its MDGs, say relating to the reduction of infant and maternal mortality. An input to this process can be the monthly registration of data on maternal and infant deaths in the last reporting period. This input is then subjected to throughput processes of storing and retrieving of data, and then dividing it by the appropriate denominator (100,000 live births to calculate the maternal mortality rate), and then displaying this output in terms of charts or graphs that compares the performance of this period with previous periods, and of one district or state against the others.

Taking the example of a routine HIS to support the management of maternal and child health programmes, and conceptualising it within a framework of systems thinking. In this case, the input comes from the recording of the data relating to the services that a field nurse provides (also called Auxiliary Nurse and Midwife or ANM in India). For example, after providing a BCG vaccination to a child, the ANM will note that event in her diary. This and such related figures noted in the diary are then transferred to the primary register (for immunisation) maintained in the facility, and the compiled figures for the month become the input to the HIS computer-based application that is installed in the nearest health facility. Once this data is provided, there is a process of throughput, wherein the software helps to conduct checks on data quality, generate aggregated reports (for example, related to monthly achievement) for the facility catchment area, and its transmission to the next level of the sub-district or district as the case may be. These output reports from the facility becomes inputs for the district HIS, and so on to the state and national systems respectively.

How we define the boundaries of the system under study is a matter of our focus and the questions we seek to answer. We can either conceptualise the entire HIS from the community to the national level as one national system or have it broken up by state, district and sub-district levels. Health information systems can be further divided by the health programmes they support such as for immunisation or malaria, or it be an integrated system including all health programmes. Similarly, the HIS can be segregated with respect to functional areas of human resources, finances, infrastructure and drugs. How we define the smaller components or pieces and their inter-relations are design choices relating to the system and architecture respectively. In Box 5.1, we define some basic elements of a HIS. A HIS can have multiple data

## Box 5.1

## Components of a HIS

*Data Element:* The lowest unit of raw data collected, for example, number of children given BCG vaccinations in this month in the PHC Data elements can be of different types. For example:

Routine data element which is collected with a routine periodicity (for example, BCG vaccination figures collected monthly).

Semi-permanent data elements data which does not change routinely. For example, number of hospitals in a district which should be collected annually.

Permanent data elements which do not change. For example, number of districts in a province (which could of course also change).

*Each data should have a defined periodicity of reporting.*

*Data Value:* The value of a particular data element, for example 10, which is the number of children given BCG vaccinations in this month.

*Indicator:* Putting a data element into context of a coverage or target population. For example, Percentage BCG Vaccination Coverage of a district takes the total number of BCG vaccinations given for a district in a month and divides it by the expected live births in the district for a month, and multiplies by 100 to get a percentage figure.

*Dataset:* Represents a set of similar data elements, so for example all data elements related to the services provided by a Sub Centre can be grouped into a Sub Centre Dataset. This dataset can further have groups in it, such as for immunisation and deliveries.

*Recording Format:* Includes the formats in which the primary data is recorded. For example, the primary register in a Sub Centre, where all the services provided by the field nurse in a day are recorded.

*Reporting Format:* Includes the format in which all the data from the recording format are transferred and sent to the appropriate reporting authority. For example, the Sub Centre nurse takes all the monthly data from her primary registers and transfers them into a monthly reporting format and sends that to her reporting PHC after doing necessary data quality checks and getting the required signatures as authorisation from those responsible.

*Organisation Unit:* It is the health facility that provides services within its catchment area or facility, and reports on the data elements representing these services.

*Organisation Unit Hierarchy:* Represents the reporting relationship, defining to which unit a particular organisational unit is responsible for its routine reporting.

The HIS is thus made up of the following “4Ws”:

- What – data element.
- When – periodicity of reporting.
- Where – organisational unit.
- Why – The indicator to which a data element contributes.

sources such as emanating from field visits of nurses, records from primary registers, births and death details from the civil registration system, population details from the district authorities.

All the above serve as data inputs to the HIS. In its raw form, this data is not useful for a health manager, as he or she needs to compare this data representing achievements for a month with what was expected, implying this data has to be put into context of a target or population coverage. This requires the processing of data into health indicators – representing information, either manually calculated or through the software. Further, the manager needs to act on this information, that is to use it to take decisions, for example, putting more resources in an area which has been identified to have a poor BCG vaccination coverage. By doing this, the information is converted to useful and practical knowledge. Based on action taken, feedback can be obtained on the relevance of the information used, and whether new forms of inputs are required to take improved action. Such application of systems thinking help us to design based on inputs, formulate throughputs such as for the appropriate generation of indicators, and design effective outputs in terms of presentation reports. Feedback loops help to treat design as an ongoing work in process and to make continuous improvements based on reviewing the impact of the actions taken.

An effective HIS should help users to answer the following types of questions:

*What* – is the disease profile of a district?

*When* – are certain diseases more prevalent?

*Where* – in a district certain outbreaks of diseases are expected?

*Why* – is malaria more prevalent in this district as compared to others?

After discussing the relevance of systems thinking on HIS, we outline some design principles and how it can support its evolution to an effective IHIA.

## 5.2 Practical Design Principles

A normative guiding principle in the design of a HIS is its need to support the use of information for local action, which provides the foundation to formulate some practical design principles. System designers possess the agency to develop design inscriptions, which when embedded into the application, shapes system use in at least two ways: 1) System restrictiveness and 2) Decisional guidance (Silver, 1991).

While system restrictiveness refers to the amount of restrictions that the designers want to provide to the user in the use of the system, decisional guidance refers to the degree of step-by-step guidance the user receives from the system. A system can be more restrictive depending on various factors including the assumptions the designers have of the users (for example, of their skill levels), capability levels of the users, and nature of deployment of the application (for example, if it is server-based or standalone). For example, in a HIS, with respect to design choices related to the generation of reports, the user can be provided with pre-configured reports or can be given the facility of excel pivot tables to create their own desired formats. The first is an example of a more restrictive system relative to the latter option. Local control of own data is a key principle, but will depend on a certain level of skill. A



design option would then be to provide both pre-defined reports and do-it-yourself analytical tools.

Given that a HIS is generally used by a variety of users and it evolves over time, the questions of how much should a system restrict or guide are not straight forward questions to answer and rarely ever cast in stone. However, we can be aware of certain principles that can help to guide taking of design choices:

- Integrated independence – Treating the HIS as a component of an architecture, and not as standalone.
- Adopt an incremental approach to design and implementation.
- Adopt a Participatory Design approach.
- Should allow for local control.
- Should provide for a hierarchy of information support.
- Should be action, not data led.

These six principles are described now in detail.

### 5.2.1 Integrated independence – Treating the HIS as an integrated component of an IHIA, and not as standalone

Especially, fuelled by the successful growth of the Internet, HIS can be arguably conceptualised within an IHIA perspective which emphasises:

- Components are always inter-connected, but applying a modular approach will help managing changes.
- There is always a historically existing technical and institutional legacy – an installed base, which has to be addressed and somehow incorporated in the development of a new system. We can never design from scratch.
- IHIA's are always in the making and thus never designed for a finite number of users, as the user community always evolves over time. This implies that requirements can never been 'frozen'. For the same reason, an IHIA never has a finite start and end date.
- There are network externalities to be obtained, because new users will seek to be enrolled into the use of the system as they see others using the system, which serves as an 'attractor'.

The Internet is a classic example of such an architecture (where roads and power grids are examples of physical infrastructures), which has evolved over more than three decades, starting from specific applications for the United States army to now where users of all kinds are engaged in different types of applications such as e-mail, web sites, music downloading, social networking (such as Facebook) and communication (for example, Twitter). Diffusion of the Internet and other communication technologies have enabled tighter integration, which again, may lead to less independence and flexibility. The case of South Africa has demonstrated a possible way out of this dilemma, by demonstrating that both integration and independence of data standards have been achieved between provinces (i.e. geographical areas) and health programmes (i.e. functional areas). A sort of integrated independence has emerged through the interaction between and within different sub-systems and the overall HIS environment. Key implications of this on the conceptualisation of an IHIA include:

- *Designing for loosely coupled and modular systems:* Given the emphasis on the inter-connected nature of systems where nothing is standalone, we need to allow for different pieces to speak to each other while ensuring the failure of one does not collapse the entire IHIA. This raises the need for designing loosely coupled systems employing bridges and gateways, which allows components to be both inter-dependent and independent at the same time. This need has been arguably the strongest reason for the use of open source systems based on open standards in the health domain.
- *Develop flexible standards.* The IHIA includes numerous interdependent standards, which may easily arrive in lock-in states resulting in whole systems being locked in. It is therefore important to develop standards and their relations so that they can adapt to a changing environment and thereby contribute to the sustainability of the IHIA, meaning that the standards themselves need to be flexible. We distinguish between use flexibility and change flexibility of standards. While the DHIS has gained popularity because it makes it easy to change data standards – change flexibility – the need to know principle of focusing on essential data in contrast to “nice to know” data, illustrates how the same data can be used by many actors in different contexts – use flexibility.
- *No pre-defined set of users and application areas:* A HIS can start as a data entry tool and slowly evolve by linking with different health programmes (for example, Malaria and TB) catering to a variety of users (facility, district, state, national and global levels), and also be used as a medium to provide access to the public. There are no pre-defined limits to users, applications and uses.
- *Specifications can never be frozen:* An IHIA perspective helps to avoid the historical trap of trying to ‘freeze’ the specifications of a system, when by very definition, the health system is inherently dynamic requiring the HIS to be flexible to adapt to its changing circumstances, and not for the health system to configure itself to the rigidity of the system.
- *Health information systems are cultivated and not constructed:* The emphasis on the installed base cautions to guard against the practice often advocated by consultants to obliterate existing processes and build brand new ones (as is the guiding philosophy of Business Process Engineering). While we may be able to eliminate existing technical systems, killing deeply embedded and historically existing social and institutional processes are by definition not possible. Health information systems need thus to be *cultivated* to a IHIA from an existing installed base (for example, the existing paper-based systems) and they cannot be *constructed* from scratch on a clean slate.

An example of the utility of such an IHIA perspective can be seen in the use of mobile phones to strengthen HIS. In India, for example, mobile phones have been provided by some of the States to ANMs to register service data and transmit it using SMS to a server hosting the state HMIS application. If the design of the mobile application had been treated as a standalone activity, then the focus would have been only on the mobile and a failure at that level would have led to the collapse of the monthly facility based HMIS reporting. However, an architecture perspective allows to see the connection between the different components (mobile phone, server, network connectivity, computers, and so on), and design for buffers and backups to minimise these systemic risks of failure. For example, till the reliability of the mobile application is established, states can decide to keep both the flows of information (the mobile

supported and the direct entry to the DHIS2 supported HMIS application) ongoing. Figure 5.2 illustrates this mobile supported IHIA which includes the DHIS2 which represents the backbone HMIS application in a state.

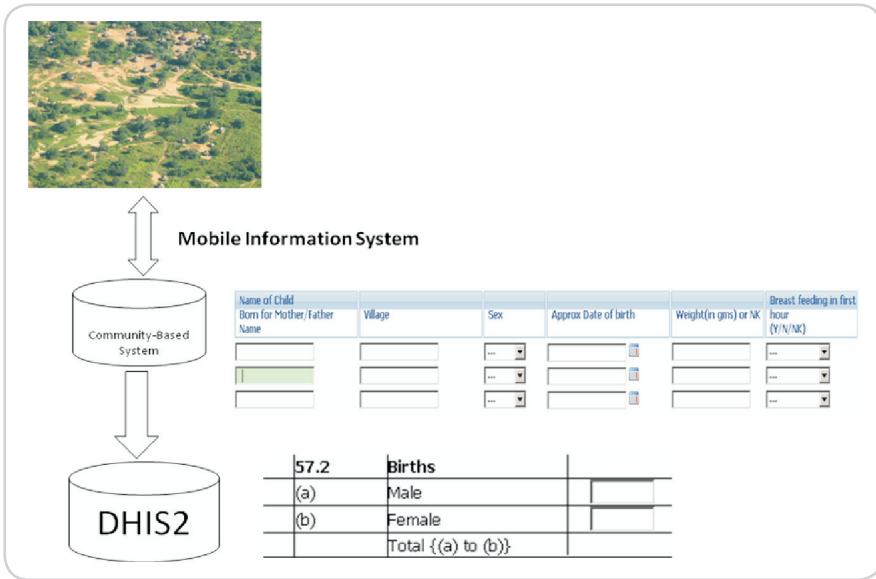


Figure 5.2 Mobile supported Health Information Architecture

### 5.2.2 Adopt an Incremental Approach to Design and Implementation

Radical change is often the aim when introducing ICTs and a new HIS. However, experiences from introducing ICTs in industrial countries, for example in efforts labelled Business Process Reengineering, have shown that full-scale changes in one go is difficult to achieve because of the complexities involved and organizational and system-wise inertia; new solutions need to build on and take the installed base into account. The golden rule is therefore that new solutions need to be designed so that they support existing practices and that these practices should then be modified and changed incrementally. This is a non-trivial task, requiring sensitively carried out design, a deep domain understanding of the work area, and an absence of arrogance on the part of the designers to not dismiss the existing practices of the users as being inefficient and irrational. Incremental development makes it possible to incorporate learning through use in the design and by delaying key decisions, for example on choices of technology, avoiding being 'locked in' and not being able to take advantages of future technological opportunities. You achieve more by starting small and growing bigger than by starting big and fail. We may label this approach radical change through small steps.

To start with the 'easy wins' and 'low hanging fruits' is a related key principle. That approach seeks to provide a good and rapid solutions to important problems for the users. In this way users get interested, and if usefulness is demonstrated, more users will be attracted, momentum may be created, and what started small will

grow bigger. The development of DHIS in South Africa illustrates this principle; the flexible data structure of the application and rapid feedback to the users of their information enabled by the decentralised technology demonstrated how changes could be achieved, how fragmented datasets could be harmonised, and more users and provinces then joined forces and created more momentum; the DHIS approach was developed into an attractor. Important in the case of South Africa was that the relative simple solution provided to what seemed to be a very complex problem worked well for end-users in the district as well as for managers and policy makers at higher levels. With this, more actors became interested and were enrolled in the process which caused the movement to grow further and gain more momentum. The case of Sierra Leone shows a similar development; users in different health programmes did not believe it was possible to unify reporting forms and procedures before it was proven possible in practice. Then they decided to join the process and thereby confirmed that it was indeed possible.

### 5.2.3 Adopt a Participatory Design Approach

The participatory design approach is a key part of the principle of incremental development. The cases of DHIS development used in this book are all about what we may call incremental prototyping, or an approach to developing the system step-by-step through use. This participatory methodology of prototyping is based on a close and mutual relationship between design and implementation, and between designer, or developer/implementer, and users. A prototyping approach, as contrasted to a system lifecycle approach that assumes a linear cycle of freezing specifications and then development, takes a view of design that is not fixed, but continues to evolve over time. It may also be called a learning approach, as what is learned through implementation and use is feedback to the design and further development of the system. In this way, the knowledge barriers between the developers who know the technology, and users, who know the context and work practices, are gradually and mutually bridged; as users are learning about the technology and the developers about its context of use.

The aim is to design and develop the system in close interactions with the users. First prototypes are developed and shown to the users, who then give their inputs to developers, who can then go and further reform the system based on this feedback. This interaction and process of change takes place in small and rapid cycles, often referred to as a process of agile development. As a result, there is an inherent flexibility in the design process which is able to incorporate new inputs, reducing the risk of having to wait for large development cycles to be completed before realising that the user is unhappy with the system. By being engaged in the process of giving inputs to the system, the user experiences a greater sense of ownership with the system right from its initiation.

A prototyping approach to design also enables an incremental approach to implementation, where first the low hanging fruits can be taken and visible benefits shown to the management. This approach also allows the implementation team to gradually learn about the context, and can then next reach out to the slightly higher fruits. An example of this approach is provided in Box 5.2 describing the approach to the development of a district hospital information system by HISP India, also referred to in Chapter 4.

## Box 5.2

## 'Low hanging fruits first' – An example of an incremental approach

*An Incremental Approach to Implementation*

The state of Himachal Pradesh developed a Request for Proposals for the creation of a hospital information system for its 20 hospitals in the state. In response to this, 51 vendors applied; however, the tender could not be offered to any of the vendors because the state had difficulties in evaluating the bid.

Subsequently, the state approached a national technical support agency for the Ministry of Health, who in turn approached their technical support partner (HISP India) to study the requirements and develop the feasibility for its development. On studying the initial requirements document, it was found that the entire system had been conceptualised by the state as a set of about 15 modules, some rather straightforward such as registration and others more complex – both from the design and implementation perspective, such as scheduling of doctor appointments through SMS. Further, the system was planned to be implemented in 20 hospitals simultaneously.

HISP India saw this proposed system to be rather complex, and many of the requirements to be utopian, not fitting in with the reality and infrastructure of what currently existed in the hospital. Instead of taking the whole system and all hospitals in one go, they proposed an incremental approach to design, development and implementation, which was envisaged to take the following small steps.

Select one representative hospital (out of the 20) as the starting point.

In this hospital, develop and implement module by module, and as a module is completed, including its testing, then integrate it with other modules.

The list of 15 modules originally envisaged were categorised into two groups, the first including the core or essential modules which needed to be addressed first and then the second group, which were more complex and not so essential which would be addressed subsequently, if the state required.

Even within the priority core modules, a further priority listing was done, and the management identified what was needed first including registration and billing. The Outpatient Department module was seen as being more complex and to be taken towards the end of the first priority list.

The plan was then to take the registration module first, customise it, implement in the first hospital and then take the next module, thus allowing taking first the low hanging fruit and showing visible results. This builds confidence and trust of the hospital administration with the implementation team. Similarly, the development and implementation team gain an understanding of the hospital context and the inherent challenges in introducing a system. Resource material like training manuals and other, which are developed can then be also used in other hospitals.

The above approach inscribes the HISP approach to development and implementation, which has fundamentally been founded on such a prototyping approach, and has contributed to large scale successes in implementation in South Africa, India and various other countries. This has also contributed to the creation of a software product that is inscribed with a high degree of public health knowledge built upon the practices of health staff in the field.

To develop a sense of ownership to the system among users is the key to sustainability and any form of successful HIS development. The need for local control of information and system is a key to develop such ownership, which brings us to the next principle.

### 5.2.4 Should Allow for Local Control

Design-reality gaps have been established by researchers to be a primary reason for the failure of many HIS in developing countries. These gaps arise from the physical, cultural and knowledge distance of the technical developers from the reality of the users. This distance firstly leads to inappropriately designed systems, and secondly of user requests for changes going unheeded by the developers. In the context of developing countries, HIS are often designed and developed by national ministries or by international consultants who are far removed from the practical setting of their use. This phenomenon of 'design from nowhere' is embedded in larger questions of power and control. With respect to user requests, they can come in the form of making changes in data elements, indicators, creating of data validation rules, incorporating new reports or in some cases even adding other modules and applications. Most often, in the institutional setting of health ministries and departments at the national and state levels, the in-house capacity to make such changes is limited or even non-existent. The important question then is what should be the mechanism by which change requests are logged, how are they responded to by the technical teams, and subsequently received back by the users from where the request originated? Typically, when proprietary systems are used, each change request has contractual implications, and vendors tend to not respond till the cost of which is covered in their contract. And since often systems are developed based on the assumption of 'frozen specifications', most change requests are seen to fall outside the purview of the existing contract, and thus not attended or at best done so after a frustrating time delay for the user. In defense, the technical team will argue that 'users do not know what they want and always come up with new demands'. The disempowered users tend to firstly get a system that does not suit their requirements and capacities, and secondly are chided for raising that as an issue.

Since existing systems of contracting are institutional legacies, and so difficult to change, the challenge for system developers is to provide appropriate tools and approaches to the users to help them exercise greater control of their local conditions. A first step in this strategy is to use software tools and platforms in which the code is under the control of the user giving them the freedom to change and customise based on their evolving needs. Proprietary systems are by definition proprietary – under the control of the vendor and not available for modification without a cost implication. Applications developed on FOSS platforms provide at least the potential to the users to be able to have the ownership and right to modify. However, realising this potential in practice is a challenge due to limited technical capacity in the institution, such as for accessing the source code and making the required changes. To address this challenge, health department needs to try and fill this gap by creating technical support partners either in-house or through external sources in the initial stages, and gradually empower the in-house staff to be able to do so in a more independent manner.

The other implication for enabling local control comes in the form of design, where systems need to be made flexible, easy to use, and allow significant degree of changes to be made through the user interface itself without requiring programming intervention. For example, a user should be able to select from the interface the category of 'data elements' and be able to add, delete or modify data elements. Same as is the case with the creation of locally required indicators and data validation rules which should be enabled through the interface. Another important aspect of local control is in the domain of reporting. Users should be able to export data into formats,

such as Excel, which they may be more familiar with to be able to create their own ad-hoc reports, design graphs and charts, and carry out further analysis (for example, to see data trends). Allowing outputs in formats which can be easily imported into other systems, which users may be more familiar and comfortable with (such as EpiInfo which is popular with the medical fraternity), further allows the exercising of greater local control. With advances in technology, various tools are increasingly being made available for not so expert users, such as for report design and presentation, which can again help to empower users as they increasingly gain local control.

In summary, through deliberate design choices, such as providing for flexibility in local customisation, having easy to use systems, and the use of open source and user friendly tools, systems can be so designed to break the monopolistic hold of proprietary vendors, and bring systems closer and more squarely within the domain of users. Strengthening local control of systems by users will go a long way in bridging the design-reality gaps and creating more effective HIS. Once more securely under the control of users (rather than proprietary vendors), the trajectory of evolution of the HIS to a IHIA can potentially become more effective.

In Box 5.3, we provide an anecdote from a training programme that underscores the importance of local control.

#### Box 5.3

#### 'Play' as a metaphor for local control: example from Kashmir

##### *Building Capacity Through Enabling Local Control*

The members of HISP India team were carrying out a training programme for district managers in the Kashmir division on the implementation of the revised datasets and the use of the DHIS2. While giving the orientation to the software, it was emphasised that the functionalities of flexibility for local customisation of data elements, indicators, validation rules, report; the ability to create local reports that need not be sent to the national level; and checking for locally collected data. Till date, normally the applications they had been provided by the ministry were centrally controlled, and only allowing for data entry for district consolidated reports. With the DHIS2 they could also include their Sub Centre facilities (the lowest level of data collection), which were meaningful for them to shape their local action. What impressed the users was that this software was under their 'local control' as they could configure and use it for their local needs.

At the end of the training programme, we asked the trainees how many of them would desire to receive a CD of an offline installer for the DHIS2. They all said yes, and one of the doctors said 'we can then play around with the software so that the next time you come, we will be much more proficient with the software'. We found the use of the metaphor 'play' to be very powerful, as the trainees felt they could locally control the software which would enhance their proficiency.

### 5.2.5 Hierarchy of Information Support

A well established principle of HIS design, discussed in detail in Part I of the book, is that, it should provide support to implement a hierarchy of information needs, implying the lowest point of entry requires the most disaggregated form of data, and at the highest level is most aggregated. This principle has been inscribed in the design of the DHIS from the start and arguably is a key factor in its uptake across the globe in multiple countries.

The principle emphasises that flexibility is ensured by allowing for 'freedom' horizontally, as long as standards are maintained vertically. There is a central core set of 'essential data or indicators' required by the national level which all levels below must report on that data and which can not be deleted. However, every level below has the freedom to add to that core given their local needs. So, while a state can add some data they cannot delete what the national level needs, and the added data need not be sent to the national level, but only used for state specific purposes. Similarly, the level below the State (the district) must report on what the State and National level wants, and in addition can incorporate others essential to their local needs. Similar logic holds for the levels below. This approach of 'flexible standards' allows for standards to evolve in a locally relevant manner. This mechanism for local empowerment enables users to view the HIS not as a tool for top down control to facilitate upward reporting, but as a tool to enable local relevance and action.

In Box 5.4, we provide an example of the use of this principle in practice from our experience in Ladakh, in Northern India.

**Box 5.4****Hierarchy principle in practice – Example from Ladakh***The Hierarchy Principle in Practice*

While conducting a training programme at the district level for sub-district level (block) users in Ladakh on HMIS and the DHIS2, we found users to be extremely proactive and wanting to engage with issues around the HIS. Historically, the users in this district have felt marginalised and neglected by both the national and state authorities.

The training involved orienting the users on a revised set of data elements that the national level had mandated for each district and state in the country to report upwards to them uniformly every month. While carrying out this orientation, the staff pointed out to a particular and significant health condition of acute mountain sickness that the district health services were combating with. The district wanted to monitor this important parameter, which however was not part of the national dataset, and in fact was also not relevant to the other districts in the State. Using the DHIS2, the users were taught to add into the dataset, the particular data element of acute mountain sickness. This dataset was then assigned to the various sub-district facilities of Ladakh and users were trained on how to report on that element for their respective facilities.

To make this data visible to the district authorities, a simple report was designed that provided details of the prevalence of the problem across facilities. Users further demanded that they would like to see a report which showed prevalence across months, as they stated that this problem was more prevalent amongst tourists visiting Ladakh than in the local population, and tourist inflow was seasonal. These reports were designed only for consumption of the district, and not for the national and even the state. Further, this data element was converted into an indicator by including a second data element of 'tourists visited for the period' and dividing the number of acute mountain sickness cases by tourists visited.

The district managers felt extremely empowered in seeing how the DHIS2 could be used as 'their own tool' and not just for state and national level reporting, which they historically felt as being irrelevant to them.



The example emphasises that the system must be endowed with multiple technical functionalities, such as:

- The ability to assign specific datasets to particular facilities and facility types so as to allow facility specific data collection.
- The ability to define a hierarchy of organisation facilities, which specifies what facility reports into which facility and the different points of aggregation. In this way, aggregation of data can take place based on an entire user defined hierarchy.
- The ability to define health indicators at every level to enable the generation of defined indicators for particular facility types or administrative levels.
- The functionality to define data quality validation checks and analysis of data status at every level so as to enable each level to analyse data coverage and quality for the group of data relevant to them.

In addition to the functionalities that the application must offer, the glue which binds this hierarchy together is, as discussed in Part 1, the three levels of standards, which relate to political agreements on what standards (user level), common definitions of data, similar periodicities of reporting from facility types (semantic level), agreed upon data interoperability, which specifies the protocols of how data is exchanged vertically across different administrative levels and horizontally across various health programmes (data level). Given that the system must cater to a diversity of information needs across administrative levels and health programmes, we cannot adopt standards based on the principle of one shoe fits all, because by definition they will not fit. Instead, the approach is to create flexible standards, where like the hierarchy principle, there has to be an agreed upon central core of standards which everyone must adhere to, and for different levels and health programmes there could be additional standards that are specific to that category. This principle is similar to the use of gateways or bridges that allows for core standards to make different parts of the system to speak to each other, and yet allows for those independent parts to adopt their own standards of working.

### 5.2.6 Should be Action, not Data Led

Health systems in developing countries, by their institutional upbringing, tend to support processes of data generation and reporting upwards towards the central ministry rather than on how data can be converted into information to support action locally. In short, HIS tend to be data led rather than action led. Given that the aim of an effective system is to process data into reliable evidence to support managers in making health programme improvements, by design the information system should seek to become action led. How does one then work towards this end of making a HIS action led? First of all, as debated in chapter 2, the information should be collected and processed for a purpose, for some kind of action! The traditional approach to this end has been to focus on Goals, Targets and Indicators based on the situation in a concrete local context:

Long term Goals such as “improve the health of mothers and children” are usually political and are set at the national/policy level. The challenge at district level is to translate these general ideas into locally owned operational targets that are SMART, i.e. Specific, Measurable, Achievable, Relevant and Time-bound. All local role-players must

be involved in this target-setting process and become part of the plan to achieve these targets. Indicators measure how far programmes have advanced towards achieving their targets. These can be quite difficult to develop, as they need to be objective, valid, reliable, and sensitive. To start with, select only a few, simple indicators that are important locally! Once these are being effectively used, increase the number and start more complex analysis. The approach would then be to use indicators to measure achievements and evaluate results, leading to new action and eventually new targets and justified and new indicators in an ongoing cyclic process.

Two characteristics are key to making the HIS support this action oriented process:

- The system should provide adequate tools to empower the user with the ability to establish that the data is reliable, implying its readiness to be used for action.
- There must be adequate tools available to be able to present data in the form of charts, maps and graphs, which helps to make the data easily interpreted and analysed to aid action taking.

These two conditions are of course inter-linked as good quality data will help build trust of managers to use it, and the easier it is to use data, the more it will be used which will lead to data quality improvements. With respect to the first condition of establishing the reliability of evidence, a number of easy to use software tools can be made available to the user. To establish the completeness of data, the user should be able to ascertain the percentage of reporting by facilities and data element types. Further, the user should have the ability to drill down on facilities, data element types and periods, which are identified as being inadequately reported. Identifying whether data values are within acceptable minimum or maximum ranges, or why for a particular period there may be an aberration further helps to improve the reliability of data. Another functionality to help establish the quality of data is to be able to assess whether it passes key validation checks. Validation checks can be of two types. Absolute validations imply mandatory rules which must be followed. For example, if a dataset includes data elements on total deliveries, live births and still births, we know that the total delivery reported must equal the sum of live births plus still births. This is an absolute rule, and if violated points to a data quality error. The other kind of validations involves expert rules, which imply that we expect these rules to hold in 'normal' circumstances. For example, we expect BCG vaccinations reported to be less than or equal to the total deliveries since every child born should be given a BCG vaccination. However, there may be cases when children born in other catchment areas come to a facility and get vaccinated, leading to a violation of the rule since there will be more vaccinations given than deliveries reported. However, this is not a data error, but merely a reflection of a programme condition.

There are thus different functionalities that can be built into the software application to strengthen quality assurance. However, it must be noted that while the software can only help to raise the red flags around quality, improvements or corrections need to be carried out only through human intervention within an institutional framework, something which the software cannot do but is often blamed for. So, when the software through its validation checks raises red flags over quality, the institution must have protocols defined and in place which guides the staff on how to deal with these red flags. These protocols must define, for example, responsibilities for who should carry out these checks, which person needs to drill down and identify the source of the problem, and finally who has the authority to make and communicate the changes.

After discussing these six individual design principles, in the next section we present an example from India of the design of the national HMIS, where some or most of these principles provided an overall framework for design.

### 5.3 Building and Applying Practical Design Principles – An Example from India

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In India, the National Rural Health Mission (NRNM) was established in 2005 with a vision of making architectural corrections within a health system framework in different technical areas including in HIS. Some of the guiding principles that the HIS needed to support included that of decentralisation, integration, and the promotion of evidence-based decision-making. With this as the point of departure, a process of redesign of the HIS was first undertaken, which was then followed by a process of implementation. This process of redesign is now described.

The redesign phase consisted of the following activities:

- Carrying out a detailed situation analysis of existing systems using data from 3 to 4 states.
- Having detailed consultations with national, state, district representatives, and also with academicians, NGOs and international experts.
- Inductively deriving principles of redesign of the HIS.
- Applying these principles to develop the revised HIS.

A brief overview of each of these activities is now presented.

#### Situation Analysis

Using some sample states for which data was available from their HIS, an analysis was carried out to identify what were key constraints in the existing system. This analysis was then integrated with the empirical knowledge the different participants had of the field situation, and the following constraints were identified:

- An excessive number of data was being collected – ranging from about 1500 to 3000 per month per facility. This created a significant work burden on the health worker and also seriously jeopardised data quality.
- Large number of data elements were being captured simultaneously in multiple forms (for example, Childhood TB was collected in Form 6, Universal Immunisation Programme and Integrated Disease Surveillance Programme) leading to redundancy of work and also to data quality errors at source, and thus contributing to a weak foundation for the overall HIS.
- While a lot of data was collected, there was limited evidence of even 5% of the data being used for the generation of indicators in a systematic way. For example, no State Plan as seen to use indicators related to Scheduled Caste and Scheduled Tribes, disaggregated data even though they constituted about 33% of the data being collected.
- A large percentage of this data being collected (say 45 to 60%) was being systematically reported by facilities and periods as blanks or zeros – raising questions of why they were being then collected.

- More than one-third of the data collected represented disaggregated data (breakups by Scheduled Caste/Scheduled Tribes/Other or by age or sex) which could arguably be more effectively captured through annual surveys rather than through the routine reporting system.
- Fragmentation and compartmentalisation of systems was rampant, which led to both the missing out of important data (for example, HIV tests of ANC cases as they represented different programmes) and repetition of certain data (like the example of Childhood TB above).
- Data only flowed upward and not downwards, implying poor use of data for supervision and feedback. Further, this created a weak motivation for data providers towards improving quality of data as they understood nothing would come back.

The details of these findings were presented in a national workshop in February 2008 in New Delhi, where a number of experts attended and feedback was obtained. In this way, user level inputs were taken into the design process much before the system was designed. Further, since a number of user groups and experts were represented in the whole process right from the beginning, at least to a certain degree inputs from users and other stakeholders were elicited.

### Consultation Process

The process of consultations with different stakeholders including national level programme divisions, Monitoring and Evaluation division of the Ministry of Health, states, the National Health Systems Resource Centre, which serves as a technical support group for NRHM and the Ministry of Health, and other experts took place in an intensive period following this workshop, and under the direct leadership and guidance of the then Mission Director of the NRHM. The aim of these consultations was to rationalise the forms and information flows, identify key indicators for different levels, and define the recording and reporting formats. As could be expected, these consultations were politically charged, with each constituency not willing to let go of what existed, even though at a conceptual level there was agreement on the need for rationalisation. An important example was the discussions around whether data with breakups of Scheduled Caste/Scheduled Tribes/Others should be collected through routine data or should they best be captured through annual surveys. The arguments for taking into the survey dataset were:

- It adds on to the burden of data collection (each data element gets multiplied three times).
- On the ground, it is very difficult to actually capture this data.
- On analysis of the Scheduled Caste/Scheduled Tribes/Other data for 3 to 4 states, the data was found to be rather 'constructed' reflecting similar percentages of Scheduled Caste/Scheduled Tribes populations in the state as reported in the 2001 Census.
- Since proportions of these disaggregated populations remain relatively stable in an area, it could be more effective to capture them through surveys rather than routine data.

Arguments for keeping the status quo were:

- The new formats have only recently been introduced, and frequent changes would be disruptive.

- The data was important for reporting to Parliament and the political constituency.
- Data quality is good and reasonably complete.

Finally, a call was taken at the highest level and a decision made to move it into survey data. Some other efforts towards rationalisation were not as successful. For example, on the integration of Integrated Disease Surveillance Project data to the HIS, despite a number of consultations with the programme division and also the WHO, they did not agree to integrate the two data flows based on the argument that the 'logic of a disease surveillance system is different from a HIS. In other cases such as the Routine Immunisation Management System, there was mixed success, with an agreement initially being made to do an integration, but subsequently a resulting ambiguity about what was to be rationalised as clear instructions did not go from the programme division to the states to remove the old forms.

### Inductively Deriving Principles of Redesign

These consultative processes were accompanied by a design activity of deriving inductively the principles on which the recording and reporting formats could be redesigned. These principles could be summarised as follows:

- No data should be entered in more than one form.
- Data should be only reported based on service provided by that facility. This implied the previous practice of area based reporting (which arguably led to duplicate reporting) would be replaced by a system of facility based reporting.
- Disaggregated data which was better captured through surveys should not be included in the routine datasets.
- To establish a hierarchy of information needs and required indicators at each level, and to clearly establish the distinction between a 'data element' (raw data) and 'indicator' (processed information).
- Every report going upwards should have a corresponding report going down to support feedback and supervision.
- Establish clearly the distinction and understanding of a reporting format and recording format.

### Applying these Design Principles

Applying these design principles contributed to the following outputs:

- Redesigned facility specific datasets for each facility type: PHC, Sub Centre, CHC, District Hospitals and others. Formats were so designed so that they could be adapted to other facility types such as private facilities based on the correspondence of services the facilities offered.
- Redesigned reporting formats with a focus on the district consolidated monthly report which was to be the standard for national reporting. In addition, there were the quarterly and annual formats for services and financial reporting.
- A defined set of indicators representing a hierarchy for different levels – with a set of about 30 indicators for the national level and 100 for the district.

These outputs were operationalised into a 'HMIS Tool Kit' including:

- A book containing all formats including their Hindi translations.

- A data dictionary which provided details of all data elements, their meanings, and data collection guidelines.
- An indicator manual, which provided a description of each indicator including its numerator, denominator and guidelines for use.

Further, National Health Systems Resource Centre in collaboration with its technical partner HISP India also customised using DHIS2 (which was already being used in some states like Kerala and Gujarat) a 'standard application' which was capable of meeting all the functionalities for recording and reporting the above defined formats, in addition to providing various functionalities of data validation, analysis, GIS mapping and presentation. This entire tool kit was made available to all states without cost.

The above example of the process of redesign of the National level HIS illustrates a number of the practical design principles that we had highlighted earlier.

Table 5.2 Applying design principles in practice

<i>General Design Principles</i>	<i>Examples of their Application</i>
Should allow for local control	Reducing no. of data elements to be collected by 90% would help field nurses to have more local control of data collected.
Treating the health information system as an infrastructure rather than a standalone system	Integration was a guiding principle, where based on the NRHM agenda, the aim was to create an infrastructure, which would gradually provide information support for health programmes.
Hierarchy of information support	Different set of indicators created for different levels, with the national level assigned a set of 20 impact indicators and the district about 100 monitoring indicators.
Action, not data led	Attempts were made to see each data element included in the dataset were linked to the generation of at least one indicator.
Adopt a Participatory Design approach	Building ownership to the revised and reduced data collection systems by actively involving users at all levels in its development. Users at local levels are happy to get their burden of data collection reduced while users at state and national levels get better quality data.
Adopt an incremental approach to design and implementation	Integration was approached in an incremental manner, where first the immunisation data was attempted to be integrated, and plans to integrate the other programmes in an incremental manner.

The Table 5.2 illustrates an effort to develop practical design principles, and apply them for independent systems, in this case, the routine HIS, while keeping in mind the broader architecture or infrastructure that was being envisaged. The learning from the process of implementation that has taken place from October 2008 to date, helps to further redefine these principles, and create others that are more suited

to the practices on the ground. For example, we found even though in the design process, the immunisation data was removed from the existing routine immunisation management programme and integrated with the HIS, in practice this integration was at best partial. This was because the child health division at the national level did not buy in completely into this change process, and as a result had not issued clear guidelines to their line departments to affect this change. The learning, thus, is that while technical integration may be relatively easy to carry out, the institutional integration is much harder due to historically existing institutional conditions. Greater amount of negotiations and consensus building needs to be thus carried out at the national level leading to clearer directions to field staff is required to make integration work on the ground.

### Summary

Some key take away concepts from this chapter are summarised below:

1. Health information systems are designed within the framework of the collective (the architecture, IHIA) in mind.
2. Systems thinking and concepts can help guide design choices as is the case with architectures, conceptualised as systems of systems.
3. Designers have agency in system design. The nature of agency can be understood through two concepts of systems restrictiveness (how much to restrict the user) and decisional guidance (how much step by step guidance to provide to the user).
4. Health information systems design can be guided by analysing design with respect to the 4 Ws: what; when; where; why – that the system should help to answer.
5. Key design principles:
  - Treating the health information system as a component of an infrastructure, and not as standalone.
  - Adopt an incremental approach to design and implementation.
  - Adopt a Participatory Design approach
  - Should allow for local control.
  - Hierarchy of information support.
  - Action, not data led.

### Reference

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# 6

## District Health Information Software – What it is

In the previous chapter, we discussed how design principles could be operationalised in practice. In this and the next chapter, we focus on the District Health Information Software (DHIS), as an example of how to inscribe these design principles in practice. While in this chapter, we discuss what DHIS is, in the next, we discuss how to go about setting it up in a new context be it a country, region, district or health facility. In this chapter, we describe and discuss three aspects of the DHIS as a project and an artifact that embodies principles of a data warehouse:

- We start by giving the background and trajectory of the process of developing the DHIS, from its start in South Africa in the 90s and to the present day.
- Then we will describe the DHIS application, and its overall structure.
- Finally, we describe its various components and the open source philosophy surrounding its development and evolution.

### 6.1 The Process of Developing the DHIS

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#### 6.1.1 Context and Origin

The DHIS project is born out of the political processes of change in South Africa following the fall of apartheid, and as a synergetic collaboration between public health activists from the anti-apartheid struggle and information system developers from the Scandinavian tradition. DHIS emphasises the use of information for action and improved health services, user participation and 'live' (in real contexts), agile and rapid prototyping. The DHIS software development effort was organised within the HISP network, and has since its inception been embedded in a synergetic mixture of public health and participatory design perspectives.

The HISP approach to action research and information systems design was initially influenced by a number of union-based action research projects in Scandinavia in the 1970s and 1980s. The focus in the earlier participatory design projects was on empowering workers who were affected by or threatened by new technology, by exploring ways in which their influence over technological solutions could be ensured. Later projects shifted toward actively producing technological alternatives by involving workers in cooperative design at the workplace. The philosophical grounding of the design approaches followed by HISP may be seen as a continuation of these perspectives, with a goal to explore ways in which disadvantaged communities, regions and countries could appropriate ICTs for their own empowerment. User



participation and rapid prototyping in the context of use, combined with capacity building, all at multiple organisational levels of the health hierarchy, became the basis for the development approaches used to pursue this goal. The original key members of the HISP team had backgrounds as social/political activists in the anti-apartheid struggle and other social movements, and were thus explicitly political actors in a larger development process.

The context of South Africa and the process of rapid change following the fall of apartheid became decisive for the design and development of the DHIS, and its robustness through time. In South Africa at that time, the health system and data requirements were extremely fragmented and constantly changing. To give a picture of the fragmentation: During apartheid (1948–1993) and until May 1994, there were 14 departments of health at the central level: the ‘general’ Department of National Health and Population Development, 3 specific ‘white’, ‘Asian’, and ‘coloured’ administrations, and 10 for ‘blacks’, ‘homelands’, and ‘self-governing states’. As one consequence of this fragmentation, there were numerous data collection tools, procedures and data definitions in use, and there were no national standards for data collection, and, as all the ‘homelands’ were included in the provinces; each province used different data standards.

As DHIS started out to support the decentralisation and integration of the health services, the design focus was on a flexible data structure; it had to be easy to add and change data elements, and to add and remove health facilities and districts, and to change organisational boundaries.

### 6.1.2 Development Process

The first phase of DHIS development can be characterised as an intensive three-year evolutionary process of participatory design, which took the system from a district pilot to a country-wide standard for HIS in South Africa. Between the years 1997–1998, HISP developed a free (open-source) database application based on Microsoft Office 97/2000, selected mainly because it was the existing defacto standard amongst potential users.

Development efforts were carried out, in line with participatory design practices, and a series of increasingly refined prototypes were tested in close collaboration with users, to enable information for local action. To some extent, the prevailing post-apartheid reform goals of decentralisation and local empowerment were consciously ‘inscribed’ into the software. Given the agenda of supporting political change in South Africa, the software design process started out with a set of objectives and scenarios the design team wanted to inscribe in the software; that is to try to enable certain ‘desired’ actions through particular functionalities and to make it less for the user to perform ‘undesired’ actions:

- Shift of control of data and information handling from central towards local levels, that is, toward more equal control between central and local levels.
- Local flexibility and user orientation – it should be easy to adapt the software to local conditions.
- Support for health sector reform towards decentralisation and the development of health districts; that is integrating the vertical flows of data from various health programs at district level.

- Empowerment of local management, health workers, and communities – by providing access to their own data on their conditions.
- Horizontal flow of information and knowledge, based on the principle of free access to all anonymous, aggregated health data/information.

These objectives were translated into concrete inscriptions through key principles laid down during the development of the first prototype 1997/1998:

- The application must support the hierarchy of essential datasets, that is, allowing users to add, modify, or delete local data elements, indicators, and so forth.
- The application should be designed in such a way as to support the drive toward decentralised capture, analysis, and use of data – in particular, support the push toward having the facility staff responsible for data collection also doing data capture, quality checking, initial processing, and output.
- The application should be easy to use for new areas (provinces, districts), and should allow users to tailor the geographic scope of their datasets to their needs. This resulted in the use of a front-/back-end solution in Access, where the back-end data files covered different geographical areas and the user could switch between them at will.
- The application should as much as possible rely on the flexible and powerful analytical and display tools already available within Office 97, such as Pivot Tables in Excel, even if this increased the learning curve.
- The application should be based on free (open-source) software – both gratis and with free distribution and redistribution of the source code.

### 6.1.3 Participatory Prototyping of the Early DHIS Application

The first DHIS application was developed in Visual Basic and Access by a team of two core developers and with a team of about 10 HISP members acting as mediators between users and the developers. The first DHIS prototype aimed at capturing and analysing routine monthly data ('the MD module'), which was released for pilot testing in the HISP pilot districts in March 1998, and went through a series of very rapid prototype cycles during the next 4 to 6 months. New 'builds' were sometimes released on a weekly or even daily basis. The informal mechanisms for reporting bugs and requesting new functionality – all tightly integrated with user support – proved popular and encouraged users to provide feedback to the development team. This combined with the rapid deployment of new or corrected versions astounded many users, who previously had experienced many long drawn-out tender processes, fully pre-specified development projects that often ended in frustrating delays or fiascos. Requests for new functionalities and/or new modules had to be filtered, prioritised and moderated by the HISP development team depending on the number of users making a request, its importance and team capacity, but all relevant requests were logged and prioritised even if they could not be implemented immediately.

The development process went through several phases, emphasising performance and progress and rapid response to user demands over any established prototyping model. Within the institutional framework in which HISP was operating, consisting of a variety of hierarchical levels and organisational and political structures, more formally organised user participation would have been impossible or inefficient. Formal user groups would easily become battlegrounds due to the ongoing large-scale

political transformations of South Africa's administrative structures. The methodology for participation and development used was, thus more informal and to a significant degree based on improvisation, whereby any interested or innovative user, regardless of his or her place in the hierarchy, had full access to the development team – a meritocratic approach. This access was either direct or indirect via the other DHIS trainers/facilitators, and users were encouraged to use whatever channels they preferred. Access was not regulated, but the development team would normally have to guide users to a significant degree in understanding their own requests and how they could be implemented in practice. Such guided user participation was obviously time-consuming and only possible with a limited number of users.

After the first phase of very rapid prototyping, the user base increased and the software and user requests stabilised, and releases of versions became more controlled, and super users in advanced and early districts and provinces were used to test new versions before national releases. By 2001, the DHIS was implemented in all provinces and districts in South Africa.

#### 6.1.4 Expanding the DHIS Project

While the rapid prototyping and iterative design process during the first phase of the DHIS project produced a close fit with the needs for reforming the health system in South Africa, the system accumulated both rigidities and a messy overall architecture. This proved problematic when it was subsequently introduced in countries such as Mozambique, India, Vietnam, and Cuba, after the turn of the millennium. To address this situation, the project embarked on a completely revised and internationalised version of the software in 2004, called DHIS version 1.4. This new development was started from a full remodelling of the database. The developer team was still confined to Cape Town, and employed the same technology (MS Access), but this time, as in contrast with the first phase of development, the users were primarily elsewhere. South Africa kept the existing installations (DHIS version 1.3), which were stable and well-adapted to the local situation. Through extensive travelling of project staff, supplemented by e-mail communication, the new internationalised DHIS (version 1.4) was developed as a participatory process between the developers in Cape Town and implementation teams in Botswana and Zanzibar.

As the new DHIS1.4 was introduced to new countries, the two-person development team became a bottleneck to supporting the expanding network of users with specific requirements. While the technology enabled rapid prototyping, the DHIS version 1 architecture was not suited for distributed development, and because of the small and co-located team, no source code sharing tools had been employed. Another shortcoming of the architecture used for version 1 was the dependence on the Microsoft platform, which meant that even though DHIS itself was open source, it required the full MS Windows and MS Office stack to run. These factors triggered yet another and simultaneous redevelopment of the software. Development of DHIS version 2 began in 2004 under the leadership of the University of Oslo, but aimed at distributing development activities to a number of the countries in the HISP network, in order to bring software development closer to the contexts of use.

A stack of 'bleeding edge' Java-based technologies was selected for the development of DHIS2, and in parallel a distributed development platform similar to those employed by many FOSS projects was set-up. However, re-implementing DHIS as a modular web

application proved quite difficult for various reasons. The radical break in technologies as well as too much reliance on the new online – electronic medium as in contrast to face-to-face communication presented a formidable obstacle to the involvement of existing technical staff in different countries and sites. The new flexible but complex architecture in fact hindered participatory design efforts in the field, as it took over a year and a half before DHIS2 could initially be deployed, first in a clinic in Kerala, India, and even then much important functionality was lacking. The system improved significantly through early use in India and Vietnam, and later also in Sierra Leone, as well as through the involvement of new software developers recruited locally in countries. While engaging with the global source code, their main task was to support local implementations, in the process trying to bridge the divide between users and developers.

The first real implementation of DHIS2 was in Kerala, India, January 2006, and from there, after a hectic period of development, it was implemented from 2008 onwards in more than 20 Indian states, as described elsewhere in the book. India is by far the largest DHIS2 open source implementation for the health sector in the world.

### 6.1.5 Open Source and Shared Development

Open Source Software development in the HISP context is intimately linked to the continuous development of the DHIS software for managing health data for decision-making in various countries in Africa and Asia over the last 15 years. Since 1997, over 15 years, a tremendous amount of man-hours have gone into the development of the DHIS application, its business logic and use cases, on-site in multiple countries in Africa and in Asia, since its inception in South Africa. For any developing country, to build their own such HIS data warehouse application from scratch, with equivalent levels of embedded knowledge and functionality of the DHIS would be a huge undertaking far beyond individual resources. This is one of the philosophical underpinnings of the HISP and DHIS project, namely that because the creation of software to support HIS in countries is so complex and so huge a task, while the requirements in many countries are quite similar, it makes a lot more sense to collaborate as a big virtual team, than to work in isolation and reinvent the wheel. Distributed development of open source software in collaborative networks of development, implementation and use, including regional and country health authorities, open source communities, and research institutions, make-up both the arena and methodology for the DHIS project.

This ideal aim of distributed and collaborative development of new functionalities and modules into a common shared toolbox, where innovations in individual countries are shared and spread in the network, is, however, a complicated project to achieve. Logically, it can be likened with the shared writing of a big document where a number of writers around the world, all with their own local experiences that they would like to capture and explore further in various subsections of the document. Despite all writers using the same draft\_1 as their point of departure, bringing all contributions together in a shared draft\_2, is a complicated process. It would require both appropriate tools for editing and a certain level of organisation and specification of responsibilities. While Google Doc would provide a tool for such writing, an editor combined with agreed rules for what to write and how update the document, would make-up the organisation. In open source and distributed software development, such as the DHIS project, similar challenges of coordination and management of the 'master' copy, is extremely critical. This is illustrated by the following example:

In 2003, the Ethiopian HISP team developed a module for International Classification of Diseases (ICDs) registration in the DHIS. In order to address the age and sex breakups of ICDs, they developed the option of multi-dimensional data elements, that is, the core data element is the singular ICD code and disease and age groups and male/female represent dimensions of it. This ICD module was elegantly implemented and well received. The problem, however, was that at that time the development of the DHIS was not organised as a distributed project, and the multi-dimensional functionality was not included in the master version. The Ethiopian DHIS version became a 'fork', not compatible with the 'master' source code. The drawback from this development was as a principle, twofold:

- The Ethiopian HISP team was stuck with the particular DHIS version in which they had hard coded the multi-dimensionality – the DHIS version 1.3.67, and they could not benefit from future improved versions of the DHIS.
- The innovation was not shared and distributed, it did not become part of the shared toolbox, and the global DHIS network was prevented from taking the Ethiopian innovation into use more broadly.

Forking is thus disadvantageous, both for the individual 'forger' and for the network as a whole, as sharing necessarily requires a common code base, which is not possible. It was this situation that triggered the DHIS2 development. The DHIS2 started out with a data model quite similar to the redeveloped DHIS1.4, which did not include multi-dimensionality. However, when a similar situation arose in the DHIS2 project; an Ethiopian developer implemented multi-dimensionality as a response to user requirements in trying to manage large and complex datasets in Tajikistan, considerable efforts were invested in making multi-dimensionality part of the DHIS2 meta data model. However, it takes more than a distributed development platform and an enabling architecture to solve the problems of shared and distributed development, as illustrated by the following example:

When DHIS2 was introduced in 2006, the HISP India team had already several years of experience with the DHIS version 1, and mastering the totally different and unknown technologies used in version 2 represented a huge challenge. As the DHIS2 at that time still did not have reporting and graphing tools, the India HISP team needed to develop such reports, but they had the problem of 'finding' their data. The database model in version 2 was quite similar to version 1, but the technology differed; version 2 included a database abstraction layer, inscribing the use of a Java Application Programming Interface (API) instead of directly accessing the database. As the Indian developers were unfamiliar with this technology, they bypassed the API and worked directly against the database in developing a range of 'hard coded' reports. An additional problem at that time was that DHIS2 had poor capacity to process the large amounts of data being managed in India, and the API was also here seen as a hindrance in providing yet another incentive for working directly on the database; why bother with a slow aggregation of a data mart for general use when you could make specific hard coded reports that were generated much quicker?

The dashboard module developed by the India team illustrates the problem facing the open source sharing philosophy. This module was developed in close collaboration with health managers and enabled 'on-the-spot' analysis and presentation of indicators, and became very popular among users. However, as it was a hard-coded workaround, it could not become part of the global repository and toolbox. To solve this problem,

the Norwegian and Indian developers spent a considerable amount of time together in reprogramming the module, but also in developing a shared understanding of the DHIS2 architecture and to develop concrete procedures for how to manage development and decision-making in the core cross-country development team. Today the country teams are working more closely together on releases and the merging of code bases. See Box 6.1 for more details on the organisation of DHIS2 development.

## Box 6.1

## Organisation of the DHIS2 development

The DHIS2 software development process is an open and transparent process similar to other typical open source software projects with source code, bug reports, blueprints, and discussion lists all accessible to anyone on the Internet.

*DHIS2 development* is a distributed effort with developers spread around the world. The coordinating office is the University of Oslo, where a team of 4–5 core developers, including the lead developer sits, with India and Vietnam being the two other major hubs of development. The developers in India are mostly developing local modules to support their large user base, and Vietnam hosts a small team of 3–4 core developers working under close supervision of the lead developer in Oslo, a team that has made considerable contributions to the global code base. These three teams of developers are all paid salaries and code more or less full time on DHIS2. Beyond these three teams, there are other local technical teams in Asia and Africa that mostly deal with customisations and some local module development. There have also been a considerable contribution by Masters students at the University of Oslo, and from 2005–2009, these were the main contributors to the source code. There is still a considerable student contribution, but now the main bulk of the work is done by full time programmers. The DHIS2 project is hosted on the Launchpad software collaboration platform, a website supporting development and maintenance of more than 22800 projects, and in 2011, DHIS2 became one of the 25 featured projects listed on the launchpad.net front page, due to its active use of Launchpad's services.

*The source code* is maintained in so-called branches, and each release (version), as well as the current in-development code (called trunk) has its own branch under the DHIS2 project on Launchpad ([www.launchpad.net/dhis2](http://www.launchpad.net/dhis2)). The developers can download the source code from these branches through the use of a version control tool called Bazaar. Bazaar is installed locally on each developer's computer and helps to synchronise local code against the central repository. Any anonymous user can download the DHIS2 source code from Launchpad, but only a team of registered and accepted (by DHIS coordinators) users (currently 42 people) can commit any changes back to the repository. A commit will automatically add a new revision to the central code and send out a message to all developers informing about the changes made to the central repository. All developers are then encouraged to update their local code against the latest revision of the code on Launchpad. Experimental work can be done in the developers' private branches, which are also public and linked to the DHIS2 project on Launchpad. This code can also be viewed by the other developers, and allow for code revision and feedback from peers as well as the lead developer. Mature work from these experimental branches can at any point in time be merged into the main branch, and new developments on the main branch are similarly merged into the experimental branches to make sure they remain compatible with the main code.

All in all, the source code hosting arrangement at Launchpad provides mechanisms for distributing the source code and keeping everyone updated on its progress, and it supports distributed development on the same application, so that developers around the world can collaborate efficiently.

*Bug reporting* is done directly on the Launchpad website by filling out an online form with details on the problem encountered with the DHIS2 software. This is typically used by the developers themselves and the more advanced DHIS users and trainers. A bug report is automatically sent to all registered users on the mailing list, and further discussions and work on the bug is also distributed to the list. The lead developer usually assigns bugs to the different developers and the bug report list on Launchpad can show who is working on the problem and helps to stay updated on its status (for example, confirmed, assigned, fix committed).

*Blueprints* or new requirement specifications are also handled through online forms on Launchpad. Advanced users, coordinators, and developers can add requests and suggestions for new functionalities, which are often also discussed on the mailing list, and then finally assigned to a future release by the lead developer. A release of the DHIS2 software then consists of a list of bugs that have been fixed and a list of blueprints that have been addressed. Anyone can view the plan for future releases and see the planned release date as well as which bugs and blueprints that will be targeted in the coming release. The release cycles in DHIS2 have in 2011 stabilised at around 2 months, which means that a new version or release is ready for download by the users every 2 months. Since the beginning in 2005 until May 2011, there have been 18 'full' releases of the DHIS2, so the pace of releases has increased during 2010/2011.

*Releases* of DHIS2 are announced on the developer and user mailing lists and made available for download on the dhis2.org website. This dhis2.org website presents the key features of the software, contains contact information to the coordinators, provides downloads of the different releases and user manuals, contains information on how to join the mailing lists, and explains how to get started as a new developer.

*The modular architecture* of DHIS2 is designed to support different user needs across a range of contexts (more than 20 countries by January, 2012). Local modules or additions can be packaged together with the global modules (the core) and the end product appears as one coherent application to the users. DHIS2 has a portal structure which provides a common look and feel and a uniform and pluggable menu system so that new modules appear as additional menu items and blend into the application by following the same standards for the user interface programming. Which modules to be packaged together is decided during the build process, which takes place after downloading the source code and before starting up the application. By adding or removing a few lines of text in an xml file, a technical person with some training (no need to be a programmer) can select exactly which modules to include in the local application. A build tool called Maven builds the application based on the downloaded source code and the build specification file (the xml file) and produces a so-called .war file (Java web archive) which is ready to be deployed on a java web server. While inside the DHIS2 user interface (in the running web application), the local system administrator can specify further which modules that are visible to the different user roles (groups of users), roles that have been defined by the same administrator.

*The local modules* typically make use of the core interfaces and underlying core code, but provide new functionality in the user interface, for example, reports that are tailor-made to local needs. The source code of the local modules are maintained by the local developer (in the country or region), but mostly hosted together with the global code on Launchpad. The central code repository has a folder for local modules and inside a subfolder for each country. All these local modules, currently 22 modules for the three countries India, Vietnam, and Bangladesh, are thereby also shared on the Internet to anyone interested, and can be downloaded and reused in other locations in need of similar functionality. Keeping all the code in one place also makes it easier for the lead developer to make sure that local modules are compatible with the latest revision of the global (core) code, and allows for code updates across all modules, for example, when updating the version of a third party tool or framework, or when changing the release version of DHIS2 in each module. This reduces the risk of local forking considerably. Forks are local modules that are no longer compatible with the global core and develop into complete local applications that are not able to benefit from the new developments on the global code. There have been examples of such forks in DHIS2 development in the past, but since 2010 all of the relevant local modules are hosted centrally and synched with global development. In the past, we have seen that quite a few local modules and functionality that have been recognised and used by many other locations (other than the origin) and gradually transitioned into global modules. This usually requires a collaborative process between a core (global) and local developer in making sure the standards for global modules are met and that it is fully compatible with the other global code. Some great innovations that today are core features of DHIS2 have been developed in this way, emerging from local use.

After the first implementation in Kerala in 2006, the DHIS2 was rolled out to many states in India, and from 2008, as it has matured, it has also been spread to many countries in Africa and Asia. An important point in this development was the decision by the HMN to use DHIS2 in their country pilot project to implement an integrated HIS in Sierra Leone. This also meant that it became part of a WHO recommended stack of FOSS tools for public health. The Sierra Leone project was a high profile HMN 'first wave' country pilot and was carried out during 2008–2009 as a very rapid prototyping project with constant demand and pressure from users at multiple levels; district, national and international (HMN/WHO) levels. Such international pressure and demand was important in order to both constantly improve the software and also to get exposure to the global community with regards to requirements and existing products.

### Summary of the DHIS Development and Current Trends

Uncountable man/woman days have gone into the DHIS project since its inception in 1997, and as part of the early HISP even since 1994. Rapid prototyping and close user participation have been the dominant approach throughout. We use the term 'prototyping' here to denote a methodology where the software application is being continuously further developed based on feedback from users during testing and real use. A system as the DHIS is never 'finished', it will always be subject to large challenges of user's requirements and new functionalities to be addressed. The design principles in this approach are characterised by learning through use and innovations combined with a development approach emphasising improvisations, experiments and rapid cycles of testing, learning and implementation. The design of the



application is kept 'open' and decisions that will close and lock future opportunities are deliberately not taken. It might be a misnomer to call this a 25 years process for prototyping, but the point is that the application is under continuous and further development.

Prototyping in an 'offline' environment, that is, the dominant paradigm in the DHIS project until before 2010, is quite cumbersome in that new versions will have to be distributed to and implemented in all sites. The most 'rapid' part of prototyping has therefore, typically, been confined geographically to smaller groups of super users and only installed everywhere for 'production' when the new version was reasonably stable. Typically, therefore, the most active part of the user centered prototyping of the new DHIS1.4 was carried out in new countries like Zanzibar, where the overall country systems were being redesigned, and not in South Africa, where the stable version 1.3 was in countrywide 'production'.

Online country implementations of DHIS2 have changed the conditions for prototyping; now, new functionality can be provided countrywide at a 'key stroke.' While online computing made it much easier to scale geographically, as discussed in Chapter 4, it also drastically changed the conditions for prototyping. Online state wide installations have been used in India since 2009, but for Africa this was still regarded as impossible, when in October 2010, we tested the Internet for DHIS2 browsing in a district in Kenya. We wanted to check how many installations in the national system that could run an online application. Everything worked fine, until a power-cut occurred, and despite the hospital's generator quickly bringing the power back, the fixed Internet line went down. We were about to conclude that 'Africa was not yet ready,' when we started to test the modem to the mobile Internet, and found that it worked perfectly well. This sparked a 100% change in strategy; Internet over modem was quickly tested in all parts of the country and, as it worked well, the decision was taken to go for an online installation of the DHIS2. Following this, a period of very rapid prototyping followed. In fact, the whole DHIS2 lab was literally moved from Oslo to Kenya as the system was implemented in the first pilot province. A lot of development addressing 'limited Internet' and the new concept of 'semi-online' deployment followed: optimising data entry; automatic generation and download of data mart for offline generation of Excel pivot tables, customised reports, dashboard, and other required features. All these functionalities were implemented directly on the online server and made available for all users on the spot, which again helped to generate feedback, adjustments and requirements for new functionalities. Furthermore; through being involved with users in the field, and facing the problem of 'how to quickly make users aware of new functionalities?', the idea of implementing a 'DHIS2 Facebook Light' was born; messaging across DHIS users in Kenya, by district or province or nationwide; informing about new functionalities, feedback, and support.

From a digital gap and African development perspective, the new opportunities for Internet based online use and development, even given the limitations of the mobile network, are revolutionary in character; making it possible for the first time in Africa what has been taken for granted for quite some time in the North. Once these opportunities are explored through use and innovation, it might be that the vast user base and rapid expansion of the mobile network combined with creative use and untapped needs that will become the driving force for the development of new and innovative Internet based services. This mirrors the process when mobile telephone banking was innovated and first spread to a large use base in Kenya.

The DHIS development strategies based on agile approaches such as prototyping (which have been ongoing since 1997!) and on-site user participation, are becoming the dominant trends in current web development environments. The new opportunities for rapid cycles of development and use of software applications in the Internet and web era are of course general, across domains. In addition to the opportunities given by the web, the need for ‘rapid changes’ has also increased, as the web-based development environment is also in constant flux and changing continuously. These conditions have triggered the current trends in web development which emphasise rapid releases based on deadlines on ‘time’ rather than on planned functionality (for example, Google every 6 weeks), and thereby enabling innovations and pivoting changes when needed.

This paradigm shift towards rapid calendar based, as opposed to functionality based, releases is well illustrated by the changes in the Firefox’ release policy; they hung on to their version 3.6 for ages because they were not able to release version 4 with all the promised features. Then, in 2011, with their version with the long awaited release of version 4, and soon after version 5, they changed to a rapid 6 weeks release policy.

Table 6.1 Stages of DHIS evolution

<i>Timeline</i>	<i>Stage</i>	<i>Use and Development</i>
1997–2000	From pilot to national system	DHIS v1 was developed in South Africa by one software team and a network of users. Essential health domain knowledge and practical applicability were translated to the DHIS metadata model and overall design, and the surrounding network of users and implementers.
2000–2005	Expansion and networking across countries	Multiple countries, but mostly pilot projects. HISP focus is on networking and research. DHIS ‘offline’ was not representing an attractive technology from countries, it was seen as something of the past.
2004–2010	Technological change: Transition to web-based	DHIS2 based on web technologies started and gained momentum. Technology was seen as part of the future and attractive. Full scale country projects initiated. DHIS v1 and v2; maintained two different teams.
2010-	Paradigm shift: Online cloud architecture	Cloud-based infrastructures and online implementations in India and Kenya demonstrates the potentials, also for developing countries. DHIS2 is riding on the ‘surf of development’ and gains further momentum. The two DHIS software teams are coming together.

## 6.2 More on DHIS2

In this section, we further elaborate on the question ‘what is DHIS2’ by:

- First, we continue where the last section ended; DHIS in the age of online computing; we describe DHIS2 in the wider perspectives of data warehousing and Business Intelligence.
- Second, describing and discussing DHIS2 as a platform, and comparing it with the perspective of an architecture.

- Third, we discuss the alternatives for server hosting, in the ‘cloud’ or in the ‘basement’.

### 6.2.1 Data Warehousing and Business Intelligence

In the age of online computing and cloud based infrastructures, access to information is assumed to be web-based and available from everywhere through the Internet. Online access to information for decision-making, stored and managed in data warehouses, is becoming increasingly important, and applications providing such analysis and information are termed BI. DHIS2 is providing users online access to dashboards and maps presenting indicators targeting decision-makers, and is, therefore, also appropriately understood as a BI application. In this section, we describe and discuss DHIS2 as a combined data warehouse and BI application, or rather a platform, as it can be used to build modules and new applications and linkages to other systems. Also, as described earlier, while data warehousing is basically about integrating data flows and getting data ‘in’, BI is about analysing, presenting and disseminating the processed data, getting the data ‘out’.

A key point we bring forward is that BI and data warehousing in the context of the health sector in developing countries, are qualitatively different from how these application types are understood, designed and used in the commercial sector in, typically, industrialised countries. The reason for this is that data providers and data users are much closer and intimately connected in our health context, they may even be the same, than what is the case in data warehousing and BI as practiced in commercial sectors and as described in the literature. In Figure 6.1, we give a schematic illustration of the relationship between data warehouse as input and BI as output. We see that data sources are paper-based or in other ways close to the social context of data generation. In fact, all health facilities in the country may include direct data sources. While there may also be computer-based sources of data to the data warehouse in the context of health sector of developing countries, these are not dominant. They may, however, become increasingly computerised at the source, in the facilities, such as local medical records, but they will co-exist with paper-based systems for the foreseeable future.

A central term in modern data warehousing and in BI is ETL (Extract, Transform, Load); Extract data from (electronic) sources, Transform data to required format, and Load data to the destination data warehouse. This is the process that is catered for by SDMX-HD in the case of DHIS2. In reality, however, most data in DHIS2 is captured from paper-based sources or directly from the source, which necessitates a very different design of the DHIS2, than of the traditional Data warehouse and BI as described in contemporary literature.

The data flows from the source to the data warehouse, the ETL, the central part of the whole information management cycle, stretching from the data source to the data warehouse to the BI provision of processed data to the users. In our contexts, data providers and data users are intimately linked; data to manage health services, districts or hospitals are generated, collected, processed and used, all, primarily, within the same realm. Systems design, therefore, needs to include all these steps.

We see much more direct interaction between data sources, which are in fact human beings and users of the data themselves, for example, health workers carrying out

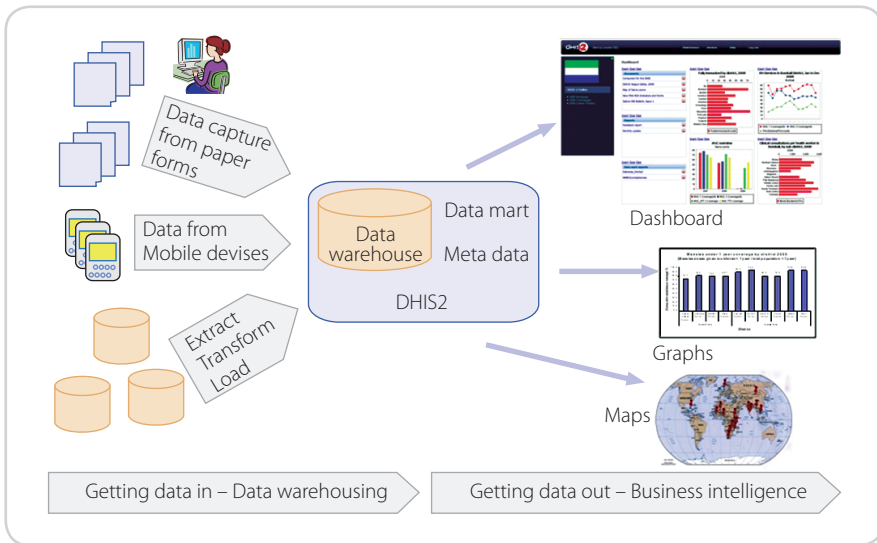


Figure 6.1 DHIS2 as data warehousing and business intelligence application

an immunisation campaign, and the end-users of the information; various levels of management as well as the health workers providing the data themselves. The situation is thus very different from the traditional 'Western' data warehouse scenario, which operates in a fully computerised environment. Such applications are all secondary data processing units, in the sense that they get all their data loaded electronically from other computerised systems, which are 'primary' production or transaction systems (for example, banking or retail transactions, or hospital admission records) or other 'secondary' data processing systems, such as systems providing updated currency rates. Data interoperability is carried out through ETL: Extract data from a data source, Transform data to the required format, and Load it into the data warehouse.

There are two current trends in BI directly related to Internet and cloud based infrastructures; real-time BI and pervasive BI, and another more general trend linked to BI used for business performance management, which we translate into health services performance management. In the following, we describe DHIS2 in relation to these trends.

#### Real-time BI

To influence decisions while the data is still fresh is the reasoning behind real-time BI being made possible through online Internet-based infrastructure. In managing on-demand stock control, air traffic control and similar high intensity tasks in highly computerised environments, latencies in the range of seconds, minutes and hours, may be both possible and important. In the context of health services management, the required latency is typically given by the frequency of the routine reporting, whereas disease reporting may need to trigger immediate action. In DHIS2, due to large amounts of data, data processing, that is aggregating data, calculating indicators and loading it into the data marts, we carry that out at night. This gives one day latency; data is processed, analysed and available 'countrywide' the day after it is

captured. In DHIS2, however, the wider information management cycle, including data collection and capture, is as important in terms of latency. We may distinguish the following types of latencies:

- *Data registration and collection latency:* This is the time it takes to collect the data. Whether data registration is paper-based or computerised, and whether data is captured directly at the source of data collection, is important in eliminating reporting latency.
- *Data reporting and capturing latency:* In the traditional paper-based system, the sending of paper reports from the source at the health facility to the block or district office where it is captured in DHIS2, is the critical process. Then there may be further delays until data is captured in the DHIS2. The strategy to reduce this latency is to move data capture to the facilities, at, or closer to the source of the data, using mobile telephones or laptops with the Internet modem. Problems related to available manpower to actually capture data is also a widespread problem, but not of a technical character.
- *Data transmission latency:* In the offline DHIS2 sites, data needs to be transferred to the national data warehouse by way of e-mail attachment or memory stick. This latency is eliminated with online installation of DHIS2.
- *Data processing and analysis latency:* Data is processed and data marts and indicators updated once data is in the data warehouse, that is, every night, meaning one day latency in nationally online central server installation. In an offline installation one may, of course, process data when appropriate.
- *Data feedback and dissemination latency:* Providing feedback to providers and users of information is traditionally a very delayed process. In Botswana, it took 2–3 years before the annual statistics were disseminated, and there were not much other feedback. In DHIS2, the feedback is available in dashboards, reports, GIS once it is processed. Immediate access to information available through online DHIS2 installations, but of course there must be institutional practices in place that encourage feedback.

At the technical level, for real-time DHIS2, latency is thus primarily related to whether online or offline installations are used, and to what extent data capture is carried out in facilities or close to the source, using mobile telephones, PDAs, laptops or desktops. At the organisational level, however, latency depends on how the wider information management cycle is managed (or not).

### Health Services Performance BI

The use of indicators to monitor achievements of health programmes and services provision according to targets is the signature element of the HISP public health approach and key part of the DHIS design. In the BI world, the use of dashboards and other means to present continuously updated 'real-time' indicators on business performance graphically are key to its management. DHIS2 enables the presentation of dynamically updated information, using dashboards, GIS and various graphical reporting tools.

### Pervasive BI

The spread of the Internet and cloud-based infrastructures have given way to the term "pervasive BI", meaning that since web-based systems are available from everywhere

with the Internet, the user base is drastically increased and all potential users in an organisation or sector may be reached. Following the online deployment of DHIS2 in Kenya, for example, we have seen a drastic increase in availability of online and updated information and its access to online users.

### 6.2.2 DHIS: As a Platform

Whether one regards DHIS as an application, a platform, or even an architecture depends on the context and perspective. When the AWARE project; ‘Action for West Africa Region – Reproductive Health’, addressing limited access to health care and low quality of services in countries in West Africa, uses DHIS for their internal reporting across countries; or when WHO Afro is setting up DHIS to monitor malaria vector control in African countries, or when in Tanzania DHIS is set-up to monitor the Payment for Performance, ‘P4P’, programme, in each place or instance, we may talk about DHIS as an application designed to address particular user needs. When in Kenya, the DHIS is designed and set-up to cover most of the data flows in the health sector and support the range of user needs expressed by a multitude of stakeholder and users, DHIS may also be regarded as an application, although a very wide and diversified one with a heterogeneous user-base, and very different from the former three examples. While in each instance, DHIS may be regarded as a unique application, multitude of applications serving very different user needs, there is also the generic ‘tool’ from which all these different applications are generated, which we may label ‘platform.’

Platform as a term is maybe most often used for generic software applications and frameworks, such as Firefox and Windows, which are context free also in the sense of not even when designed in particular ways are targeting particular organisations or end-users. The defining elements that make them differ from applications are their support to a heterogeneous and growing user-base, constant generification, and that they form a framework for a suite of IT capabilities.

Box 6.2 gives working definitions for different terms related to ‘platform.’

#### Box 6.2

#### Working definition of terms related to ‘platform.’

Tiwana et al 2010, provide a coherent set of concepts, spanning the range from Platform to Architecture;

- *Platform*: The extensible codebase of a software system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate.
- *Module*: An add-on software subsystem that connects to the platform to add functionality to it.
- *Ecosystem*: The collection of the platform and the modules specific to that platform.
- *Interfaces*: Specifications and design rules that describe how the platform and modules interact and exchange information.
- *Architecture*: A conceptual blueprint that describes how the ecosystem is partitioned into a relatively stable platform and a complementary set of modules that are encouraged to vary, and the design rules binding on both.

In concrete terms, DHIS can be perceived as a platform on several levels. First, the application database is designed ground-up with flexibility in mind. Data structures such as data elements, organisation units, forms and user roles can be defined completely freely through the application user interface. This makes it possible for the system to be adapted to a multitude of locale contexts and use-cases. We have seen that DHIS supports most major requirements for routine data capture and analysis emerging in country implementations. It also makes it possible for DHIS to serve as management system for domains such as logistics, labs and finance.

Second, due to the modular design of DHIS it can be extended with additional software modules. These software modules can live side by side with the core modules of DHIS and can be integrated into the DHIS portal and menu system. This is a powerful feature as it makes it possible to extend the system with extra functionality when needed, typically for country specific requirements as earlier pointed out.

The downside of the software module extensibility is that it puts several constraints on the development process. The developers creating the extra functionality are limited to the DHIS technology in terms of programming language and software frameworks, in addition to the constraints put on the design of modules by the DHIS portal solution. Also, these modules must be included in the DHIS software when it is built and deployed on the web server, not dynamically during run-time.

In order to overcome these limitations and achieve a looser coupling between the DHIS service layer and additional software artifacts, the DHIS development team decided to create a *Web API*. This Web API complies with the rules of the *REST* architectural style. This implies that:

- The Web API provides a navigable and machine-readable interface to the complete DHIS data model. For instance, one can access the full list of data elements, then navigate using the provided hyperlink to a particular data element of interest, then navigate using the provided hyperlink to the list of forms which this data element is part of.
- Data is accessed through a uniform interface (URLs) using a well-known protocol. There are no fancy transport formats or protocols involved - just the well-tested, well-understood HTTP protocol which is the main building block of the Web today. This implies that third-party developers can develop software using the DHIS data model and data without knowing the DHIS specific technology or complying with the DHIS design constraints.
- All data including meta-data, reports, maps and charts, known as *resources* in REST terminology, can be retrieved in most of the popular representation formats of the Web of today, such as HTML, XML, JSON, PDF and PNG. These formats are widely supported in applications and programming languages and gives third-party developers a wide range of implementation options.

There are several scenarios where additional software artefacts may connect to the DHIS Web API.

First, Web portals may be built on top of the Web API. A Web portal in this regard is a website which functions as a point of access to information from a potential large number of data sources which typically share a common theme. The role of the Web portal is to make such data sources easily accessible in a structured fashion under a common look-and-feel and provide a comprehensive data view for end users.

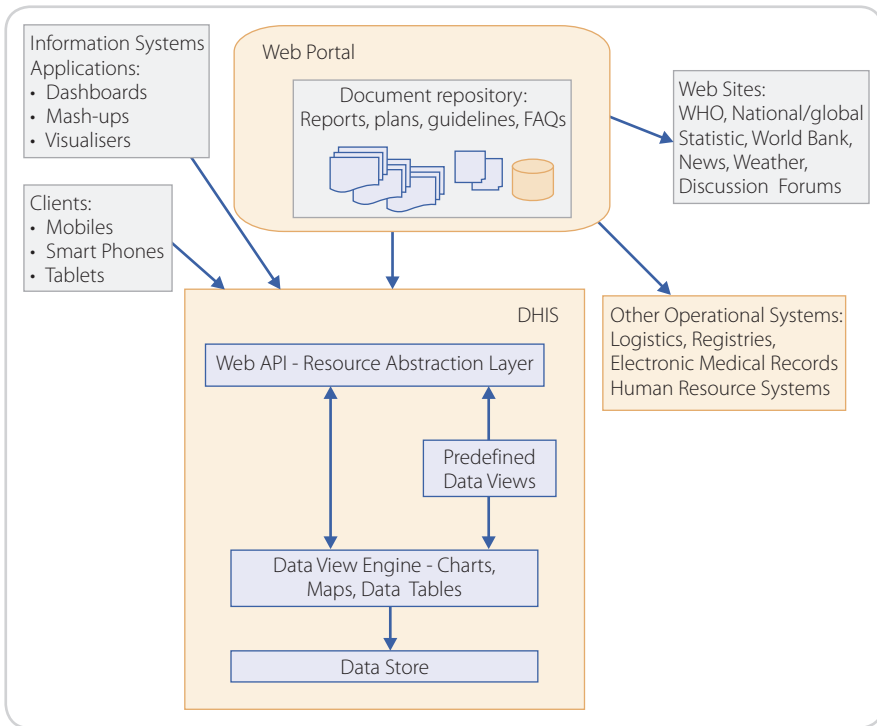


Figure 6.2 DHIS and integrated portal solution

*Aggregate data repository:* A Web portal targeted at the health domain may use the DHIS as the main source for aggregate data. The portal can connect to the Web API and communicate with relevant resources such as maps, charts, reports, tables and static documents. These data views can dynamically visualise aggregate data based on queries on the organisation unit, indicator or period dimension. The portal can add value to the information accessibility in several ways. It can be structured in a user-friendly way and make data accessible to inexperienced users. It can provide various approaches to the data, including:

- *Thematic:* Grouping indicators by topic, such as immunization, reproductive health, HIV / AIDS, notifiable diseases and environmental health.
- *Timelines:* Trends over time.
- *Geographical:* Grouping data by states / provinces / regions and districts. This will enable easy comparison of performance and workload.
- *Presentation:* Using maps, charts, tables, etc.

Relating to the discussion on BI in the previous section; the portal is providing end-users access to the data in the DHIS as a BI application.

*Mash-ups:* The Web portal is not limited to consuming data from a single Web API - it can be connected to any number of APIs and be used to “mash up” data from auxiliary systems within the health domain. If available, the portal might pull in specialized data from logistics systems for tracking and managing ARV medicines, from finance systems for managing payments to health facilities and from lab systems for tracking lab tests



for communicable diseases. Data from all of these sources might be presented in a coherent and meaningful way to provide better insight in the situation of the health domain.

*Document repository:* The Web portal can act as a document repository in itself (also referred to as content management system). Relevant documents such as published reports, survey data, annual operational plans and FAQs might be uploaded and managed in terms of ownership, version control and classification. This makes the portal a central point for document sharing and collaboration. The emergence of high-quality, open source repository/CMS solutions such as Alfresco and Drupal makes this approach more feasible and compelling.

*Knowledge management:* KM refers to practices for identifying, materializing and distributing insights and experience. In our context it relates to all aspects of information system implementation and use, such as:

- Database design – data warehousing and Business Intelligence.
- Information system usage and how-to.
- End-user training guidelines.
- Document and documentation management – content management systems.
- Data use, analysis and interpretation.

Knowledge and learning within these areas can be materialised in the form of manuals, papers, books, slide sets, videos, system embedded help text, online learning sites, forums, FAQs and more. All of these artefacts might be published and made accessible from the Web portal. In this way, the portal may be designed as a “Knowledge management system.”

*Forum:* The portal can provide a forum for hosting discussions between professional users. The subject can range from help for performing basic operations in the HIS to discussions over data analysis and interpretation topics. Such a forum can act as interactive source for information and evolve naturally into a valuable archive.

Second, third-party software clients running on devices such as mobile phones, smart phones and tablets may connect to the DHIS Web API and read and write to relevant resources. For instance, third-party developers may create a client running on the Android operating system on mobile devices targeted at community health workers who needs to keep track of the people to visit, register vital data for each encounter and receive reminders of due dates for patient care while travelling freely in the community. Such a client application might interact with the patient and activity plan resources exposed by the DHIS Web API. The developer will not be dependent on deep insight in the DHIS internal implementation, rather just basic skills within HTTP/Web programming and a bit of knowledge of the DHIS data model. Understanding the DHIS data model is made easier by the navigable nature of the Web API.

Third, information systems developers aiming at creating new ways of visualising and presenting aggregate data can utilise the DHIS Web API as the service layer of their system. The effort needed for developing new information systems and maintaining them over time is often largely under-estimated. Instead of starting from scratch, a new application can be built on top of the Web API. Developer attention can then be directed towards making new, innovative and creative data representations and visualisations, in the form of e.g., dashboards, GIS and charting.

## DHIS, architecture and portal design

The architecture perspective we have discussed so far has been illustrated by interoperability between the data warehouse for aggregate data and transaction systems such as Human Resource and Medical Records systems. To this perspective, the Web API and portal approach add at least two additional dimensions: first, it provides user interface and access point to a range of end-users and the general public, and second, it provides an approach to group together components that are naturally belonging together in an enterprise design perspective, but which are “technically” incompatible; such as e.g., data processing and document management. Together these two dimensions of the portal approach make up a powerful part of the architecture; while the easy end-user access contributes to the aim of increased dissemination and use of information, the new design possibilities help provide richer and more targeted information.

### 6.2.3 Servers: In the Basement or in the Cloud

Using ‘cloud’ as a metaphor for the Internet, ‘cloud computing’ is a loose term used for everything from the more narrow meaning of virtual servers available over the Internet, to software based services more generally and even to denote ‘everything’ outside the organisation’s ‘firewall’. In our context, ‘cloud computing’ is illustrating the fact that the server may be anywhere as long as you have Internet connection to it. When the user in a remote rural health center in Kenya is accessing DHIS through the wireless Internet over the mobile network, cloud computing is indeed an apt metaphor. Furthermore, an important reason to the successful implementation of DHIS in Kenya was that the focus could be on the users’ access to the Internet and not on the proper functionality of the server and its connectivity. In the case of the Kenya implementation, the server was in the ‘cloud’, located in London. When implementing online web-based systems, the server is extremely critical as it needs to be optimally accessible next to 100% of the time. The new paradigm of online web-based systems is breaking with the tradition of each organisation and Ministry having their own computer centre and servers. Implementing DHIS ‘on the web’, means that it does not rely on any particular physical location. Generally, therefore, we would recommend modern cloud-based infrastructure, where all the technical parts of managing and maintaining the servers are done externally, in the ‘cloud’.

It maybe argued that modern cloud-based computing is a new infrastructure, which is actually providing countries with poor infrastructure the same opportunities as the rich countries. That is, of course, only the case if the country has sufficient Internet, good connectivity to the international grid. We have seen that in Kenya, as an example, the Internet is good. The advantage of renting external server capacity, in the cloud infrastructure, is that it makes everything such as setting up and maintaining the system done easier and faster, while at the same time the general services such as security, availability and scalability are guaranteed. The cloud infrastructure is providing a unique elasticity, while there are virtually no need for any up-front commitments on payment or rentals, there are ‘infinite’ resources on demand, for example, if the trial is successful.

But can one trust the ‘cloud’, will the data be safe, also in the future? These are of course important political questions. The fact that the US Government has decided to move significant parts of their data processing to the cloud has been used as an argument for other government also to move towards cloud hosting. However, the

“cloud” used by the US Government is firmly located in a high security “basement” on their own territory, which, again, is emphasising the differences in infrastructure between countries. Therefore, the use of the “cloud” by rich countries is underlining the fact that the cloud is only a metaphor and that in reality the clouds will always be physically located somewhere. In Kenya, the DHIS2 was initially implemented on a rented, external server located in London. This was necessary because the server and network in the Ministry of Health were not working. There is an ongoing project to refurbish the computer room and install a donated server. The plan is, therefore, to move the DHIS2 to the local server once it is running properly. The start of a project to implement the DHIS2, or any such online web-based system, is very critical. It is, therefore, important that the servers are working properly. The advantage of using external servers in the startup of a project is that it only takes a few hours to set up the system and it is easy to manage. This is very important in the first cycles of prototyping a new system, as we do not want to be distracted by the technicalities of the server, when the software and capacity building is the focus.

Obviously, there are political arguments for countries to remain in physical control of the data and the servers. Rich countries in Europe and the US are all making sure their data are confined within their own territory and under their ‘physical’ and maybe also legal control. All countries are concerned with security, but it should generally not be seen as the Ministry of Health’s primary task to manage servers. If the government has hosting facilities serving the public sector, or if there are local companies with hosting services, that is fine.

### 6.3 The DHIS Metadata Model

The first version of the DHIS was designed and developed in the HISP pilot districts in Cape Town aiming at supporting a public health approach to build the new health services in South Africa. The key questions to address through the DHIS were related to health status of the population and achievements of the health services. The focus in the public health approaches at that time was on epidemiology and health management. The drawing in Figure 6.2 was used in training sessions in pilot districts and at the Universities in Cape Town, the base of the HISP at the time, and asked two questions:

1. *With respect to epidemiology:* Who is getting sick? With the follow-up questions: With what? Where? When? and, Why?
2. *With respect to health management:* What health services exist? With follow-up questions like: Where? For whom and for what? When? How much? and, Why?

These questions are represented in the picture:

Answering these questions went into the design of DHIS. The ‘why?’ would rather be linked to analysis, but data on the more exact questions of what? where? when? where captured in the DHIS data model, as illustrated in Figure 6.3. The question about ‘where’ is linked to the health facility, where the data is registered. The health facility is located both geographically, with address and x,y coordinates, and administratively, in the hierarchy of the health sector, called org.unit hierarchy.

Figure 6.4 illustrates how the ‘reality’ of Figure 6.3 is represented, or mapped, into a data structure. If we take the information management cycle one step further, we see

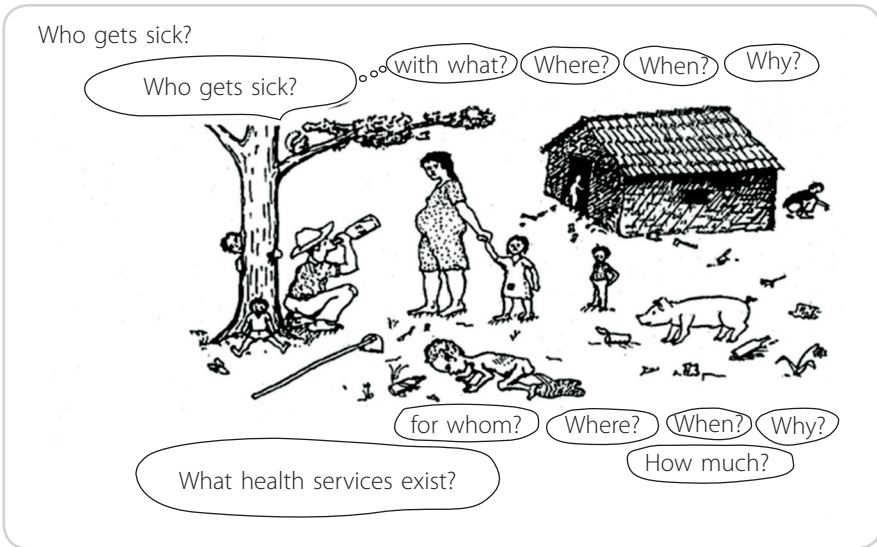


Figure 6.3 Epidemiological questions

the same data representation analysed and presented graphically in Figure 6.5, where the ‘what’ is malaria incidence, the ‘where’ is Kenya, and the ‘when’ is by each month of the last quarter 2010 and the first quarter 2011.

Data elements (or data variables, or counts) in the DHIS are handled as singular atomic units, which can be broken up in dimensions, such as age groups and sex. The handling of data elements as atomic units, and not as columns in a table, is what enables the flexibility in adding and removing data elements, characterised in the DHIS. Keeping data elements as atomic units is also important in making the metadata structure transparent and easy to understand and update by information managers;

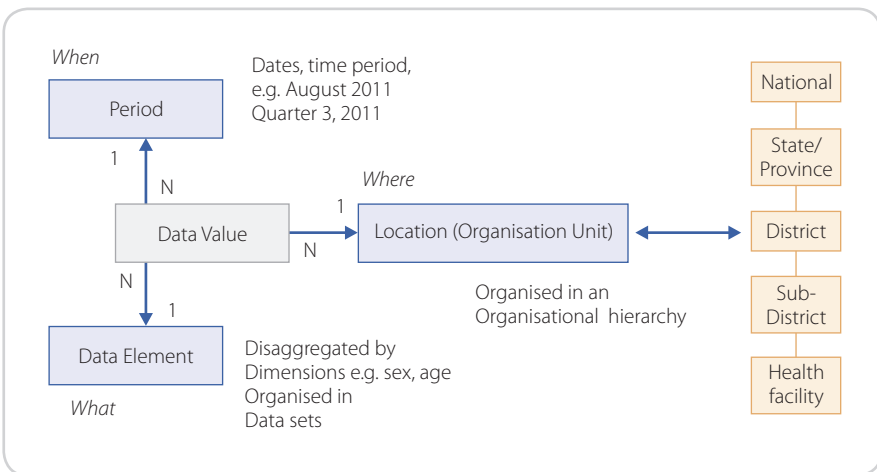


Figure 6.4 Addressing the ‘where’, ‘what’, ‘when’; the basic data structure in DHIS

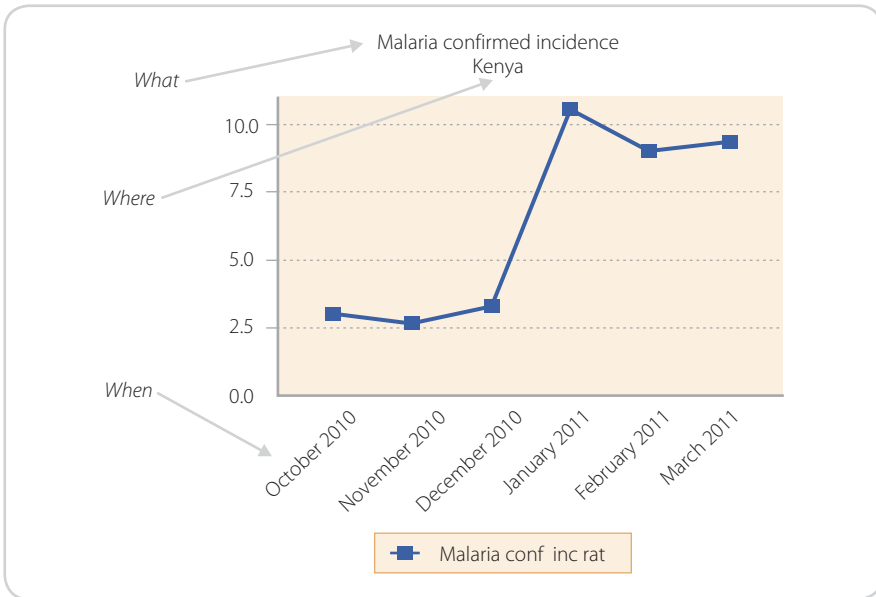


Figure 6.5 The 'what', 'where', 'when' data structure represented as graphical output

datasets, indicators and evaluation rules are easy to define and add. The different foundation concepts of the DHIS data model are described in Box 6.3.

#### Box 6.3

#### Components of the DHIS

##### *DHIS Components*

*Data elements, the What dimension in DHIS:* The data element is an atomic unit of data and the key building block in DHIS. It is the raw data in a statistical system, called 'counts' in some contexts, being collected through tally sheets or other tools or generated through 'transactions' in computerised systems, e.g. patient admissions in a hospital. 'Confirmed malaria cases' and 'Measles (antigens) doses given' are typical data elements in DHIS that may be collected using paper forms, or in fact generated from paper register books or computerised patient registries. We may distinguish between frequent routine data from health programmes and services, e.g. monthly, and less frequent, semi-permanent data, such as population (census) data, data on staff, and equipment.

Data elements may be disaggregated in dimensions called categories, such as age and sex, which are individual atomic components of the data element. The data element is thus not an 'absolute' atomic unit, but for management, analysis and aggregation of data, it is best understood as an atomic unit.

Datasets are used to bundle and organise data elements for the purpose of data entry and for export and import between instances of DHIS. Datasets are linked to services that are provided by a health facility. Health facilities, or

organisational units, are assigned the particular datasets they use to collect data, that is, the services provided. Datasets are not linked directly to the data values, only through their data elements and frequencies, and as such a dataset can be modified, deleted or added at any point in time without affecting the raw data already captured in the system, but such changes will of course affect how new data will be collected.

Datasets are used for the construction of *Data entry forms* in DHIS2. Once assigned to an organisational unit, the dataset is made available for data entry for that unit. There are three options of increasing flexibility for visual design of the data entry screen and correspondingly more work to set it up:

The *default data entry form* is quite simply a list of the data elements in the dataset and a column for inputting data. If data dimensions (categories) are defined, these will be automatically generated. *Section forms* allow for more flexibility in setting multiple tables and subheadings. *Custom forms* allow you to construct the data entry forms in a HTML editor.

*The organisational hierarchy and units, the where dimension in DHIS:* The organisational hierarchy is defining the health facilities, geographical areas and administrative units being addressed by the particular DHIS instance and their relationships in the health system through a system of child-parent relationships. The hierarchy is defined with one root unit (for example, Ministry of Health) and any number of levels and nodes below. The nodes in this tree-structure are called organisational units, and they may be health facilities, that are providing services, or administrative units. The design of the hierarchy will determine the geographical units of analysis available to the users as data is collected and aggregated in this structure.

The organisational units, or *orgunits* in DHIS language, are categorised and defined using group sets, for example, 'Type' and 'Ownership' (default group sets), and groups for each group set, such as 'Dispensary', 'Health Centre', 'District hospital', for type, e.g. 'Central government', 'Local Government', 'Faith-based organisation' for ownership.

*Indicators* represent the most powerful data analysis feature of the DHIS2. While data elements represent the raw data (counts), the indicators represent formulas providing coverage rates, incidence rates, ratios and other formula-based units of analysis. An indicator is made up of a factor (for example, 1, 100, 100, 100000), a numerator and a denominator, the two latter are both expressions based on one or more data elements. For example, the indicator 'Measles coverage <1 year' is defined by a formula with a factor 100, a numerator ('Measles doses given to children under 1 year') and a denominator ('Target population under 1 year'). The indicator 'DPT1 to DPT3 drop-out rate' is a formula of  $100\% \times (\text{'DPT1 doses given'} - \text{'DPT3 doses given'}) / (\text{'DPT1 doses given'})$ .

Due to the management of data in atomic units, which is also used for denominator data such as population data, makes it easy for users to define indicators by selecting data elements and formulas for numerators and denominators. Indicators can be added, modified and deleted at any point in time without interfering with the data values in the database.

*Validation rules* are data quality checks used to improve the quality of the data being collected. Rules are composed by left and right side expressions built by data elements and mathematical operators and numbers, with a logical operator, such as 'less than', 'greater than', 'equal', 'not equal', between the two sides. Validation rules may be absolute, meaning cannot be true, like 'number of live births' + 'number of still births' cannot be less than 'number of deliveries'. Or they may be logical, or expert rules, such as 'number of live births' should not be more than 'number of deliveries' + 20%. Such rules need to be used with caution, and typically not made mandatory for 'all users'.

The rules can be run in data entry, after filling each form, or as a batch process on multiple forms at the same time, for example, for all facilities for the previous reporting month. The results of the tests will list all violations and the detailed values for each side of the expression, where the violation occurred, thus making it easy to correct the values using the data entry.

*Information dissemination; reports, tables, charts, pivot-tables, dashboard, GIS:* DHIS2 provides the range of reporting facilities used by Business Intelligence applications. Standard reports in DHIS2 provide aggregated data by organisational units or levels, of data elements and indicators, and over time. External report designers such as Business Intelligence and Reporting Tools (BIRT) and iReport may be used for customised reports. Pivot tables are dynamic and online, or datamart may be downloaded to generate Excel pivot tables. A chart dialogue guides the user through the creation of various types of charts with data on indicators, organisational units and periods. These charts can easily be added to one of the four chart sections on the dashboard and be made available right after log in (Figure 6.6).



Figure 6.6 DHIS2 Dashboard. Users add their own charts, which are dynamically updated to the chart sections on DHIS2 main page.

## 6.4 DHIS2: Modules and Components

In this section, we describe three important modules and fourthly the components used in the DHIS2. These include:

- The patient, or tracking module.
- The GIS module, which is an important part of the DHIS2 analysis and presentation layer.
- The module for mobile reporting.
- Finally we will discuss components, by providing a description of the Open Source Frameworks and tools using which DHIS2 has been built.

### 6.4.1 From Aggregate to Discrete Data: The Generic Case, Event, Patient, Tracking Module in DHIS

DHIS2 is a tool for collection, validation, analysis, and presentation of aggregate statistical data. As the use and technology are both maturing, however, and as discussed in Chapter 4, vertical scaling in terms of requests for more comprehensive solutions and more granular data are gaining momentum. The DHIS2 case based 'discrete' data module is developed as a response to demands for in particular cases being able to handle the rollup and roll down of the data captured, from singular discrete cases to statistics, and vice versa, to be able to move quickly from singular cases, or events, to statistical analysis. The registration of vital events, such as registration of deaths according to the ICD10, is a typical use case. In this case, the registration is one-off, a way to organise data as both singular cases and statistics, and to enable aggregation and disaggregation one step further within the same framework. Maternal death is another typical use-case; by registering each case of maternal death much richer data can be registered, and following the ease of aggregation, much richer data analysis may be carried out.

Line-listing is another use case; each case or patient encounter is typically registered on a line in a registry. In the traditional paper-based system, data are then aggregated by month from these register books and compiled into monthly reports, typically then entered into the DHIS2. In many countries, for example, in India and Ghana, for particular diseases, or deaths by diseases from hospitals, paper-based line-listing are being reported. In such cases, names are not the issue, as each line is to be regarded as a 'discrete event' for statistical purposes.

One step up in terms of increased complexity from the singular case registration is the tracking of cases, for example, infants for immunisation, pregnant women for Antenatal Care visits and delivery, and ultimately, the tracking of the pregnant woman through lifecycle of the different ANC visits to delivery and then to postnatal visits, and the immunisation scheme of the baby. Other important use cases are linked to tracking of patients with chronic diseases necessitating continuous follow-up such as diabetes or tuberculosis. A key principle in the design of the DHIS case based discrete entity tracking module is that the singular cases, or events, and the aggregates are using the same data elements. This allows for the registering of each case, event, count or occurrence, or the individual patient or client that are then aggregated to become the data value stored in the DHIS2 'aggregate' module. This is illustrated through the Figure 6.7.



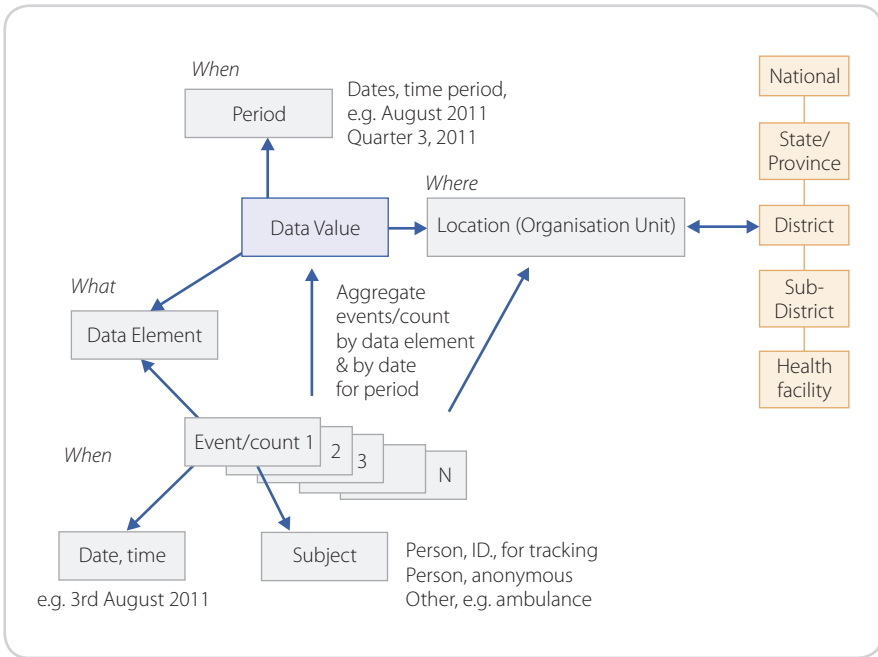


Figure 6.7 The DHIS2 case, event, and patient design module – data model

## 6.4.2 DHIS GIS – GIS Module in DHIS2

### Background

Spatial representations of health data, enabled through GIS, represents a powerful way to present data and indicators, including for identifying spatial trends of diseases, identifying access patterns to health facilities, understanding determinant of diseases, and various others. HISP was early to recognise the importance of spatial visualisations and GIS, and the importance of linking spatial and non-spatial data in one database. To arrive at the current powerful Open Source GIS module in DHIS2 has taken time involving significant amounts of research and development. During 2009–2011, the focus has been on developing the WHO OpenHealthMapper, the web version of their earlier desktop based Health Mapper. This has been bundled as a module inside the DHIS2 – which we call DHIS GIS. The development was enabled through an agreement between the WHO and University of Oslo.

### The Technical DHIS GIS Solution

The cartographic engine in the DHIS GIS is an open source Javascript library called OpenLayers. It provides an API for building rich web-based geographic applications similar to Google Maps and Bing Maps. The library includes components from the Rico JavaScript library and the Prototype JavaScript Framework. Health data is presented graphically through Scalable Vector Graphics (SVGs) on the OpenLayers map helped by the MapFish JavaScript client. MapFish is an open source web mapping development

framework that extends the Pylons development framework and provides support for spatial data.

The GIS user interface is mainly built by the use of ExtJS and GeoExt JavaScript frameworks. ExtJS is a JavaScript library for building interactive web applications using techniques such as Ajax, DHTML and DOM scripting. Originally built as an add-on library extension of YUI by Jack Slocum, Ext includes interoperability with jQuery and Prototype. GeoExt brings together the geospatial know how of OpenLayers with the user interface of Ext JS to help you build powerful desktop style GIS applications on the web with JavaScript.

Setting up of DHIS GIS is basically a matter of populating the *coordinates* field of the organisation units in the database as the maps are generated from the coordinates information that are linked to the organisation units. No additional files are needed. As soon as the organisation units have coordinates, the maps will be available in the GIS module. Although it is possible to add/edit coordinates directly in the *Edit Organisation Unit* window (*Maintenance* → *Organisation Units*). It is recommended doing this in a batch job using the general import process in the import/export module of the DHIS2.

The import process will need a GML file with at least two properties of *Name* and *coordinates*. To generate the GML file, we have to start by installing the open source tool called *ogr2ogr*. This should be available for most Linux distros ('sudo apt-get install gdal-bin'). For Windows, we have to get FWTools (<http://fwtools.maptools.org>). The most common format for GIS data is the ESRI shapefile, which consists of three identically named files with extensions *.shp*, *.shx* and *.dbf* (you can use *ogr2ogr* to convert between any formats, see the example below). After opening the *.dbf* in a spreadsheet application (for example, MS Excel), we have to make sure there is a field (column) called *Name*, which has organisation unit names, and that these organisation units are already existing in DHIS2. We have to make sure that all spellings are identical since the matching is done on this name. On Windows, we must open the FWTools Shell and navigate to the folder with the shapefile. The following command has to be issued (replace 'output' and 'input' with the actual names): *ogr2ogr -F GML output.gml input.shp*.

The column in the *.dbf* file with the orgunit name would then have been converted to an XML element inside the GML file. Next, the GML file has to be opened in a text editor (for example, Notepad++ for Windows or Geany for Linux) and do a search/replace to make sure this element is called exactly *ogr:Name* (case sensitive), for example, *<ogr:Name>Badjia</ogr:Name>*. Import the GML file into DHIS2 through the import process in the import/export module (under services menu). There is no need to zip the file. Change import type to *preview* before doing the import to see which changes that will be made and resolve any issues with orgunit name matching that may exist. After importing, the coordinates will be added to the organisation units' metadata and also be available from the organisation unit edit window.

### Basic Usage and Concepts of DHIS GIS

*Thematic mapping*: The left panel of DHIS GIS lets you use the defined organisation units and health data for thematic mapping. All you need to do is select the desired indicator/dataelement-period-organisation units combination in the left side menu. Then by clicking either the boundary or level, the organisation unit selection

window is opened. Here the user can select both the parent organisation unit and the level of its children. If the database has coordinates for these organisation units, they will appear on the map. Calculation method alludes to the size of the legend classes. Set to *equal intervals*, they will be 'highest map value – lowest map value/ number of classes'. Set to *equal group count* the legend creator will try to distribute the organisation units evenly. Choose *fixed bounds* and you may define your own class break values, type for example, '20, 40, 60' using a comma to separate each of them. The map view combo box lists all map views (favorites) saved by the user. The settings that are stored in the map view will be automatically applied to the thematic map panel.

*Favorite map views:* This window will save the current thematic map view in order to restore it whenever you want via the map view combo box in the thematic map panel. By adding your views to DHIS2 Dashboard, you may access them there by inserting map views into one of the link areas.

*Legend sets:* A legend set may be connected to many indicators, but an indicator may only have one legend set. Thus, multiple indicators can be selected while creating a legend set. When an indicator that has a legend set is selected in the thematic map panel, the number of classes, low colour and high colour is automatically set. Example usage (vaccination coverage):

- Create the legends that are going to constitute the legend set.
- The first one could be "Low bad" (display name), 0 (start value), 30 (end value), red (colour).
- Then create "Medium"/30/70/yellow and finally "High good"/70/100/green.
- Now, open the *legend set* panel, type for example, "High is good" as display name and select the desired legends below.
- Multi-select the three legends by pressing and holding the Ctrl/Shift button when selecting.
- Then click the register button to store the legend set.
- Assign indicators/data elements to the legend set in one of the two last panels.
- Select the legend set in the combo box and multi-select items in the list that is given below.
- Click the assign button to update the legend set.

*Export map images:* Click the image icon on the map toolbar and the print window will open.

- Title: Image title, will appear as a headline in the image.
- Layers: Choose whether polygons, points or both will be printed.
- Width/Height: The pixel resolution of the image. Choose among the predefined *small* (800 × 600), *medium* (1190 × 880), *large* (1920 × 1200). If you want to exclude the legend from the image, uncheck the legend checkbox. Finally click the export button to print the image on png format.

*Layer options:* Right or left click any layer in the layer tree in the upper right corner to open the layer options context menu. There are currently three layer options available for vector layers: *Locate feature*, *Show/hide labels* and *Opacity*

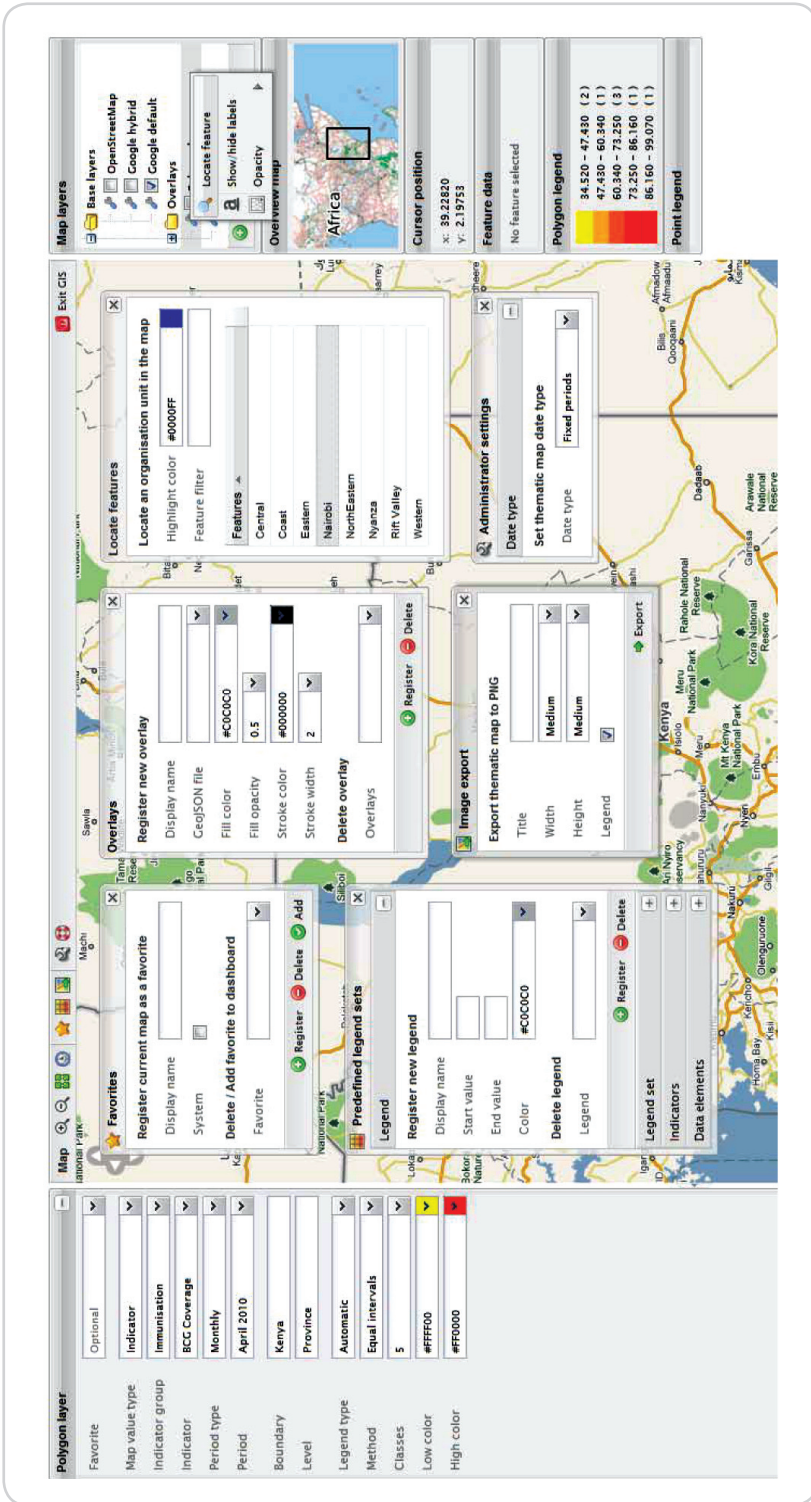


Figure 6.8 User interface in the DHIS GIS module

- Locate feature (organisation unit): Click one of the units in the list and its colour in the map will change to the colour you have specified in the *Highlight colour* combo box. If the list of organisation units is long you can easily create a text filter in the text field below.
- Show/hide labels: By clicking this option, a label with the organisation unit name and its value (based on the current indicator/period selection) appears on the map.
- Opacity: Adjust the opacity/transparency of the layer in the map.

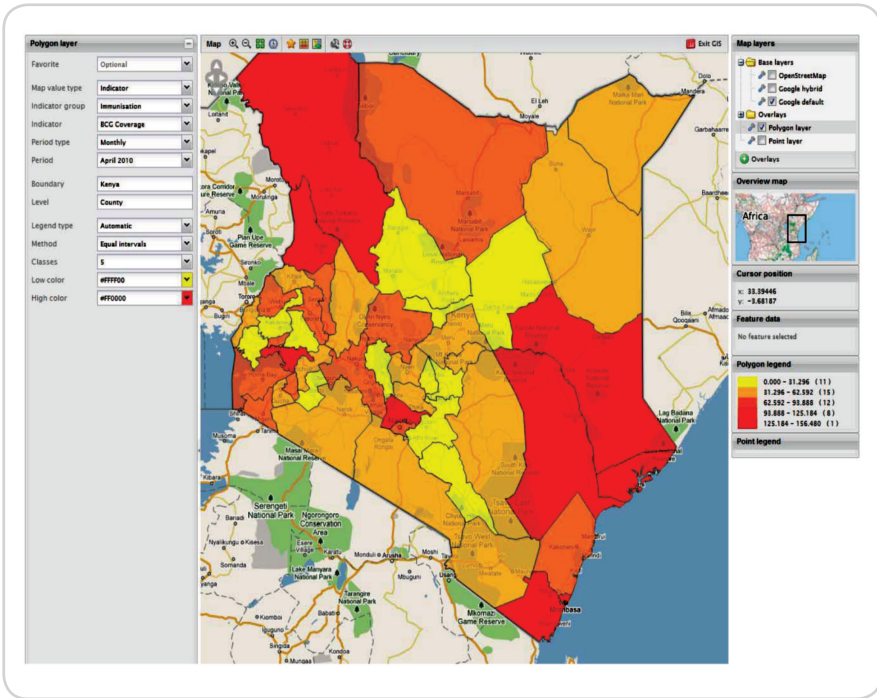


Figure 6.9 Indicator presented for the different counties in Kenya

### 6.4.3 DHIS Mobile: Mobile Module in DHIS2

Mobile telephones and Internet over the mobile network are drastically changing the way health information is interchanged, managed, accessed and used in the DHIS2. What we see is that the different types of devices and technologies are converging, not into one 'thing', but into a seamless range of computing technologies. DHIS2 primarily being a web application can be hosted in the cloud and can be accessed by many mobile devices ranging from cheap feature phones to full blown desktops/laptops that use wireless modems and connect with mobile phone networks to communicate with DHIS2.

In Table 6.2, the range of mobile technologies and their implementation in DHIS2 is outlined:



Table 6.2 Integration models of mobiles with DHIS

Application	Primary Use	Complexity	Status in DHIS2
Formatted SMS	Data is typed as a formatted text, with codes representing different meaning of terms and values	Difficult to use, simple to implement	To send data from any phone with need to install application on phones. This is also used to send feedback or notification from DHIS2 to the user.
Form-based SMS	A form based application is used to capture data and then data is transmitted as SMS	Simple to use, somewhat complex to implement	This has been implemented in DHIS2 since Mar'09 and has been used by more than 6000 users to report monthly, weekly or daily data.
Form-based GPRS	A form-based application is used to capture data and then data is transmitted to a web application using GPRS or other modern data services	Simple to use, simple to implement once web application is deployed	This has been developed to download forms from the Internet onto the phones. These are used to report aggregate data, but also for individual patient-data and also provide activity plans for health workers.
Web Access	The web browsers in mobile phones are used to connect to a web application and data is directly fed into the web application. Browsers use data services in mobile phones to communicate with web servers hosting the web application.	Somewhat complex to use, easy to implement once web application is deployed	A light version of DHIS2 allows users with smart phones to use the phone browsers to view the DHIS2 web application. This allows users to do data entry, view graphs and perform some analysis. The full DHIS2 application will be available to be compatible with mobile browsers.
Interactive Voice Response (IVR) Systems	Mobile phones are used to make calls to a phone number and then keypad is used to respond to questions heard on the phone call.	Easy to use, complex to implement and requires hardware/software for setting up the system	Many projects use this to collect data by allowing users to type-in keypad responses to the questions asked on the phone.

While there are other hybrid ways to capture and send data, the above table illustrates the broad governing principles and approaches for data capture and reporting through

mobile phones. Mobile phones can be used with existing DHIS2 deployment including datasets and forms. Mobile phones cannot be looked at as standalone devices in an infrastructural context free mHealth perspective, but as part of the overall health information system and integrated architecture. In the following table a SWOT analysis on Strengths, Weaknesses, Opportunities and Threats, regarding mobile technologies and the integrated architecture is given in Table 6.3:

Table 6.3 SWOT analysis of mHealth system	
SWOT	<i>Mobile technology and Internet over mobile network</i>
Strengths	Cheap devices; easy to use; low power usage; deep market penetration; widespread network coverage, allows easy use by mobile health workers.
Weaknesses	Limited visualisation; small screen size; low processing power; low memory availability; small keypads.
Opportunities	Scalable, less investments to maintain, already established installed base; Smartphones and portable computers are getting cheaper and network/GPRS getting better, opening up for seamless convergence across the range of technologies.
Threats	New vertical initiatives provide end-to-end infrastructure for fragmented sections of the Health Information System; cloud infrastructure leads to outsourcing of software based services from poor to rich nations; outsourcing of both the 'value adding chain' and the 'learning, innovation and entrepreneurship chain' to rich companies in the North.

The integrated disease surveillance and response system is an example of a module inside DHIS2, which is adapted to mobile technology for reporting and receiving data (Figure 6.10). The module is processing response on aggregate data about communicable diseases, preferably through mobile phones because of timeliness of data reporting.

The system is based on generic rules for triggers that are created by data managers or disease surveillance officers. Based on these rules, triggers of actions are performed and these could range from notifying a group of users over email, SMS or on DHIS2 user interface to perform 'suggested actions to be taken' as a response to the trigger. The rules for the triggers are created by using min/max ranges of data value for a data element, making comparisons with values of other data elements, indicators, geographical groups/distances, and known disease prevalence rates.

#### 6.4.4 Layers and Open Source Frameworks in DHIS2

After having discussed three key modules in DHIS2, we elaborate in this section on the open source components that are used in DHIS2. From its inception in late 2004, open source principles have been important for the development of DHIS2. This has several dimensions; not only is the software distributed under a specific open source license, but there are implications for the libraries and tools utilised and for the organisation of the development.

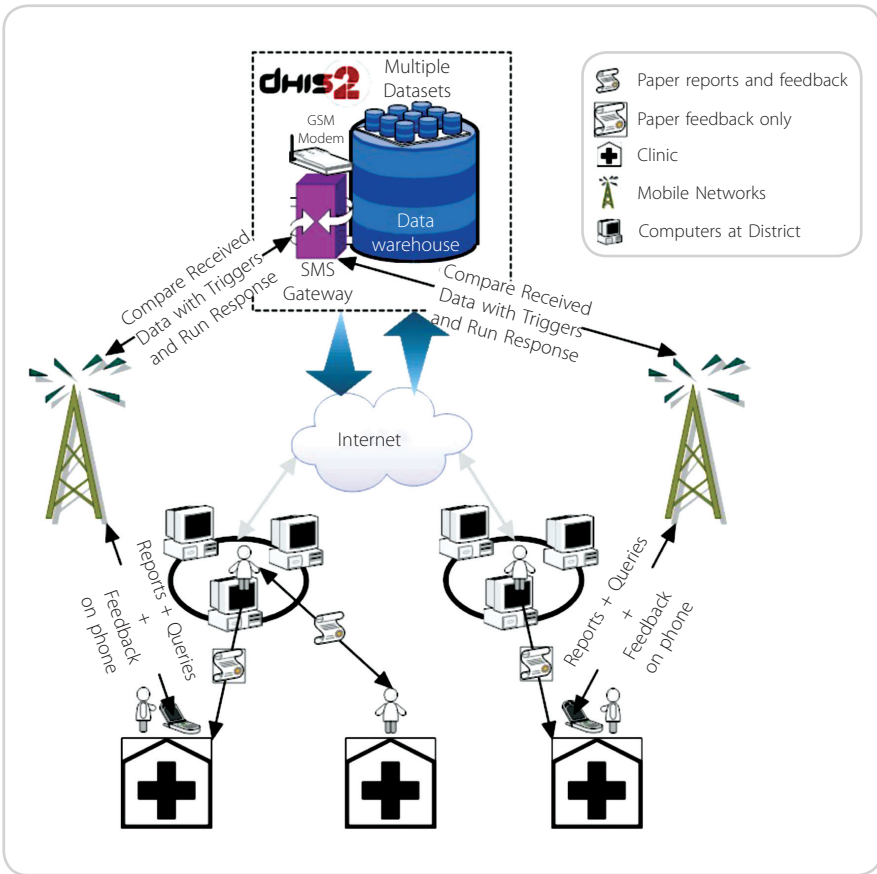


Figure 6.10 Disease Surveillance Architecture – IDSR

The particular legal regime chosen for DHIS2 is the well-known BSD license,<sup>1</sup> which stipulates very few restrictions on what people can do with the programming source code. As with any FOSS project, the license meets the Open Source Definition,<sup>2</sup> which means people are free to modify and redistribute the source code. Additionally, they may even incorporate the source into proprietary software without releasing the source of the derivative work. This last point is the main contrast with the relatively restrictive General Public License (GPL), which is the most widely used open source license.

A number of leading open source Java frameworks are employed in the DHIS2 development which help to structure and generalise the code. The core frameworks, the various components, and the developer toolkit are themselves the product of large

<sup>1</sup> See <http://www.info.org/bsdlicense.html> for a thorough discussion of the BSD license and how it compares to the GPL.

<sup>2</sup> <http://www.opensource.org/docs/osd>



collaborative communities, which often also includes large commercial companies. These communities represent both rich and varied demands as well as a number of resources, which together help ensure continued refinement and rapid development. In several cases, this has resulted in the projects taking a leading role within their fields, often emerging as de facto standards. Since the frameworks themselves are freely available without license and cost constraints, they form a common platform which attracts large numbers of people to help with further refinement while using it for their own needs. Their wide recognition and the open licenses also serve as guarantees against vendor lock-in: any number of developers around the world can be hired to improve code built on these frameworks, making them a suitable basis for stimulating the local software industry in the South. However, as with commercial software, support in the form of documentation, training, and certifications is key.

DHIS2 uses a three-tiered architecture, including:

- *A data layer:* This is where the data is stored and retrieved and kept as neutral and independent as possible with regard to its usage by applications and the business layer. This separation of the data from the logic is important for scalability.
- *A business logic (service) layer:* This is where the knowledge of the health sector 'business' is handled, such as the metadata structure, calculation of indicators, evaluation and aggregation rules, and the actual processing of data. It also serves as a bridge between the data layer and presentation views. The data can also be exposed as web services which can also be used by other applications.
- *A presentation layer:* This is a layer which handles the user interfaces. The presentation layer translates information from the layer below and formats it into user views, and transmits the user's commands to the lower layers. In fact, the layered architecture allows for alternative presentations of data from the service layer – for example, specialised to small screens like those on mobile phones. In the DHIS GIS module, for example, the dialog boxes, colour pickers and navigation controls (zoom, pan, and so on) that are used to select and design maps are part of the user interface (the presentation layer), whereas the actual polygon and point coordinates and indicator values are provided by the layers below. Furthermore, for online installations, map images are pulled in from external services like OpenStreetMap and Google maps as background to the map views.

This layered architecture is depicted in Figure 6.11.

Such clearly defined layers allow different objects to follow the same rules, enabling modularisation, which is the key to collaborative development among teams distributed across countries and continents.

- The data layer consists of a standard SQL database and Hibernate<sup>3</sup> is used to link Java objects to the database and thus also allows for abstraction of the data access layer and independence from the particular database chosen. DHIS2 comes with an in-memory Java database called H2, but is usually deployed using an external database engine such as PostgreSQL or MySQL.

<sup>3</sup> <http://www.hibernate.org/>

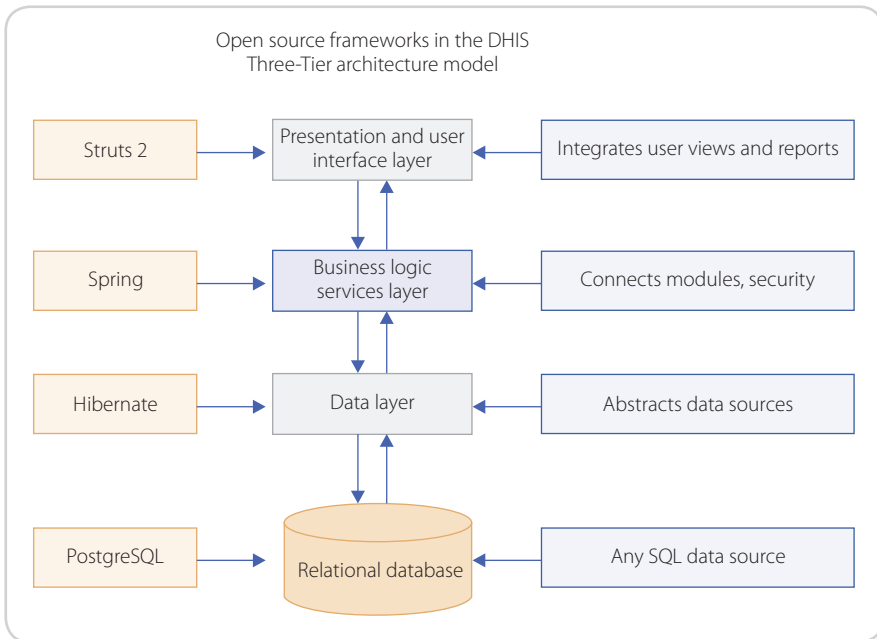


Figure 6.11 The DHIS2 three-tier architecture model

- For the service layer, the Spring<sup>4</sup> framework is used to tie together the server side components application logic. It provides a consistent programming and configuration model, and comprises a range of services: A container for the various DHIS2 modules, transaction management, authentication and authorization via the Spring Security sub-project and messaging between components.
- Struts 2<sup>5</sup> is a well-established and popular framework for developing sophisticated web applications. The presentation layer also includes CKEditor for designing input forms, Jasper Reports for analytical output and charts, and GeoExt and MapFish for the GIS module, as well as the powerful JQuery library for interactive JavaScript based functionality (for example, updating only parts of a web page using AJAX instead of reloading the whole page).

In addition to the core frameworks, the system also relies on a range of open source Java libraries for functionality like XML processing and unit testing. All of this is made possible because of the Free and Open-Source Software culture of sharing and avoiding reinventing of the wheel.

Furthermore, the whole development process is transparent, as all changes to the source code can be tracked on the online hosting platform, Launchpad.<sup>6</sup> The same openness applies to bugs and their resolution, as well as feature requests (called

<sup>4</sup> <http://www.springsource.com/>

<sup>5</sup> <http://struts.apache.org/2x/index.html>

<sup>6</sup> <http://launchpad.net/dish2>

'blueprints'), which are assembled into a roadmap for future releases. In addition, the developers use a suite of open source tools which include Maven, Bazaar, Eclipse or NetBeans, and a number of Firefox browser add-ins to work with and build the code.

## 6.5 Priorities for Future Development of the DHIS2

Looking at the current landscape, by 2012, and looking into the future, we identify and outline the following priority areas for the further development of the DHIS2+:

1. **Integration from 'below' and integration from 'above':** Developing DHIS2 further as a platform for integration of data sources – from below and as a platform for information user web services:
  - ◆ **From 'below'** – Integration of data sources; continue to strengthen the data warehouse and interoperability capabilities of the DHIS. The SMX-HD standard for exchange of metadata and statistical data illustrates the open standard based approach which we see as a priority to expand into real use, whereas to establish practical and useful 'production' use-cases will be the main approach to achieve this. We will work with in particular our partners in the iHRIS (human resources), OpenMRS (medical records) and OpenLMIS (logistics) to establish such use cases.
  - ◆ **From 'above'** – Develop effective web-API (interface) to the DHIS2. In order to foster innovation in and around the DHIS user and implementer communities, it is necessary to strengthen the ease with which new modules maybe developed and interfaced to DHIS2. This aim maybe seen as targeting two levels of use and development:
    - Make it easy to develop add-on extensions, 'apps' or modules, using data and functionalities in DHIS2, mainly for external developers. For example, a web site for health information in a country accessing data and/or analytical tools in the DHIS2.
    - Make the interfaces more durable and general so that more 'internal' developers and DHIS implementers find it easier to make extensions and plug-ins that are easily brought to new versions of DHIS2 and not 'locked' to versions that quickly become past versions.

To develop effective portal solutions is another priority which may also be grouped under the integration from above label. Portals will be key mechanisms in disseminating data and providing targeted information to a range of users, from super users to the general public.

2. **'Semi-online'; optimising Internet connectivity and functionality in developing countries; 'being online even while offline':** Internet connectivity in the developing world, and in disadvantaged regions, will be relatively poor for the foreseeable future. As argued earlier, online web computing and one central server represents a tremendous improvement to the traditional offline installations of DHIS. In order to achieve this in more constrained networking contexts, the DHIS is optimising the availability of the Internet both at the levels of data use and data entry (Figure 6.12):
  - ◆ Providing offline access to data and analytical tools. Data for selected areas and periods are downloaded and updating a datamart, by only adding new data. The datamart is then used to load Excel pivot tables and eventually other

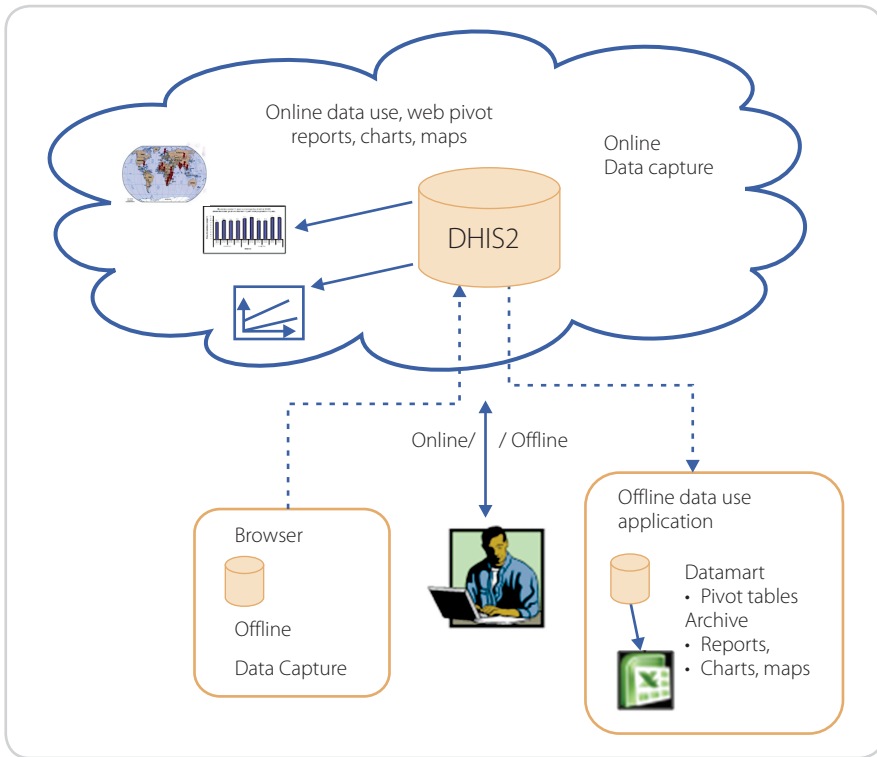


Figure 6.12 Semi-online through offline data analysis and use and data capture

analytical tools. Archive facilities for downloaded maps and reports are also provided. This functionality provided by a ‘small’ offline application was ready for testing first quarter 2011 and will be made more user-friendly and usable in the future.

- ♦ Providing offline data capture. The HTML 5 standard is including offline database and storage facilities. We expect to have this functionality running during 2011.
3. **Business intelligence and decision support systems:** A key longer term goal is to strengthen DHIS2 as a platform for supporting decision-making processes and monitoring organisational performance. We need to get the DHIS2 project fully part of the current advances in Business Analytics and BI technologies, now increasingly labelled, not only BI, but BAI technologies. In addition to the general use linked to decision-making and monitoring and evaluation in health, increasing focus on ‘payment for performance’ in health, make it important to translate the BAI approaches developed in business and commercial domains to the context of global health. GIS, dashboards, monitoring ‘live data’ against thresholds calculated from, e.g. surveys as an effective way to integrate survey data with routine data, and so on, represent some of the areas where DHIS2 is already working and which plan to be further strengthened.
  4. **Mobile web interface: Better and stable web and GPRS-based mobile and touch screen solution and data capture using low-end devices:** We see the

mobile Internet and the converging of computers, iPads, netbooks and mobile telephones into online computing devices as the key way to achieve the web-based DHIS in developing countries. Interchanging between touch screens and/or key boards over web and/or GPRS will be the new standard for online computing in developing countries. Developing robust solutions in this area is thus an important priority area for DHIS.

DHIS also needs solutions for contexts with poor infrastructure written for low-end java-enabled feature phones. These can work offline from the DHIS2 instance, but sync with the server through web APIs when GPRS is available and also send data reports over SMS. Where mobile infrastructure is mature and lower-end android smart phones are starting to become available, an important focus is on extending and tuning the DHIS 2 Web interface for use in the browser on these devices.

5. **DHIS academy and documentation:** Given the rapid scaling of the DHIS2, training and documentation are now the key obstacles. The DHIS Academy will be developed to become a self-contained 'package' of material and live and generically updated documentation. User-friendly documentation is a related area which will be focused. Various training materials being developed within the different HISP nodes will be converged using online learning platforms like Moodle.
6. **New modules:** Where to develop new modules as part of DHIS, and where to work with partners depends on context, situation and priorities. The following are current priorities:
  - ◆ Further development of the (vital) event-based module and lightweight patient/client tracker and aggregation. To develop use cases and real use of the aggregation functionality will be prioritised.
  - ◆ Improve basic logistics and inventory module. Functionality in the data entry form for logistics ordering form; calculate order based on stock and consumption.

### Summary

In this chapter, we have provided a kaleidoscope of the DHIS artifact including its past development history, current modules and components, and some of the identified future priorities. Key summary points include:

1. The first version of DHIS was based on MS Office platform and distributed free. It has been developed in South Africa and continues to be supported from there.
2. Early DHIS development was based on a strong participatory design philosophy, and principles of user empowerment and local control were key design aims that were inscribed in the design, development and implementation of the software. The interaction between DHIS development and use was mediated with a strong public health focus.
3. From 2004, a process of remodeling of DHIS1.3 as DHIS1.4 was initiated, where internationalisation was a key design aim.
4. Also from 2005, the DHIS2 development was initiated by Oslo based on a stack of bleeding edge Java technologies, and using principles of open source and shared distributed development.

5. Guiding aspects of DHIS2 architecture include:
  - a. A three tiered architecture including data layer, business logic layer, and presentation layer.
  - b. Based on data warehousing and BI functionalities.
  - c. Built as a platform to support the development of supporting systems and modules.
6. A recent development is of the Web API based on REST architecture style in order to achieve a loose coupling between the DHIS service layer and additional software products.
7. Key DHIS2 modules include:
  - a. Patient and tracking.
  - b. GIS.
  - c. Mobile reporting.
8. Priorities for future development:
  - a. Integration from “below” as well as “above”.
  - b. Being “online” even while offline.
  - c. Supporting BAI (Business Analytical Intelligence) functionalities.
  - d. Building a stable web and GPRS based mobile integration.
  - e. Strengthening of DHIS Academy for regional capacity building efforts.

## Reference

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# 7

## How to Set-up DHIS2 in a New Context?

In the previous chapter, we provided a broad overview of DHIS2. In this chapter, we describe some guideline principles based on our experiences around how can DHIS2 be made operational and be set-up in a new context – be it a country, province or a district. Our focus is primarily on the country level. Introducing DHIS2 is an integral part of the wider issues of strengthening a country's HIS using primarily evolutionary approaches of participation and development. In countries, typically, there will be various computerised and paper-based systems in place already, which will form the point of departure for database design and implementation strategies. Setting-up the DHIS2 database is a pragmatic process; data elements and datasets need to be designed and the issue of harmonised or overlapping data reporting forms dealt with.

This chapter is divided into four sections:

- We start with presenting three archetypical approaches of DHIS2 database design, and discuss how to deal with existing systems within particular institutional and political contexts.
- Thereafter, we present two individual cases of practical DHIS2 implementation; Burkina Faso and Bangladesh to illustrate the challenges and approaches in a practical setting.
- We will present a summary by the way of 10 general guidelines for enabling DHIS2 implementation in new contexts.
- We discuss processes of joining the DHIS2 development community, and how this can contribute to fostering local innovations. A brief summary of the chapter is then presented.

### 7.1 Three Approaches to Standardisation Using DHIS2

In this section, we present three different approaches representing ways to deal with existing systems and the political context. These are characterised as follows:

- *All data in one bucket*: Fragmented data addressed by a heterogeneous database.
- *Minimum dataset*: Solving overlaps, duplications and fragmentation through a rationalisation process.
- *Maximum dataset*: Accommodating all and incrementally harmonising.

These three approaches are illustrated through country examples using DHIS2.

#### 'All data in one bucket'—Heterogeneous database approach: Example Botswana

During 2005–2008, DHIS1.4 was implemented and piloted in Botswana. At that time, the HIS in Botswana was extremely fragmented, with several ministries involved in the system and running and supporting different subsystems, and with the health programmes adding their own vertical systems contributing to further the fragmentation. As the main official routine, HIS run by the Health Statistics Unit was ineffective, the various health programmes relied on their own systems, which were designed and run by each of them. While all stakeholders acknowledged the suboptimal situation, it was difficult to get enough resources together for a total revamp of the system. In this situation, a pilot project to try to integrate the information flows at the district level using the DHIS1.4 was established. It was supported by all stakeholders and funded as a research project with limited funding by European Union. Despite fragmentation of the HIS at the national level and with vertical reporting structures at the district level, most of these information systems were handled by one or two persons in one office, thus representing a paper-based data warehouse.

The approach to database design in Botswana was to make a direct mapping of the paper-based system into the DHIS1.4, meaning that each cell in the paper forms represented a unique definition in the database. Even if the paper forms had overlaps and duplications, the duplications were replicated in the DHIS, without standardisation of, in essence, equal data definitions.

The reason for the lack of standards between health programmes was typically due to existing differences in funding and organisational ownership. For example, rich health programmes, such as the HIV programme of Prevention of Mother To Child Transmission (PMTCT), had money enough to set up their own infrastructures to collect timely data by providing transport, hiring their own people, and equipping them with computers and software solutions. The Mother and Child Health (MCH) programme, on the other hand, despite targeting the same pregnant women, had very little resources and poor data collection and reporting routines. As an example, both these programmes collected data on First Antenatal Care visits representing the total number of pregnant women taking part in the Antenatal Care programme at any time, a programme that is run by the MCH programme. Data on 'first Antenatal Care visits' is an important piece of information, and is used as the denominator for pregnant women served by PMTCT, and to monitor coverage and achievements by MCH. The data collected by the two programmes on the same items such as the first ANC visit differed, and, given the differences in resources, the data collected by PMTCT was of better quality than the MCH data. Due to much better completeness rate, 'getting in more data', the PMTCT reported generally significantly higher numbers. In a perfect world, of course, the two programmes would have joined their resources and established joint procedures and systems for data collection. Alas, due to organisational politics, and the fact that each of the programmes collected a lot of data in addition to where they were overlapping, it was not possible to merge in the short run. The DHIS mediated a 'tactical' solution, which was to store the data from both the reporting systems and organise by labelling and 'name' the data elements differently; such as 'PMCT\_1st ANC visit' and 'MCH\_1st ANC visit'.

In a similar situation in Malawi, the Expanded Programme on immunisation (EPI) had more resources and better data than the official HMIS of the Ministry of Health.



However, here it was decided to replace the immunisation data in the HMIS with similar data from the EPI, because it was the 'best data.' A similar 'swap' was more difficult in Botswana due to more complicated overlaps between the datasets. Acknowledging that this approach of 'heterogeneous data management' would not solve the duplications, the rationale for doing it was to allow for a fast implementation by sidestepping 'political' obstacles in the set-up of the database. As long as no paper form was changed since it was copied to an electronic format, a database could easily be agreed upon by the various stakeholders. This strategy opted for a quick solution in an environment, where the capacity to negotiate an integrated solution was not present at that time. The heterogeneous semi-integrated data collection tool, the DHIS, was then to be used as a platform for further integration. However, the efforts to integrate the data flows in Botswana stalled, it turned out to be too difficult to manage the heterogeneous database as too much knowledge about the data (meta-meta-data) had to be managed by the managers rather than through the metadata in the database. While the failure of this approach to achieve integration was also due to not enough resources and support by the programmes, which was required to manage such a complex technical and institutional process.

To conclude: to manage similar data elements with different values and different sources, is difficult and not recommended as a general process to standardise and harmonise disparate data-flows in a country. Such a process maybe required for special cases, for example:

- Funders need to monitor projects they are supporting, where projects are sources and they may deliver services, and report from them, within and in addition to the general health services.
- Comparing data of similar types but derived from different methods, such as comparing routine data with survey data, where survey data maybe used as thresholds against which routine data are correlated.

#### 'Minimum Dataset' – Fragmented Data – Harmonised Database: Example Sierra Leone

When the integration project started in 2008, Sierra Leone had a severely fragmented HIS with 17 compulsory forms to be reported from each facility, many of which with overlaps and confusing definitions and procedures for data collection. The first approach to the integration process was to keep the paper-based data collection forms as they had been used, and use the DHIS to standardise the fragmentation and overlaps 'behind the scenes' in the database. Using this approach, all data elements appearing in the paper forms were identified and organised, in order to identify and avoid both the duplications from overlapping data forms and of data elements in terms of their definitions. As a result, a coherent integrated data warehouse was built, where one data element in the database could be related to a field in several data collection forms. While the forms may have several similar and replicated data elements, each data element was given a unique representation in the database. Figure 7.1 shows how multiple and duplicate data elements from the existing paper system were joined and made unique in one data element in the database. For example, with respect to DE5, only one value would be accepted, and if the two forms had different values, this would be handled 'outside' the database, based on the programme level 'ownership' of the data.

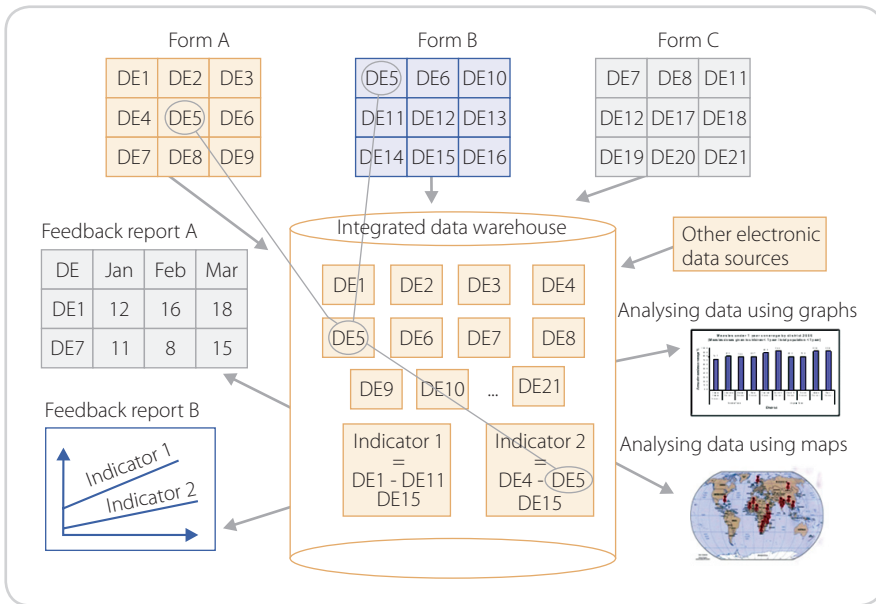


Figure 7.1 Data needs in all the levels and across

During 2008, an integration based on this approach was implemented in more than half of the country, while at the same time data were collected from the rest of the country. By the end of 2008, a rather extensive national dataset was available for analysis and presented to the stakeholders. The stakeholders were made fully part of the process, which convincingly documented the problems with the current system such as overlapping data collection forms, inconsistent data definitions, and poor data quality in terms of both correctness and completeness. At the same time, through actually practically doing this process of integration, it was also established that shared common datasets in a national repository was possible to achieve. This learning process sparked an increased interest to revise the current collection forms, and during 2009, a series of meetings took place among the key stakeholders to negotiate a new set of harmonised data collection forms. As a result, by January 2010 a new set of completely rationalised and harmonised forms were implemented.

This approach of using the DHIS2 to harmonise disparate datasets by joining duplicate data elements in the database represents a very useful approach to solve also 'smaller' incompatibilities, present more at the fringes of the system than what was the case in Sierra Leone, where the whole system was addressed through this approach. Even in countries where HIS are relatively more standardised, there will be inherent overlaps, for example, between the HIV/AIDS reporting to and from funders such as PEPFAR and the routine country HIS, regarding '1st ANC visits', 'HIV tests', 'New AIDS patients on ARV', and so on. This is what we refer to as 'fringes' and where the above creative harmonisation approach is both needed and very useful. It is, therefore, an important tool in the more mainstream approach to implement DHIS2 in a context where datasets are regarded as well standardised.

### “Maximum Dataset”: Harmonised Data Mapped to Harmonised Database – Example Zanzibar and Tajikistan

In most of the countries implementing the DHIS, the system is intended to replace a previous offline system, and/or the DHIS project is part of a process of revising and harmonising the data collection forms. Here we give first the example of Zanzibar and then Tajikistan.

Zanzibar represents an archetypical case of setting up DHIS in an ideal process of existing collaborations between health programmes and stakeholders. The project to implement DHIS in Zanzibar started in 2005. Following a survey that revealed fragmented data collection and reporting due to disparate HIS and its subsystems, the key objectives of the project were formulated as:

- Strengthen information use at the district level.
- Set-up an integrated data warehouse at the national level to facilitate access to information by all health programmes and stakeholders.

All stakeholders agreed to revamp the system and to develop new and harmonised datasets and data collection forms representing the needs of the different programmes. Ministry stakeholders, health programme managers, district medical officers, and HISP consultants conducted a series of meetings to agree on a set of standardised data collection forms that would form the basis of the integrated data warehouse. The new data collection tools included essential data from all health programmes taking part in the integrated approach, such as Reproductive and Child Health, Immunisation, HIV/AIDS, and Disease Surveillance. These standard datasets were both made available on paper forms to be used for data reporting from the health facilities and the district level, and electronic forms, that is data entry screens mimicking the paper forms in the DHIS used to register, validate, analyse, and report data at the different levels. In 2005, the customisation and implementation of DHIS started by using the new version of DHIS1.4, which was also simultaneously under development and refinement, making Zanzibar, the primary testing case for this new development. Communication of requirements and testing of new functionality from Zanzibar became an important process in supporting the development of a more flexible and globally relevant 1.4 version of the DHIS software, which subsequently became the basis for the design of the DHIS2, a process initiated simultaneously in Oslo.

Every year since the first version of the unified data collection forms, there has been a revision process (enabled through a 3-5 day workshop), whereby the datasets were revised and updated based on negotiations amongst key stakeholders and departments at the Ministry of Health and Social Welfare (MOHSW). As a result, the paper forms and the DHIS are updated on an annual basis to adapt to these revisions. The standardisation process in Zanzibar toward one harmonised system has been relatively successful and institutionalised due to the solid political backing from both the Danish International Development Agency (DANIDA) and the Ministry of Health.

During the first phase of the project from 2005, Internet was very poor in Zanzibar, and DHIS1.4 was installed in each of the 10 districts on the two islands of Unguja and Pemba. By 2010, however, the Internet connectivity improved drastically, and by 2011 the separate districts installations of DHIS1.4 were replaced by the DHIS2 on a central server. The migration from the DHIS version 1.4 to version 2 was easy to

carry-out because of the institutionalised buy in to the integration process. The Zanzibar and Sierra Leone integration processes yielded the same result of a harmonised and ongoing institutional process of data revision and unification. Both these cases contrast with the South African approach of an agreement of a 'minimal' dataset in that these two countries preferred a more all-encompassing and comprehensive approach representing a 'maximum dataset', which was incrementally pruned based on experiences from use and ongoing and institutional negotiations.

A similar situation with respect to HIS, but with a different strategy employed is now illustrated through the case of Tajikistan.

### The Case of Tajikistan

The Republic of Tajikistan, a country in central Asia, like many other similar developing countries, was plagued with an inefficient HMIS, which international donors and the national ministry were keen to reform. Many of the common problems existed, including excessive data being collected, centralised reporting, no analysis and local use of information. These challenges were all identified by various consultant analysis reports. There was a software called MEDSTAT, which was in use for many years, based on an outdated Foxpro platform, and with next to no functionality for creating indicators or graphs and charts. The MEDSTAT application was controlled by the national MEDSTAT office (the full form being Centre for Medical Statistics and Information, Ministry of Health), managed primarily by statisticians. This application was a mere electronic replication of the existing paper-based forms where all data collected in the field needed to flow to the national level, with limited functionalities for aggregation and no analytical features such as the ability to automatically generate indicators. The extreme inefficiency of the existing HMIS was a key area that the Ministry of Health and donor organisations were concerned with, and a series of interventions were initiated, including the Ministry of Health and Asian Development Bank supported Health System Reform Project (HSRP), which we report from and where the revision of HMIS was one of its key components. At an earlier stage of the project, a group of (Pakistani) consultants had worked out the strategic plan and conceptual framework for a new national HMIS. Their analysis reduced number of indicators from 1300 to 834 taking into account demands of national health strategy. These 834 indicators were grouped into six main categories: demography, healthcare resources, environment, healthcare services, MDGs and lifestyle. This framework was then taken as the basis for next intervention – the design and implementation of HMIS – carried out by HISP team members.

In 2007, we were invited by the Asian Development Bank, to carry-out a situation analysis of the national HMIS, and develop recommendations on strategies for further reform and strengthening, including demonstrating the 'proof of concept' for the software solution. Initially, a situation analysis was carried out at the national level including of the central statistics division, about 8 of the national health programmes, and other funding agencies such as the World Bank and WHO. Members from these organisations were interviewed and their opinions solicited.

The situation analysis identified the existence of multiple primary recording forms (hospitals – 25, polyclinics and health centres – 54, hospitals and health centres – 34, Laboratories – 33, medical and forensic examination – 17, epidemiology services – 84, others – 12) used at different levels of health facilities to record services provided. Overall, we estimated about 35,000 data items were being collected with varying

frequencies, as each element typically had multiple disaggregations of age and sex types. At the district level, data aggregated from these primary recording forms from the different health programmes were captured into 37 reporting forms and sent to the provincial level and further to national level office of MEDSTAT. Further, there were parallel reporting systems in place with both the health programmes and the MEDSTAT department sending the same information to their corresponding superior level in the National Ministry, moreover in different formats, which created compatibility issues. The 37 reporting forms of MEDSTAT were poorly designed, each hosting an enormous amount of data elements, for example, the form titled 'Prophylactic Treatment Activity of Facility' contained about 50 sub-forms, covering 1836 data elements, and spanning about 75 pages. Two of the forms were collected on monthly basis, and the rest were collected annually. Reporting forms were designed from different perspectives, some were dedicated to cover entire activities of particular type of health facility, while others were targeting narrow areas. This was leading to duplication or overlapping data.

There was no interoperability amongst the systems. For example, at the sub-national level, the Tuberculosis programme entered data into Epi Info software and sent it to the national level. However, since MEDSTAT could not import that data electronically, the same had to be manually re-entered into the MEDSTAT application. Further, the WHO had set up a web-based application to monitor some key MDG related national indicators. However, since MEDSTAT did not support the functionality of indicator calculation and also was not interoperable with the WHO system, the MEDSTAT data had to be then manually made available to the Data Presentation System (DPS) for the generation and presentation of these key indicators.

After the analysis by the HISP team, the first set of recommendations was to carry-out a radical reform of the data elements, information flows, and to link it more closely with the indicators. However, the Ministry of Health gave no permission to make any change in the existing system arguing that would require clearance from very high levels of the President office – including the State Statistics Committee. We were told, 'not even the logo of the paper form can be changed or moved.' The HISP team comprised of both health and IT professionals, who had experience in similar implementations from other parts of the world. Given the lack of permission to carry-out any change, the team was faced then with the dilemma of automating existing inefficiencies into the computerised system. The strategy adopted then was:

- Take the existing system with all its data elements, recording forms, and reporting formats as it is, and develop the same on DHIS2, to establish that the tool can do the job.
- For some selected pilot sites, take all legacy data and import it into the DHIS2 to be able to carry-out analysis on data quality and indicator generation.
- Show the redundancies and missing data to the decision-makers, arguing for the irrelevance of the existing data, and based on that, the need for change.
- Simultaneously, identify key indicators that had been formulated by the Ministry and their international partners, identify what data is required to generate these key indicators, and then raise questions on the need for the data elements not being used for indicators.

The strategy of adopting this 'maximum data approach' while being in apparent conflict with the minimum dataset approach learnt in South Africa, was our political response for the lack of permission to carry-out any changes. The idea was that

through demonstrating firstly the DHIS2 functionality and secondly making visible the inefficiencies of their existing system, we could try to create a basis for carrying out further improvements and reforms when the political environment was hopefully more favourable. Then working closely with a local open source focused NGO, the HISP team successfully customised the DHIS2, imported legacy data, and demonstrated results. Table 7.1 shows the degree of blank/zero values was included in the recommendation for future improvement.

Table 7.1 Percentage of zeros/blanks for 2005–2006 data for randomly selected forms at different levels

Form number	Table name (multi-table forms)	Number of Entries analysed	Number of zero/missing values	Percentage of zero/missing values
1	Infectious diseases	76370	66153	86.62
	Parasitic diseases	8576	6913	80.61
	Hospital acquired diseases	11286	11127	98.59
5	Reproductive health facility activities	1360	148	10.88
	Contraceptive resources	3060	1483	48.48
	Contraceptive health	3672	1426	38.83
	Contraceptive assistance	3264	627	19.21
7	Temporary disability and work injury	91403	82645	90.42
8	Active tuberculosis diseases	22848	16158	70.72
9	Sexually transmitted diseases, fungal skin diseases and itch	26928	23352	86.72
10	Psychological disorder (alcoholism, drug addiction)	16214	13243	81.68
10D	Employees with scientific degree working in organisations, enterprises.	7548	6702	88.79
11	Mental disorder and behaviour connected with usage of psycho-active substances	15488	14303	92.35
12	Diseases registered in treatment facility of catchment area	692736	542084	78.25
12D	Diarrhoea diseases registered in treatment facility of catchment area (0–14 years)	17226	13306	77.24
12O	Acute respiratory diseases registered in treatment facility of catchment area (0–14 years)	11154	6741	60.44
13	Abortion report	11232	8920	79.42
Total		1020365	815331	79.91

The average percentage of non-zeros or blanks was identified to be close to 80% displaying a very high redundancy or non-use of data. With respect to the other strategy of analysis with respect to indicators, Table 7.2 is reflective of the approach.

Indicator group	Quantity of indicators in a group	Percentage of data availability from existing data elements (apr.)
Demography	353	30
MDG	12	25
Lifestyle	28	20
Environment	89	5
Health conditions	224	90
HC Resources	128	70
Average		40

Table 7.2 analyses the ‘(mis)match between data element and indicators’ based on the design principle that all raw data should be converted to indicators if it has to be of actionable use. Table 7.2 indicates that despite an enormous amount of data being collected, less than 40% out of the 833 defined indicators could be calculated using the MEDSTAT data. For example, the MDG6 indicator calculation (United Nations – 2001) requires data on women in the age category of 15–24 years, whereas the Tajikistan HMIS collected data on the 15–19 years age group.

The above two examples depict how we analysed and presented anomalies with existing data. Further, the customised DHIS2 application was installed in seven pilot districts, and staff members were trained to use the new system. Also legacy data from the MEDSTAT system was imported into the new database. At the end of pilot project, the Ministry of Health acknowledged both the value of the DHIS2 and the redundancies in the existing system, and initiated a new round for HMIS strengthening based on the pilot experiences and the recommendation report from the HISP team in 2008. Phase II, which is ongoing, is concerned with revising metadata to match the national health strategy plan for 2010–2020. In this phase, a series of round tables were organised to bring professionals from various health programmes together and revise indicators and forms. The earlier list of 834 indicators was reduced to 367 in number, their definitions were revised, and sources of numerators and denominators defined. Now a list of 42 core indicators have been determined, which directly measures and monitors progress toward achieving the national health strategy for 2010–2020. Furthermore, a comparative study of the existing system versus the HMN framework was performed, contributing to the revision of reporting forms, and the expectation is also to reduce the number of data elements to the level, which fulfils indicator needs. A Third phase project is to be launched in early 2012 with the support of the European Commission, to enable a national roll-out of DHIS2 based on the revised forms.

At the technical database level, different strategies for harmonisation have been illustrated. The South African case, described in greater detail in Chapter 1, was based

on an approach of designing data for decision-making, only including the most important data from each area. However, with growth in momentum, gradually more areas and data were added, which was easily accommodated through the flexible database structure. In this way, national standards for essential data were developed 'on top of' other existing systems. The South African strategy, based on sound public health principles, however, can be argued as being a product of their times where the paper forms dominated and databases were standalone and more limited. The web-based architecture and the data warehouse strategy, however, provides alternative approaches to data harmonisation and integration. As the archetypical approaches, illustrated by Botswana, Sierra Leone, Zanzibar and Tajikistan exemplify, a starting point was to include all data 'as they are,' without solving inconsistencies between them in a heterogeneous database. While this strategy is not something we will recommend, given the complexity of managing metadata, it provides a political approach to get around the reluctance of health programmes to part with any of their data. As contrasted with this above approach as followed in Botswana, Sierra Leone provides a more sophisticated two-step strategy where in the first stage we accept that there are different overlapping data collection forms in use, but address these inconsistencies 'behind the scenes' at the level of metadata structure of the database. In the second step, build upon the gains from the first step to demonstrate that 'full' integration is possible, and strengthen institutional buy-in. The Zanzibar example illustrates a hybrid approach of a technical solution with an ongoing institutional process of discussion and negotiation with constant revisions taking place on an annual basis. Here, the start was with the revision of the data collection tools and to solve the inconsistencies before setting up the data warehouse. The move from DHIS1.4 to DHIS2 provided further possibilities to revise and quickly deploy the revisions.

In summary, the various strategies followed for standardisation, as described through these examples, are context dependent and employing varying hybrids of technical and institutional processes. Standardisation in the process of implementing datasets in the database typically helps to reveal existing inconsistencies, making the problems visible, and to lay the ground for the next step of reform. It is important to note that standardisation will always be an ongoing process, and whether it is radical (for example, South Africa and to some extent Sierra Leone) or incremental (for example, Botswana), or whether we start with the 'minimum' or 'maximum' approach, will be highly dependent on the political context and the technological options that the existing infrastructure allows. The web-based and data warehouse approach no doubt allows for a strategy of accommodating 'all' but runs with it the danger of automating all existing inefficiencies of the paper-based system, and with it undermining the sound public health principles of 'using information for local action.' It is important thus for the technical processes to be accompanied with sound and ongoing institutional mechanisms based on a public health inspired approach to reform.

Drawing from the discussions and different examples discussed, we provide a figure which summarises the different approaches to standardisation (Figure 7.2).

## 7.2 Setting Up DHIS2 – Two Cases

In this section, we present detailed guidelines on how to set up and implement DHIS2 in a country using two cases from Burkina Faso and Bangladesh.



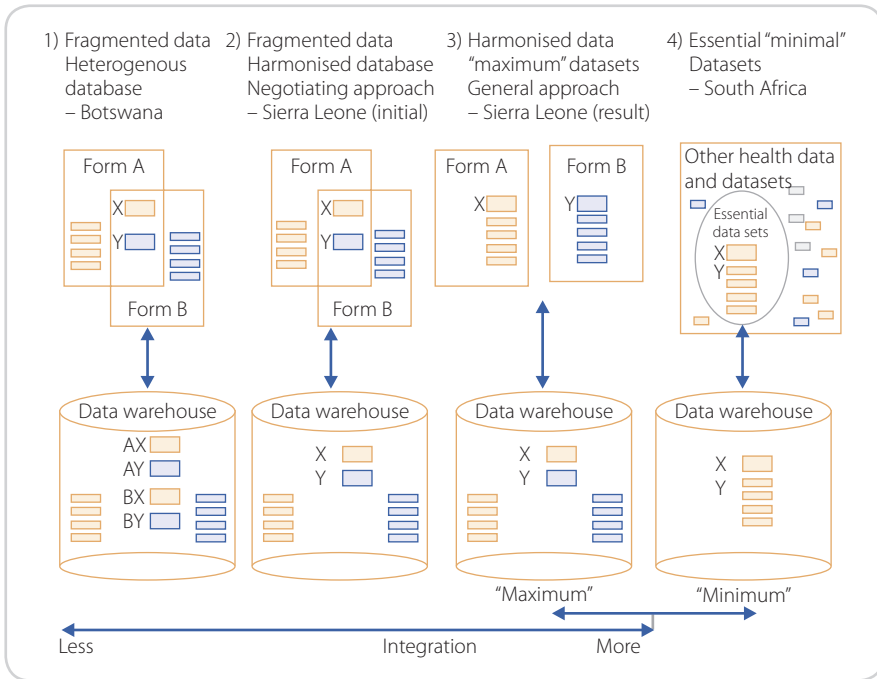


Figure 7.2 Comparing four different strategies for setting up the DHIS

### 7.2.1 The Case of Burkina Faso

Burkina Faso is a land-locked Francophone country in West Africa. They developed a strategic plan for their HIS in 2009–2010 as part of the HMN process and started to set-up DHIS2 as their national data repository in 2011. The HISP team provided the Ministry a set of guidelines towards setting up DHIS2:

1. **To establish a local team** that can work together on setting up the DHIS2. In Burkina Faso, a team of about five core people from the Ministry of Health was formed and provided hands on training by HISP team on defining metadata and setting up the DHIS2.
2. **Establish a ‘demo’ or preliminary prototype** of the application using DHIS2 as a means to develop ideas and develop shared understanding of what is to be developed and next steps. This was done by selecting few datasets; EPI; maternal health; and population. After defining the organisational unit hierarchy, the demo prototype included these three datasets and backlog data were imported into it. A few relevant indicators were defined, such as Full Immunisation and BCG coverage. Further, some shape files (maps) were imported, pivot tables set-up and linked to the database, and charts were defined on the dashboard. This simple prototype helped to concretely visualise what could be done and provide the point of departure for design discussions.
3. **Define data elements, dimensions and datasets:** Collect all data entry forms and analyse them in order to identify data elements, and also use this to understand the data flows. Here, all the existing reporting tools were collected and pasted

on the wall in order to get an overview. Then the duplicate data elements were identified made up of same data elements with different names, or appearing in different collection forms, or overlapping data element where the element was a sum of or component of other data elements. Then the heading of columns were analysed in order to see how data elements could be best named and made into categories, a process which was driven by the needs for data analysis. For instance, if the primary information needed was on disease conditions regardless of the care (OPD and IPD), then the care categories could be options of category—combination of the data element, such that Pneumonia will have two dimensions: at OPD and for IPD. Detailed information (by OPD and IPD) could be got by drilling down. The screen shot for this is given in Figure 7.3.

Here we have two data elements (Hemoculture tests done and Hemoculture test result) each having two dimensions: hospitalisé (IPD) and externé (OPD).

4. **Set-up the facility list and organisational hierarchy:** Map the country organisation unit tree to the DHIS2 hierarchy, and group the facilities. If the facility names are being imported from an existing database it is better to group them as the importing takes place. Although the system could, in theory, support unlimited levels, it is advisable not to have more than six or seven levels. When defining the organisational hierarchy, it is important that the lowest coherent level for which there is population data, should be in the tree. While organisation unit grouping is a way to represent alternative hierarchies, it is not possible to enter data for organisation unit groups, but only for individual facilities.
5. **Identify, collect and import existing electronic data from legacy systems:** In the case of Burkina Faso, an Access-based database system called RASI was previously implemented at the district level, which was reporting district aggregate data from all districts to the national level. There were also specific databases at the district level for EPI (Immunisation) and IDSR (Disease Surveillance), which were identified for importing into DHIS2.
6. **Compare 'old' data elements imported with those in the new data collection tools:** The existing datasets had been revised at the start of the DHIS2 project, making it necessary to map the old data elements to the new ones in order to enable data import. Typically, in the old datasets, data elements would be disaggregated by age while in the new forms there would be further disaggregated by age and sex. So, in our design, we would keep data elements separate, one named 'old' to store backlog data disaggregated by age and the other for the new disaggregation.
7. **Define in DHIS2 data elements from new data collection tools and group data elements:** As in the step above, it happens that when the structure of data elements is changing the old structure cannot be manipulated to meet the new structure. For example, it was not possible to map the data elements Malaria under one year (old structure) to Malaria under one year male and one year female. However, the other way, of course, is possible.
8. **Import population data:** Population data was available in Excel sheets, which could be easily imported by writing scripts.
9. **Create datasets and design of the data entry screens:** To not waste time in designing HTML layouts for the data entry screen, the paper-based layout was just copied and pasted from OpenOffice into DHIS2 data entry screen designer (Figure 7.4). And then the data elements were inserted into the layout. Some forms

**District Health Information Software 2**

**Data element management**

Filter by name:  Filter Clear Select data dictionary: [ All ] Get PDF Sort Add new

Name	Operations
Hémoculture réalisées	
Hémocultures Anormal/Positif	
Hémogrammes réalisés	
Hémogrammes réalisés anormal/positif	
Hémorragie de la délivrance HD	
Hémorragie sous conjonctivale HD	
Hémorragie sous conjonctivale NCE	
Hémorroïdes NCE	

**Data Element**

- Data Element
- Data Element Group
- Data Element Group Editor
- Data Element Group Set
- Data Element Category
- Data Element Category Combination
- Concept

**Indicator**

- Indicator
- Indicator Type
- Indicator Group
- Indicator Group Editor
- Indicator Group Set

**Data Dictionary**

- Data Dictionary

Figure 7.3 Category-combination options – screen shots

Examens réalisés au laboratoire				
Nature des examens	Hospitalisés		Externes	
	Total	Dont anormal/positif	Total	Dont anormal/positif
<b>BACTERIOLOGIE</b>				
Hémoculture	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Coproculture	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Uroculture	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
ECBU	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
LCR (cytologie ou gram)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
BK (intégrer les données du PNT)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Prélèvement vaginal	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Prélèvement urétral	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Prélèvement de pus	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Prélèvement de gorge	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Liquide d'épanchement	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Spermoculture	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
TPHA pour syphilis	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Coloration de Gram pour recherche de N Gonorrhoeae	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Liquide d'aspiration gastrique	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Autres examens	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Figure 7.4 Category-combination options – data entry screen

were very challenging because of their length had to be split into multiple forms. Particularly, the newly harmonised forms were designed like a book and not suited for an electronic data entry screen. So since the final layout was not yet validated by stakeholders, it was possible to improve the layout and even save paper.

10. **Identify and group indicators and validation rules and include them in the DHIS2:** There was a national Metadata document including indicators. Further, specific indicators were also provided by health programmes. Both indicators and validation rules were defined in the DHIS2.
11. **Create views and connect them with pivot tables:** Views are kind of pseudo tables or a way to organise presentation of data from different tables. They are what you will connect your pivot table to in the database. You have to write your own SQL queries for views. You can also use DHIS to create the views but then your query cannot exceed 255 characters.
12. **Import GIS map files (shape files) into DHIS2:** Shape files for different divisions (national, region, province, district, commune and health facilities) were imported into DHIS2 (Figure 7.5).
13. **Identify reporting needs and designing appropriate reports in DHIS2 using iReport:** Preliminary work was done in collaboration with stakeholders to identify their reporting needs. While some reports were standardised in pre-defined formats to be generated dynamically for different organisation units of different periods, for the adhoc, user driven reports, Excel pivot tables were used.
14. **Creating users and defining user roles:** The following user levels and roles were agreed, which were documented in a handbook:
  - ♦ *District health information officers:* Authorisations for data entry, run validation rules, generate reports, view GIS, add min/max values, view dataset completeness module.

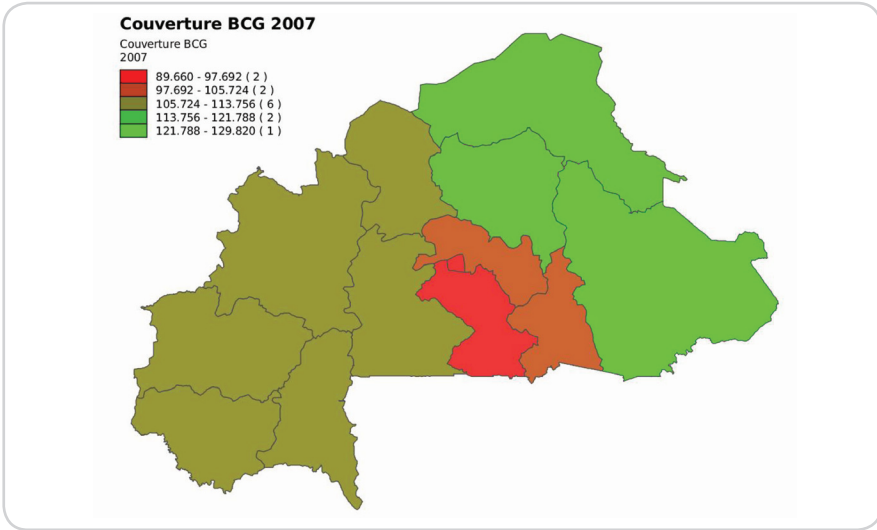


Figure 7.5 Map of regions in Burkina Faso displaying BCG coverage, for 2007

- ◆ *Regional health information officers:* Authorisations for validation rules, create or edit organisation units, generate reports, do data analysis, create users, and view GIS.
- ◆ System administrator: All rights.

15. **Implement the system and continue development and improvement in close collaboration with users:** The system after demonstrating to stakeholders was then installed on a central server for testing and validation before going to districts for roll-out (training and utilisation). This formed the basis for piloting, evaluation and further evolution of the system.

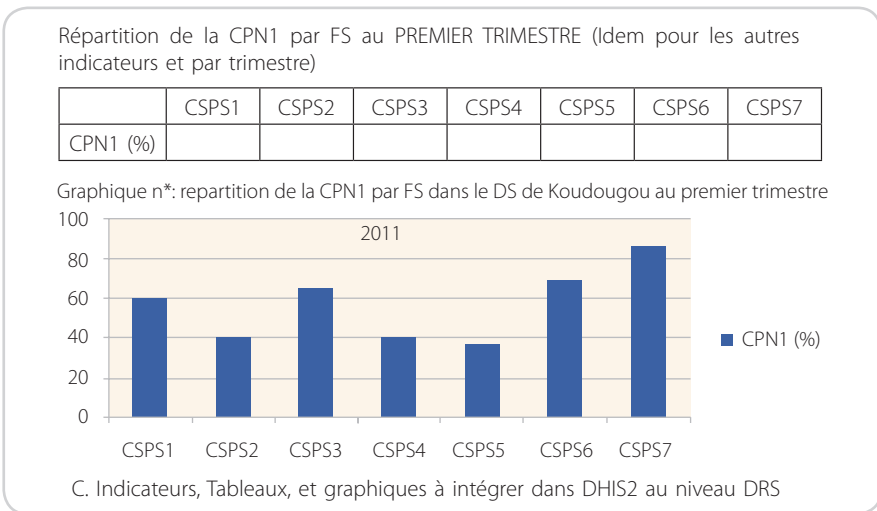


Figure 7.6 Sample report based on user requirements

## 7.2.2 The Case of Bangladesh

The Bangladesh HMIS represents a case of extreme fragmentation, where there exist for the different directorates multiple HIS involving independent platforms, software, business models, with large amounts of overlapping data and next to no transformation of data into indicators and its use. Furthermore, each system collects data from the district and Upazila (sub-district) levels through their own channels, involving different formats ranging from paper, Excel sheets, and Word documents. Once the data reaches their specific national level directorates, the multiple systems click into play. To try and address this complex situation of extreme fragmentation, the Bangladesh Ministry of Health in collaboration with international development partners launched the Health, Nutrition and Population Sector Programme (HNPS) in the year 2008. Further, the Government of Bangladesh asked GTZ, now called as GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit), to support the Ministry towards HIS strengthening. With this in mind, the GIZ launched the Data Management Information System (DMIS) project in March 2009, with the aim to strengthen information support to HNPS through more effective integration of information flows and systems using the strategy of a centrally managed composite data warehouse.

A first step in the DMIS initiative was the mapping of the disparate information flows. Initially, the focus was on the systems of the following four key stakeholders:

- Director General of Health Services (DGHS).
- Directorate General of Family Planning (DGFP).
- National Nutrition Programme (NNP).
- Second Urban Primary Health Care Project MIS (UPHCP).

The DMIS went about mapping the different information flows, understanding the varying deployment models, collecting the list of data elements being used, and also the data from the different systems were collected for the previous three years. Figure 7.7 represents the 'spaghetti' of information flows which we identified to exist in the Ministry of Health.

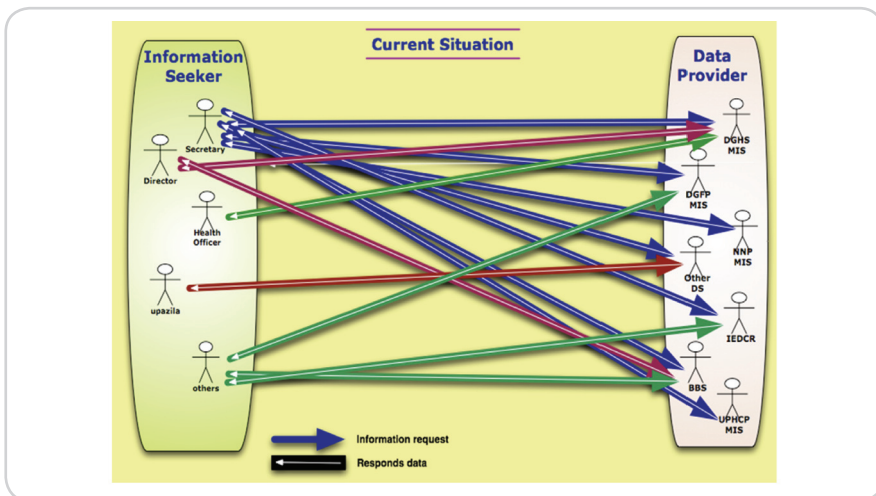


Figure 7.7 The "spaghetti" of information flows in the Ministry of Health, Bangladesh

After having conducted the situation analysis, the next step was the selection of the tool for the data warehouse. One of the options considered was the creation of an application from scratch using the skills of the overseas consultants attached to the DMIS project. However, through a coincident visit of the DMIS Team Leader to India where she saw the DHIS2 in use, they decided to use it for the DMIS data warehouse. To carry-out the required customisations, to import all the available legacy data into the DHIS2 database, and to carry-out the required training and capacity building, the DMIS contracted HISP India for required technical support. With the aim of facilitating this integrated data warehouse and also strengthening the individual systems of the directorates, an agreement was signed between GIZ and HISP India, which involved periodic visits of the technical people from HISP India to Dhaka and carrying out both the technical tasks and also training and building capacity of both the GIZ and Ministry staff.

Most of the above mentioned directorates had different data collection systems using software built from different technologies and on varying platforms. For example, DGFP had a software built using ASP.net and Oracle as the back end. It also had legacy data collected and stored in Microsoft Access. The complexity was heightened as the directorates all had different information flows and organisational unit hierarchies making it challenging to create an integrated data warehouse in which all data could be accommodated. Another of the directorates had outsourced the entire information function to a private vendor, and even had to pay for receiving their monthly reports. The plethora of platforms, software, deployment models and metadata structures, all made the data warehousing task an extremely complex one. A key aim of the DMIS was to get data from different sources into the DHIS2 database, which required firstly a detailed list of metadata concepts (organisational units, and its hierarchy, data elements and datasets) which was created in collaboration with the member of directorates through the mechanisms of workshops, and populated into the DHIS2 database. Further, a mapping of these metadata concepts was stored in an Excel sheet which provided for the linkage between the DHIS2 and the various data collection systems. Within a short period of time, over five million data values from the different legacy systems representing the different directorates was imported into the DHIS2, either using a onetime adhoc script or through the use of ETL (Extract, Transform and Load) tools. Figure 7.8 represents the linkages between the data warehouse and the different systems.

After importing data from the different sources in to DHIS2, various training programmes were conducted at the national level with district and sub-district health staff towards use of the DHIS2 and also highlighting the data quality issues and to analyse the health status at the national level. Multiple workshops were conducted involving DMIS team and representatives from the different directorates from the Ministry of Health. An example of the kinds of analysis charts that were prepared is provided in Figure 7.10.

Further, to strengthen the visualisation of data, the HISP team customised the GIS module of the DHIS2 using shape files representing the Upazila boundaries. The indicators generated from the DHIS2 could then be displayed using maps as shown in Figure 7.11.

Through these various efforts, a successful data warehouse was designed at the national level, which could be represented through the Figure 7.12.

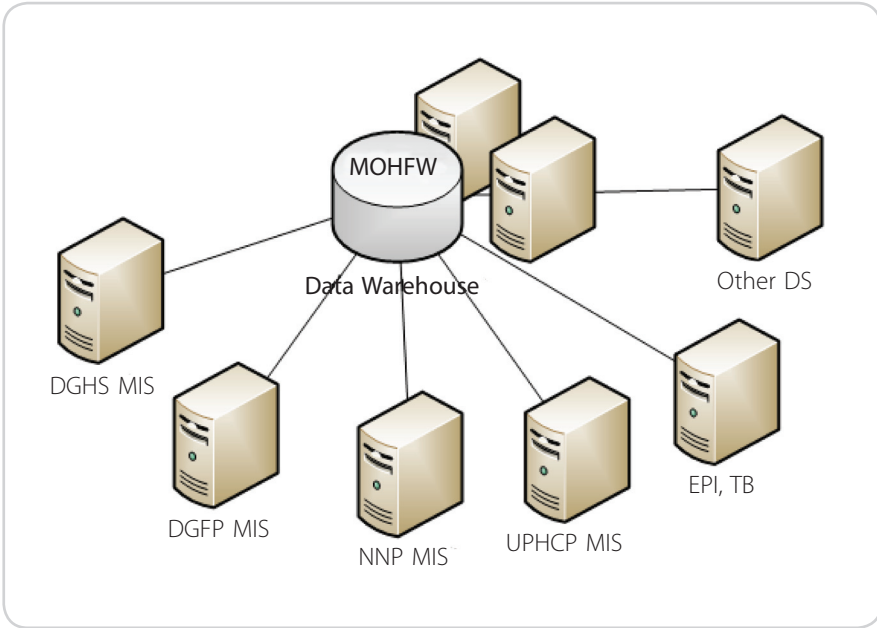


Figure 7.8 Data transferred from different data sources

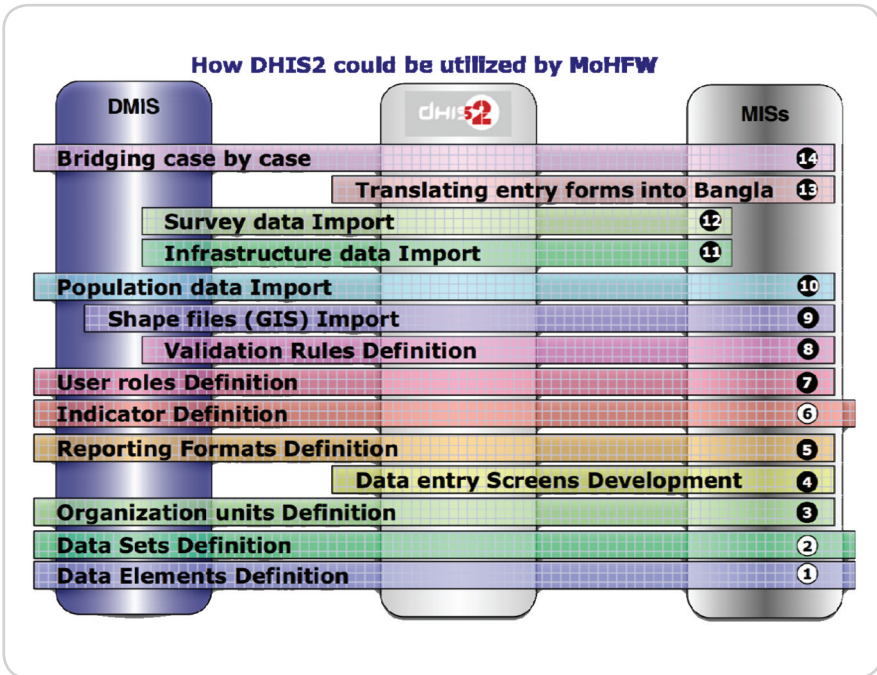


Figure 7.9 List of tasks carried out towards creation of data warehouse



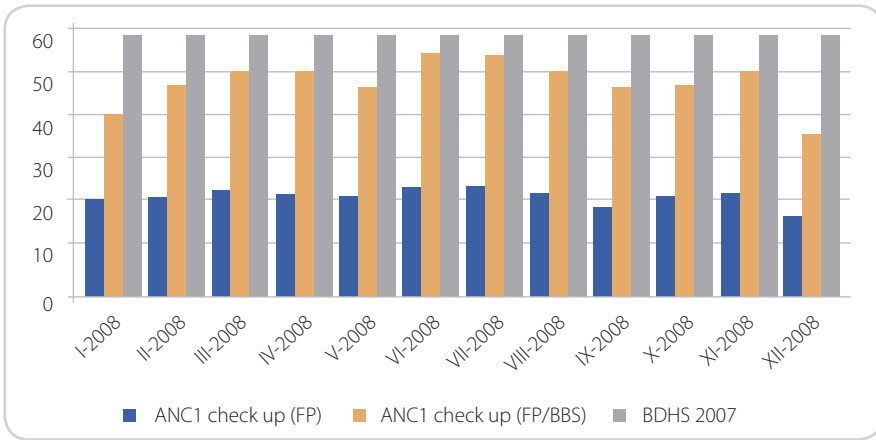


Figure 7.10 An example of data analysis using legacy ANC data

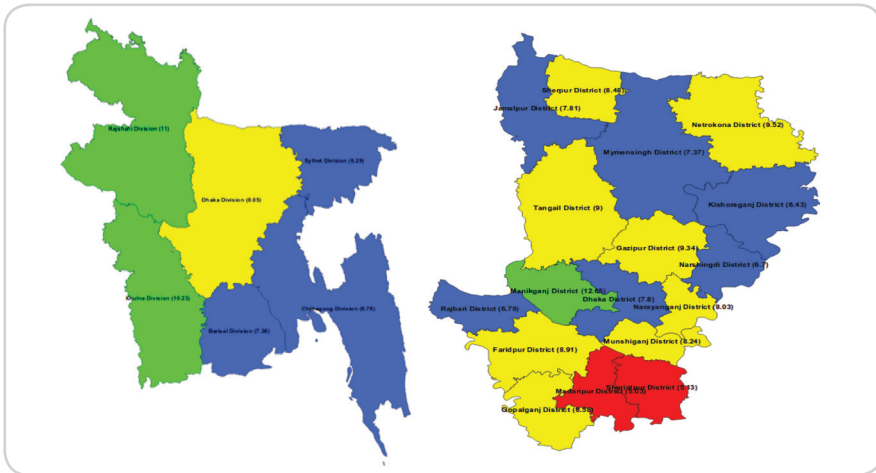


Figure 7.11 Spatial representation of Family planning rate nationally and drilled down to Dhaka Division: 2008

While arguably, a successful design prototype for the national data warehouse has been established, a number of unfinished tasks remain, if the process has to be carried on further. Some of the key tasks identified include:

- While the national level integration of the various systems has been carried out in an adhoc manner, to sustain them institutional agreements have to be reached with the different stakeholders on the overall governance model. This will include agreeing on whether these stakeholders want to continue their existing systems, or will they merge with DHIS2, and if it is the former, setting up the strategy for developing the integration bridge.
- Currently, the integration is only being done at the national level, and still processes have to be established for setting up the district level data warehouse, and establishing the mechanism of flows from there to the national level.

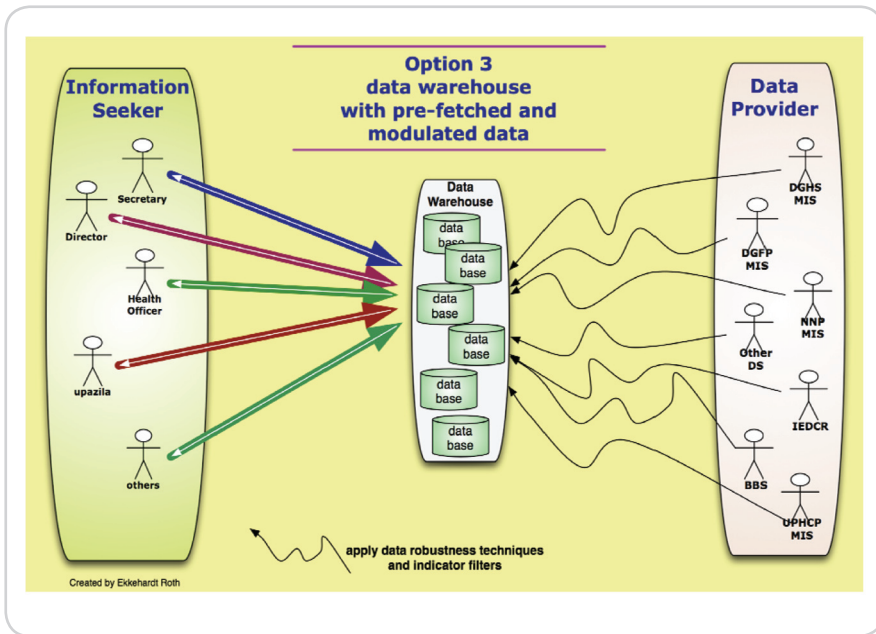


Figure 7.12 The DMIS national data warehouse based on DHIS2

- While huge amounts of data are available over the last few years, there is very limited definition of indicators and data quality rules. Institutionalised processes of rationalisation to eliminate the data redundancies and overlaps, and to define health indicators is urgently required.
- Infrastructure too must be rationalised, as currently there are multiple platforms and servers, and a data warehouse requires a uniform deployment model.

In summary, the Bangladesh example demonstrates a process of national level integration, creating results, and slowly establishing the grounds to scale downwards, and for the implementation of an integration model based on a nationally owned and institutionally agreed templates.

### 7.3 General Guidelines for Setting up and Implementing DHIS

Based on our empirical experiences in implementing DHIS over more than 20 countries, and spanning about 15 years, we have inductively created a set of 10 principles to guide the setting up and implementation of DHIS. These are discussed.

1. **Database development – data, the content, the *What?*:** When developing a new database, a natural start is to define the data elements for which to capture data, the different datasets (grouping of similar data elements) and to design the data entry forms. An important precondition to that is the establishment of a 'data dictionary' which lists out the different data elements, provides operational definitions for them, defines the primary sources of their recording and to whom they are reported and in what periodicity. Data elements, uniformly defined and

understood, will represent the core building blocks of the database and must be reasonably stable before moving to the next step. This next step would be to define validation rules based on the mentioned data elements to be able to better ensure the correctness of the data being captured. After the input part is defined, the next step is to define indicators, which are the core elements of the analysis part of the system. Definition of indicators should normally be done through an 'indicator dictionary' which includes defining the indicator, the formulae for its generation (with numerator, denominator and factors), explaining the context of its use, and describing how it should be used in conjunction with other related indicators. Later analysis tools such as reports and charts can be designed based on the indicators and the data elements that have been specified.

2. **Database development – the organisational hierarchy, the *Where?*:** Health facilities are generally the source of the data collection, and the organisational hierarchy involves locating the facilities in both geography and in the administrative structure—which facility reports to whom? In many countries, there are no strictly defined and continuously updated 'master file' for health facilities, and one of the very first steps in database development is to identify and set-up this reporting structure in the form of an organisational hierarchy. As there may not be an official standard, this process needs to include the different stakeholders as well as the district level, as they will be the ones who know the situation. Establishing this hierarchy also involves standardising the names and types of facilities, for example, in India the same facility – a PHC – maybe known by various names including New PHC, Additional PHC, and Main PHC, which makes it highly complex, for example, to aggregate data by facility types. In India, an attempt is being made to standardise this nomenclature through establishing the IPHS (Indian Public Health System) norms for different facility types in terms of what is the infrastructure they should have, and what is the level of services they are expected to provide.
3. **Import and mapping of existing databases:** Bringing in existing data to the new system adds significant value in the initial phase as it makes it a lot easier to demonstrate analysis capabilities such as the generation of charts and reports. Further, importing in of legacy data helps to make visible the existing inefficiencies in the data, such as duplications, redundancies and blanks, which helps to create an awareness of the issues, and develop the impetus for change. With this, comes the ability to convince stakeholders such as health programme managers and donors to support the new system. In most cases, there exists a large amount of electronically stored data from in-house database systems, Excel sheets or other third party systems. This data should whenever possible be imported and mapped to the data elements and the organisational units (locations/facilities) of the new system with whatever feasible technical solution – adhoc scripts or more enduring electronic bridges. However, most often, this should be regarded as a one-time job for bootstrapping the database and does not necessarily have to be an elegant and reusable method.
4. **Securing necessary resources for the implementation:** Doing a national rollout is an expensive effort, which requires generating appropriate funding for a sustained period for various aspects including the procurement of hardware, server hosting, internal and external training workshops. The funding could be retrieved from the government budget and/or with help from external donors. It is vital that even relatively small amounts needed, for instance for airtime for mobile Internet modem, are budgeted for and provided in order to avoid frustrations and

unnecessary problems for end users. While we are advocating FOSS, which avoids investing in large-scale licensing costs, it is important to budget adequate costs for software customisation and for building in-house capacity on software within the system. Often the states believe that given that it is free software, they have nothing to invest at all in this domain. This is not correct; else, they are left with no sustainable capacity in-house.

5. **Integration of parallel systems:** The typical government health domain has a lot of existing players and systems. It is acknowledged and apparent that an integrated database containing data from various sources becomes a lot more valuable and useful than fragmented and isolated ones. For instance, it improves usefulness when analysis of epidemiological data is combined with specialised HIV/AIDS, Tuberculosis, financial and human resource data, or when immunisation is combined with logistics/stock data, as it will provide a more complete picture of the situation. Second, there is typically a lot of overlapping data elements being captured by the various parallel systems. For instance, HIV/AIDS related data elements would be captured both by the general counselling and testing programmes and the specialised HIV/AIDS programme, or data elements related to malaria in pregnancy will be captured by both the reproductive health programme and the malaria programme. There are redundancies and gaps both within and across health programmes. Harmonisation of the data collection tools of such programmes will reduce the total workload of the end users, and bring in improvements in data quality. This implies that such data sources should be integrated into the national information system and also harmonised with the existing data elements, which involves both data entry and data analysis requirements and requires flexible and extensible information system software. Most importantly, to achieve this, there must be an institutional buy-in of all the relevant stakeholders based on individual discussions and negotiations. Technical and institutional integration are thus fundamental in the integration of the various parallel systems.
6. **Set-up of a reliable online national server:** As the technological development moves on, most countries will have a mobile network that provides coverage for a certain part of, if not all the districts. The use of networked based information systems accessed over the Internet (also referred to as 'cloud computing') combined with Internet modems using the mobile network is a great modern approach for rapid scaling of the systems. This assumes a reliable online server at the national level. The recommended approach is to procure such hosting services from external providers (such as Linode and Amazon) which relieves the government of providing necessary features such as back-up electricity solutions, regular data backup, server maintenance and security and reliable Internet/network access, all of which are difficult to find within the existing structure of the health system. A typical concern is policy and in-country location of the data storage but this can be mitigated with special arrangements with the provider.
7. **Pilot phasing of the initiative:** Before initiating the national system roll out, a pilot phase is required, typically for all districts in one province or region, or all facilities within a district. It is important to establish full coverage for one geographical unit so as to be able to test the overall reporting and analysis facilities of the system. The objective is to field test the application and get feedback on the system from all stakeholders. Typically, end users will provide feedback on the data entry experience, involving the data entry form designs, the usability of the data entry

functionality and design, content of reports and other analysis tools, the feasibility of doing online data entry (modem and airtime accessibility) or offline data entry (reliability of local installation). While undoubtedly, such feedback helps to improve the quality of the overall system, it also enables the creation of user ownership of the system. Typically, one will experience some resistance from end-users regarding the change from paper-based to electronic systems, for instance related to the decoupling of data entry forms and data analysis tools. Pilot testing helps to examine the feasibility of the network connectivity and the national server configuration with regard to performance and up-time.

Often, there maybe legacy systems that are running which needs to be gradually replaced with the new system. One strategy is to shut that system down in the pilot area, and replace it with the new system. If the legacy system is still in production the primary focus of the end-users will be on entering data in that system and the piloted system will get peripheral attention with sub-optimal testing and learning as a result. Further, users will be burdened if they have to enter data in two systems. If maintaining the legacy system is a priority and is non-negotiable, then the data should be transferred by the technical team from the legacy system to the new system without burdening the end-users. In this way, first the users could be exposed to the reporting and analysis functionalities of the new system, before establishing the grounds for removal of the legacy system.

- 8. Rolling out of the initiative, including review and ongoing extension:** Following a successful piloting of the system, the roll-out to the entire country needs to be planned. The roll-out process is traditionally associated with installation and basic training of the system. It is, however, useful to consider it as a more comprehensive process involving multiple phases.

*The first phase corresponds to the traditional activities where the first objective is about achieving data completeness:* To ensure that close to 100% of the data is being collected. First this implies that the system should be implemented and used in all districts and facilities in the country, and second it implies that data for all data elements included in the forms are actually reported by the districts or facilities. Another important parameter to be considered is timeliness of reporting where data is reported within the institutionally agreed time frame.

*The second objective is related to data quality:* To ensure that data capture errors are reduced to a minimum. Several measures should be affected to achieve this: First, the data entry and data review should be done by skilled personnel, typically with a public health perspective and a sound understanding of the context of data. Merely applying statistical techniques of data quality analysis without an understanding of the public health context of data, will lead to erroneous and incomplete analysis. Having said this, it is important to apply automatic data evaluation methods such as logical validation rules and outlier analysis to understand abnormalities of data, but these need to be further investigated from a public health perspective.

The second phase is about enabling district and hospital officers to use standard analysis tools such as reports, maps, charts and pivot tables. Users should be able to find (within the application) and execute those tools while being able to access data relevant to their facility or district. This must be followed by a basic understanding of the purpose, meaning and consequences of those tools and of the data being analysed.

*The third phase involves data usage:* Regular use of data analysis to improve evaluation, planning and monitoring of health activities at all levels helps provide meaning to the HIS. Data from the information system should be used to evaluate the effects of implemented measures by looking at key indicators. That learning should later be used to make informed decisions on future planning. For instance, when low immunisation rates are discovered through an immunisation report coming from the HIS, this should help to create the trigger for strengthening an outreach vaccination campaign. The effects of the campaign could then be monitored and evaluated based on up to date reports and informed decisions made on whether to intensify or wind down. Later, the system could provide information regarding what quantity of vaccine doses which must be ordered from the supplier, when, and for which facility to strengthen the overall programme. However, it must be noted that information is a necessary but not a sufficient condition to take decisions based on information. While the HIS can provide the necessary information, sufficiency of action will only come with political will, the availability of required resources to take decisions, and basic competencies of the users in analysing, interpreting and converting this understanding of information into action.

To accommodate for large-scale roll-out processes, a detailed plan is required outlining the details of training and follow-up strategy as covering all districts in a country in a phased manner with clear milestones and indicators. This represents a logistical challenge in terms of organising workshop venues, trainers, participants, equipment and hardware. To speed up the process and achieve full coverage, several training teams need to be organised to carry-out activities in parallel.

A national HIS is a growing organism, which needs to be maintained and constantly extended. As the system usage increases, more requirements and needs will emerge from new and existing stakeholders such as district record officers and health programme staff. Regular review meetings including such stakeholders should take place where data capture tools, such as data elements and forms, and data analysis tools including indicators and reports, should be revised and new tools potentially added. In addition, requirements for new functionalities should be managed and appropriate software development resources be secured. Such regular activities for supporting the extension and enhancement of the system are vital to maintain the current momentum and learning processes and to improve long-term project sustainability.

- 9. Training and capacity building:** Most of the objectives mentioned in the roll-out section depend heavily on appropriate user training. User training can be conducted in several ways. An effective activity, especially for getting started, is training workshops. Users such as district and province record officers, district managers, data entry officers and health programme managers are gathered and given training, which represents a combination of theoretical lectures and hands-on practice on relevant topics including data entry, validation, analysis and reporting functions. Participants should be kept to a manageable number depending on the facilities and number of trainers available. Sufficient hardware for all participants to do practical work must be provided.

Another useful activity is on-the-job training which has the advantage that users get individual follow-up in their home working environment. This provides the

ability to help with individual specific needs or questions and address issues related to hardware. Also, giving individual support will help boost the motivation and ownership feeling of end users.

The period between a workshop and on-the-job training can be used for home work assignments, where users typically are assigned to create meaningful analysis of their district or province. This work can then be given feedback on and used as basis for individual training, and covering the formal component of training evaluation.

- 10. Decentralisation of data capture and management:** Migrating from paper-based systems or primitive databases to full-fledged web-based HISs and from capturing district-based aggregated data to facility-based data entails new possibilities for decentralised data management, which should be exploited. Firstly, the facilities with sufficient hardware and network connectivity should be tasked with entering their own data, which would help reduce the workload of the district health records officer who might use the freed up time for data analysis, data use, feedback to facilities and improvement of data quality efforts. Secondly, maintenance of the facility hierarchy in terms of facility classification and health services provided at the facilities is a resource demanding task and should be decentralised and done as a joint effort by all district officers rather than by a single national team. This will make the facility information more correct and up to date since the district officers have better knowledge of their local situation and have incentives for proper management, as it will eventually affect their performance indicators and data completeness scores.

## 7.4 The DHIS Network as an Ecosystem of Innovation

Innovations of new technical solutions and new ways of doing things are generally seen as being generated through active use of the technologies in question. Following this line of thinking then, use of DHIS2 will generate ideas for improvements, new functionalities, modules, 'plug-ins', and so forth. However, this will not happen just like that, without cultivation. In order to *generate* innovations, we need an enabling environment, which is actively cultivating new ideas. In our context, innovation is organised around the DHIS2 platform, that is inventing new ways of applying the DHIS2 platform, using it for building new functionalities, solutions and modules, fostered through practical deployments on the ground aimed at solving practical problems such as registering a death or tracking a pregnant mother. For such innovations to be enabled and fostered optimally, that is to be taken up and given a practical 'shape', we need both an innovation enabling technical platform and a social organisation that is actively cultivating innovative processes. While the former aspect regards the DHIS2 as a platform, the latter will include the wider HISP and DHIS network of action, including users, implementers, developers, implementation nodes and so forth, which in this perspective we call an innovation ecosystem. We outline both dimensions of such an innovation-enabling environment here.

### DHIS as a Technical Platform for Innovation

For DHIS to become a global innovation engine, the following dimensions of the 'platform for innovation', are important:

## Scalability

The Internet, cloud infrastructures and mobile networks have drastically improved the scalability of the DHIS2 platform; anyone with Internet can download DHIS2 and build their own specific applications, which can then be accessed by anyone among their targeted users, as long as they have Internet access. Applying the principle of central servers, innovations in the nodes, such as new modules and functionalities, are immediately spread to all users, and, providing that innovations be included in the global core, all DHIS2 implementations globally.

## Agile and Rapid Development Cycles

We regard innovations as emanating from technological learning, which again, is catalysed through the use of technologies, and learning from trying. Innovations, that is, in our contexts, represent new ways of addressing old as well as new problems and needs, and more concretely, new modules and functionalities developed within the DHIS2 platform. 'Trial and error' is the archetypical approach to innovations. This principle is well translated to 'rapid prototyping' in the DHIS context. In order to enable innovations, what is normally regarded as product-cycles, need to be short in time, and they need to be rapid. The DHIS platform is developed and evolved in this way.

## Support and Interfaces to other Groups and Third-party Development

Ideally, local innovations in the country and other nodes should 'flow-up' directly and be included in the DHIS2 core, and thus be made available to everyone. However, as discussed earlier, to include local innovations seamlessly requires organisation and management at the levels of core developers and implementers, which is the key organisational challenge of building the DHIS innovation ecosystem. The next level in developing DHIS as a real innovation engine is to make it possible and easy for third-party development of modules that can be plugged into the DHIS. Typical use cases would be where DHIS is serving as a larger data repository and the third-party innovators are building modules that in various ways are enhancing the access, analysis and use of these data. The development of 'apps' and 'plug-ins' for Google, Firefox, Mobile telephones and so on, is the driving engine behind the Internet economy of innovation. In the case of more context sensitive application areas typically addressed by DHIS, however, these approaches of creating a 'market' where such applications would provide an economic opportunity, are of course less immediately obvious. However, the cloud infrastructure will for sure create more demands for health and other data from, for example, country data warehouses based on the DHIS2 platform, which may spur innovations by third-party developers. In order for DHIS2 to be able to tap into this potential avenue of innovations, we will need to develop a generic and easy to use web-API, that is, a way to access the data in DHIS2 by an application through the web presentation layer.

## Innovation Ecosystem

The DHIS2 innovation ecosystem is the label we give the network of action surrounding the development and implementation of the variety of instances of the DHIS2 around the world and all the developers, groups, HISP nodes, Ministries of Health, Universities, NGOs, international agencies and so forth, involved in the network. We may distinguish some key groups of actors in this set-up:



*The core DHIS2 platform developers:* The global team who are developing the software constituting the platform in close interaction with the use context through the DHIS2 implementers and designers. They are developing the innovations that are shaped as technical artifacts.

*The DHIS2 implementers and designers:* These are the facilitators and developers of the DHIS2 instances that are being implemented in countries. They are working in close cooperation with users, and they are mediating ideas and requirements for new functionalities and feedback on the software between the users and the developers. They are the innovation mediators between users and core developers. They are also innovators in terms of developing new ways of applying and using information.

*Potential and actual users of the range of information and services:* These provided by the DHIS2 are many, and they are ranging from the individual users in the field to the health managers at district and higher levels, policy makers, international organisation, to the general public. This is the both the context and driver of innovations. Innovations are generated in direct interaction with the DHIS2 platform, resulting in its further reconfiguration, extension and development. Key innovations are linked to new ways of doing things with the help of technology.

*Third party developers:* These are targeting actual and potential users and use cases as a market for their particular innovations, which may take shape as new modules or plug-ins, but also as new configurations of the platform, without new add-ons.

*Educational schemes, training and universities:* Make up the institutional glue, which enables innovations to actually materialise through the cycles of use-ideas for improvements-trial-workable module or work practice. While 'learning through use' as a first step in a process of innovation and 'conceptualising new ways of doing things' as the second, the following steps of bringing ideas all the way to technologies and implementations will require a range of skills where universities and wider training schemes are key components. Masters and PhD programmes and now also the DHIS2 academy have been important building blocks in the innovative DHIS processes since the start in the 1990's.

Figure 7.13 provides an overview of the DHIS2 innovation ecosystem.

A key challenge in the DHIS2 innovation ecosystem is to establish ways for local innovations to be spread globally by being made part of the global core, or by being compatible with the generic interfaces to the DHIS2 core. In the previous chapter, we have discussed the complicated process to organise distributed development and deployment in such a way that all the country specific branches and versions of the DHIS2 are compatible with the 'core', that is using the generic interfaces. This is needed in order to ensure that local innovations are becoming part of the global core and thereby are shared by all nodes in the system. Innovations may become part of the core through simple inclusion, in the cases where the module is developed as being compatible with both the global core code base (using standard interfaces) and the DHIS2 coding standards. If this is not the case, the essence of the local innovation will be included through redevelopment, as was the case with the Indian Dashboard. Ideally, therefore, the more synchronised the local module development is with the global core development, the better, that is, the less resources it takes to make it part of the global core.

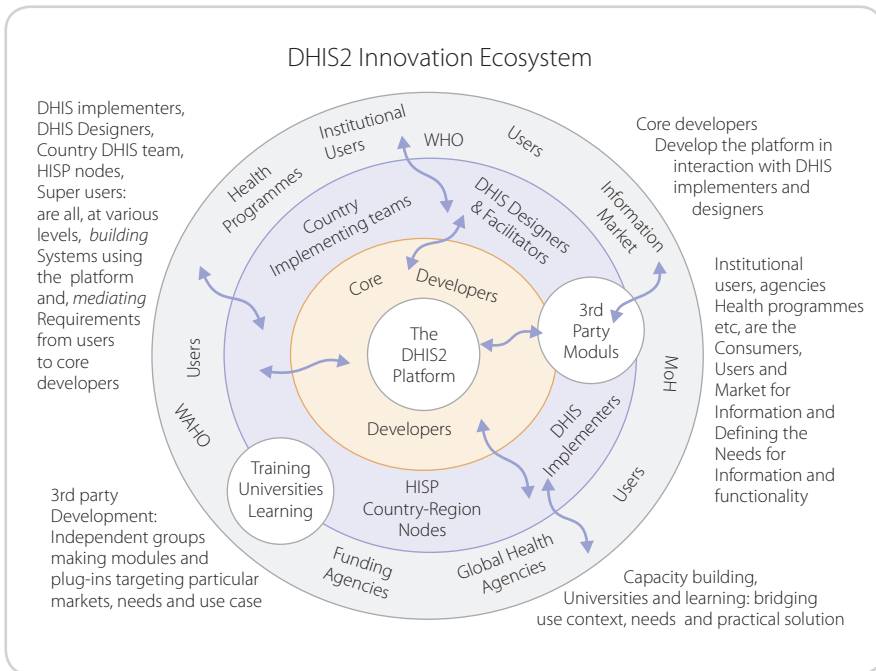


Figure 7.13 The DHIS innovation ecosystem

The DHIS community; the country DHIS and HISP teams and nodes and what we label DHIS implementers and designers are the key actors in making the complicated DHIS innovation system evolve. We have seen how important these DHIS activists and their 'circulation' between countries and between 'nodes' are for the working of the DHIS innovation system. They are mediating requirements and innovative new ways of doing things between the users communities and the DHIS developers. The key challenge is to 'innovate' ways to institutionalise this circulation of people, ideas and new practices within and around the DHIS community, and to constantly extend this community. Practical institutional ways of organising the DHIS community are through the DHIS2 academy, that is, regionally organised and providing advanced training in design and implementation of DHIS2, and by organising developers and implementers workshops. In addition to institutionalising the face-to-face meetings and physical circulation of people, the electronic communities like the DHIS2 developers and DHIS2 users email lists are important.

To sum up, key aspects of the DHIS2 innovation ecosystem are:

- Generate innovations through local use and global cooperation: To ensure rapid product cycles between local innovations and global inclusion or redevelopment as part of the core DHIS product. This will rely on effective mediation by DHIS implementers and designers between users and uses cases and core developers.
- Share local innovations globally through the DHIS network of action: This will rely upon the circulation of people, ideas and best practices between countries and nodes in the network.

### Summary

1. There are at least three approaches to data standardisation that have been empirically carried out by the HISP team globally:
  - a. All data in one bucket – “heterogeneous database”.
  - b. Minimum dataset.
  - c. Maximum dataset.
2. The specific approach selected in a country will be context specific depending on the infrastructure available, the tools they support, political will and the legacy systems in play.
3. Setting up DHIS2 in a new context will involve a series of inter-connected steps, including:
  - a. Establishing local team from the Ministry of Health.
  - b. Creating a demo prototype.
  - c. Defining the “what” – data elements and their dimensions.
  - d. Defining the “where” – the organisational unit hierarchy.
  - e. Importing data required from legacy systems, and carrying out their integration with DHIS2.
  - f. Mapping out the “old” and “new” data elements and carrying out their harmonisation.
  - g. Creating data collection tools based on logical grouping.
  - h. Importing population and other baseline data and indicators.
  - i. Designing datasets and data entry screens.
  - j. Identifying and defining groups and indicators.
  - k. Creating views and connecting to pivot tables.
  - l. Integrating the shape files in the GIS module.
  - m. Designing and developing reports.
  - n. Creating user roles and authorisations.
  - o. Implementation in a phased manner starting with a pilot and incrementally scaling systems.
4. DHIS as a global innovation engine is based on the following principles:
  - a. Designing for scalability.
  - b. Development based on agile and rapid prototyping cycles.
  - c. Supporting the integration to third party developers.
  - d. Creation of an innovation ecosystem.

# 8

## Building Capacity – The Power of Networks

Capacity refers to the ability to realise a certain potential to do something purposeful. Building capacity then involves addressing at least three key set of questions.

- What is the task or problem at hand, which we wish the capacity to address?
- What is the potential that is available to us?
- How best can this potential be nurtured or cultivated so that it can be made equal to addressing the problem at hand.

These are discussed.

### 8.1 Developing Human and Institutional Capacity in the Area of Health Information Systems

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Sustainable development relies on the nurturing of human and institutional capacity. It is necessary to radically increase the number of health personnel with skills in information system design and use *and* in the number of IT professionals with knowledge of health issues. Broader educational programmes for building national capacity and changing organisational culture need to be developed in order to enhance and sustain HISs and to ensure national/local control over the process. Key issues are:

- Develop a training scheme for health workers and managers. Decentralised district based systems for information handling implies that a large number of health workers and managers from all health facilities and district and higher level offices need to be trained in basic information handling, analysis and use.
- Include courses in health information in the curriculum at nursing colleges, medical schools and informatics departments. These courses need to be contextualised and made locally relevant by basing them on local data and case studies.
- Masters Programmes as an institutional base for wider educational programmes. In South Africa, for example, a training scheme of short courses ranging from basic to the advanced subjects on HIS is based at the Masters Programme in Public Health at the University of the Western Cape. Many thousands of health workers have attended these courses since they started in the late nineties. This university based institutional framework is appropriate for several reasons:

- ◆ Developing a sustainable institutional base for the training scheme as well as a centre of 'excellence' in health information.
- ◆ Providing participants with university certified courses and the opportunity to work towards a full Masters, thus providing incentives for continuous education.
- ◆ Offering Certificate, Diploma, Masters, and PhD courses in HIS to students and in-service staff. Such courses would normally benefit from international collaboration (south–south or south–north).
- Collaboration between informatics departments and medical schools on Masters courses on health information. Health professionals need to learn about information systems development as systems developers need to learn about health. Shared courses between the two disciplines are an obvious way to optimise the use of resources and include the best from both worlds.

In order for countries to be able to be on top of the technological development over time, university-based capacity building through Masters programmes integrating the academic disciplines of 'general' information systems and Public Health into a 'Health Information Systems' programme are important. In the following section, we describe such a Masters programme which is part of the global HISP-network.

## 8.2 Integrated Masters, PhD and Action Research

Within the public health domain, the following areas of skills and competencies will be needed, as applied within the same three level framework of architecture that was described earlier:

*Social system level:* This is the health system domain with the needed areas of competencies that range from knowledge of data flows and routines to epidemiological knowledge combined with knowledge of health services delivery and health management and the use of information to support these processes and functions. This is a wide area and ranges from the local level of primary health care delivery, to facility management, district and programme management to policy making. This involves specifying 'information for action', both in terms of targets for action and how achievements maybe measured by indicators, and their definition.

*Application level:* This is where the applications are being customised to the needs of the local context and represents the area where the health domain knowledge is translated into concrete specifications. Defining indicators, evaluation rules, and reporting functionalities in the DHIS2 illustrates how domain knowledge and informatics skills are both needed and complement each other.

*Data layer:* This is the level of data standardisation; from developing national and province level indicators and datasets to their maintenance and expansion over time. Other important systems of data standards and related skills needed includes knowledge about the ICD10, classification of diseases, and other systems of appropriate classification in third world contexts, where diagnostic capacity maybe very poor, and time not available given the large number of patients to be attended to.

The complementary combination of the two academic and professional domains of public health and information systems, or informatics, are obviously needed for the successful development of HIS, but not easy to achieve. The developing world is full

of examples where informatics specialists have developed inappropriate systems that are not responding to user needs and that are outdated and not running because the 'consultant left'. Furthermore, the plethora of in-house developed systems, typically in Excel, only adding to fragmentation and poor data management, represent the other side of the typical situation emphasising that informatics competencies are needed to complement medical and public health ones in order to design and develop effective systems.

The University of Oslo initiated an integrated Masters Programme in Mozambique in 2000 and which has since spread to other countries as part of the HISP network. This programme provides a vehicle for practical operationalisation of integration of the disciplines of informatics and public health. At the Eduardo Mondlane University in Mozambique, two Masters programmes in health informatics were started; one as part of the public health programme in the Medical Faculty, and one as part of the informatics department in the Faculty of Science (Figure 8.1). The two Masters had some courses specialising their 'own' students, and a general introduction course for the 'other' students, and a shared core module for students from informatics and health worked together. Research and theses writing were also carried out with the two groups working together.

These integrated Masters programmes were based on the following pedagogical and developmental principles:

- Engage students in local practical development to ensure both the local relevance of education and research as well as contributing to local systems development.
- Establish synergetic collaboration between the academic disciplines of informatics and public health to ensure that the informatics students learn about the health domain and how IT could be applied there and vice versa.
- Establish collaboration with the Ministry of Health, both for education and applied research; Ministry of Health staff taking part in teaching, and staff from the Ministry of Health also being enrolled as students, and student research projects being designed as to support Ministry of Health by developing HIS in pilot provinces contributing to the larger national strategy.

Who is going to run and sustain the Masters programmes? In order to respond to this developmental question, a PhD programme was established in Mozambique together with the Masters programmes. Six staff members from the UEM University were enrolled as PhD students at the University of Oslo in a 'sandwich' mode, meaning that they carried out their research in Mozambique while also helping to supervise the Masters students, while taking courses and attending their PhD related seminars in Oslo.

The model is described schematically in Figure 8.1.

Since the start in Mozambique, over the last 10 to 12 years, the University of Oslo in collaboration with respective national universities have established in-country Masters programmes including in South Africa, Malawi, Tanzania, Ethiopia, Sri Lanka, and Bangladesh. With funding and scholarship support from the Norwegian government, and in some cases supplemented with national funding, more than 500 students to date have been awarded such Masters degrees, many of whom have gone on to register for doctoral programmes at Oslo. Till date, about 25 such PhD students

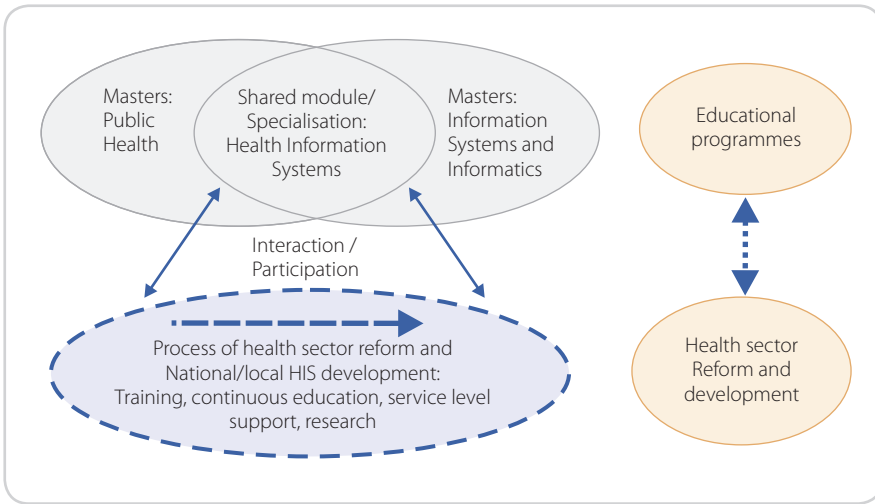


Figure 8.1 The integrated Masters programme model

have graduated, and about 40 are in process at various stages of their research. Both the research and Masters students have also actively contributed to the teaching of the Masters programmes and also for the in-service courses in different countries. Since individual students come from countries where such HIS reform initiatives are ongoing, this model has contributed to the development of sustainable capacity at the institutional levels within the Ministry Departments of Health and also the Faculties of Public Health and Informatics of the national universities.

Public health informatics necessarily requires the understanding of issues of IT including the software applications. Often health informatics is taught in a kind of vacuum without a concrete grounding in the software being used, and students end-up with limited practical understanding of issues around the design, development, customisation and use of the software. An important aspect of the Oslo model is the use of the DHIS2 for providing students with grounding in software and related issues. Further, since the software is actually being used by many partnering governments; for example, in Tanzania, Vietnam and Malawi, students from these countries actually get the opportunity to address software issues in their context.

A crucial part of this model is the link of both the Masters and Doctoral programmes with action research. The University of Oslo, together with their partners, have initiated HISP as an action research network which has been engaged over the last 15 years in addressing HIS design, development and implementation issues across various countries in the South. Within the framework of this network, Masters and Doctoral students undertake the thesis component of their studies in actually solving real problems that the health systems in their home countries are experiencing. This work takes place in a framework of formalised collaboration between the universities with the Ministries of Health at the national and state levels. For example, some of the research topics have included building sustainable systems in Tanzania, or Strategies for integration in Ethiopia, and the building of a hybrid knowledge framework in India. Action research seeks to solve practical problems, thus enhancing the motivation

of the health department to participate. Further, publications emanating from the research help to create visibility of efforts and contribute to the knowledge pool. The collaborative and networked model creates understandings of best and worst practices from other contexts, and how these can be adopted or avoided in their respective settings.

The broader HISP ‘network of action’ is schematically described in Figure 8.2.

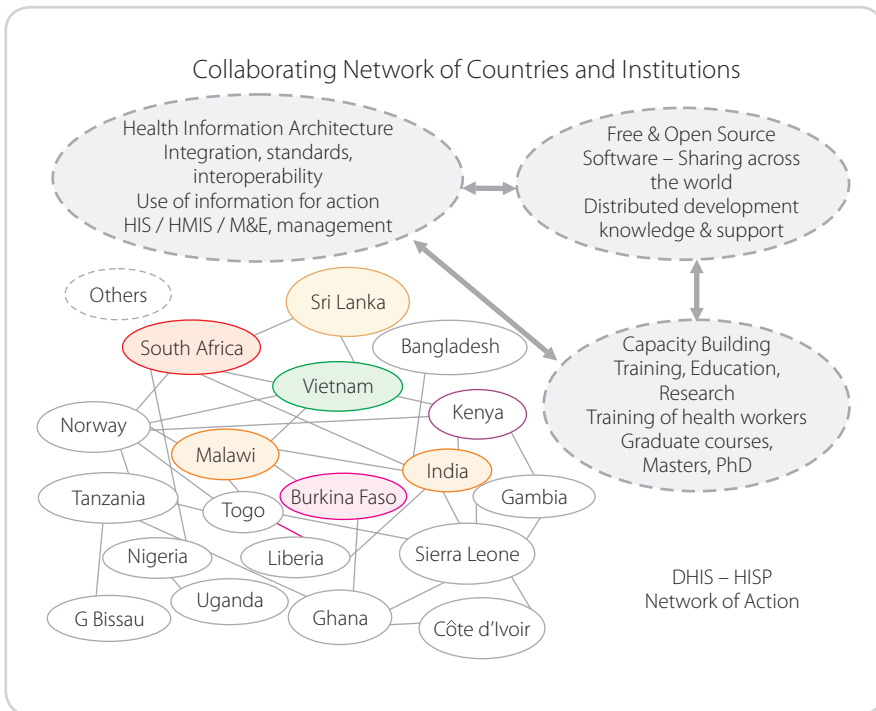


Figure 8.2 The HISP network of action

### 8.3 Training Health Workers and Managers – What is the Task or Problem at Hand?

Broadly defined, the identified key problem at hand is to make HIS more effective and public health friendly wherein they are useful both at the institutional and individual levels. While useful may mean different things for different people, in our context, the critical criterion is the capability to effectively use the data being generated from the system to address critical public health problems. It is the *usability* and *usefulness* of the system, which is of critical importance, and capacities of the users need to be developed keeping these normative aims in mind.

For example, a health problem facing a particular district is the increasing number of maternal deaths from its catchment area. To address this problem, the medical officers and district administrators require effective information support through the HIS. This includes information on the geographical spread of pregnant women in the



catchment area, the prevalence of Anaemia amongst this group of pregnant women, the availability of trained Skilled Birth Attendants (SBA) capable of providing outreach services, the availability of facilities in the catchment area that are capable of providing Basic Emergency Obstetric Care (BEmOC) services, and the availability of referral transport to move women in times of emergency to the nearest facility equipped to provide care. For this information to be provided and also used by managers to take action, we need:

- A well-designed HIS that has in its data warehouse data from different sources of services (of pregnancies), infrastructure (on BEmOC compliant facilities), human resources (SBA trained staff), GIS maps (that show distribution of villages and nearest facilities) – and tools to conduct effective analysis of cross cutting indicators.
- Decision-makers who have the capability to analyse, interpret and use this processed information (shown as indicators) for making decisions, such as related to how to strengthen training of SBAs or improving the coverage of Anaemia care.
- An organisation which is committed to use the health information and promote the practice of evidence-based decision-making by investing necessary resources (time, money and encouragement) and creating the enabling infrastructure.

Building capacity to achieve these above aims represents a complex socio-technical challenge, which often cannot be dealt with a simple 2–3 days training programme, but requires multiple and ongoing interventions geared towards creating long-term sustainability. These interventions need to be geared towards building at least the following set of skills:

*Technical:* Concerning the design of appropriate infrastructure, system, usability skills of users, and higher order competencies of application customisation.

*Public health:* To support the creation of a culture of information use for local action, health programme domain knowledge to help identify information needs, hard skills around analysis and use of information, report writing, dissemination and feedback of analysis.

*Political advocacy:* To help promote the message around the utility of HIS, being able to defend the value of routine information against competing information sources (such as surveys), to argue the value of evidence-based decision-making; and, to secure more resources to support activities.

*Implementation:* To understand issues of design and the redesign of workflow and related practices around information use to enable their local institutionalisation.

Particular individuals will not have all competencies, but will need to develop particular skill sets, which could then feed into a collective resource pool. The capacity building challenge then becomes to identify the different capacities to be developed for varying user groups, and the process by which they can be synergistically leveraged.

## 8.4 What is the Potential Available?

A common fallacy in designing building capacity programmes is to assume that there is limited or no potential available in the existing system or worse still that what

exists is counterproductive to the task of introducing a new HIS. A consequence of this assumption amongst donor agencies and also national ministries is to then plan for the injection of expatriates, external consultants and short-term experts to try and build required capacity from scratch. Histories of such attempts have resulted in complete or partial failures. Most external injections, when only external, tend to be unsustainable, remaining confined to the status of pilots as the experts supporting it will tend to lack a sensitive understanding of the local context, and the resulting systems will tend to be inadequate to be scaled.

A study of HIS implementation in Mozambique provides a pertinent example of the potential which is inherent in the system, but which often is ignored. The field nurses in a district were being trained to use a particular HIS, and the implementing agency was finding limited success in their efforts. A deeper examination of the problem helped to identify that the trainers assumed that nurses had no computer related skills, and thus required a week long all day training session on computer basics. This assumption and plan ignored the existing context where the nurses had a heavy workload of seeing about 200 outpatients daily, in addition to carrying out various administrative tasks such as collecting salaries and drugs from the district office and also making home visits. Since the training was organised in a separate room, the nurses were pulled out of the context of their everyday tasks, such as dealing with an emergency patient or for dispensing drugs. Frequent disruptions in the training schedule led the trainers to conclude that the nurses were not serious about being trained, and so were unable to learn to use the system. On a suggestion from a researcher, the training venue was subsequently shifted to the office of the nurses to allow them to participate in the training while simultaneously tending to their regular work. Given their high level of multi-tasking competencies, the nurses could get reasonably trained on the system while also ensuring other work did not come to a grinding halt. The important point here is that there was significant multi-tasking potential available in the existing staff and system, which had enabled work to go on for years despite the extremely poor infrastructure, resources and high workloads. For example, even in India, the field nurses (ANMs) ensure that tens of reports flow every month while catering to the care needs (outreach, awareness and clinical) of the villages under their jurisdiction and also to various administrative tasks demanded of them. In being able to historically deal with these complex conditions, and find solutions to problems on hand in innovative and opportunistic ways, a rich potential is created in the system that needs to be sensitively understood and tapped into to support the HIS efforts. Alas, that is rarely ever done, and this local knowledge most often ignored or even dismissed as being irrational to the computerisation efforts. It is important to turn such thinking on its head, and understand how such systemic potential can be leveraged and nurtured for the larger support of the HIS.

In the Box 8.1, we provide an example from Kerala, India, to describe the positive results of the state decision to cultivate the skills of the complete staff base.

Similarly, the institutional level also carries latent potential in the collective through the simple fact of having historically being engaged in solving everyday problems, and ensuring the show always goes on. Going back to the Mozambique example, it was found that in a health facility that the printers rarely worked and repeated requests by the staff to the superiors had not led to a solution. Despite this, superiors kept demanding for printed reports. To deal with this situation, the nurses who had friends in a nearby Missionary facility that was externally funded with better

## Box 8.1

## Tapping the potential of field nurses: Example from Kerala

HISP India has been engaged since 2005 in implementing DHIS2 in the health facilities and carrying out training of the staff at different levels on various facets of HMIS, including data entry, report generation, data quality analysis, health status analysis, and on how HMIS processes can be institutionalised.

The state of Kerala historically has one of the most well developed health indicators in the country, comparing even with the best in the developed world. The state is famous for its high levels of literacy including of the women force in the state. The state also has a history of a strong left movement which has contributed to creating significantly mature (as compared to other states in the country) processes of decentralisation and unification, including of their HISs. A consequence of this strong culture of decentralisation has been the decision by the state to have computers placed at the level of individual PHCs which contrasts with the other states in the country where computerisation is at the level of the Block, which is a sub-district unit at a level higher than the individual facility.

In 2008, the state signed a Memorandum of Understanding (MOU) with HISP India to provide HMIS technical support including capacity building of more than 12000 health staff in the state. A significant and influential decision of the state was that data entry would be done by the field nurses rather than by external data entry operators. Consequently, all nurses were trained on HMIS. This had a positive influence on the quality of data being reported as the field nurses knew intimately the context of data and were able to spot data entry errors based on their field experience and local knowledge. In absence of such contextualised knowledge, external data entry operators make common mistakes in entering data. For example, against 'Number of Polio cases', in some states the figures were reported in thousands even though Polio had already been eradicated or at worst reported a few isolated cases. Persons with knowledge of the health domain, like field nurses, would be far less likely to make such mistakes.

Today Kerala has one of the most mature and decentralised HMIS in the country, with well-institutionalised processes of local level data analysis for both quality and health status.

infrastructure, would use their goodwill to get print outs when needed. Similarly, the non-availability of an ambulance was often met by borrowing a car from the community on a voluntary basis to transport a patient in need of emergency care. The institutional potential identified here was of the ability to draw upon resources from the community networks to cope with resource constrained settings of the health system. These networks if sensitively nurtured could no doubt also support HIS implementation. Both at individual and institutional levels, there is historically existing potential available which needs to be recognised and celebrated, and not dismissed as is often the case.

The metaphor of cultivation helps to understand and discuss how a system evolves over time. The metaphor used in the domain of capacity helps to emphasise the inherent potential of existing legacies, which needs to be provided with enabling conditions to blossom and grow. A seed planted in the soil requires to be nurtured through fertilisers, sunlight, water, and the removal of weeds. This nurturing takes place over time and varies at different stages of the process and the process itself varies for

different seeds. This approach acknowledges the existing installed base, for example, the nature of soil and its cropping capacity, which needs to be considered and taken account of accordingly, and is not something which can be done away to start from scratch. The network approach helps to understand how to cultivate capacity, as different resources required for this could be obtained from varying sources, of those who know that best.

## 8.5 How Can the Potential be Cultivated? – The Power of Networks

A network, in contrast to a hierarchy which is defined in terms of hierarchical relationships, in general terms refers to different people or institutions linked together with respect to specific activities or tasks – a purpose. For example, the Facebook represents a social network enabling social relationships using the medium of the Internet. We discuss here how a network; electronic but also physical, can be mobilised to support capacity development activities around the HIS. Specifically, we discuss ‘a collaborative network of action’ aimed at creating collaborative and co-operative linkages through specific action around HIS development and implementation.

HISP has, over the last 15 years, evolved as a network spanning multiple countries and also creating linkages across various kinds of activities ranging from software development, capacity building, research and education. Collaborative networks, it has been argued by HISP researchers, are a powerful means of addressing the challenges of sustainability and scalability facing HISs in the South. Sustainability involves making a HIS work, in practice, over time, in a local setting. This involves shaping and adapting the systems to a given context, cultivating local learning processes, and institutionalising routines of use that persists over time as well as when the external support agencies go away and funding dries up. Scalability concerns the challenge of how to make one working solution spread to other sites, and be successfully adapted there. Scaling involves not only the spreading of technical systems, but also the necessary *learning* processes which involves questions of who learns what, and through what mechanisms, in order for the HIS to scale to new settings. Capacity development thus becomes crucial and a fundamental process to inculcate and strengthen such learning and go towards addressing pressing challenges of scale and sustainability.

Capacity development through networks has the strength of providing the possibility of learning in a collective which is more effective than doing so in singular units. A pilot will remain a pilot and not scale if the learning from that pilot is not linked to other facilities, systems, people and institutions to which it needs to scale. And only when these inter-linkages are created, will a critical mass of interested people be mobilised to take ownership of the system and in the longer run enable its sustainability. Networking not only enables the creation of this critical mass, but more importantly helps the collective to learn to work together, share learning and with this make the network more robust. A key principle underlying networks is that more are the positive linkages, the more robust the network will be. Alignment is a relative measure of the extent to which the agendas and interests inscribed into the practices, institutions, and strategies of the network pull in the same direction, and serve the same purpose. A high degree of alignment is accordingly a characteristic for robust and enduring network.

Networks are never apolitical, and there are always negotiations around who gets included and who does not. Care must be taken to ensure that some actors in the network do not get marginalised for technological or institutional reasons, and they have the space and legitimacy to make their voices heard. In the absence of a hierarchy, interests have to be translated, based on an understanding and ongoing negotiations. Interests have to be enrolled in a manner that others identify with the initiative, while having the freedom to incorporate their knowledge and experience in shaping the initiative. Further, it is not necessary that all initiatives need to start at the centre, and may very well originate from other levels and sources, including from the periphery. In fact, these are the kinds of innovations that a network like HISP seeks to inspire. Such an approach of translation lies in contrast to that of 'technology transfer' where initiatives start from the 'top' and 'centre' without adequately considering the needs and interests of the others, especially in the periphery. Metaphors used to describe this process have included 'parachuting' and 'design from nowhere,' which often ends-up with the following implications:

- The centre does not have an adequate understanding of the conditions and needs of the peripheries – so, poorly designed systems.
- One shoe does not fit all, so initiatives always require a degree of sensitive customisation to fit into varying contexts.
- The periphery tends to dismiss these 'instructions from the top,' as they are seen as 'yet another one.'
- Local knowledge and experience tend to get marginalised, and even worse dismissed as irrational and counterproductive to the proposed initiative.

A translation approach acknowledges that change takes place in small steps, and each step requires work such as creating buy-ins and adaptations of the technology to suit the new context. At each stage of this translation, the technology may get modified, new networks get created, and with it new forms of knowledge get infused in the collective. Translation also is a dialectical process, with every step of change, something of the old, and maybe also desirable, is lost as something new is added. Translations necessarily are more effectively done in a networked model, as it involves a process of give and take and mutual learning which runs counter to the principles of functioning of a hierarchy which believes in a 'top to down' flow. In the context of HIS implementation efforts, which necessarily require that technologies and processes be sensitively and artfully integrated into different contexts and ways of working, arguably a hierarchy based model is not effective. While this model maybe useful in starting pilots, they are not so in the scaling and sustaining of efforts where the local must necessarily take ownership of efforts.

Having discussed the effectiveness of a networked approach (over one of hierarchy) with respect to HIS, some concrete examples are discussed to understand the role of networks in fostering and nurturing capacity development.

## 8.6 Networks in Public Health Informatics

A network consists of inter-connected *nodes*, where each node is engaged in their specific individual activities around HIS, while simultaneously having *network linkages* with other nodes, collaborating on mutually agreed activities. Some nodes may serve as regional or global *hubs* playing a co-ordinating function, while other nodes could play *supporting roles* for specific activities. The HISP network is now concretely discussed.

### 8.6.1 A Global Network – HISP

HISP is an example of a global network which includes different kinds of entities:

- Universities and their Departments of Informatics and Public Health.
- Ministries of Health at the national and state or province levels.
- Users of the HIS at different levels.
- International agencies like the WHO, Health Metrics Network and NORAD.
- Local implementing agencies in various countries like HISP India and HISP South Africa, and their local partners.
- Software development groups around DHIS2, and also other open source communities such as around OpenMRS and iHRIS.
- Other NGOs, friends and well-wishers.

Table 8.1 summarises these different nodes and their roles in the network.

<i>Entity</i>	<i>Status in network</i>	<i>Key roles played</i>	<i>Network linkages</i>
University of Oslo	Global hub	<ul style="list-style-type: none"> <li>• Manage core DHIS2 development and maintain software repository.</li> <li>• Conduct Doctoral and Masters programmes in HIS, where students from partnering countries enroll.</li> <li>• Obtain funding through scholarships, university research grants, commissioned research.</li> <li>• Define formal MoUs with WHO, HMN, National Ministries, and other partners.</li> </ul>	<ul style="list-style-type: none"> <li>• With WHO and HMN engaged in development of Public Health Information Toolkit, and its implementation in Sierra Leone.</li> <li>• MoUs with universities for running Masters programmes and student support for PhD.</li> <li>• Running courses in HIS.</li> </ul>
African country partners	Nodes with South Africa as a regional hub	<ul style="list-style-type: none"> <li>• In country implementation of DHIS.</li> <li>• Universities running Masters programmes and in-service courses.</li> </ul>	<ul style="list-style-type: none"> <li>• Within country between Ministry, State, University and other agencies.</li> <li>• With University of Oslo.</li> <li>• Externally, with other countries for sharing software development and training material.</li> </ul>
Asian country partners	Nodes, with India as a regional hub	<ul style="list-style-type: none"> <li>• In country implementation of DHIS.</li> <li>• Universities running Masters programmes and in-service courses.</li> </ul>	<ul style="list-style-type: none"> <li>• Within country between Ministry, State, University and other agencies.</li> <li>• With University of Oslo.</li> <li>• Externally, with other countries for sharing software development and training material.</li> </ul>

WHO, HMN and other international agencies like NORAD in Norway and the EU	Supporting role	<ul style="list-style-type: none"> <li>• Creating global standards around HIS in which DHIS is a key component.</li> <li>• Funding support.</li> <li>• Creating international legitimacy.</li> </ul>	<ul style="list-style-type: none"> <li>• Creating MoU with Oslo.</li> <li>• Funding research and scholarships at Oslo.</li> <li>• Presenting DHIS and HISP to national ministries.</li> </ul>
Other open source software development groups	Collaborators	<ul style="list-style-type: none"> <li>• Carrying out collaborative software development.</li> <li>• Sharing of software code.</li> <li>• Working in the WHO framework for the development of the Public Health Information Toolkit.</li> <li>• Collaborations on research paper writing.</li> </ul>	<ul style="list-style-type: none"> <li>• Linkage with development groups.</li> <li>• Collaborative groups linked with WHO.</li> </ul>

Notes

1. African partners include South Africa, Tanzania, Ethiopia, Nigeria, Liberia, Botswana, Gambia, Mozambique, Malawi, Sierra Leone, Mali, Namibia, Togo, Ivory Coast, and Bukina Faso. South Africa plays the role of a regional hub, for example, responsible to provide technical support to Nigeria, Namibia and Liberia.
2. Asian partners include India, Tajikistan, Bangladesh, Vietnam and Sri Lanka. In Asia, India is growing into the role of a regional hub providing technical support to Bangladesh and Sri Lanka.
3. Currently, there are two main open source software groups that HISP is collaborating with:
  - OpenMRS for the development of patient-based system.
  - iHRIS for the development of human resources for health system.

Given this structure of the HISP network, the various forms of *collaborative action* aimed at capacity development within and between network nodes are:

- Developing and sharing software.
- Promoting the use of information for action.
- Conducting research, education and training.
- Creation of training and other resource materials.
- Fund raising.
- Carrying out political advocacy.

Table 8.2 elaborates on the above actions and benefits to the network.

Collaborative action	Details of action	Translations involved	Benefits of action to network partners
Software development & its sharing	<ul style="list-style-type: none"> <li>• Architecture design.</li> <li>• Software development.</li> <li>• Maintaining core repository.</li> <li>• Responding to enhancement requests.</li> <li>• Collaborating with other partners.</li> </ul>	<ul style="list-style-type: none"> <li>• Conducting courses.</li> <li>• Conducting developer workshops and seminars.</li> <li>• Encouraging partner countries to participate in core development.</li> <li>• Decentralising development responsibilities.</li> </ul>	<ul style="list-style-type: none"> <li>• Enhanced software development expertise and confidence.</li> <li>• Functional products made available.</li> <li>• Detailed documentation made available.</li> <li>• Collaborations lead to other benefits, such as new opportunities for development.</li> </ul>

Promoting use of information for action	<ul style="list-style-type: none"> <li>• Development of analysis skills.</li> <li>• Creation of manuals and other resources.</li> <li>• Responding to analysis requests.</li> <li>• Collaboration with other partners.</li> </ul>	<ul style="list-style-type: none"> <li>• Conducting courses.</li> <li>• Carrying out research and its supervision.</li> <li>• Conducting workshops and seminars.</li> <li>• Encouraging partner countries to participate in core development.</li> <li>• Decentralising software development responsibilities.</li> </ul>	<ul style="list-style-type: none"> <li>• Enhanced public health analysis skills.</li> <li>• Spreading of culture of information use.</li> <li>• Detailed documentation made available.</li> <li>• Collaborations lead to other benefits and building cross country understandings.</li> </ul>
Research, education & training	<ul style="list-style-type: none"> <li>• Running courses and programmes.</li> <li>• Conducting PhD research and its supervision.</li> <li>• Publications and presentation.</li> <li>• Conducting in-service training programmes.</li> </ul>	<ul style="list-style-type: none"> <li>• Encouraging partner countries to nominate promising candidates for higher studies.</li> <li>• Collaborations on writing projects</li> <li>• Collaboration on research projects</li> <li>• Creating funding opportunities.</li> </ul>	<ul style="list-style-type: none"> <li>• Higher institutional capacity to conduct research.</li> <li>• Higher institutional capacity to conduct courses.</li> <li>• In-service training modules are shared.</li> <li>• High visibility of institution for research strengthening culture for higher studies.</li> </ul>
Fund raising	<ul style="list-style-type: none"> <li>• Writing research proposals.</li> <li>• Partnering in research programmes.</li> </ul>	<ul style="list-style-type: none"> <li>• Collaborations with partners.</li> <li>• Learning from past proposals.</li> <li>• Expanding networks of support.</li> </ul>	<ul style="list-style-type: none"> <li>• Increased funds for research, education, and implementation.</li> <li>• Linking of studies with practical work – richer educational experience.</li> </ul>
Political advocacy	<ul style="list-style-type: none"> <li>• Promoting use of free and open source software.</li> <li>• Promoting HIS as one to support use of information for local action.</li> <li>• Promoting approaches to integration.</li> <li>• Creating buy-in for implementation access.</li> </ul>	<ul style="list-style-type: none"> <li>• Attending workshops, seminars and other events.</li> <li>• Creating linkages with international bodies such as WHO and HMN.</li> </ul>	<ul style="list-style-type: none"> <li>• Higher buy-in for open source technologies.</li> <li>• Higher buy-in for perspective of HIS as tool for supporting local action.</li> <li>• More robust network of supporters.</li> </ul>

In Tables 8.1 and 8.2, the structure and action related processes in the HISP network are described. Such a network arguably provides a more effective structure to support various multifaceted activities around HIS capacity development. By consciously creating network linkages, synergies can be obtained to help provide larger benefits to the network without each node having to create their own pilots and reinvent the wheel, while also supporting broader processes of scaling and sustainability. We discuss how a global network like HISP can support and enable capacity development in a country context – the example of India.



## 8.6.2 Merging of Global and National Networks for Supporting Capacity Development: Example from India

Since early 2008, the Indian Ministry of Health has been engaged in an intensive process of reforming their HIS, including its redesign and implementation with the supporting software. The different entities involved in this network include:

- The National Ministry of Health, which controls the overall network.
- The National Health Systems Resource Centre (NHSRC), which is the nodal technical support agency to the Ministry of Health including for the strengthening of health information systems.
- Various state governments engaged in implementing the National Ministry's health information systems reform package including the supporting software.
- Vyayam technologies, partners with the Ministry of Health for the development and support of the national web portal.
- HISP India, technical partners of NHSRC for the development and support of the State application DHIS2, where it is being used, and also for conducting capacity building programmes in the States.
- International Development partners who are supporting particular health information systems initiatives at the national and state levels.
- Other educational institutions involved in the process of institutionalising educational programmes in public health informatics.

In Table 8.3 the different roles of the network partners are outlined.

Entity	Status	Key roles played	Network linkages
Ministry of Health	National hub	<ul style="list-style-type: none"> <li>• Defining national HIS agenda, including the reform package.</li> <li>• Monitoring of the coverage and quality of data for each states.</li> <li>• Conducting various training programmes and workshop to support HIS implementation.</li> <li>• Designating roles and responsibilities of different partners.</li> <li>• Providing funding support to states through the planning process.</li> </ul>	<ul style="list-style-type: none"> <li>• With states to pass directives on implementation with NHSRC to coordinate and monitor their support activities.</li> </ul>
National Health Systems Resource Centre – NHSRC	Technical support hub	<ul style="list-style-type: none"> <li>• Active participant in HIS redesign process.</li> <li>• Customisation of state HIS applications and creating linkage with national HIS portal.</li> <li>• Conducting capacity building programmes.</li> <li>• Building state support structures using different models.</li> <li>• Building collaborations with other partners.</li> </ul>	<ul style="list-style-type: none"> <li>• With MoH in advising and reporting roles.</li> <li>• With States in advising and supporting roles.</li> <li>• With educational institutions and other partners in enabling roles.</li> <li>• With HISP India in contractual relationship around Memorandum of Understanding.</li> </ul>

State Health Departments	Nodes in the national network. State is the hub within the state	<ul style="list-style-type: none"> <li>• Recipient of HIS package from national MoH to implement.</li> <li>• Partnering with NHSRC and MoH for capacity building.</li> <li>• Working towards maturing the HIS.</li> <li>• Working towards building scalable and sustainable systems around HIS.</li> <li>• Responding to various MoH directives.</li> </ul>	<ul style="list-style-type: none"> <li>• Providing directives to districts and sub-districts to implement.</li> <li>• Receiving technical support from Ministry of Health and NHSRC.</li> </ul>
Vyayam technologies	Software development	<ul style="list-style-type: none"> <li>• Developers of national web portal, and its support and enhancement.</li> <li>• Training and capacity building around software.</li> </ul>	<ul style="list-style-type: none"> <li>• Contractual relation with Ministry of Health.</li> <li>• Technical support to States.</li> </ul>
HISP India	Technical support partner	<ul style="list-style-type: none"> <li>• Carrying out state specific customisations of state application on DHIS2.</li> <li>• Trouble shooting and support.</li> <li>• Carrying out capacity building programmes.</li> <li>• Promoting analysis and use of information for action.</li> <li>• Collaborating with NHSRC for the production and dissemination of resource material.</li> <li>• Technology development in new areas such as mobile and hospitals.</li> <li>• Promoting integration of various information systems.</li> </ul>	<ul style="list-style-type: none"> <li>• Contractual relation with NHSRC.</li> <li>• Educational linkages with Oslo and Universities in India.</li> <li>• Software development linkages with Global HISP network.</li> <li>• Direct support to States where requested</li> </ul>
International development partners	Supporting role to various nodes – states	<ul style="list-style-type: none"> <li>• Funding for specific projects.</li> <li>• Funding for manpower.</li> <li>• Promoting new concepts such as of data triangulation.</li> </ul>	<ul style="list-style-type: none"> <li>• Relation with Ministry of Health through donor co-ordination committee.</li> </ul>
Educational institutions	Collaborating role	<ul style="list-style-type: none"> <li>• Seeing to establish programmes in public health informatics.</li> </ul>	<ul style="list-style-type: none"> <li>• Initiating relation with NHSRC and HISP India.</li> </ul>

After having sketched out the structure of the network and the associated processes, we discuss how the global HISP inter-mingles with the national HIS in India in supporting capacity development in the following areas:

- Software development and its sharing.
- Promoting the use of information for action.
- Research, education and training.
- Fund raising.
- Political advocacy.
- Policy support.

These different action areas are discussed:

### Software Development and its Sharing

In India, with respect to software development, two key entities are identified. Vyayam technologies for the national web portal and HISP India for state applications based on DHIS2. Currently, linkages between these two entities are weak, requiring strengthening, for example, to ensure database level integration of the state and national applications to enable seamless transfer of data between them. This will help to avoid redundancies as when data entered in the state application does not need to be re-entered in the national one due to absence of software linkages.

Another weakness in the existing network is the limited capacity in the state nodes around software. This creates two sets of problems:

- The state has a high level of dependency on the software providers, and as a result, their own capacity continues to be limited.
- There is limited institutional capacity to be able to translate software requirements of the departments into effective solutions.

Such a capacity to understand and translate requirements becomes especially necessary in systems like the national web portal that is built on a proprietary platform in which only the vendor has the capacity to modify the code. In such a case, it becomes imperative that there is an in-house technical unit who can mediate between the user and the vendor.

To try and strengthen these weak network linkages, different actions can be taken:

- Advanced technical training can be provided to the state HIS teams to help gradually grow their capacity and ownership over the software.
- Other state agencies can be included into the network to help the development of specialised skills such as the State Health Resource Centre or the State IT Department. In specific settings, strong local NGOs can also be enrolled in the network.
- The vendor of the proprietary software could be contractually obliged to provide the code base to the Ministry, who can then take the responsibility to provide the required support for customisation and enhancement.

The linkage between the states and the national level will undoubtedly be stronger than a linkage between the state and the vendor that is mediated through the Ministry. A more radical suggestion in this regard would be to establish a national policy, like in Brazil and South Africa, to have all public sector applications to be developed on open source platforms using open standards. This will enable free sharing of software amongst nodes, which could motivate states to take more proactive interest in building their capacity to independently manage their application.

### Promotion of the Use of Information for Local Action

This is another weak link in terms of action focus in this network for various reasons:

- Due to the existing hierarchical model of governance, the key focus of the HIS has been primarily towards strengthening upward reporting, and not horizontal sharing or local action. The culture for such use of information is largely absent, and urgently needs to be cultivated.

- The trust of planners and decision-makers to use data from the HIS is limited because of a historical neglect of this system.
- The capacity of planners to actually analyse and use this data is limited because of their prior training and their inertia to learn new techniques.
- Institutions which have the skills and mandate to carry-out such analysis tend to be currently not part of this network.

The action points to encourage addressing this complex problem can be multiple:

- In the different nodes, champions can be promoted who can show examples of use of information, which would encourage others to follow.
- The software tools available for analysis at the national level include a complex statistical package, which tends to be beyond the reach of learning of common users. Serious attempts are needed to create more user-friendly tools, requiring stronger network linkages between the developers and programme managers who are important users of information.
- Institutions like medical colleges and their public health departments should be included in the network to build capacity to carry-out such analysis, feedback to the states, and help build capacity there to carry-out such analysis independently.
- Professional training content developers need to be included into the network, and made responsible to produce creative and interesting materials towards the use of information for local action. Content development needs to necessarily be based on local examples to allow users to better identify with the cases in relation with their own situation.

#### Research, Education and Training

This action area again represents a weak link in the network. The primary reason for this has been the absence of educational and research institutions in the network. Further, agencies that tend to be entrusted with responsibilities for research tend to do so in a consultancy mode suggesting short-term and quick fix prescriptive solutions to problems that necessarily require a more nuanced and long-term approach. For example, the solution of more training to address the problem of poor data quality is a rather simplistic one, since problems of quality maybe linked to larger problems of institutional fragmentation and poor record keeping. It is thus important to have competent researchers and institutions to be engaged in this domain to define a relevant research agenda for the Indian public health system. Creating multilevel linkages between in-service training, education and research will help to focus the action on relevant problems faced by the network.

#### Fund Raising

The availability of funds does not seem a limiting factor in the network, but its distribution does. For example, huge amounts of money are invested in the purchase of hardware and software, while a marginal amount on the development of people and institutions. This proportion of funding needs to be urgently reversed. To carry-out this reversal, more experts on HIS need to be introduced in supporting roles in the planning and budgeting processes. The state health departments tend to have weak capacity to be able to evaluate hardware or software proposals from vendors on its technical merits, and instead are swayed by presentations promising the moon. Staff within the state department needs to be trained in this regard, or external experts

need to be included in the network in supporting roles to be able to carry-out such assessment and providing advise on feasible solution.

### Political Advocacy

Political advocacy involves people at senior levels being able to promote the value of HIS, and be able to garner strong political support. Such advocacy remains weak in the current network, as senior decision makers either do not have the time to engage with deep issues, or are quickly transferred, or do not have coherent perspective on HISs and how it can benefit the health system. Putting such senior people through orientation and awareness building courses and seminars can help to develop a more effective form of political advocacy. Political advocacy can be also strengthened by creating linkages with international agencies and standard making bodies such as the WHO and the HMN, which can help ensure the national systems are in tune with global trends, and further to strengthen legitimacy of their actions.

## 8.7 Institutional Level Building Capacity

In the public health system of many developing countries, a continuing problem is that of HIS initiatives being person dependent, implying that while particular individuals are at the helm, a system may flourish but wither away with their departure. For example, in India, officers from the cadre of the Indian Administrative Service tend to be the head of different departments like health, but are subject to frequent transfers depending on the needs of their cadre, and often not of the health system. While this system of transfer is something we can do little about, what can be worked at is building institutional capacity with a design which transcends individuals, and creating an institutional memory, which allows new incumbents to carry forward the initiatives within an institutionally agreed framework. Some areas of focus are discussed.

### Strategic Understanding of the Value of Health Information Systems

The institution, especially its leadership, must clearly understand the strategic importance of HIS, including its value for planning, monitoring and evaluation, creating transparency and confidence in the public. More important than understanding the potential of technology, is the need to have a realistic perspective on the trials and tribulations inherent in making systems work effectively, and understanding that there are no silver bullets available to solve problems that are systemic in nature. Strategic thinking also includes understanding of technology related standards that the institution wants to adopt, for example, related to open source software and accredited partners for collaboration.

### Planning for HIS

Given an acknowledgement and understanding of the strategic importance of HIS, the institution requires planning skills to translate their strategic vision into operational plans. In India, states are allowed approximately 4% of their annual state budget to be earmarked for Monitoring and Evaluation, and very often this amount is left unutilised. This reflects an inadequacy in the planning capacity of the state where on one hand funds are unused, and yet on the other hand, lack of resources are described to hinder HIS development processes. Planning skills also requires a clear understanding and prioritisation of where money should be spent. For example, an important thumb rule is that nearly 90% of budgets should support people and implementation related

efforts and the rest on hardware and software. Normally, we see the ratio is reversed. Creating realistic budgets for HIS becomes an important capacity that institutions should have for strengthening their systems.

### Advocacy Skills in Promoting the Value of HIS

Advocacy can be seen as a form of evangelism or marketing of a concept that we believe in and want others to enrol in to. Having political advocacy skills in promoting the importance and use of HIS is extremely important, especially in a context where the value of it may be unknown or worse still have a negative connotation attached to it. Often, there is no high level champion of the cause, and the proponents are at too low a level in the administrative hierarchy to be able to make a difference. Advocacy is a capacity which needs to be cultivated to enable a larger level buy-in for the system, and to create a network of champions who are willing to speak on behalf of the HIS.

### Keeping Abreast with Technological Trends

The technology domain of HIS is a virtual minefield with multiple and powerful global vendors that recognise the large cake at stake to be procured for the public health system. There are many new technologies being sold with utopian promises, such as smart phones, notebooks, PDAs, smart cards, mobile phones, digital pens, and many such more. The problem arises when smart and sleek presentations by vendors manage to sway decision-makers who may not be very conversant with the technologies. Decision-makers thus need to be equipped to be able to intelligently read through these presentations and visualise ways of harnessing the capabilities of the technology to the benefits of their organisation, and the inherent challenges in doing so. To be abreast with technological trends, decision-makers need to develop a sound advisory structure to get critical opinions and to guard against large amounts of funds being wasted on irrelevant projects. Building the capacity of senior decision-makers in this regard is thus, a crucial and increasing challenge.

### Institution Building

The institution must develop self-perpetuating systems processes to support the creation of strong and robust systems around the HIS, including:

- Expert committee to take decisions on standards for data elements, indicators, integration, data policy, and so on.
- National and state level technical teams for managing the required infrastructure, and enabling integration mechanisms – both technical and institutional.
- A state level capacity to strengthen training systems, including identifying training needs, defining training calendars, preparing logistics of training programmes, publication and distribution of resource material, and the evaluation of training programmes.
- An expert group of people responsible for establishing an overall framework for HIS development, such as policies for use of free and open source software, providing access of data to public, data security, and budgeting priorities.

If such and other institutions are in place, HIS development can evolve within a defined framework irrespective of movement of key individuals. Capacity then needs to be developed in an institution on establishing mechanisms such as defining terms of

reference, emphasising global and national level best practices to guide operations, establishing procurement and contracting procedures around open source software and other equipment, and development of standardised templates for working.

## 8.8 Building Individual and Group Capacities

As the point of departure, we acknowledge HIS involves different groups of people requiring varying skills to be cultivated, and with different starting potentials. The capacity building needs for different groups in a typical health system is summarised in Table 8.4:

<i>Groups</i>	<i>Key skills to be cultivated</i>	<i>Identified existing potential</i>	<i>Identified skill gaps to be cultivated</i>
Field level service providers	<ul style="list-style-type: none"> <li>Standardising of formats, data elements, reporting and recording, information flow.</li> <li>Data management including data quality, common errors and how not to repeat them.</li> </ul>	<ul style="list-style-type: none"> <li>Deep practical understanding of ground realities.</li> <li>Solving problems in resource constrained settings.</li> <li>Can relate data to practical experiences.</li> </ul>	<ul style="list-style-type: none"> <li>Formulating the practical and experiential knowledge in terms of HIS concepts.</li> <li>Participatory techniques by which their knowledge can feed into HIS design.</li> <li>Use of tools such as mobile phones and software</li> </ul>
District and sub-district level health information staff	<ul style="list-style-type: none"> <li>Understanding of formats, data elements, indicators and information flow.</li> <li>Use of technologies such as software, mobile phones and others.</li> <li>Deep understanding of issues of data management including quality, and how computerised tools could help in their management.</li> </ul>	<ul style="list-style-type: none"> <li>Understanding of how the health system works at the district level and below.</li> <li>Typically, with educational skills in computers, management and statistics.</li> <li>Possess technical skills around computers and other peripheral equipment.</li> </ul>	<ul style="list-style-type: none"> <li>Complementing their technical skills with public health concepts of data, indicators, coverage, and so on.</li> <li>Skills to identify data quality aberrations and how they can be addressed and not repeated.</li> <li>Understanding of how the health system works in general terms.</li> </ul>
State and district level health programme officers	<ul style="list-style-type: none"> <li>Analysis, interpretation, feedback and use of information for developing programme based interventions.</li> <li>Understanding issues of data quality from a health programme perspective.</li> <li>Advocacy skills to promote the use of information.</li> </ul>	<ul style="list-style-type: none"> <li>Understand the practical challenges of implementing health programmes, such as for immunisation or maternal health.</li> <li>Understand programme specific information needs.</li> <li>Typically have a public health or medical background.</li> </ul>	<ul style="list-style-type: none"> <li>Skills in data analysis and interpretation.</li> <li>Skills in being able to formulate their programme related problems in informational terms.</li> <li>Skills to use the dashboard of the HIS for carrying our analysis.</li> <li>Skills in using GIS for spatial public health analysis.</li> </ul>

State level technical team	<ul style="list-style-type: none"> <li>Managing state wide application, including its regular maintenance and local customisations.</li> <li>Managing state level technical infrastructure, including trouble shooting.</li> <li>Server management.</li> <li>Database administration.</li> </ul>	<ul style="list-style-type: none"> <li>Technical competencies in computers, software and infrastructure.</li> <li>Being collocated with state programme managers, understand their information needs.</li> <li>Typically has the confidence of the State responsible of the overall health system.</li> </ul>	<ul style="list-style-type: none"> <li>Advanced skills in managing the HIS.</li> <li>Managing servers.</li> <li>Managing databases.</li> <li>Programming for being able to enhance the applications in place.</li> </ul>
State level public health team	<ul style="list-style-type: none"> <li>Analysis, use and dissemination of monitoring data to health programme manager and feedback to lower levels.</li> <li>Organising capacity building initiatives.</li> <li>Creating and managing a repository of public health resources.</li> </ul>	<ul style="list-style-type: none"> <li>Understand the practical challenges of implementing health programmes, such as for immunisation or maternal health.</li> <li>Understand programme specific information needs.</li> <li>Typically have a public health or medical background.</li> </ul>	<ul style="list-style-type: none"> <li>Skills in data analysis and interpretation.</li> <li>Skills in being able to formulate their programme related problems in informational terms.</li> <li>Skills to use the dashboard of the HIS for carrying our analysis.</li> <li>Skills in using GIS for spatial public health analysis.</li> </ul>
National level health information systems team	<ul style="list-style-type: none"> <li>Use of information for programme evaluation and impact analysis.</li> <li>Creating national health information policy including standards, procurement, integration norms, etc.</li> <li>Keeping abreast of global trends and its incorporation into national systems.</li> <li>Visualising integration of programme specific information systems.</li> </ul>	<ul style="list-style-type: none"> <li>Skills in statistics.</li> <li>Skills in monitoring of programmes.</li> <li>Understanding of the political context of the HIS.</li> <li>Close proximity to the national policy makers, and thus can provide useful inputs to the same.</li> </ul>	<ul style="list-style-type: none"> <li>Complementing statistical skills by building a public health perspective, for example, differentiating between data elements and indicators.</li> <li>Building competencies in programme evaluation, and not just monitoring.</li> <li>Planning, coordinating and general management skills.</li> </ul>

Table 8.4 helps to identify different groups who are targets for building capacity, the capacities they should have, what can be assumed to be their inherent potentials in place, and based on these what building capacity interventions are required.

Within the health sector, as technical systems become increasingly integrated, the building capacity efforts also need to become more interlinked. For example, in the state of Himachal Pradesh in India, the HIS includes an integrated suite of applications with systems for routine health information, mobile health, name-based tracking, and hospitals. While at the technical level, data interoperability would need to be assured, at the institutional level, the field nurses and supervisors will be the direct recipients



of all these systems, thus requiring building capacity efforts to be also integrated, in which, not only are the interlinkages across systems well explained, but also users are made competent on not one but the suite of technologies. This becomes increasingly challenging for both the trainers and trainees.

## 8.9 Strategies for Building Capacity

Given the multifaceted nature of the building capacity challenge, strategies to develop them necessarily need to be multiple and interlinked. Building capacity is not just a question of creating mechanical skills of using software, but requires a process of education and a deep seated change of mindset, not just a mechanical learning of how to follow the steps to run a software application. While skill development is indeed an integral component of the building capacity agenda, it needs to be carried out within a framework of critical questioning that can help to change mindsets, and build a larger perspective on what HISs are. Some strategies are discussed.

### 8.9.1 Establishing Formal Education in Public Health Informatics

Many universities across the world offer degree and diploma programmes in Public Health or Community Medicine at the Masters and Doctoral levels. In some countries, like in India, there are also plans to offer similar courses at the undergraduate level. However, very few of these programmes tend to offer specialisations in public health informatics, despite its importance, and given the current work trends. Since public health graduates are typically absorbed in the state or national level health systems, providing them with formal training on public health informatics is arguably the key to strengthen institutional and individual capacities to deal with HIS.

Such formal education can and needs to take place at multiple levels. The first level is at the Masters, where students are given a conceptual and practical grounding in public health informatics, basic concepts that underlie it, understanding its value within a health systems context, and also associated challenges and approaches in making informatics solutions realise their potential on the ground. All the topics described under building institutional capacity – strategic value of HIS, planning, advocacy skills, technological trends and institutional development – all need to be included in such a Masters curriculum, in addition to topics identified under individual capacity building, such as competencies in data analysis, interpretation, report writing and dissemination.

Graduates from such Master level programmes have various career opportunities, including being absorbed within states or national level HIS teams. Another career path for such graduates could be research and teaching within university settings. Pursuing Doctoral studies could help students in building a research career and contributing to framing a relevant research agenda for the sector, while also providing supervision capacity to students taking Masters degrees. Further, together with the Masters students, they can provide a valuable resource pool to carry-out in-service short-term courses for staff from the health department.

In this way, a multi-level pool of capacity can be nurtured at the in-service, Masters, Doctoral and faculty levels contributing to the development of large scale and institutionalised public health informatics capacity in the country. In the context

of India, this model of education in public health informatics has been discussed with various premier universities currently offering programmes in Public Health or Community Medicine, and how they may want to develop specialisations in Health Informatics. Some of the universities engaged in these discussions include Birla Institute of Technology and Science, Pilani; All India Institute of Medical Sciences (AIIMS), Delhi; Postgraduate Institute of Medical Education and Research, Chandigarh; Sri Ramaswamy Memorial University, Chennai; Jamia Hamdard, Delhi; Sri Chitra Tirunal Trivandrum, and Tata Institute of Social Sciences, Mumbai. Drawing from the Oslo experience of more than a decade in running such courses, strategies have also been discussed to try and adapt the curriculum and methods to the Indian context, and create a common pool of courses and other resources, which can be used by partnering universities. Bilateral or multilateral Memorandums of Understanding between these universities and also involving other global partners currently similarly engaged such as Oslo, Addis Ababa University, and Colombo, can help to facilitate exchange of students and faculty for strengthening respective institutional capacities to run these programmes.

### 8.9.2 Short-term Specialised Courses for In-service

On one hand, while education programmes seeks to build more formal and institutionalised capacity, there still exists a large gap of in-service capacity needs of existing staff. Staff who have joined the health system more than a decade ago have a lot of experience and practical knowledge, but limited formal exposure to HIS, computerised or not. Typically, such staff does not have the luxury of being able to take a one or two years break from their everyday work and to enroll for university programmes. Further, one or two day training sessions typically carried out by the health departments to support new HIS initiatives tend to be rather adhoc, coming in between hectic everyday work schedules and a multitude of other training programmes. As such, they do not provide adequate time and space for staff to pick up required specialised skills. Further, as adhoc training efforts often do not provide certificates of appreciation to the trainees, they do not offer motivation in terms of career enhancement.

There is thus an urgent need to establish a complete suite of specialised short-term courses, say of one or two weeks, within a formalised institutional setting which offers certificates from a recognised authority which the health staff can also use in their CV for career enhancement. In South Africa, such a successful structure of imparting short-term courses has been established within the aegis of the School of Public Health in the University of Western Cape. Different provinces sponsor their staff to attend these courses, which are imparted through the public health faculty of the School and also various experts with practical experience and knowledge. Through this, staff are exposed to current problems being experienced, and cutting edge attempts to address them. There also is the flexibility for interested students to build upon credits earned in short-term courses and cumulate them towards diploma or degree courses. Over a decade, these courses have been run and literally thousands of health staff have benefitted. Through this, a large scale institutional and individual level capacity in health informatics more broadly and particular specialisations have been created, which undoubtedly has contributed to make the South African HIS one of the best in the developing world.

Developing countries can try to take a leaf out of the South African book, and examine how public health institutions in the country in collaboration with organisations

engaged in practically addressing HIS implementation can be supported to conduct a suite of short-term in-service courses. Establishing this structure within a public health rather than an informatics institution arguably is more effective in meeting aims of developing capacity towards public health friendly HIS. Regional centres of such institutions could be established so as to enable more convenient and widespread access. One such collaboration has been established between the Community Medicine department of BITS Pilani, HISP India and NHSRC, with the aim to create both a specialisation in public health informatics, and also a structure for conducting short-term in-service courses.

In Table 8.5, a list of some samples of service courses envisaged are summarised. This list is not exhaustive but indicative of potential short-term courses.

<i>Name of course</i>	<i>Target audience</i>	<i>Particular skill sets to be cultivated</i>
Global trends in HIS – 7 days course	Senior policy makers – State Directors, Health Secretaries, Directors – from the national and state levels	<ul style="list-style-type: none"> <li>• Strategic understanding of HIS.</li> <li>• Planning for HIS.</li> <li>• Technological trends in HIS.</li> <li>• Advocacy skills in HIS.</li> <li>• Institutional development for HIS.</li> </ul>
Data management in a State context – 7 days course	State HIS responsible persons	<ul style="list-style-type: none"> <li>• Basics of HIS, including concepts of data elements, indicators, coverage, data warehouse, etc.</li> <li>• Data management, including issues of information flow in a state context, data quality, addressing them.</li> <li>• Using HIS computerised tools.</li> <li>• Institutional issues around HIS at state level, including teams, budgets, responsibilities, processes.</li> </ul>
Data management in a district context – 7 days course	District HIS responsible persons	<ul style="list-style-type: none"> <li>• Basics of HIS, including concepts of data elements, indicators, coverage, data warehouse, etc.</li> <li>• Data management, including issues of information flow, data quality, addressing them.</li> <li>• Using HIS computerised tools.</li> <li>• Institutional issues around HIS at district level, including teams, budgets, responsibilities, processes.</li> </ul>
Analysis, interpretation and use of information for local action – 7 days course	National, state and district level health programme officers	<ul style="list-style-type: none"> <li>• Basic concepts such as related to indicators, coverage, targets, information cycle and so on.</li> <li>• Understanding different sources of data and their uses.</li> <li>• Skills in carrying out analysis and interpretation of data for data quality and health status.</li> <li>• Report writing and dissemination.</li> <li>• Putting analysis of data into use – for priority areas such as State, district and sub-district plans, immunisation micro plans, and for programme specific analysis.</li> </ul>

Technical training on HIS	National, State and district technical teams	<ul style="list-style-type: none"> <li>Advanced use of the various software tools, including features of customisation, user authorisations, system administration, etc.</li> <li>Integration – standards, data exchange and interoperability.</li> <li>Server management.</li> <li>Database administration.</li> <li>Programming for HIS enhancement.</li> <li>Managing data security.</li> </ul>
Using GIS for public health analysis – 3 days	<ul style="list-style-type: none"> <li>Programme managers at State and district levels.</li> <li>Advanced HIS users.</li> </ul>	<ul style="list-style-type: none"> <li>Principles of spatial analysis.</li> <li>Formulation of public health challenges in spatial terms.</li> <li>Use of GIS for spatial analysis.</li> </ul>
HIS for health service providers – 14 days	ANMs, Male Nurses, Health Supervisors	<ul style="list-style-type: none"> <li>Basics of HIS, including concepts of data elements, indicators, coverage, data warehouse, etc.</li> <li>Data management, including issues of information flow, data quality, addressing them.</li> <li>Using Mobile technologies for reporting, and other computerised tools as required.</li> <li>Institutional issues around HIS at district level, including teams, budgets, responsibilities, processes.</li> <li>Engaging service providers to proactively contribute to HIS development.</li> </ul>
Other customised courses as per demand	Based on course	As per demand

### 8.9.3 In-house Training

In addition to the longer term diplomas/degrees and short-term in service courses offered by institutions like universities, National and State level training or support institutions, and other partners, the state health system are continuously running short programmes or workshops of one or two days, either to build particular skills or carry-out orientation on new HIS initiatives. Such programmes are conducted in house or through some technical support agency at the national or province level. These efforts are very important as they seek to fill the skill gaps. However, often such efforts are not very effective in filling the gaps, as since the programme is conducted within the premises of the office, the staff often still has to deal with their everyday tasks, answer phones, and carry-out other errands. Dedicated attention cannot be maintained from both the trainers and trainees. While in house training efforts have certain limitations by the very nature of how they are designed and carried out, they play an important role to play to implement certain focused tasks. They are not a substitute for the other longer or short-term building capacity programmes identified earlier. They can only complement them, specifically with respect to the following efforts:

- Orienting staff on new initiatives.
- Completing specific tasks like monthly data entry and data quality checks.

- Identification of master trainers who could be given additional responsibilities and provided more specialised training.
- Dissemination of government instructions and resource material.

#### 8.9.4 Support Through Networks

The general approach to capacity building support followed by HISP has been to use the power of the networks, in which learning and experiences can circulate. Strategies used for circulation, as discussed above, come from educational programmes, research, and in-service courses. Another approach using networks has been created by OpenMRS through their OpenMRS Implementors Network (OIN). The stated objectives of the OIN are to develop capacity for OpenMRS development and implementation in developing countries. The network provides the mechanism to identify the needs of the implementers and also to strengthen the community-based applications of the application. The network becomes a dedicated forum for discussing and resolving implementation issues, and also to develop capacity for training and mentoring. The OIN has four key elements in their strategy to provide capacity building support:

- Face-to-face networking.
- Capacity development.
- Community outreach.
- Peer support and mentorship.

A fundamental point of difference with the approach of HISP and OpenMRS is the emphasis on the Masters and Doctoral education programmes in the case of HISP. These programmes are geared towards trying to strengthen educational capacity in health informatics in national universities, which then in the longer run can serve to create a more enduring hub for capacity development in the country. For example, the national universities can become the base to carry-out in-service training courses for the health department staff. Another point of difference here concerns the approach to implementation. In countries where HISP is working, the implementation is also seen as a primary responsibility of theirs along with the software support, and this is carried out in various means such as university based teams, HISP NGOs, and third party groups. The OpenMRS see themselves primarily as the development group who links with local and third party groups to facilitate implementation.

#### 8.9.5 Hand Holding and Support – Learning by Doing in Context Over Time

Often staff from districts is called to the state office for a 1–2 days training programme, introduced to new software. Following which, they go back to their respective facilities and are expected to carry-out their tasks without further support. The problem arises, which often is the case, that when a user is stuck while using the software or the new tool, they have nowhere to go to get support. Slowly, as requests for support go unheeded, user interest in the application dwindles, leading to its stoppage. Thus, arguably often more important than the 1–2 days training programme at a centralised location, is the need for providing continuous and ongoing hand holding and support to help promote *learning by doing*. In such an approach, the users are encouraged to themselves solve the problems that they are experiencing and which they understand best. However, to enable this process to be effective, a support group should be at hand to help answer the queries they have, to backseat drive the process.

An important question here is what should be the form of this support group, and how should support be organised. This group can be in two forms:

- As an in-house group made up of master trainers from the national, state, district and sub-district levels. While the advantage of this model is that internal members have a deeper understanding of the problems, the downside is that they often do not have the time to provide dedicated support as they are dealing with multiple other everyday issues.
- To organise a dedicated support through a third party technical support agency. While the advantage of this model is that group is dedicated and accountable for the support they provide, the disadvantage can be in terms of them creating an external dependency wherein the health staff themselves do not take the initiative to learn and expect everything to be done by this agency.

A hybrid of these two models may provide the benefits of both systems. This could be in the form of a technical support agency providing dedicated support for one or two years, with an explicit component of their contract to build sustainable capacity in the health system to manage this function independently in the future. The state of Kerala in India has adopted such a support arrangement with HISP India, with significant results.

Another example of learning by doing is provided from Ethiopia in the context of the design, development, and support of ART (Antiretroviral Treatment) system for HIV/AIDS management. The technical support group engaged in this process comprised primarily of two students doing their Masters degree in informatics at Oslo and carrying out their fieldwork under the HISP framework in Addis. To be able to provide this support, this team of two needed to build our capacity in various facets of the project. The first challenge was gaining access to the politically charged field of ART management, dominated by American donors, and it is only after this access could be gained that they could start to engage with understanding the requirements. Thus, building capacity so as to be able to penetrate this brick wall like political condition was a challenge. Following that, the team needed to build capacity to understand the field of ART and its context of HIV/AIDS management, a domain in which they had no prior experience. Further, technical capacity needed to be cultivated to be able to design and develop the system in an open source environment, which again was novel. Sustaining and scaling the system required continuous and ongoing support to the users, made especially difficult with the limitation of resources (for example, of data entry clerks) and ongoing political attempts to destabilise the efforts. In Table 8.6, these multiple approaches to building capacity are summarised.

### 8.9.6 Supporting Capacity Development Through Toolkits

Toolkits can provide crucial support towards capacity development. The metaphor of a toolkit helps to understand the package of tools that planners and doers of HIS need to have at hand to ensure its smooth progress. Like a toolkit for a carpenter will include screwdrivers, hammers and saws to allow him or her to carry-out different kinds of related tasks, similarly, the toolkit for a HIS planner will include tools for varying purposes such as training manuals to support capacity building, user manuals to guide the use of software, questionnaires to help evaluate the maturity of the HIS, and web-based resources to access to particular types of relevant information. The important

Table 8.6 Multiple approaches to building capacity

<i>Facets of the problem domain</i>	<i>Methods of building capacity</i>
<ul style="list-style-type: none"> <li>Gaining entry (infiltrating the politics surrounding HIV/AIDS and ART management in Ethiopia)</li> </ul>	Creating a political counter network by leveraging upon: <ul style="list-style-type: none"> <li>The experience of the pre-existing local HISP team and its global dimension.</li> <li>The links the local HISP team previously established with the state health department.</li> <li>Enrolling individual champions from the health department, for example, The State's HIV/AIDS Programme Manager.</li> </ul>
<ul style="list-style-type: none"> <li>Eliciting requirements in the unfamiliar domain of HIV/AIDS and ART management (understanding different public health issues, e.g. terminologies used in the various paper formats, and information and analysis needs from the perspective of health workers).</li> </ul>	Leveraging upon the broad mix of expertise available in the global HISP team, including: <ul style="list-style-type: none"> <li>Public health specialists (fellow students).</li> <li>Programmers (fellow students).</li> <li>IS experts (faculty).</li> <li>Suitable design and development approaches (for example, evolutionary prototyping, and participatory design approach).</li> </ul>
<ul style="list-style-type: none"> <li>Designing and developing the ART System (learning the technologies adopted in the project).</li> </ul>	
<ul style="list-style-type: none"> <li>Implementation and scaling up.</li> </ul>	Through employing various methods and resources <ul style="list-style-type: none"> <li>Employing assistant data entry clerks from HISP funds, and providing required training.</li> <li>Providing informal, on-site, and successive trainings to data clerks at each improvised versions of the system.</li> <li>Exchanging database tables over e-mail with non-technical team members who implemented the system in other states.</li> </ul>
<ul style="list-style-type: none"> <li>Maintaining political backing (withstanding the prolonged political situation to make the system work).</li> </ul>	Through cultivating the political counter network, benefits were obtained from enrolling more champions at both the macro- and micro-level health workers including data clerks.

role of toolkits to support capacity building processes around HIS has been recognised by HMN as depicted in Figures 8.3 and 8.4 on tools and auxiliary tools, respectively.

Some examples of components of a toolkit are summarised in Table 8.7.

Brief overview of some of the tools mentioned is given below:

1. **Tali tool to assess levels of information usage:** This tool was developed by HISP South Africa in early 2000 that helped to identify three levels of information usage, and the detailed criteria by which a facility or a district system could be assessed and placed into level 1, 2 or 3. Assessment can be done using a qualitative assessment supported by a checklist containing the different criteria of each level (see Annexure 1).



Figure 8.3 HIS tools identified by HMN

2. **Readiness matrix on use of information for action:** This matrix has been developed by Professor Geoff Walsham of Cambridge University in collaboration with the NHSRC in India, and pilot tested for Indian states. It aims at supporting the evaluation of the ‘readiness level’ of a province or district with respect to using of information for action. The matrix is based on six dimensions of readiness each with three sub-dimensions (see Annexure 2). Each sub-dimension then has to be rated on a four level scale signifying different degrees of readiness. The dimensions and sub-dimensions are summarised in Table 8.8:

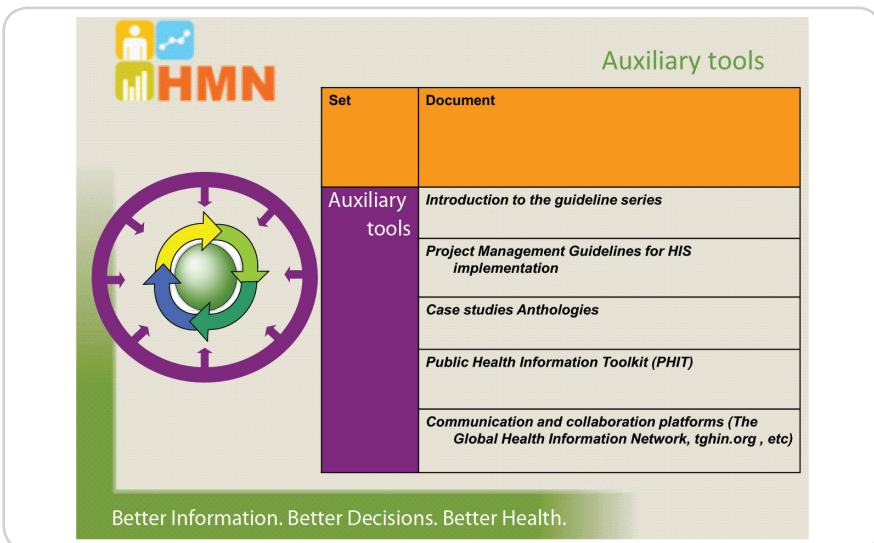


Figure 8.4 HIS auxiliary tools identified by HMN



Toolkit	Examples
Training manuals	<p>User manuals for software to help develop individual level competencies in understanding and using the software.</p> <ul style="list-style-type: none"> <li>• User manuals for information analysis and use to help develop individual level competencies to understand principles of information analysis and how it can be put to support action.</li> <li>• User manuals for data management to help develop understanding of basic principles of information flow, data, indicators, data quality and validation.</li> <li>• Training methodology handbook on how to carry-out training on HIS at state and district levels.</li> </ul>
Dictionaries	<ul style="list-style-type: none"> <li>• Data dictionaries which describe data being collected in the HIS, including details of its meaning, how it is recorded, which indicators it is used to generate, and common errors made.</li> <li>• Indicator dictionaries which describe useful indicators for health programmes, formulas for generation, what interventions they can help to design, how to make interpretations, their relationship with related indicators and common errors made.</li> </ul>
Frameworks	<ul style="list-style-type: none"> <li>• Implementation planning framework which helps to identify the various processes that need to be in place at different stages of the implementation process.</li> <li>• To identify infrastructure related gaps for supporting an effective health information system.</li> </ul>
Assessment tools	<ul style="list-style-type: none"> <li>• Readiness Matrix to assess readiness of health system to use information for action.</li> <li>• Talli tool for assessing levels of information usage.</li> <li>• IMF Data Quality Assessment Framework.</li> <li>• Assessing the maturing of various processes such as training, technical support, implementation, or data quality.</li> <li>• Assessing maturity of the health information system.</li> </ul>
Survey questionnaire	<ul style="list-style-type: none"> <li>• User satisfaction survey related to software use.</li> <li>• Trainee satisfaction related to training programme conducted.</li> </ul>
Competency tests and associated certification	<ul style="list-style-type: none"> <li>• Software competency tests and certification levels.</li> <li>• Public health competency tests and certification levels.</li> </ul>
Web-based resources	<ul style="list-style-type: none"> <li>• Software code repositories.</li> <li>• Survey data, like National Family Health Survey and District Level Household and Facility Survey in India.</li> <li>• Relevant web links on manuals and handbooks, for example, WHO Toolkits on monitoring health systems strengthening – WHO HIS:  <a href="http://www.who.int/healthinfo/systems/WHO_MBHSS_2010_full_web.pdf">http://www.who.int/healthinfo/systems/WHO_MBHSS_2010_full_web.pdf</a>  <a href="http://www.who.int/healthinfo/systems/WHO_MBHSS_2010_section3_web.pdf">http://www.who.int/healthinfo/systems/WHO_MBHSS_2010_section3_web.pdf</a></li> <li>• Monitoring the building blocks of health systems—a handbook of indicators and their measurement strategies  <a href="http://www.who.int/healthinfo/statistics/toolkit_hss/EN_PDF_Toolkit_HSS_InformationSystems.pdf">http://www.who.int/healthinfo/statistics/toolkit_hss/EN_PDF_Toolkit_HSS_InformationSystems.pdf</a></li> </ul>

3. **HMN assessment tool for national HIS:** An assessment tool (see Annexure 3) was developed by Arthur Heywood, Jorn Braa, Sundeep Sahay, and Calle Hedberg for HMN in collaboration with representatives from the health services and other stakeholders from the following countries: South Africa, Botswana, Malawi,

Dimension	Sub-dimensions
Technology	<ul style="list-style-type: none"> <li>• Software customisation.</li> <li>• Server capacity.</li> <li>• Internet access.</li> </ul>
Information system processes	<ul style="list-style-type: none"> <li>• Regularity of upward reports.</li> <li>• Practice of feedback reports.</li> <li>• Procedures for data verification.</li> </ul>
Data quality	<ul style="list-style-type: none"> <li>• Completeness.</li> <li>• Accuracy.</li> <li>• Verification procedures in place.</li> </ul>
Human capacity	<ul style="list-style-type: none"> <li>• Adequacy of team.</li> <li>• Adequacy of training.</li> <li>• Advocacy on information for action.</li> </ul>
Institutional collaboration	<ul style="list-style-type: none"> <li>• Involvement of programme management.</li> <li>• HIS budgets in place.</li> <li>• Integration of systems.</li> </ul>
Use of information for action	<ul style="list-style-type: none"> <li>• Data analysis.</li> <li>• Feedback reports being generated.</li> <li>• Action taken.</li> </ul>

Mozambique, Tanzania, Ethiopia, India, Vietnam and Thailand. This tool aimed at assessing the status of nations on their HIS, by quantifying achievements of countries according to a normative framework across 11 categories. These categories were identified based on HIS related problems found to be endemic at all levels of the health administration. This included:

- *Fragmentation*: A lack of coordination and integration among numerous subsystems, where each health programme runs their own system with little regard as to how this is integrated with the overall HIS.
- Excessive data and reporting demands on health workers, with multiple uncoordinated forms overlapping each other and leaving gaps.
- Lack of standardisation and alignment within and between datasets and reporting forms contributing to poor quality of data and the information that can be derived from it.
- Management hardly uses existing information for planning and monitoring.
- Staff responsible for the HIS is inadequately trained and under-skilled at all levels.
- Insufficient financial and political commitment to the HIS at the national level.

To try and address these adverse conditions, a normative framework was formulated representing conditions that should necessarily be in place (Table 8.9).

This tool was used by a network of researchers to make an assessment of the National HIS of 11 countries including 3 States in India. Results indicated that except for Thailand and South Africa, a well-functioning HIS was not identified in any of the surveyed countries. Various best practices, especially relating to addressing the problem of fragmentation were identified through the practices seen in Thailand and South Africa. While this tool was originally designed to make a national level assessment, it maybe customised to do a similar exercise at the state or province and district levels.

Table 8.9 Normative framework for HIS assessment

Context and resources	<ul style="list-style-type: none"> <li>• Legal and regulatory framework: Policy and priority.</li> <li>• Resources: Human, financial and equipment.</li> <li>• Data flow and information infrastructure.</li> <li>• Management: National and local HIS committees.</li> </ul>
Process	<ul style="list-style-type: none"> <li>• Integration: Institutional, data and technical.</li> <li>• National indicators and datasets.</li> <li>• Software at the district.</li> </ul>
Outputs	<ul style="list-style-type: none"> <li>• Quality of data and information.</li> <li>• Use of information: Mechanisms promoting information use.</li> <li>• Information culture.</li> <li>• Information for action.</li> <li>• Dissemination and advocacy.</li> </ul>

The above three examples are only indicative of the kind of tools that can be used to support capacity building in HIS, but many more tools are needed. These tools need to be necessarily developed in networks of action so that resources are optimally used and freely shared, and also to enable that multiple learnings can go into the design, development and revisions of these tools. More importantly, each member has the possibility to learn from the experiences of others, and to contribute their learning to the rest of the network. This is the guiding principle and essence of the network of action – the possibility to learn together, and the strength of collective learning is more than individual learning. The use of web-based resources like the Wiki makes it very possible for electronic sharing of resources and storing it in repositories which can help provide access to all interested.

## 8.10 Institutionalising Capacity – Creating a Cadre of ‘Health Information Officers’

For the different efforts towards building capacity, at both the institutional and individual/group levels to be effective, they need to be institutionalised within the health system. Institutionalisation involves the system to take ownership of the whole set of processes around how capacity development is organised and also how the products from these processes subsequently become a part of the health system.

The experience of South Africa is interesting in their strategy of institutionalisation through a cadre of Health Information Officers (HIOs) for districts and hospitals to manage the DHIS database which is being used nationally. The National Department of Health have seen the value of the HIOs initiative and have extended it to posts for data capturers, and the HIOs would then be responsible for the data processing once it has been captured. They would for instance then make reports available to various managers, create GIS maps, and also send data upwards to next level. In South Africa, HIOs come from a mixture of backgrounds – some are environmental health officers, others are nurses, some from the IT sector, and a few are statisticians. Empirical experiences have shown there that the IT people invariably left to go back to the IT sector where they earned more, whilst a health worker tended to remain in the post.

Surveys conducted there have shown that it was easier to train a health worker to use the application and understand the statistical issues, than it was to orient an IT person, or the statistician to the health sector issues (for example, terms and definitions used in the database, and an understanding of the inherent value of the data). Through ongoing training and orientation, the HIOs now also understand the aspects of the IT world, and can better communicate with the developers. This experience has been largely successful notwithstanding individual differences in skills and interests, and has helped to create a passage towards the middle road where public health and IT people are at the two ends of the extremes. In Box 8.2 the job description of a HIO as used in the South African system is presented.

## Box 8.2

## Job description of Health Information Officer in South Africa

*Job Purpose:*

- Co-ordinate the collection, analysis, presentation and appropriate utilisation of District Health and Management Information at District, Sub-district and facility level.
- Provide good quality information at sub-district level to assist with indicator driven decision-making.
- Responsible for the overall quality of health data at the sub-district office and provide accurate and appropriate information to facilities and management.
- Participation in the development of the DHIS.
- Provide management and professional support within the sub-district health information unit.
- Submission of required data to provincial level.
- Manage health information and coordinate and support related activities at sub-district level.
- Contribute to other strategic and operational programmes/policies within the sub-districts by being an active member of the Sub-District Health Management Teams (SDHMT).
- Supervision/ongoing review of individual performance of the data typist.

*Knowledge:*

- Proficient in the use of computers and Microsoft programmes and in possession of an appropriate recognised tertiary qualification
- Thorough working knowledge of District Health Information System (DHIS).
- Working knowledge of basic statistics and experience in informatics.
- Sound public health knowledge.
- Information for health.
- District health information requirements.

*Skills:*

- Ability to work in MS Excel and MS Word as well as a working knowledge of e-mail, Intranet and Internet.
- Working knowledge of Arc Explorer.
- Ability to work with DHIS (MS Access based).
- Efficient in manipulating the DHIS and converting data into meaningful information.
- Efficient in dealing with people from diverse disciplines and good interpersonal skills.

Independent activity, initiative, integrity, interpersonal understanding, patience, perseverance, problem-solving, self-responsible, and team facilitation.

Other developing countries could think of a similar strategy where the existing District Managers or there equivalent are subject to building capacity programmes so as to obtain a core skill set of the kind described in the Box 8.2. These core skills can be defined as the essential skills which all health information personnel should have. At the state or province level, additional competencies would need to be added on as identified in discussions above. For example, the State health information team members would need additional competencies in server management, database administration and programming. Conversely, at the sub-district levels, such as field nurses and supervisors, the staff may not need similar computer-based skill training if they are not engaged with computerised data entry and reporting. In short, the strategy is to define a core essential skill set for health information systems staff, and add or delete from that as per job requirements.

**Summary**

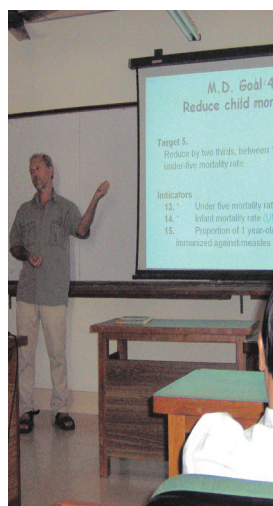
1. This chapter addresses three key questions:
  - a. What is the task or problem at hand, which we wish the capacity to address?
  - b. What is the potential that is available to us?
  - c. How best can this potential be nurtured or cultivated so that it can be made equal to addressing the problem at hand.
2. Often the potential which already exists in the system is not given due importance, and is even seen as unproductive. This is an inappropriate view, and the existing capacity should be celebrated and built on.
3. Key to HIS strengthening is building synergetic competencies which combines the disciplines of informatics and public health. Informatics people should know about the domain of public health where the systems are to be applied, and the public health people must learn about IT in order for them to use it more effectively to address field level problems.

4. Capacity building is a multi-level and interconnected exercise involving:
  - a. In-service training for health staff.
  - b. Masters level courses in health informatics, shared by departments of informatics and public health.
  - c. Doctoral level studies in public health informatics.
5. The University of Oslo has been implementing this model for over 15 years across multiple countries in an effective manner.
6. Potential capacity for cultivation needs to be nurtured at both the levels of the individual and institution.
7. Collaborative action for capacity development in the network of action would include:
  - a. Software development and its sharing.
  - b. Promoting use of information for local action.
  - c. Research, education and training.
  - d. Fund raising.
  - e. Political advocacy.
8. Capacity building programmes would need to be tailored differently for the following varying groups of people:
  - a. Field level service providers.
  - b. District and sub-district health information staff.
  - c. State and district health programme officers.
  - d. State level technical team.
  - e. State level health information teams.
  - f. National level health information teams.
9. Some short term courses envisaged for the above groups of people identified include:
  - a. Global trends in HIS.
  - b. Data management in a state context.
  - c. District management in a district context.
  - d. Analysis, interpretation and use of information for local action.
  - e. Technical training on HIS.
10. Some tools which can aid capacity development efforts include:
  - a. Tali tool to assess levels of information usage.
  - b. Readiness matrix on use of information for action.
  - c. HMN assessment tool.
11. The South African model of “Health Information Officers” is a useful model for institutionalisation of capacity development efforts.



# Maturing Information Use

- ⊙ Maturing Use – Towards the Nurturing of an ‘Information Culture’
  - ⊙ Cultivating Capacity for Local Action
- ⊙ HIS Policy – Role of National, Regional and Global Levels in Building and Promoting HIS in Countries
  - ⊙ Technology, Health and Development







# Maturing Processes of Use: Impact of Integrated Health Information Architectures

The third and concluding part of this book concerns the impact of IHAs in terms of how they contribute to the maturing of processes of information use, which arguably is a key input to making improvements in public health outcomes, such as improving institutional deliveries or improving coverage of vaccination, all crucial to the attainment of the MDGs. This part is comprised of a set of three chapters, and is followed by a concluding chapter.

In the first chapter of this set, 9, titled “Maturing use – towards the nurturing of an information culture” the focus is on first defining the concept of information culture, and then operationalising it over three levels of increasing maturity. These three levels are illustrated through country examples from Zanzibar, Mozambique, South Africa and India, as a vehicle to describe strategies and impacts of maturing information use. This chapter then discusses the challenge of institutionalising information culture, and describes three strategies relating to educational programmes in public health informatics, creating structures within governmental processes, and approaches to break the vicious cycle of data non-use.

Chapter 10, the second in this set, is titled “Cultivating capacity for local action” focuses concretely on what means capacity in the context of HIS and the ability to take action, and how this can be cultivated. Three facets of capacity are identified including related to technology, the domain of public health, and the implementation context. In each of these areas, we specifically identify the concrete skills that a health staff needs to take local level action oriented towards making health programme



improvements. Finally, we discuss how this capacity can be scaled in order to be useful at the level of the health system. The strategy of collaborative networks of action, a cornerstone of the HISP approach is discussed as an approach towards this challenge. An example from Kerala, India is taken in order to illustrate this approach.



Chapter 11, the concluding chapter of this set is titled “HIS Policy – Role of National, Regional and Global Levels in Building and Promoting HIS in Countries.” There is an inherent paradox when we address this question since the role of State and policies emanating from there tend to favour centralisation and upward reporting, while we have argued the normative aims of an effective HIS is towards supporting local action. How can policy and effective HIS support each other is the challenge addressed in this chapter. In this context, we identify some key roles that the State can play the policy needs, including the definition and governance of standards, addressing of inequities, supporting the development of capacity and infrastructure. We draw upon the efforts of the Health Metrics Network (HMN) to support the development of HIS related policy to illustrate this issue.



Chapter 12 titled “Technology, Health and Development” presents in brief the conclusions from this book. We reflect on the role of technology in shaping larger concerns of Health and Development.

# 9

## Maturing Use – Towards the Nurturing of an ‘Information Culture’

### 9.1 Introduction: The Historical Problem

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Health Information Systems (HIS) in many developing countries have historically been trapped in the domain of (poor quality) data, and not really moved to the stage of information, generation and much lesser knowledge creation and its use in practice. The reasons for this entrapment are many, ranging from the centralised form of functioning, the shackles of which are institutionally complex to break free from, the dominance of statisticians who favour centralised control, the near absence of public health specialists in Ministry M & E departments responsible for HIS, the dominance of vendors who have managed to thrive in a framework of ‘sell and run,’ and the role of donors in promoting vertical programmes and islands of systems and experts to support them. A data led approach has thus thrived, which can be described to have the following underlying characteristics:

- More (data) is better – preference for raw data rather than processed indicators.
- Data is for upward reporting and not to support local action.
- Data represents an independent statistical artifact rather than a public health event.
- Central ministries taking the role of monitoring rather than evaluation and impact analysis of health programmes.

How does one break out of these deep rooted institutional conditions and nurture an ‘information culture’ is the focus of this chapter. This chapter sees this challenge of nurturing a vibrant information culture as a process, which can be identified as passing certain levels. We start by describing these three levels of maturity of information use, using country specific examples, before trying to unpack the characteristics of an information culture.

### 9.2 Information Culture, and ‘Levels’ of Maturity of Information Usage

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Active and engaged analysis and use of information for decision-making, management, planning and more generally for supporting health services delivery, at all levels, are key objectives for all efforts to strengthen the HIS in a state or in a country. ‘Statistics save lives’ was the bold slogan used by the HMN in their promotion of HIS strengthening. Despite such slogans, the prevailing and important problem in most countries is that health information is poorly used and that this information is made

up of data of poor quality. Poor quality data is not used, and because it is not used, it remains of poor quality. Although, however, data quality and information usage are closely linked, as only through use of data close to its source as well as through use more generally, may data quality be improved. In reality, countries struggle more with getting to the first step of generating quality data rather than the following steps of exploring ways to actually use the data.

There is a dynamic interlink between demand, supply and quality of information. If information needs are not being specified and quality information not requested by the various user groups, this information will not be provided, and use of information will not improve. An effective and proactive linkage between this demand and supply determines the quality of information, which shapes to what extent information is appropriate, timely, easily accessible, and presented in understandable ways so that it is actually used. Strengthening the quality of information requires efforts along the following dimensions:

1. **The organisational use dimension:** This concerns the institutionalisation of the processes wherein information is demanded, and its supply and use promoted. This is the basis of a vibrant 'information culture' reflecting institutional mechanisms and incentives for information usage; for example data-driven budgeting.
2. **The information system dimension:** This relates to the strengthening information practices along various dimensions of the entire information cycle (see Figure 9.1 below) required to promote information use. Use of information is not restricted to data collection or only to its actual application (action), but also to various

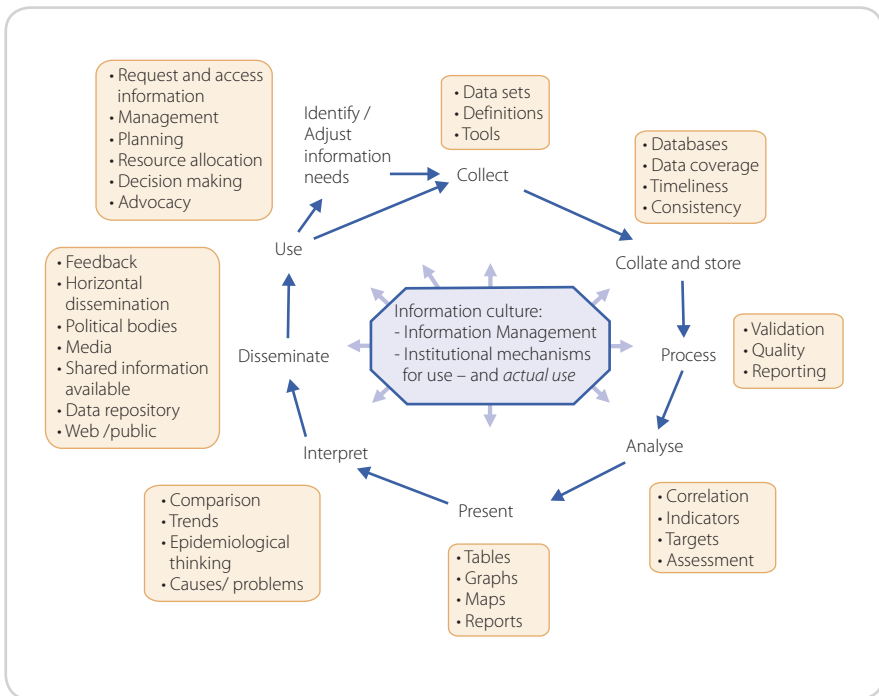


Figure 9.1 The information cycle

inter-connected practices concerning analysis, interpretation, presentation and dissemination of information. Without committed data collectors seeing that their interests are being addressed by the system, poor data will result. Further, without user participation and a sense of ownership to the information system among the users and producers, quality information and its sound use will be hard to achieve.

3. **The technical and tools dimension:** This relates to all the tools such as computers and paper-based tools, as well as standards such for data, indicator sets, and for data exchange. The presentation layer of the data warehouse discussed in earlier chapters are important in order to visualize data for users and to analyse data using maps, graphs and tables.

Strengthening information culture and the maturing of information use is necessarily a long-term and ongoing process. While in the next section we describe an example (from Zanzibar) of a participatory methodology for improving data use, in the section that follows, we generalise from this process, describing it over three analytical levels, or thresholds, although in practice there will be a multitude of ‘levels’ of information usage maturity.

## 9.3 District Data Use Workshops – Methodology to Promote Data Use

### 9.3.1 The Case of Zanzibar-Background and Methodology

Zanzibar consist of two islands called Unguja and Pemba, each of which make up a Zone in the health system, which cover 6 and 4 districts respectively. A process to revise data reporting, implement the first version of DHIS and to strengthen the HMIS more generally in Zanzibar started in 2005, and was carried out for 3 years as part of the overall HMIS strengthening project. This programme consisted of a series of quarterly data use workshops at which District Health Management Teams (DHMTs) presented their own data to their peers. Participants came from each of the 10 districts including all the DHMT members (roughly 7 per district), and the major users of data, which were the District Health Information Officers (DHIOs) District Medical Officers (DMOs) and District Reproductive Health Co-ordinators (DRCHCs). Workshops were organized by zone, with districts from both islands meeting for approximately 5 days at a time. Workshops were facilitated by external facilitators from HISP, supported by the Zanzibar HMIS unit and selected Zonal staff. The main methodology was based on three principles:

1. Each district and programme presents their own data and their peers from other districts would discuss, provide feedback and critique these presentations.
2. Comparing presentations, and identifying issues of data quality and related to health services performance across all districts.
3. Overall, the data use workshops need to be part of a larger scheme to strengthen the HMIS, enabling these workshop findings to feedback directly to the system developers in relation to both revision of datasets (longer cycle, for example, annual revisions) and to the DHIS developers; requesting new functionalities, reports, and so on. (short, ‘agile’ cycles).

As participants became more familiar and proficient with the data analysis process and the tools (for example, Excel pivot tables and graphs), the length of participation in workshops by individuals became shorter. At the same time, as more programmes started to use the DHIS (for example, HIV, TB, Hospitals, Malaria) more programme managers participated and the overall workshop duration increased.

### Achievements/Results

**Data collection:** Forms were simplified during the overall HMIS reform process, based on the revised indicator and datasets, dramatically reducing the number of data elements collected, thereby reducing workload on facility staff. This was achieved mainly by showing how various disaggregations of data (by age, gender and diseases) were not used, and by identifying and eliminating duplications. Duplication of data collection by different programmes (for example, Reproductive and Child Health (RCH) unit collecting HIV, EPI, Malaria, but not Emergency Obstetric Care) was virtually eliminated due to increased communication promoted by the workshops directed by strong leadership from the Ministry of Health.

Data submission improved considerably over the 3 years, with most districts reporting increasingly regularly on most forms. From a modest start which focused on Outpatient Department and Antenatal care, a number of additional programmes started using the DHIS, including maternity, Tuberculosis, HIV/AIDS and all hospitals, including the National Referral Hospital. Indicator set changes were negotiated annually with programmes and the number of indicators per programme being considerably reduced, though total indicators increased as more programmes started to participate. The HMIS unit, HISP and the Zones jointly negotiated with programmes to introduce changes to datasets and reporting forms, based on agreed indicators.

*Integration:* These workshops provided a stimulus for integration of the previously separate databases of PHC units and hospitals and the vertical programmes, allowing DHMT members to get a better idea of the roles played by the different actors.

Integration of programme data into DHIS was a major achievement, and by the end, there was only one national dataset that covered MDGs, poverty reduction and national strategic plan indicators as well as programme-specific indicators. This was a slow process, as the more powerful, externally funded programmes were reluctant to share 'their' data and initially did not trust quality or the timeliness of the national database.

**Data quality:** Data quality improved dramatically, mainly due to increased awareness by data collectors of data quality checks (timeliness, correctness, consistency, completeness) at facility level and follow-up by the Zonal, District and HISP co-ordinators. During workshops, mistakes were identified when data was analysed and often it was peer identification of these quality issues that made the greatest impression on participants.

**Data analysis and interpretation:** At the start of the process, most DHMT staff (and even HMIS/HISP staff) did not think in terms of indicators and presentations were on raw data rather than on indicators. As the workshops continued and a cadre of officers competent on HMIS developed, and data analysis tools became more widely used and understood, 'epidemiological thinking' became stronger. The link between goals, targets and indicators was emphasised, contributing to increasing analysis

and use of indicators at the local level. For example, while initially most programme managers did not analyse service delivery interventions, but with this growth of capacity and perspective, various examples of information analysis and use could be found, such as:

- RCH unit developed indicators to monitor Emergency Obstetric and Neonatal Care (EmONC), availability and quality of Antenatal Care (ANC), introduced Maternal death audits and developed indicators to monitor quality of skilled birth attendant coverage. They also introduced the concept of Couple Year Protection to measure uptake of family planning services.
- Malaria programme placed increasing emphasis on ITN (bed net) coverage, Malaria in pregnancy as well as clinical treatment of confirmed cases – for example, reduction of Pemba malaria incidence by 80% by convincing the military hospital to use Rapid Diagnostic Tests (RDTs).
- Expanded Programme on Immunisation (EPI) investigated high dropout rates and coverage over 100%.
- HIV/AIDS and STI reduced excessive data categories and age groupings when they realised that 90% of the different categories had zero data.
- Hospitals were stimulated to improve systems to:
  - ◆ Collect basic inpatient indicators like Average Length of Stay and Bed Occupancy Rate.
  - ◆ Focus on emergency obstetric signal functions, not just complications.
  - ◆ Include laboratory data to check quality of diagnosis, particularly of Malaria.
  - ◆ Report OPD data elements identical to PHC, enabling meaningful comparisons.
  - ◆ Streamline special clinic data and add it to the database.
  - ◆ Implement data flow guidelines and send data to Districts (not to Zones as before, which bypassed the district).
- Human Resources developed workload indicators to measure staffing needs.

**Other results:** Use of the database for analysis, presentation and dissemination improved, along with understanding of basic hardware and software maintenance, virus protection and backups. Active interaction during workshops gave developers new requirements from users to develop, and developers could see weaknesses in context, such as related to local configuration.

Presentation skills were initially weak, with DHMT members unused to drawing graphs, using power point, engaging in debate or offering constructive criticism. These skills improved dramatically as the workshops continued, and when the HMIS unit and HISP developed standardised templates for presentation.

**Overall results:** The data use workshop methodology, first developed in Zanzibar, is general in nature and has later been introduced and used also in other countries, such as in Kenya, where the aim is to make them a ‘compulsory’ part of the quarterly review process.

The Zanzibar example describes a process of maturing of information usage from which we develop some general principles relating to the maturing of information use.



## 9.4 Three Levels of Maturing Information Usage

Maturing of information use, as described above, must necessarily be viewed in a process perspective, which will take years and not months to nurture. Both the dimensions of organisation use and information systems need to be cultivated over time and in conjunction. For example, even if high-quality data are produced by strengthening the information systems dimension, this may not necessarily result in their effective use in decision-making, which requires making the organisation-use dimension more proactive and accountable. Examples of some of these measures would include:

- Developing mechanisms for linking data/information to actual resource allocation (budgets).
- Developing indicator driven short (1 year) and medium-term (3–5 years) planning.
- Establishing organisational routines, where managers are held accountable for performance, based on routine and/or survey-based health indicators at all levels of the health system.
- Addressing behavioural constraints, for example, through the use of incentives for data use, such as awards for the best service delivery performance for the most improved district, or for the best HIS products utilisation.
- Providing a supportive organisational environment that puts a premium on the availability and use of data for decision-making.

All these measures are fundamentally concerned with processes of organisational change, and history and experience tells us these are hard to achieve and takes time. For example, even after setting up an information system that can competently convert data into information (a relatively short-term task), this information needs to be used on a regular basis at meetings, displayed on walls for staff and the public, as well as disseminated to politicians and managers in health-related sectors. These involve creating new practices, and for people to give up their existing ways of doing things, which due to human and institutional nature, are difficult to achieve in practice. By definition, these change processes involve learning through cyclical iterations involving design, action taking, reviewing outcomes, and making required revisions. By learning through hands-on experiences, problems are identified, new needs are defined, new features are added, which with the next cycle around can be criticized and improved.

This process of learning, is described at three levels, and is operationalised through the TALI tools (see Annexure 1), which has also been discussed earlier. These three levels and the characteristics of HIS are discussed below.

### **Level 1: Technically working information system, emphasising data completeness:**

Data flows are established with high levels of completeness of data reporting and data are of reasonable quality and basic data quality control procedures are in place. There are designated 'Information officers' in place with job descriptions placing responsibilities for information handling, data reporting and data management at all levels. At the central level a HIS unit is in place. Even within this level, there can be different degrees of sophistication, for example, reflected through the ability of the system to synthesise data from multiple sources, the capacity to examine inconsistencies and contradictions, and be able to summarise and synthesise this

into a consistent assessment of the health situation and trends, including the burden of disease, patterns of risk behaviour, health service coverage, and health system metrics. Establishing a data repository as a shared resource at national, sub-national and district levels is, therefore, an important step in improving information practices. Data completeness and timeliness are key indicators for assessing this level.

**Level 2: Information system characterized by analysis, use and feedback of data:**

Summary reports using graphical tools and maps (where appropriate) on key indicators for the facility or district are produced every month and disseminated to all relevant stakeholders and fed back to the facility level. Information is used and discussed and indicators are assessed against performance targets on a regular basis at review meetings, staff meetings, and so on. These practices are towards creating an information culture, where information is actively used in the running of the health services, programmes or districts. This level of information usage is indirectly about data quality, as active data use is the only way to ensure data quality – only by analysing and using the data in relation to the local context, it is possible to verify the data and ensure data quality. Indicators to assess this level of information usage are the availability of analysed and disseminated information; graphs on the wall, monthly/quarterly bulletins, presentation of information at review meetings, and the creation and dissemination of feedback reports. In short, there are ‘conversations’ taking place around data.

An important aspect of this level, is the ability of the system to recognise the multiplicity of users and functions it needs to support. Users range from those delivering care to those responsible for the management and planning of health programmes, including those financing and external donors. Users of health-related data are thus not confined to health care professionals or statisticians, as often is the assumption in the design of HIS, which ignores also the informational needs of the wider community, including civil society as well as policy makers at senior levels of government. They have varying information needs in terms of the level of detail and technical specificity required. For example, health care planners and managers who are responsible for tracking epidemiological trends and the response of the health care system, generally require more detailed data than policy-makers who need data for broader strategic decision-making.

**Level 3: Information system shows evidence of impact on decision-making:** This level is about moving towards an active use of information in planning and evaluation, and the institutionalisation of these processes in the practices of the health system. While of course it is hard to assess such impact of information, but we would expect such information usage to be documented in the evaluation of achievements as according to annual plans, and the using of information to follow-up on planned activities. This level of maturity is also reflected in information use for diverse and higher levels of sophisticated impact assessment such as budgeting, resource allocation, equity management, and performance measurement. Bringing together a comprehensive analysis of the health situation and trends with data on health inputs, such as health expenditure and health system characteristics is particularly important. Such analytical work requires planning and investment and institutionalizing this work as a joint activity of multiple constituencies in the country.

In summary, this three-level roadmap highlights the criteria to achieve different levels of information use maturity. We now present certain country examples from where

we have been engaged with to illustrate these different levels of maturity. While these examples necessarily span these different levels, we tend to emphasise one primary level for purposes of illustration.

## 9.5 Achieving Level 1: Technically Working Information System, Emphasising Data Completeness

### 1. Example from Kenya

In a traditional implementation phase, users and support staff are trained to run and maintain the system. In Kenya, the initial rollout of the system included basic training, 'homework', on-site supervision and refresher training. Table 9.1 summarises the process followed.

Table 9.1 Training process to establish Level 1 information maturity in Kenya

Weeks	Generic rollout activities and schedule for each training unit (not more than 50–60 people) – This is to establish the new system technically.
Week 1	<i>Activity 1:</i> One week training of information officers, and introducing them to DHIS2. Bring own data for practicing data capture. All general aspects; data entry, evaluation and report generation – data completeness first focus. Homework specified: Enter backlog data and report generation
Week 2–4	<i>First homework session:</i> Duration 2–3 weeks. Entering data for 2011. Run evaluation and data quality checks. Generate data completeness reports. Systematic follow-up of data completeness. Make analysis, report and plan for ensuring data completeness. Also more general report generation.
Week 4–6	<i>Activity 2:</i> On-site follow-up 2–4 weeks after training. All districts to be visited. On-site refresher training and problem solving. Meet with District Medical Officers Health (DMOH), present the project and discuss and 'sensitise' how DHIS2 rollout can support management and how DMOH should be in charge and require good information. Training in report generation and use of DHIS2.
Week 5–10	<i>Second homework session:</i> Duration about 4–6 weeks.
Week 10–12	<i>Activity 3:</i> Three days refresher training and review meeting with managers. Information officers present analysed data and managers feedback on their information needs. DMOH should participate in at least one of the three days. Repeat training on all aspects of DHIS2 use with focus on report generation and data analysis and use. Including pivot tables which are important part of data analysis and use.
Week 11–12 onwards	<i>Third homework session:</i> Guidelines and procedures for data management, report generation and information dissemination for districts, hospitals and other facilities will be developed, including job descriptions for District Health Record Information Officer (DHRIO) and Health Record Information Officer (HRIO) in terms of tasks to be performed every months and quarter, how information should be disseminated, etc. This third homework session will represent an effort to institutionalise these new guidelines.
Week 16–20 All review meetings	<i>Activity 4:</i> Data use workshop, including DHMTs and programme managers from Province. DHIS2 trainees are convening for two days practicing before, preferably, the quarterly review meeting. Alternatively, we conduct normal three-day session with participation from DMOHs and other managers. Use and analysis of data will be sought institutionalised by applying key elements of the 'Data use workshop' methodology to the quarterly review meetings that are held at all levels in Kenya every quarter.

In the initial phase, all efforts were geared towards getting the data in, and data completeness was the key indicator used to monitor progress. This was done through an online and a constantly updated ‘League Table’ comparing completeness across reporting units at the same level (districts, counties, provinces). This stimulated a competition amongst districts who wanted to be the best, inspiring them to make extra efforts to get the data capture done quickly and efficiently. The Figure below shows one such league table from Nyanza province.

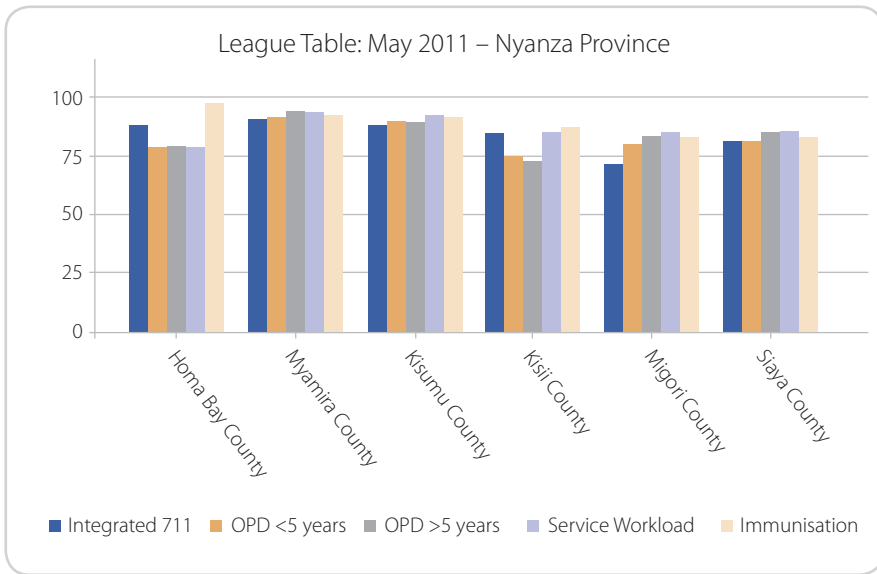
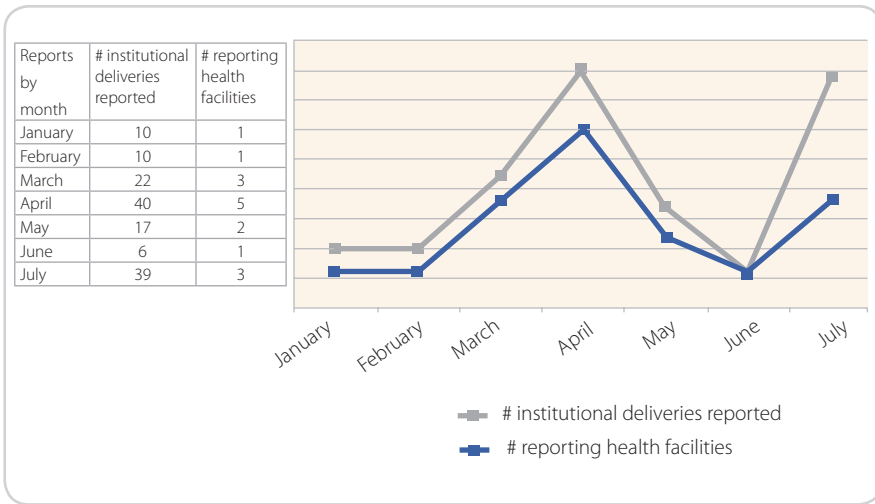


Figure 9.2 League table Nyanza, Kenya comparing data completeness between counties

### Example 2: Mozambique

Another example from early 2000 from Niassa province in Northern Mozambique illustrates the significance of data completeness. Studying the data at the provincial information office, we found data to fluctuate much more than what seemed natural for particular months. As the districts were reporting aggregate district totals it was not possible to drill down to the facilities and investigate the reason for the fluctuation. One example was of the number of reported institutional deliveries in Mecula district, for the first 7 months of the year (see Table below) where figures fluctuated between 6 and 40. It could of course be due to rain in January and February, that mothers could not reach the facilities, we reflected. But when visiting the district office in Mecula, we found that the fluctuation was simply due to a similar variation in reporting, as the changing numbers of deliveries correlated with the number of facilities reported. The only thing that we could read from the data was that the rain prevented the reports to be submitted, about the deliveries, we know nothing about. The Figure below could be seen as telling the obvious, namely that data reported was a function of the number of facilities actually reporting. That may be so, and that is the purpose; to demonstrate that data completeness is an extremely significant dimension of data quality. Further, it is important that the information system allows the ability to ‘drill-down’ to assess the quality of the data in the system.



**Figure 9.3** The importance of completeness: Correlation between number of facilities reporting and total reported deliveries. Table and graphical representation where the number of facilities are multiplied with 6 to provide similar scale

### Example 3: India

Data quality problems are often seen as something ‘bad’ requiring normalisation and correction. However, a mature HIS should not recommend normalisation without drilling down to the root of the problem, and understanding the information hidden within a data quality aberration. Often, there is important information there, requiring analysis as a public health event, rather than normalisation as a statistical artifact. For example, in India we found a higher number of polio cases being reported from a certain state, which was surprising as Polio Surveillance studies had not shown such figures. While trying to understand the why for this, it was found that Acute Flaccid Paralysis (AFP) cases were being reported as polio cases as the HIS had no data element to record AFP cases. This then highlighted certain systemic issues:

- The need to align reporting to a single window (Polio surveillance and HIS figures to be synchronised).
- To establish institutional ownership of data reported.
- Data entry operators to be trained to understand basic data elements such as:
  - ♦ The difference between AFP and Polio cases.
  - ♦ To raise a red flag when abnormal figures are identified.

A level 1 system should allow drill down to enable more granular analysis on the quality of data – the what of the reports? Particularly alarming is the picture, as seen in many countries, including India and Tajikistan, where we have had first hand experience, with respect to the percentage of zeros reported. For example, in India, on an average districts tend to show 25% to 40% completeness; while in Tajikistan, this figure was about 10%. However, on drilling down on these filled values a more alarming picture emerges with respect to ‘zero’ values, showing a significant drop on completeness. See for example, Table 9.2 from one state in India.

Table 9.2 Data completeness with and without ‘zeros’

<i>District</i>	<i>Nov % (with 0s)</i>	<i>Nov % (without 0s)</i>	<i>Dec % (with 0s)</i>	<i>Dec % (without 0s)</i>	<i>Jan % (with 0s)</i>	<i>Jan % (without 0s)</i>
District 1	99%	20%	75%	16%	11%	2%
District 2	53%	17%	52%	18%	53%	17%
District 3	74%	13%	78%	14%	84%	19%
District 4	15%	10%	11%	6%	91%	12%
District 5	26%	10%	27%	11%	26%	11%
District 6	28%	6%	8%	5%	3%	2%

The reporting of zeros per se need not be bad, and can reveal pertinent information requiring further analysis. The reasons could be that either a service which should be available in a facility is not available, and is thus being reported 0; or, the data is just being entered as 0 to fill in the numbers. Either case is problematic, and needs to be investigated by field visits to examine primary registers and to educate the service provider and data entry operator on the different implications of a zero, blank and a non-reported figure. Data (in)completeness may not be uniform across all data element groups, as Table 9.2 below depicts.

Table 9.2 Variations in completeness across data element categories

<i>Data element category</i>	<i>Data filled % (Nov to January average) including 0s</i>	<i>Data filled % (Nov to January average) excluding 0s</i>
JSY (an incentive programme for pregnant mothers)	76%	67%
Delivery	46%	15%
Pregnancy outcomes	60%	29%
PNC	54%	26%
MTP	42%	0%
RTI/STI	45%	6%
Family Planning	52%	19%
Immunisation	72%	57%
ANC services	62%	39%

These figures show relatively complete data for immunisation, poor data on delivery and pregnancy outcomes (see data excluding 0s). Worrying is MTP data where 46%

of data is reported, but all these values are 0s. Since different groups of data are the responsibility of different programmes, understanding the weak spots helps to identify areas of focus.

With respect to data quality, often, the larger challenge is often related to who defines the problem and how. When there may be an agenda of some to discredit the HIS, it gets branded as a problem of data quality instead of as a symptom of deeper institutional conditions, which need correction. This is harder to do and requires long-term measures rather than the quick fix methods of normalising aberrations. A mature HIS should constantly be engaged in carrying out increasingly fine grained analysis, including on the following dimensions:

- Patterns of data across provinces and districts, drilled down to the facility level.
- Patterns across periods, helping to identify seasonal variations.
- Patterns across data element categories.

The HIS becomes a valuable tool to carry out the analysis of patterns which helps to distinguish between data and health programme artefacts. A data artefact reflects a problem in data such as a typing error or a deliberate changing of the figures, while a programme artefact indicates that the data is correct and it reflects issues in the health programme component. For example, as in the table above with the example of MTP, the problem could actually be that services are actually not available. However, to be able to carry out such an analysis, the HIS needs to be treated not as the source of the problem where people are making typing errors or manipulating numbers, but as a tool to be used to drill down to and analyse the problem and identify alternative explanations of the situation. This requires a reformulation of the perspective towards HIS, wherein data issues are not branded as reporting errors and manipulation by users but a reflection of the conditions of the health system.

This reformulation then requires also a fundamental shift in who carries out such analysis. Statisticians who see the situation primarily from the lens of 'data' may not be addressing the public health context that shapes the data, and the analysis of statistical trends thus necessarily needs to be complemented with a public health interpretation. Else, we may continue to be addressing the wrong problem, and reprimanding state and district staff for problems out of their control, and their response is in the form of a 'normalisation' of data, which does not show up as an outlier painted in red on the Excel sheets.

In summary, increasing maturity of a HIS reflects a growth in capacity to carry out fine grained analysis of variations across facilities, time, data element groups and types of data values – zeros or blanks. Further, the HIS should allow to distinguish between data artefacts and programme artefacts, and examine data as a public health event and not just as an isolated statistical element.

#### Example 4: Analysing based on 'Life Cycle Events' from Mozambique and India

Completeness of data is a key indicator for assessing the functional quality of the HIS. 'Eyeballing' is a first level approach to scrutinise data quality based on experiential and public health knowledge to identify obvious anomalies, outliers and otherwise suspicious values of data. A way to approach eyeballing in a more systematic way, which we may call as rapid data assessment techniques, by comparing data across related programmes and with denominator data and target populations:

‘The life cycle data assessment technique’ is one such way to examine programme data related to the numbers of pregnant women (ANC clients), deliveries, infants for BCG and measles vaccinations, and various types of post-natal controls. We illustrate this approach with an example from Mozambique using official data for 2003 from the EPI and MCH programmes from three administrative levels, including:

- Three health districts in Niassa province.
- The whole province (Niassa).
- The national level.

Further, the database included population data, which was based on Mozambican 1997 Census projections (see Figure 9.3). In terms of coverage rates, which by definition cannot exceed 100%, the figure shows significant over-reporting of ANC visits and BCG, sometimes even three times the target population. Furthermore, the figures also indicate that the health services or data, are not correlated across these related events. For example, in Niassa province while ANC coverage is nearly 200% (which is not possible), while at the same time reporting about 100% coverage on Polio 0. Both the ‘perfect’ results on Polio and the improbable result on ANC coverage show problems in data or programme conditions or both. If seen together, and assumed correctly reported, these two figures indicates that only roughly 50% of the expected babies are given Polio 0. This example shows the importance of the MCH and EPI programmes to discuss and correlate their data to jointly identify anomalies in data and to also assess effectiveness of programme delivery.

Adding together erroneous numbers from local levels gives wrong aggregates at the higher levels. For example, the national figure for ANC shows nearly 100% coverage, which is perfect. However, given that this figure includes an incorrect figure of 200% coverage in Niassa, one of the 11 provinces in the national aggregate, we can conclude that the national figure is incorrect.

There is a stark dropout between the first ANC visit and institutional deliveries. For example, in Marrupa district, only 20% of the women attending the first antenatal visit, had an institutional delivery. Similar dropout rates can also be seen in other districts, province and at national levels. This raises questions about the quality of services being provided, including facilities to travel long distances, lack of maternity waiting homes, and other cultural and social factors, in addition to the quality of data. If ANC visits are over-reported, and institutional deliveries are not, then the dropout would be shown to be less. These are issues that should have been checked when ‘eyeballing’ such data in the first place. Lichinga is the province capital with the provincial hospital and see many referrals for deliveries. The dropout from ANC to delivery is therefore much less here.

The pattern that BCG is higher than Polio 0 is driven by the fact that, while Polio 0 and BCG (ideally) should be administered right after birth, given the low institutional delivery rate, the higher number of BCG is because it can be administered at any time before 12 months of age while Polio 0 must be administered within 6 weeks from birth. In Marrupa district, we see that, despite this explanation, the BCG data is wrong. BCG doses given is systematically over-reported, which may be partly due to wastages of vaccines being reported, and for BCG a vial of several doses need to be used the same day, providing an incentive to reduce wastages.



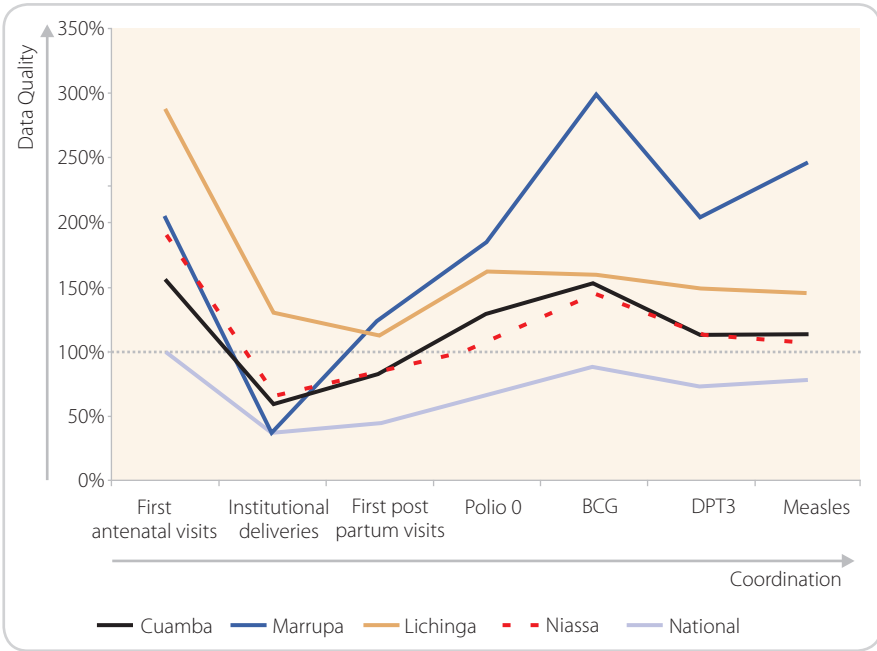


Figure 9.4 Graphical representation of data from ‘life cycle events’ of MCH and EPI programmes in Mozambique. Data from three districts – Cuamba, Lichinga and Marrupa in Niassa province, Niassa province and the country, for 2003.

We use the same approach to analyse data from India (see Figure 9.5). While in the example from Mozambique, we used institutional deliveries, in India registered births was used as the reference. We see a stark dropout between ANC clients and births, and a similarly sharp increase in the numbers of BCG doses given, and a slight decrease in measles doses. This indicates that a significant number of births are not registered.

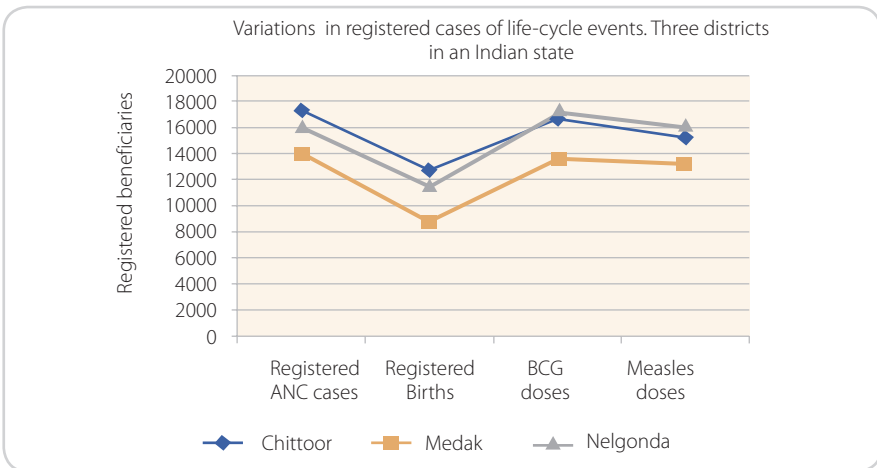


Figure 9.5 Three districts in India; reported data on the ‘life cycle events’; ANC cases, registered births, BCG doses given and measles doses given.

This life cycle events approach to data analysis described here represents a good way to identify both target groups missing services and missing data. In the examples used here, the focus has primarily been on identifying data incompleteness, and may therefore be seen as a method used to see to what extent Level 1 in data use is achieved. This also represents a more general approach to present, discuss and make sense of data, a precondition for achieving Level 2.

## 9.6 Achieving Level 2 – Improving Information Analysis, Use and Dissemination

Example: Sierra Leone

While Level 1 deals with establishing technical systems and data completeness, Level 2 reflects a higher level of maturity in analysis and dissemination of information. We present an example from Sierra Leone showing efforts towards achieving Level 2.

The process in Sierra Leone started in a post-war situation of very poor infrastructure and general conditions, and obviously, from a very low level of information availability and use. The challenge was then: How do you promote use of information for decision-making in a setting where this has earlier been lacking? Three years of efforts in Sierra Leone can provide some examples of both grand strategies and concrete measures to achieve this. First, it is seldom a question of introducing completely new concepts. Nurses, doctors, and health managers use information all the time, the issue is rather to change from informal, adhoc, ‘gut-feeling’ management based on incomplete, and often mistrusted, data, to a more systematic, transparent reliance on complete and up-to-date information. Linking a dormant demand to a new supply of quality data was the strategy followed in Sierra Leone from 2007 onwards.

Main efforts in Sierra Leone evolved around capacity building, improving data quality and disseminating information and turning it into use. In short, to increase the amount and quality of data available for use, while at the same time train staff at all levels to process, analyse, present, disseminate, interpret, and evaluate this data. These processes can be self-reinforcing, as limited use is often the root of poor data quality, and vice versa. The use of data is necessary to create the incentives for improving quality, and good quality is necessary to sustain use. The first step in improving the system was to improve completeness and quality of data through disseminating the data and ranking the districts from worst to best performers of data reporting by using so-called league tables, which quickly became a popular way to compete about having best data. Since the early focus was on improving data quality, a couple of the indicators were on that, awarding data completeness and consistency of data (which could be checked by validation rules in the DHIS2 software). The Table 9.3 gives one such example of a league table for districts.

The league tables were widely disseminated through quarterly Health Information bulletins and had immediate effect on data completeness, which improved quickly. The reporting rates for most districts quickly rose to above 90% (of facilities providing key reporting forms to the districts), for several districts, and by 2010 almost for all. The distribution of league tables to the districts in terms of feedback, while initially causing some stir due to the sudden visibility in the ranking of districts, also contributed the districts to start using information more for planning. The picture shows the front

Table 9.3 League table comparing districts from Sierra Leone

<i>League table of district performance, January to April 2009</i>							
	<i>Data</i>	<i>Data quality 1</i>	<i>Data quality 2</i>	<i>Penta 3</i>	<i>Deliveries in PHU</i>	<i>Services/clinician</i>	<i>Total score</i>
Pujehun	99	3	3.6	102	60	20	19
Bonthe	66	7	0.9	111	52	11	15
Kailahun	98	6	1.3	65	30	11	15
Kenema	85	6	1.7	75	38	12	15
Bombali	47	8	2.1	75	30	15	14
Moyamba	97	7	0.4	85	44	9	14
Kambia	60	7	0.6	79	33	12	13
Western	88	8	0.7	92	26	6	13
Bo	45	8	0.8	46	37	12	12
Kono	92	8	0.4	70	27	9	12
Port Loko	67	7	0.6	87	24	12	11
Tonkolili	19	6	0.6	102	38	18	11
Koinadugu	32	6	0.3	80	31	13	9

page of the bulletin from 2010, which is focusing on analysing information on, in this case, immunisation. In the following Figure 9.6 provides an example on active use of information in Sierra Leone.


In 2009, Western Area (mostly consisting of the capital Freetown) was one of the districts scoring very low in term of institutional deliveries. Being very concerned by the poor performance of his district, the District Medical Officer (DMO) in Western Area decided on two strategies to improve.

To collaborate with private facilities (of which the district has many more than more rural districts) to get their data on institutional deliveries.

To release a note in the newspaper informing the public that maternal and child health care was now to be free of charge in Western Area district.

As shown in the Figure 9.7 below, institutional deliveries have increased steadily in the district. The free maternal health care policy could not alone explain this increase, the involvement of private facilities has to be taken into account. But, in any case, the results were remarkable and soon distributed globally by the HMN as a strong case for investing in HIS. The new figures, in turn, helped them plan well and advocate for adequate resources for the district.

Better Information,  
Better Decision, Better  
Health



This bulletin provides statistics from the District Health Information System (DHIS) through routine data collected by facility workers of the Ministry of health & sanitation of the Government of Sierra Leone.

**Government of Sierra Leone**  
**Ministry of Health & Sanitation**  
**Health Information Bulletin**

**Volume 2, Number 1**

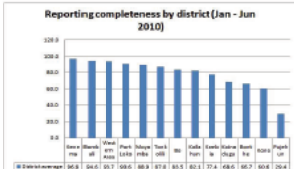
**Jan-Jun 2010**

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### 1. Reporting Completeness

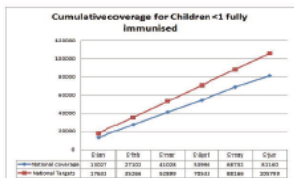
The District Health information System (DHIS) manages data from 5 key data collection forms submitted monthly by each health facility to report on services, stocks and HR. Statistics generated from this system permits district and national officials to continually monitor health care services including those related to the Free Health Care (FHC). Figure 1 shows the reporting completeness by district for the first half of 2010. Overall, 80% of health facilities reported for the first 6 months of 2010. Only 4 districts (Koinadugu, Bonthe, Kono & Pujehun) had less than 70% reporting completeness (see figure 1), a remarkable improvement from the 30% rate in 2007. There is a need to support the districts to sustain and even improve on this rate so that effort in 2011 could be focus on improving timeliness and data quality.



**2. Child Health**

#### 2.1 Immunization

The objective of Immunization program is to see that all children are fully immunised before their first birthday. A child is certified as fully immunised if he/she has received full doses of following vaccines according to schedule: BCG, 3 doses of OPV and Pentavalent vaccine, a dose of measles and yellow fever vaccines. Figure 2 clearly shows that the immunisation coverage for the second quarter of 2010 (the period after the launch of free health services) seem to show a downward trend rather than the desired increment. There is need to review this trend and institute necessary measures to improve on coverage. This is because, the higher the fully immunized coverage (FIC), the higher the herd immunity of the children which is a strong guarantee reduction in mortality and morbidity due to vaccine preventable diseases.

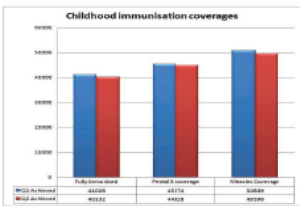


#### 2.2 Underfive Consultation

Treatment of <5 children with ACT within 24hrs of onset of fever reduces the possibility of malaria becoming complicated and leading to death. As seen in figure 4 below the ACT uptake amongst under-five children increased considerably with the launch of the FHC by 148% in April further rising to a peak of approximately 372% in May and tapering down to 272%. The sudden increase in May could be related to the FHC and the decline may be as a result of patient flow regularising itself after the FHCI euphoria or distortion in the supply line of the ACT. In its fight against the key killer disease the Ministry has adopted several strategies including the use of com-

#### 2.1 Immunization

**Childhood immunisation coverages**



As seen in figure 3 above, the country is progressively slipping further from the set immunisation targets which are underscored by the same trend for two anti-gents (Penta3 and measles coverage).

Figure 9.6 Front page of a Quarterly Health Information Bulletin from the Ministry of Health, Sierra Leone, 2010

Districts also had their monthly review meetings, and following the example of the bulletin and league tables, several districts started to make chiefdom league table, ranking the sub-districts (chiefdoms) in a similar way. These review meetings were attended by all district stakeholders such as health partners, community counsellors, health providers, traditional and religious leaders, and so on, and have led to the plethora of locally driven initiatives on improving service delivery in their respective communities. The development of district and chiefdom league tables covering

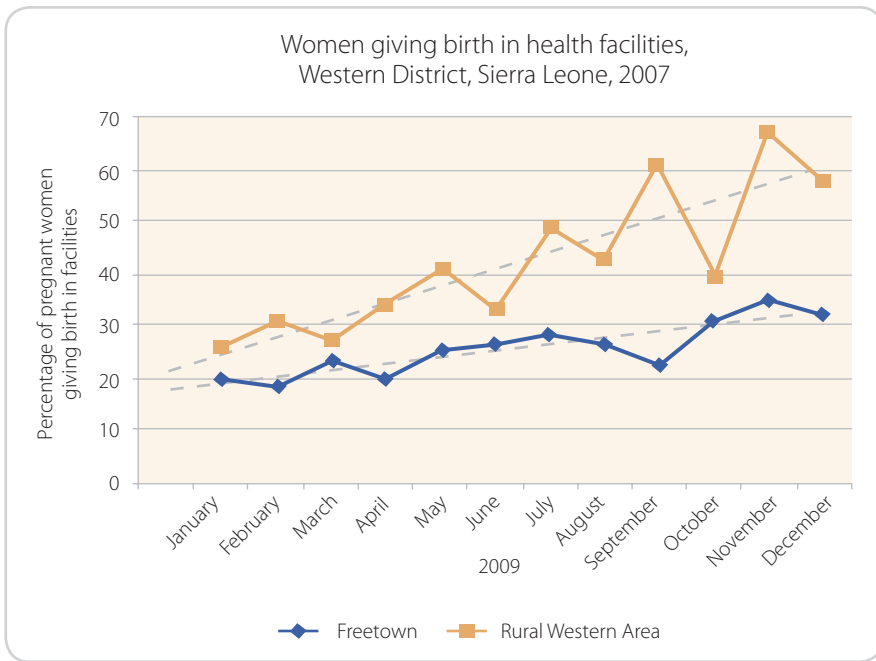


Figure 9.7 Increasing institutional delivery rates in Western Area, HMN Results Report (2010)

important health indicators, the active dissemination of these, and discussions with key stakeholders on how to improve on these indicators form the highlight of such review meetings. For instance, the use of the chiefdom league table showing performances of each chiefdom on key health indicators (such as institutional delivery, fully immunised children, and so on) in Moyamba district raised a competitive feeling among the local communities. Table 9.4 shows an example of chiefdom league table.

In this case, Kongbora Chiefdom, after coming last in the first quarter review, improved to take the first place in both the second and third quarter reviews. Fakunya Chiefdom was the sixth in the first quarter review, but improved to take second and third places in the second and third quarter reviews. Dasse Chiefdom was eighth in the first review meeting but took third and second places in the second and third quarter reviews. Certificates of this, provided to the paramount chiefs at the review meetings, were brought to local council meetings as proof of good performance, as shown in the Figure 9.8.

By comparing themselves and knowing more about health indicators, local community leaders decided to better organise health service delivery in their community and put more pressure on upper level for more resources and more support. In many communities, local counsellors started putting in place bye-laws for the Traditional Birth Attendants (TBAs) to help pregnant women deliver in the health facility, where they can have a clean and safe delivery with trained staff in attendance. The DHMT also organised outreach activities eagerly requested by community leaders (Paramount chiefs) after the review meetings to increase the coverage for key health outcomes like childhood immunisation. Some communities have also used these meetings to

Table 9.4. Chiefdom league table in Moyamba district, comparing data between those sub-district traditional units.

Chiefdoms	% Full Immunised 2nd Quarter	% PHU Delivery 2nd Quarter	% 3rd ANC Visit	% 2nd Dose of IPT	% MMRC Submitted	% Exclusive Breastfeeding at Penta 3	Average Score	Ranking
Kongbora	98.2	45	170.9	96.6	86.6	93.3	5.3	1
Fakunya	124.3	62	154.3	86.2	100.0	48.1	5.0	2
Dasse	134.9	57	90.5	86.3	100.0	45.9	4.8	3
Kaiyamba	90.3	55	162.7	93.4	75.0	71.3	4.8	3
Timidale	140.3	46	106.8	91.7	91.7	33.0	4.8	3
Kowa	118.4	52	96.5	46.7	100.0	78.2	4.7	6
Lower Banta	88.3	48	201.6	120.8	100.0	35.6	4.7	6
Bagruwa	61.4	37	110.3	92.4	93.0	32.1	4.3	8
Kamaje	55.6	35	69.7	140.7	100.0	86.5	4.3	8
Kargboro	80.4	45	93.2	77.6	100.0	36.5	4.3	8
Kori	49.8	40	92.6	89.4	86.6	64.0	4.3	8
Ribbi	71.8	26	53.7	57.4	100.0	60.5	3.7	12
Upper Banta	61.1	29	68.0	101.2	77.8	38.6	3.7	12
Bumpeh	54.9	29	73.8	38.2	100.0	28.3	3.2	14
Total	91.4	43	114.3	32.4	93.6	20.8		



Figure 9.8 P. C Banya (Kongbora chiefdom) with chiefdom league table certificates (2nd and 3rd quarters) at Moyamba district council monthly meeting, where health and other local issues are discussed

advocate for more resources (human, financial and infrastructure) in order to address the low uptake of services in their catchment areas. In some chiefdoms, where institutional delivery rates were low, the paramount chiefs mobilised local resources to build birth waiting homes where pregnant women staying far away from health centres could stay until they delivered.

Involving the communities, including religious leaders, traditional health service suppliers, and the paramount chiefs, the districts started to improve institutional delivery rates, an efficient strategy to reduce infant and maternal mortality. The Moyamba DMO was very proud of the interest expressed by the community members who were now determined to improve service delivery coverage in their communities. 'Using the data from the DHIS for the quarterly review meetings, the population could better understand the health services performance and were happy and interested to be involved' claimed Dr. Kandeh, the Moyamba DMO, 'without their interest, we could not move forward and have high performance'. Being able to show improvement in service delivery by using health information at district level, regularly shared with key stakeholders, led to a major change in prioritizing health services with community involvement.

The possibility of being part of a larger set of other communities made it easier for local communities to compare themselves with neighbouring communities which in turn triggered the propagation of best practices leading to improvement of health services and high performance. While the data quality shown in table 9.4 is obviously an issue, as seen from the rather wild percentages for some of the chiefdoms, this triggered a review into denominator data such as population figures, which tended to be outdated and not taking into account recent migrations.

## 9.7 Achieving Level 3 – Information for Decision-Making and Impact

Action means that information should have impact – in decision-making, planning, allocation of budgets, evaluation of planned activities and in strategy and policy formulations.

### Example 1: South Africa

Information use in South Africa has gradually moved through the three levels of focusing on:

- Completeness and quality data.
- Data use for analysis.
- The current trend of actively using information for improving the health services.

Data and information form for the HIS is now used for planning purposes at all levels of the health system such as for annual performance plans, their formulation and evaluation of achievements according to plans. All districts are engaged in expenditure reviews, where financial data on expenditures and data on human resources, which make up the major financial input, are used alongside more traditional ‘HMIS’ data on performances of the health services. The planned introduction of the National Health Insurance will represent the next challenge for the HIS, as such a scheme will include a close relationship between data on health services delivery and budget allocations.

Increased granularity of data important for annual performance planning and expenditure review is a general trend in South Africa; when data is actively used, the users will always tend to require more details and better quality, for example, more data derived from individual records of TB patients and patients with chronic diseases.

### Example 2: Thailand

Thailand has a population of 66 million people and is divided into 75 provinces and 795 districts. The HIS in Thailand may be regarded as a best practice among mid-income countries and uses an extensive Internet and ICT infrastructure that reaches all districts and most of the health facilities. Data on individual patients is captured electronically in most health facilities and standard datasets are submitted online to the central, from where feedback and key information for the management of the health services is accessible through the web ([http:// eng.moph.go.th](http://eng.moph.go.th)). The health system works well, and according to the 1997 constitution, every Thai has the right to health care. From the inception of the universal coverage insurance scheme in 2001, there was a tremendous push to improve data quality, in order to, justify the decentralised distribution of funds based on capitation costs (paid per capita) for prevention and health promotion and for direct costs for hospital and high-cost patient care. The National Health Insurance Scheme has established a system of contracting units (CUPs) in each district, consisting of a hospital and their network of clinics, which are then paid for the services they are rendering according to the data submitted. The actual payment, quality control, and accounting are decentralised to the province level. The CUPs are provided with Internet and computers as part of their payment. Two sets of standard national data are identified:

- The first covers community services and is made up of 18 sub sets including immunization, family planning, disease surveillance, chronic diseases, and so on.



- The other covers hospital services and consist of 12 sub sets including inpatients, outpatients, patient payment, referral, and so on.

As more and more districts got adequate Internet and web access over the last 10 years, interchange of data and information between local and central levels has become increasingly robust and scaleable and providing high quality data.

The Thai system was initiated and built, in order to solve one very specific problem – the model for financing the health services. The data required for this purpose turned out to be useful for other purposes as well. In Thailand, there is a maturity around the use of information that can be gauged from the fact that the information is being used to support the everyday working of the health department as well as national initiatives of ‘Healthy Thailand’, and the national insurance scheme. The key to improved information use in Thailand is the direct linkage between payment of contractors and the routine reporting of services delivered. Regular surveys are used to triangulate accuracy of routine information.

Thailand also reflects a strong culture of information dissemination in the form of books, periodicals and journals. The annual Thailand Health Profile is a particularly impressive consolidation of a wealth of information from numerous data sources within and outside the Ministry of Health. Web-based dissemination is also very strong in Thailand.

The direct links between information and resource allocation in Thailand and gradually also in South Africa have radically increased the potential for ‘internal’ advocacy, where managers at lower levels use information to argue for higher budgets, more staff, better equipment, reforms, and so forth.

Summarising the two cases of Thailand and South Africa, we may conclude that the ‘holy grail’ of promoting analysis and use of information is clearly to link information to resource allocation (budgets) as well as developing indicator-driven short- and medium-term planning. We now discuss some emerging trends with respect to information for decision making and impact.

#### Payment for performance programmes and their link to information

We saw that in Thailand, the link between performance of the health services and payment for these services was established and managed through the use of information. Without quality data on performance, the insurance scheme in Thailand cannot work. Such national insurance schemes, however, may still be too expensive for most developing countries, but efforts to link performance to funding is nevertheless being explored by donors and administrations alike. In this section, we explore this growing trend.

With the increasing global prominence of initiatives like the MDGs, President’s Emergency Plan for AIDS Relief (PEPFAR), Global Fund and Global Alliance for Vaccines and Immunisation (GAVI), focus is very much on what have been the impacts of these programmes, on outcomes such as reducing maternal and child deaths, or on improving health access and coverage. Various studies are reporting that while building clinics, buying drugs, recruiting consultants are important to improve health outcomes, they only address a part of the larger problem of improving overall health quality. What is being identified through these studies are that even when the health service providers (for example, governments) have the required inputs (human resources, drugs, logistics support) to produce health services of adequate quality, they are unable to do so and we see a very low utilisation of services which remain sub-standard and of inadequate coverage. And from the demand side, mere awareness

of services available are not leading the population to access the health services for various reasons including their negative prior experiences of public health services.

The current thinking in the Global Health community towards addressing this problem is through the provision of incentives for both the demand and supply side of health services. Incentive schemes of various types – Performance Based Financing (PBF), Pay for Performance (P4P), Performance Based Incentives (PBIs), Conditional Cash Transfers (CCTs), Results-Based Financing (RBF), Differential Planning are currently being designed and implemented by donors and national governments in various countries. A common aspect of these schemes is that it involves the transfer of money or material goods conditional on taking a measurable action or achieved predefined targets. Some examples of such schemes are given below:

- Health facilities receive a financial incentive when they achieve pre-defined service delivery and quality targets. Some of the countries where such schemes are being implemented include Brasil, Congo and Tanzania.
- Health facilities receive services on improving quality of services such as reduction in C-section deliveries. For example, in South Korea.
- Patients receive financial incentives to obtain services at health facility, including covering costs of transportation and food, for example in India.
- Pregnant mothers are given cash incentives for accessing institutional delivery service, for example in India.
- District authorities receive a bonus payment when the service outputs of their districts improve. This scheme is being implemented in Ghana, Rwanda and Tanzania.

Some of the expected benefits that such schemes are supposed to provide, for example, related to improving maternal health, include:

- Increased expenditure on maternal services.
- Increased access to ANC or facility services.
- Increased coverage for maternal services.
- Increased deliveries attended by skilled birth attendants.
- Improved quality of services, including aspects related to prenatal care, delivery and child preventative care.
- Increased utilisation of services.
- Enhanced equity through targeting and differential planning.

But along with these expected positive consequences, various people taking a more cynical view have pointed to the negative implications for such schemes. These include:

- Unintended effects such as neglecting schemes that are not being rewarded.
- Misrepresentation of achievements to obtain higher incentives.
- Use of coercion to obtain financial incentives, such as through limiting family size and forcing the use of contraceptives.
- Undermining team morale for example in a facility where some workers get higher incentive than the other because of being affiliated to richer activities.
- Decreased access to unrewarded incentives.
- Fraud within schemes, such as misrepresenting names or giving incentives to those who do not qualify for the schemes.

- Exclusion of ownership and autonomy when people affected by the schemes are not invited to participate in the design of the schemes.

From the perspective of this chapter, the important point to emphasise is that to understand the impact of these schemes, from both demand and supply, and also from the input and output side of the incentive schemes, there must be in place effective and robust HISs as stated by Dr. Margaret Chan, the Director General of WHO.

The report (Keeping promises, measuring results) and its recommendations are a major achievement to public health and will help us save the lives of women and children.... But our work is only beginning. One of our top priorities must be investing in helping countries build the capacity needed to capture this health information – that means giving them the financial and technical resources required to monitor things such as births, deaths and causes of deaths, and achieve the mutual accountability needed to save women and children from dying.

The report has highlighted a list of 10 recommendations, including health indicators, that need to be monitored to assess the impact of various initiatives concerning maternal and child health. These recommendations summarised in Box 9.1.

## Box 9.1

Keeping promises, measuring results, 10 Key Recommendations.  
United Nation Commission on Information and Accountability for  
Women's and Children's Health

Recommendations that need to be monitored to assess the impact of various initiatives concerning maternal and child health:

- Increasing the number of countries with well-developed systems to measure births, deaths and causes of deaths.
- Measuring against 11 common indicators on reproductive, maternal and child health.
- Helping countries to integrate the use of Information and Communication Technologies in their national health information systems.
- Countries with high maternal and child deaths, track and report resource indicators.
- Country governments and major development partners put 'compacts' in place that require reporting based on country format, on externally funded expenditures and predictable commitments.
- All governments have the capacity to regularly review health spending and to relate spending to commitments.
- Countries have established national accountability mechanisms that are transparent, inclusive of stakeholders and recommended action as necessary.
- All stakeholders are publicly sharing information on commitments, resources provided and results achieved annually at both national and international levels.
- The Organisation for Economic Co-operation and Development's Development Assistance Committee (OECD-DAC) agree on how to better capture all reproductive, maternal, newborn and child health spending by development partners.
- An independent Expert Review Group is reporting regularly to the UN Secretary General on results and resources related to the Global Strategy for Women's and Children's Health and progress of the implementation of these recommendations.

From the perspective of IHAs, the need to design effective monitoring systems need to adhere to certain key design principles, which is line with our discussions in the earlier chapters:

1. A lot of data required for the monitoring of these indicators are already available through the routine system or ongoing surveys. There is no need to design systems from scratch.
2. There will be need for some new types of data, such as related to financial figures. While such data may not be available in the existing routine system, they could be available in other systems such as those for finance and accounting. Developing interoperability mechanisms between these various systems would be a key aspect of design.
3. Cross cutting indicators would need to be developed through inter-disciplinary groups, as such monitoring necessarily brings together programmes and activities which till now were independent.
4. An architecture perspective based on a data warehouse approach, which seeks to create a repository of various data types would be essential in creating an integrated monitoring system.

A contrary approach to an architecture one, as is very much in evidence today, is to only focus on isolated systems such as the mobile device for data capture. An example of this is reflected in the following quote from a senior official of the ITU.

“In addition to (mobile phones) facilitating data gathering, sharing and analysis, platforms like the Internet and social media can also be used as tools to create safe and empowering spaces for women, where they can obtain accurate, up-to-the-minute health information in a confidential, multilingual environments.”

While not denying the power of mobile technology to gather useful and timely data, we often tend to forget this collected data needs to be ‘sent somewhere’ to another system, which can aggregate data received from various phones, provide the processing and visualising capacity to the data, and make it available to larger audiences, and to health planners in a manner that allows them to make relevant decisions. In the ‘feel-good’ and hype about the mobile technology, we often tend to overlook this important need for integration, a point that is emphasised through the IHIA approach.

## 9.8 Information Culture – Institutionally Approaching its Cultivation

At the outset, we define the process of maturing use in terms of the cultivation of an ‘information culture’, which values how information generated from the HIS is geared towards supporting public health action and interventions at various levels of community, field level service providers, the medical doctors in peripheral facilities, the district and state administrators, the health programme managers at district and state levels, to the national policy makers. Another aspect of this heightening maturity concerns users having more awareness about the value and use of a HIS and also having more capacity at data management including skills to carry out analysis of data quality, health status, and to integrate such analysis with making practical health programme improvements.

Some guiding principles an institution can adopt to nurture a vibrant information culture would include the following:

1. *Focus on information use – Technology for information and information for action:* A primary focus of the HIS on information use rather than on the tool. For example, planning budgets could establish norms where 80% to 90% of the budgets are towards capacity building, implementation and hand holding support. Currently, the reverse is the case with hardware, software and equipment purchase accounting for the bulk of budgets. The technology supporting the system needs to be designed and developed in a way that it can process the data (for example, validation checks) and convert it to useful information through easy-to-use representations of charts, graphs and maps. How this information is then converted into action and knowledge largely depends on institutional conditions of leadership, motivation, and capacity building focus and efforts.
2. *Decentralised information for decentralised action:* Decentralised information is based on the globally established pyramidal principle of hierarchy of information with the lowest level requiring the most disaggregated information (for example, the field nurses need to know the names and addresses of pregnant women) while the national level the most aggregated (for example, percentage of institutional delivery) to be able to measure programme impact and take policy measures. A pyramid based information flow acknowledge varying information needs by levels, and supports ecentralised information for decentralised action – rather than centralised information for centralised and top down action.
3. *Integration of information flows – Data warehouse approach:* Today integration, both technical and institutional, has been established as the largest challenge to effective systems. While technically, flows can be relatively easily integrated, institutional linkages are more complex to establish. An approach being advocated to address this challenge is through data warehouses, based on open standards and open software to facilitate data interoperability irrespective. The approach of creating a monolithic ‘single window of truth’, which does not interoperate with other systems runs counter to this current thinking, and leads to further fragmentation in the longer run.
4. *Strengthening collaborative participatory design:* Participation of end users into processes of system design, development and use promotes more ownership of systems, stronger capacity to use them, and systems better configured to support more focused use. Often systems fail because of ‘design-reality’ gaps, implying a deep schism between the worlds of technology development and its use. For example, a centrally designed system which only allows for web-accessed use is distant from the reality, where such access is relatively non-existent. Or the promotion of high-priced and sophisticated statistical packages does not match with the reality of the district user, who is insufficient in statistical expertise, and further who can get all analysis required performed by an off-line Excel system. Participatory design provides a mechanism to bridge this gap, and encourages a prototyping approach, where systems are never frozen, but represent versions fluid in time and space.
5. *Networks of action to support sharing and learning in collectives:* Experience of HIS implementations in the developing world point to the problem of systems dying as pilots, and being of little use to managers who want full scale data. The HISP strategy of ‘networks of action’ seeks to address this problem by getting users and

developers to support and strengthen each other by the sharing of experiences, advocacy, ideas, products, software, and training resources. This network model necessarily requires a shift from a centralised model of bureaucracy based on principles of discipline, surveillance and reprimand, to one where the onus is on the network members themselves to share and learn through their respective experiences. Such a networked model of sharing and collaboration becomes a fundamental aspect of a vibrant information culture.

#### Example of cultivating an information culture – India

In India, while significant challenges exist, significant gains have been made with respect to nurturing an information culture. Some of these gains are summarised:

1. District wise reports now (in 2011) report nearly a 100% coverage, and also various states have initiated processes of decentralised data reporting and its institutionalisation. A case in point is the state of Bihar, where since 2010 block (sub-district) level reporting has been initiated and today nearly 95% of the blocks are reporting. From initially in 2007-2008 when many districts were even not reporting data, the State has made systematic efforts, where first all districts, and then from the beginning of 2010 all block level data entry has been initiated. Today 95% of blocks report data.
2. Various states have initiated processes providing evidence that they have moved beyond data to information. For example, in Manipur every district analyses their monthly data using graphs and charts, and identify action points to make data quality improvements. In Bihar, all districts used HIS analysis to develop their 38 district Health Action Plans.
3. In a more limited amount of states (say 3–5), we can see evidence of them moving from the stage of information to knowledge, where information is actually being put to action in identified areas of programme improvement.
4. Large scale capacity building programmes have been completed in nearly all states, and in many states nearly 3 rounds of training have taken place at the state level, and in more limited amount of states training has been carried out at the district level, where the district and block staff have attended.
5. These capacity building efforts have contributed to the development of a cadre of Master Trainers in various states at the district level, which in the longer run with continued and focused efforts can help to ensure sustainability of systems and processes in the states.
6. Large scale training materials have been prepared, discussed in training programmes and distributed to the state, district and even block level teams. These materials relate to software manuals, implementation frameworks, data dictionary and indicator manuals.
7. Large scale infrastructure improvements have been carried out in various states, including initiating processes of server upgradation whereby the state applications and data will be moved to the state server, making improvements in providing computers and Internet access to sub-district levels and in some cases even to the facility levels. Some states like Uttarakhand have also been innovative and districts have established local AMCs with vendors to provide hardware maintenance support, thus reducing their dependency on state support for locally solvable problems.

These improvements have come through intensive institutional efforts, spanning domains much larger than just the technology.

## 9.9 Strategising – The Way Ahead Towards a Strong Information Culture

In this section, we discuss at a strategic level, what long-term interventions can be made to mature the use of information within a health systems perspective. To understand the nature of strategic interventions, we need to first elaborate on the 'gold standard', which we want the health system to attain. Following which, a situation analysis can provide light on what is the existing situation, what interventions have been made in the recent past, their impacts and remaining gaps. This process can be depicted through the Flow chart 9.1.

Three sets of strategic interventions are identified:

1. Broad basing of education in public health informatics.
2. Institutionalising public health information related structures and systems in the government.
3. Providing appropriate software support that encourages local information use.

### 9.9.1 Broad Basing and Institutionalising of Education in Public Health Informatics

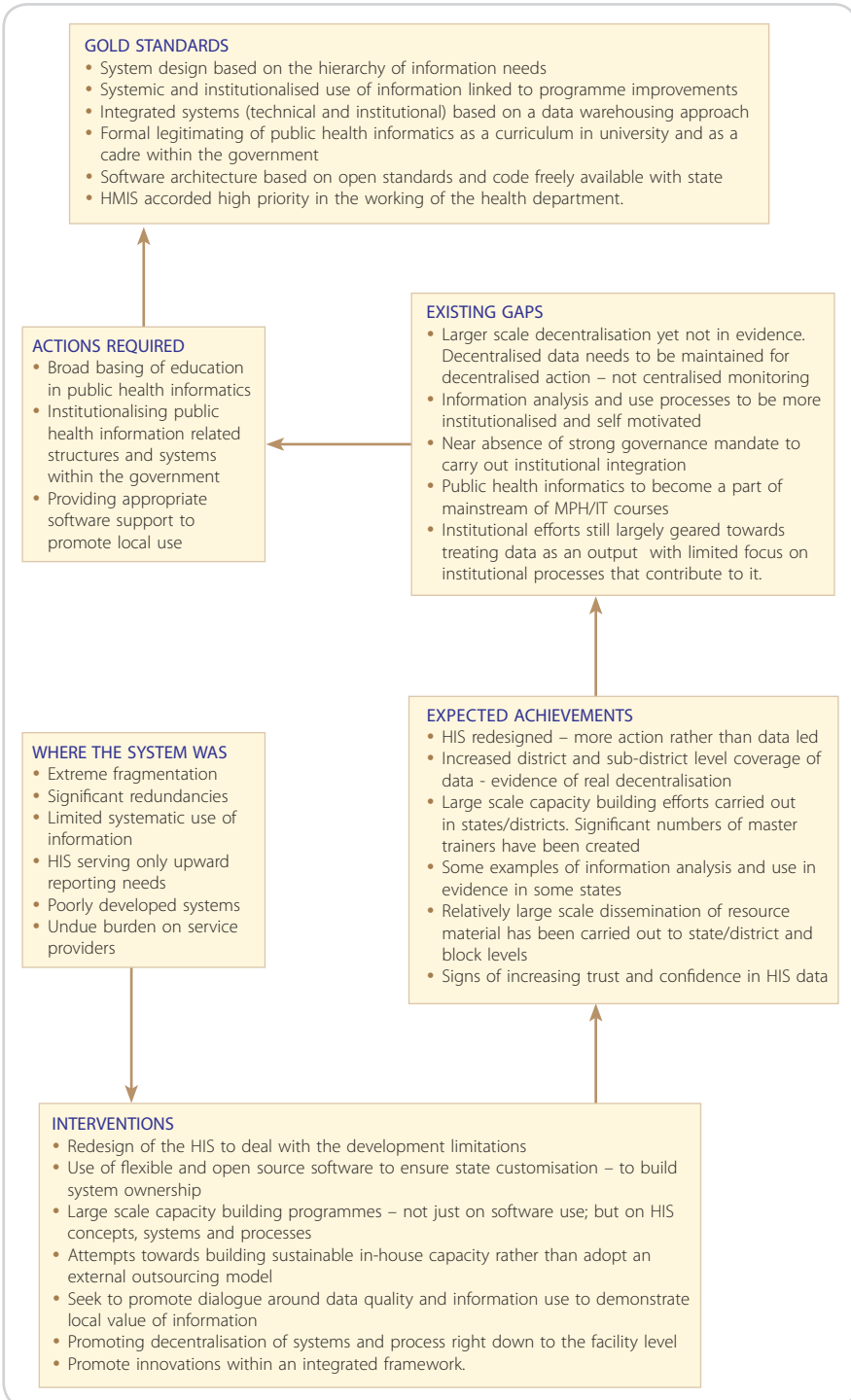
This topic of education including Masters and Doctoral programmes has been discussed in an earlier chapter of this book. Keeping in mind the danger of repeating, we just outline some of the strategic aspects of this intervention.

In most developing countries, educational programmes in computer science focus primarily on the development of technical skills such as programming and networks, with limited or no focus on the aspects of information systems, which deals with the interaction between technology and the application domain. Such a technical focus has strengthened the outsourcing industry. For example in countries like India and Vietnam, by being able to provide low-cost 'bodies' but not able to retain significant high intellectual property, which fundamentally requires the blending of domain and contextual knowledge with the technical. The strategic implication, in terms of the design of educational programmes in public health informatics, is to create interdisciplinary programmes that combine public health and informatics. This will help to reduce the significant existing gap in the production of specialists who are grounded in the public health domain and have competencies enough in informatics that they are able to apply these computerised tools in addressing public health problems and challenges. Till date, this gap has been tended to be filled by statisticians, and this too comes with its own limitations of being able to nurture a public health grounded perspective towards information. The University of Oslo Masters and Doctoral programmes described earlier is an effort towards addressing this gap.

### 9.9.2 Institutionalising Public Health Informatics Processes Within the Government

With respect to governance of HIS in developing countries, two cadres of staff are predominant including statisticians and computer personnel, with the public health cadre largely absent. While, this imbalance needs to be urgently corrected, doing so is a non-trivial challenge. Various measures could be instituted to support this task, such as including public health specialists in the team with statisticians in the M & E team

Flow chart 9.1 Strategising a strong information culture





at the ministry. This can help to redefine the thrust of M & E activities from one of enforcing data discipline to understanding the public health significance of data and how it can feed into making health programme improvements. Further, national level ministries can consciously seek to shift their mandate from one of monitoring to that on evaluation, where indicators reach them and not raw data. Similar kind of structures incorporating public health people need to be created at the district and sub-district levels. In South Africa, such a structure has been created through the cadre of Health Information Officers who have been appointed at the district and facility levels.

### 9.9.3 Breaking the Vicious Cycle of Data Non-use

Many developing countries tend to be locked in a cycle, which broadly can be described as follows:

- Historically, data from the routine HIS is described as being of poor quality and thus not trusted and used.
- For reporting on performance, the national level then relies on survey data ignoring the routine HMIS data. Survey data does not provide the required granularity to support programme related everyday interventions, and its primary function is for upward reporting of statistics.
- The more the routine data is not used and formally ridiculed, the less is the attention given to its process of strengthening.
- The lack of trust in routine data continues to be high resulting in its non-use.

The vicious cycle described above needs to be broken, using at least two sets of arguments.

1. To argue that data currently on flow in the routine system is adequate, arguably of sufficient coverage and level of quality to be put to use by planners.
2. To argue that for existing level of planning needs for information, the level of quality tolerance is not so extreme that the current routine data cannot satisfy.

Both these issues are now elaborated:

1. *The data perspective – Level of coverage and quality:* There are always actors in the system who would like to undermine the value of routine data, arguing that its quality and coverage is of inadequate quality. Their interest may be to use other sources of data or not at all. Such arguments need to be countered by unpacking what they mean data quality is inadequate. In India, where similar arguments are heard on data quality, we see on drilling down that there exists nearly 100% of district and 30% of sub-district coverage. Given the right environment and support, this coverage can be further heightened. By all accounts then, the volume of data available tends to be non-trivial and quite sufficient to meet more than 90% needs of the planners. Further, a focus on 'essential data elements' (for example ANC registration, immunisation, and so on), where data is relatively better that can help to strengthen information use. Often the non-use of data is justified by the argument of poor quality legacy data. Such an argument is counter-productive, and constant reprimand for gaps which current staff has little control over will continue to de-motivate them from the present task at hand. It thus becomes important to live with the limits of what exists, which is a product of the historical legacy of systematic inefficiencies, and instead focus attention on strengthening present and future systems.

2. *The planning perspective – Level of quality tolerance needed:* In public health planning, arguably the quality level tolerance on data can be much lower than what may be used in patient level clinical trials. For example, if we take the level of information support required for managing the problem of maternal mortality, we see that a majority of the data is available in the existing HIS. And what is not available, can be easily obtained by a phone call to the district (for example, to get the number of gynaecologists available in a district). While this is not, in the least, an argument being made that existing HIS is perfect, in its present form and in relation to planning needs, there may be a reasonable level of sufficiency in it to warrant its use. Further, the more important point is that to establish a degree of trust and confidence in the data, planners need to convey to the others they are not adverse to using it. A contrary message of lack of confidence and the non-use of data will continue the overall neglect and apathy towards the HIS, and continue the entrapment in the vicious circle of data non-use.

We can further attempt to break out of this vicious cycle by having the districts to report only on actionable indicators rather than raw numbers. For example, with respect to deliveries, it may be more effective if districts give figures of percentage by different facility types that are not providing expected level of services (such as deliveries, safe births, C-sections, Basic Emergency Obstetric Care services (BEmOC), and so on). This can then be used by planners to strengthen coverage of BEmOC services with direct implications on maternal mortality. Details of raw numbers of deliveries will always be available at state or district levels and can be called upon if needed. Disaggregated data can always be at hand, say in offline systems, and can be called upon if required. This represents the established principle of hierarchy of information, where the most detailed information is at the lowest level and national level reviews aggregated and actionable information. Similarly, there can be other examples like stocks, where national level reviews only percentage of stocks out, while the lowest level maintains details of receipts and consumption of stocks. This also helps to re-direct our attention from being continued to be locked in data to its transformation to information and knowledge, towards a more vibrant information culture.

After outlining the process and levels of information use, and discussed key strategic interventions required towards creating an information culture, in the next two chapters, we delve further into the challenge. We first discuss what are interventions required at the local level to build appropriate capacity, and following that, we discuss the role of the State.

### Summary

- A ‘data-led’ rather than ‘action-led’ condition of HIS dominates in most developing countries.
- Strengthening quality of information requires efforts around the following interconnected dimensions:
  - a. Organisational use.
  - b. Information systems.
  - c. Technical and tools.

- Maturing of information use can be conceptualised as a process comprising of three analytical levels:
  - a. Establishing technically working systems emphasising data completeness.
  - b. Information systems characterised by analysis, use and feedback of data.
  - c. Information system shows evidence of impact on decision-making.
- The TALI tool developed in South Africa provides an instrument to assess these three levels of maturity of a health information system.
- Examples of Level 3 HIS are relatively scarce, but will play an increasingly important role in future in order to support global initiatives such as Pay for Performance and Performance Based Financing.
- Life cycle events approach to data analysis represents an effective way to identify both target groups missing services and also missing data.
- Maturing of information use fundamentally involves the nurturing and cultivation of an information culture.
- A mature HIS would look at data quality problems as comprising of both data artefacts and health programme artefacts. This implies data 'aberrations' not being dismissed as isolated statistical events that require 'normalisation', rather as public health events that need sensitive contextualisation.
- Institutional efforts towards cultivating an information culture:
  - a. Focus on information use: Technology for information and information for action.
  - b. Decentralised information for decentralised action.
  - c. Integration of information flows: Data warehouse approach.
  - d. Strengthening collaborative participatory design.
  - e. Networks of action to support sharing and learning in collectives
- Strategising towards a strong information culture requires:
  - a. Broad basing and institutionalising of education in public health informatics.
  - b. Institutionalising public health processes within the government.
  - c. Institutionally breaking the vicious cycle of data non-use.

# 10

## Cultivating Capacity for Local Action

**H**ealth information systems in developing countries have historically been criticised for not contributing to information use for supporting action at local levels at the point of service delivery. While data which is collected is primarily used to be sent upwards to the central ministry where it is used for the compilation of statistics, it is not used for supporting everyday action towards local interventions. Examples of such local action could be of the field nurse using the health information to identify which children are dropping out from their immunisation cycle or to identify pregnant women in a village that need to be motivated to accept institutional (rather than home) delivery. Medical officers in a health facility can use the information to see how their reporting sub-units are performing to help plan for more optimal resource allocation. Local action can be of various types including for monitoring, planning and evaluation around the different health services that are being delivered.

While the above examples seem obvious uses of information, and even may appear relatively easy to achieve technically, in practice it has been found quite problematic to materialise. Contributing to this are various knowledge demands and socio-technical challenges. Knowledge challenges relates to the fact that hands-on tacit practical knowledge relevant here needs to be developed through routine processes of learning-by-doing, where the problem is that such routine processes of using information for action are not taking place, leaving us with a chicken-egg problem of “How to start creating such learning processes?”. Technical challenges include the use of rigid, centralised, proprietary systems, that are not oriented towards supporting local use, are inflexible to change, and do not promote interoperability across systems. Often, health departments go in for the purchase of complex and expensive statistical packages which are not amenable to key public health analysis of generating indicator graphs, drilling down and making comparisons across facilities and over time. Public health related challenges include the focus on raw data rather than processed indicators, and the violation of the hierarchy principle where all raw data collected in the field is sent to the central ministry. Lack of standardised definitions of data elements and indicators, redundancies in data collection forms, coupled with high existing work load of field staff serves as serious deterrents to the use of information for local action. Computerisation efforts, in such contexts, typically take on the agenda of automation with a high focus on the technicalities of hardware and software, while implementation support to promote local action tends to get marginalised.

While we tend to understand the reasons behind the poor use of information, we have more limited understanding of how to address this challenge. Superficial recommendations of “more training is needed” remains rather ineffective as it does

not help to understand what does it mean to take local action and to actually start creating new practices of information use, and what capacities are required to do so. Answering these questions form the key focus of this chapter. In the first section, we discuss the question of capacity, and what it is constituted of. This is described as three facets of capacity – technological, public health and implementation. After having unpacked the nature of capacity, in the second half of the chapter, the focus is on participatory approaches to learning and building and scaling of this capacity.

## 10.1 What is the Nature of Local Capacity?

Local action, by definition is situated, contextualised and represents knowledge in use that should necessarily provide practical benefits to the user. An operational definition of local action is *the use of health information for understanding and supporting work practices of the health functionaries (such as field nurses, medical doctors, district administrators) for the design, implementation and monitoring of interventions towards practically improving health outcomes*. While such action is largely based on the everyday experiences and local knowledge that health staff have, this can undoubtedly be strengthened by appropriately designed HIS which enable the processing, analysis and display of data, and its utilisation by users to guide practical action and gain practical benefits. For example, if by using the computer based HIS, the field nurse can reduce her burden of manual compilation of report or minimise her time of travel to deliver reports, or be able to identify more correctly those pregnant mothers who have skipped a check up, she obtains practical benefits and further motivation to use the HIS.

Challenges to achieving these practical benefits are socio-technical in nature, including related to *technology*, the *domain of public health*, the *context of implementation*. Building capacity of users to use information for local action needs to address these three inter-related domains. This is now discussed.

### 10.1.1 Technology related capacity

This relates to the capacity of health staff to use technology (the HIS application) to take practically useful local action. Such capacity is conceptualised as the *practical capacity to use the HIS and to solve basic technical issues to keep the application operational*. This definition helps to identify the following facets of technology related capacity:

*Capacity to carry-out local customisation*: This reflects the ability of the user to make local changes and customisations in the HIS to address local needs, such as:

- Addition or deletion of local data elements in the database;
- Modifying organisational unit structure to reflect changes in the hierarchy;
- Creating new validation rules for carrying out data quality analysis; and,
- Creating new indicators for conducting health status analysis.

Building capacity to carry-out these concrete operations, not only helps users in their everyday work, but also empowers them by reducing their dependencies on external agencies for support. Increased self-reliance provides users with more freedom to learn other things. Below, we provide examples of making modifications in the organisation units (Figure 10.1) and data elements (Figure 10.2) in the DHIS2, directly through the user interface without any programming intervention. The skills to carry-out such local

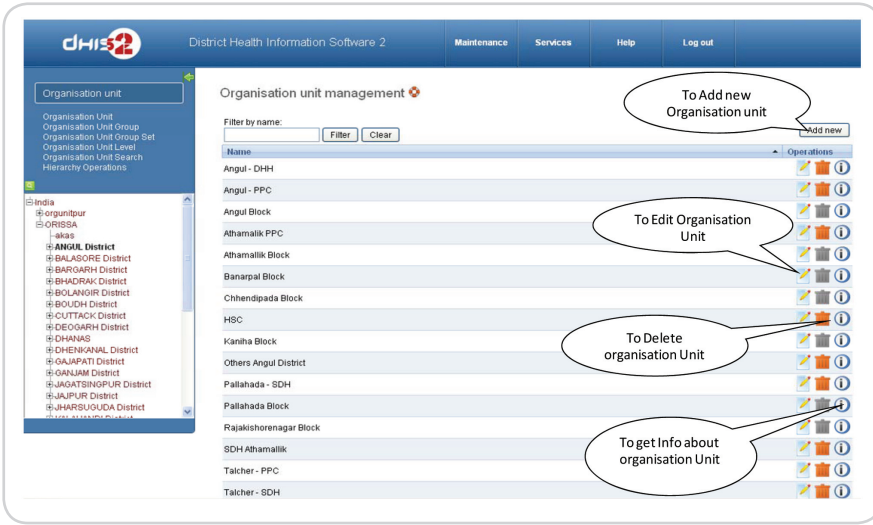


Figure 10.1 Flexibility for local customisation of organisation units

customisation can be developed relatively easily through focused training, and helps to demystify the technology for the user.

*Capacity to use the data analysis tools:* This capacity helps provides the user with the ability to use data analysis tools such as Pivot Tables and Dashboards for visualising and presenting data and indicators. Representations such as charts, graphs and maps

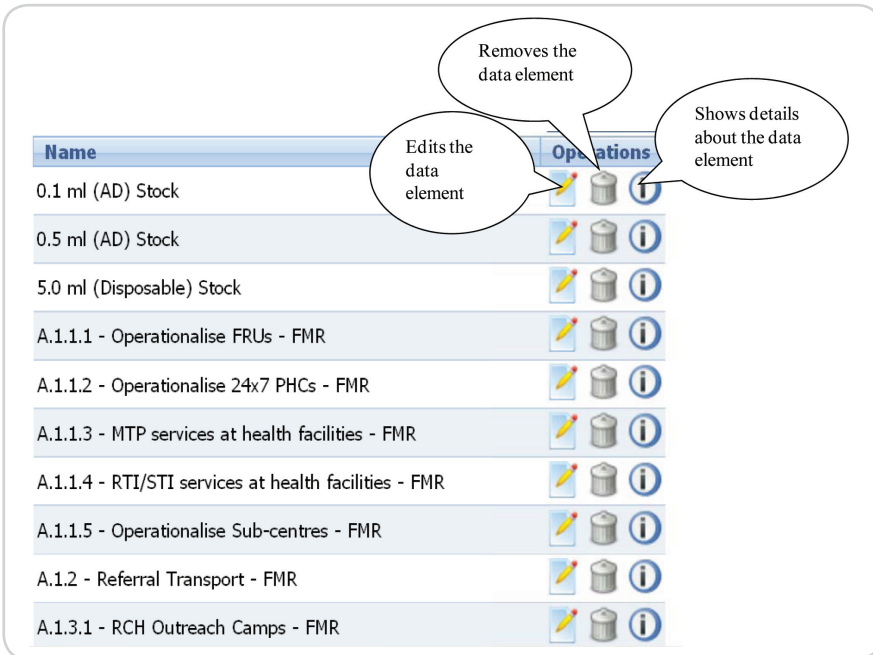


Figure 10.2 Flexibility to add, edit and delete data elements

helps the user to visualise data pictorially, and understand better how “data behaves” to enable the taking of relevant local action. Some examples of the practical tasks the user can carry-out through these data analysis tools include:

- Creation of “achievement against target” charts.
- Creating routine performance charts.
- Comparison of related indicators.
- Comparison of indicators across health facilities.

As an example, a chart is shown below.

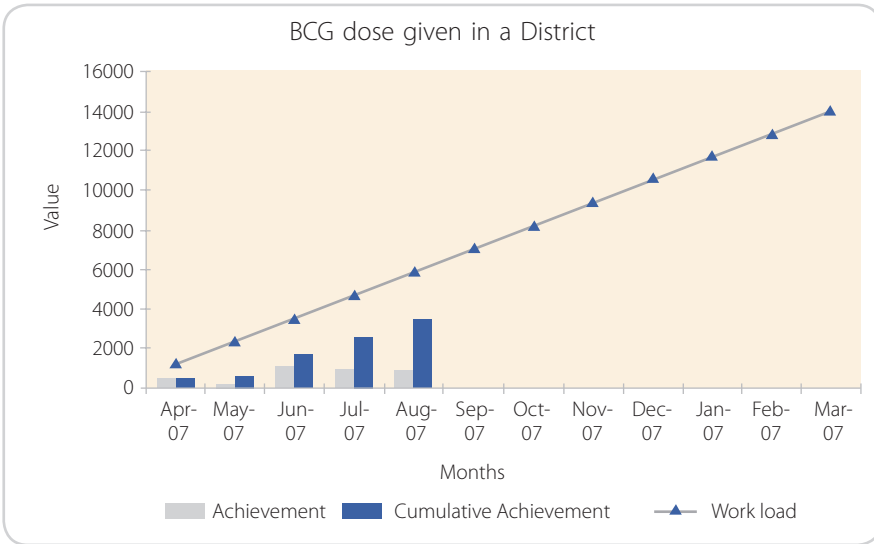


Figure 10.3 Comparing monthly and cumulative achievement with annual target

In Figure 10.3 the yellow line represents the cumulative monthly target given to the health worker for a particular service she is expected to provide (in this example administering BCG doses), while the brown and blue bars represents the monthly and cumulative achievement figures. Health workers by viewing the above chart can assess their monthly progress in relation to their targets and take required corrective action. This supports self-monitoring, intrinsically more empowering than when externally controlled.

Another example is given in Figure 10.4 on skilled birth assisted deliveries.

The above graph on district wise performance of skill birth assisted deliveries can be useful for the state level planner to assess district performance on an important parameter, also relevant for MDG goal achievement. By identifying poor performing districts, the planner can in consultation with the district, seek to design relevant interventions such as increasing skill birth assistance training, providing more facilities for basic emergency obstetric care services, and improving referral transport services for pregnant mothers.

Figure 10.5 of the dashboard in the DHIS2, shows how the user can select their required indicators and compare them across all facilities under a parent organisation

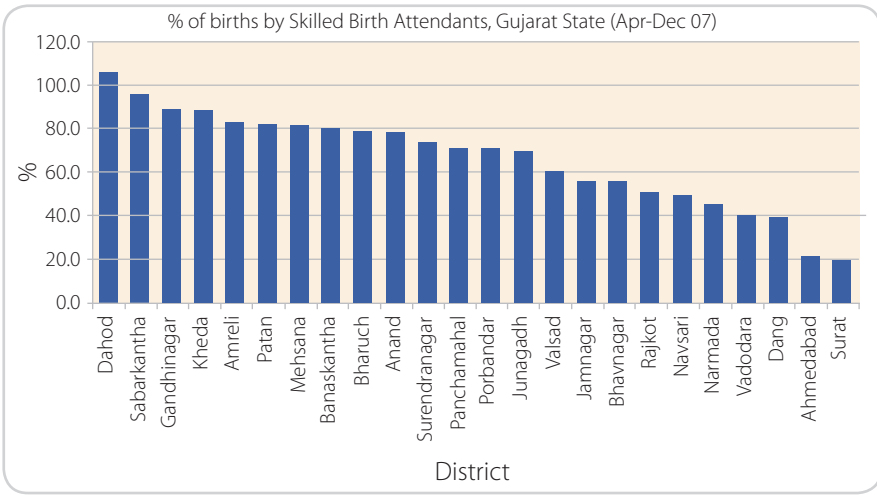


Figure 10.4 Percentage of skilled birth attendants assisted deliveries across districts



Figure 10.5 Use of dashboard monitoring tools of DHIS2



(districts in a state, or blocks in a district) and also over time. This provides the user with the flexibility to carry-out local data analysis and monitoring of performance across *their own* health facilities, to make effective diagnosis, and based on this, focused action.

*Capacity to carry-out basic troubleshooting of technical problems:* This capacity concerns the ability of users to address basic technical problems in the HIS before seeking external technical help. This is relevant for firstly providing the user with a sense of local control and understanding of the application, and secondly to reduce external dependencies, often hard to obtain in rural settings. Some examples of such skills include:

- Ability to reset forgotten passwords for users in the application;
- Skills to create new users and define their access roles.
- Ability to address data mismatches between data entry and reports: A common problem in data aggregation is the mismatch between data entered and the report generated. Often, this is attributed as a software bug, while it could be a data entry mistake, where data for same data elements are entered both at the child and parent organisational unit levels, creating a duplication in aggregation, hence the data mismatch.

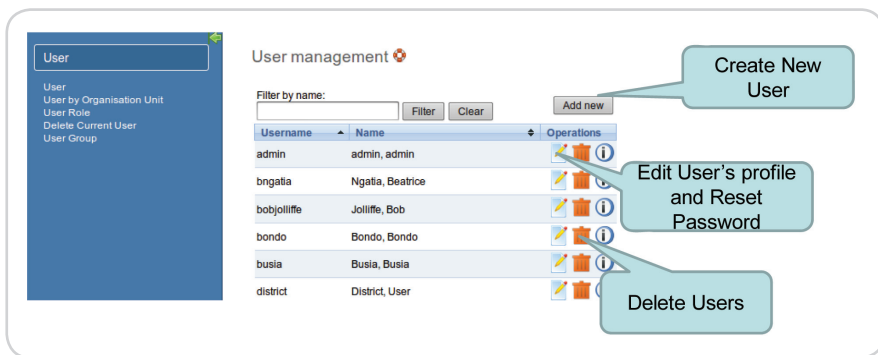


Figure 10.6 Functionality to create new user and reset of password

Figure 10.6 represents the user interface for creating new users and the resetting of forgotten passwords. Users with due access to carry-out this operation can create new users and also help users with lost passwords, a very common occurrence in the field.

*Capacity to use visualisation tools such as GIS:* This capacity concerns the skills required towards the use of GIS for improved visualisation of data, including the generation of health indicators and viewing them on a map. This does not involve core technical skills on GIS such as the creation or editing of a map, a function more appropriate for the state level. Map based visualisation of indicators provides a powerful avenue for users to spatially understand issues, for example, the prevalence of a disease across a district, and which surrounding facilities it can affect. Seeing these spatial inter-connections can help to identify necessary actions. Some specific skills that can be developed for the user in this regard include:

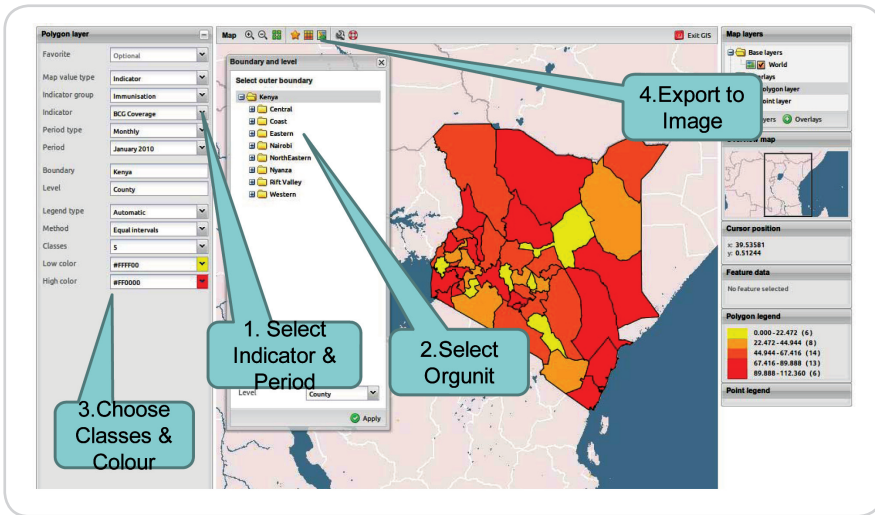


Figure 10.7 Screen shot of user interface of GIS module in DHIS2

- Ability to differentiate between a GIS (e.g. shape file) and non-GIS map (e.g. jpeg file);
- Ability to use the GPS to record the longitude and latitude for health facilities;
- Capacity to use the GIS software to help generate health maps to display health indicators and data elements; and,
- Skills to export the generated maps to jpg so format that they can be included in presentations and documentations.

The Figure 10.7 represents a snapshot from the GIS module in DHIS2, and the functionality to export it to a presentation. This allows the user to link health data, both indicators and data elements, to a spatial map.

### 10.1.2 Public health related capacity

Public health capacity can be operationalised as the *ability of health professionals to interpret and use information for supporting their everyday work*. Such knowledge relates to the understanding of diseases, their determinants, and also about the different services (e.g. immunisation) that the health system provides. The relation between these domain issues and the HIS is primarily through the ability to define appropriate data elements that need to be collected (which should reflect the problem to be addressed), how these data elements can be converted into actionable indicators, and their interpretation and action in the context of the problem on hand. Some specific skills in this regard include:

*Capacity to understand data elements and indicators, and their significance in use:* This capacity concerns the ability of health staff to have a common understanding of data definitions and linkages towards actionable indicators. For example:

- How to use the data dictionary which provides data definitions, guidelines and processes of aggregation; and,

- How to use the indicator dictionary which provides indicator definitions, their rationale for use, suggested actions and levels of use.

The excerpt from a data dictionary provides the definition of the data element *Total number of pregnant women registered for ANC*, guidelines for its collection and details of the primary source of data – the antenatal or pregnancy register (Box 10.1).

Box 10.2 represents the screen shot from the indicator dictionary for antenatal care first visit coverage rate, giving the definition, the data elements to be included in the

Box 10.1 An example of the data element dictionary

*Data Element:* Total number of pregnant women registered for ANC

*Definition:* Total number of NEW pregnant women registered for antenatal care during the reporting month.

*Guideline:* The visit should include relevant check-ups required for antenatal care. Registration should include ANC check-up. ANC first check-up is same as ANC registration. A pregnant woman is generally registered during the very first contact with the health facility/worker, irrespective of her state of pregnancy.

*Data Source – Antenatal Register/Pregnancy Register*

Box 10.2 Indicator dictionary for Antenatal care first visit coverage rate

*Indicator:* MH 1: Antenatal care first visit coverage rate

A: ANC under 19 years

B: ANC in first trimester

**Definition** Percentage of pregnant women who used Antenatal Care (ANC) provide by skilled health personnel, for reasons related to pregnancy, registered and examined for the first time and received some form of care, such as TT1

Women under 19 years of age

First visit in first trimester of pregnancy

**Numerator** ANC first (initial or registration) visit  
ANC first visit under 19 years  
ANC first visit in first trimester of pregnancy

**Denominator** Total expected pregnancies  
A and B ANC first visit

**Rationale** This first visit should be a “*registration*” visit where all initial procedures relating to assessing/preparing a woman for pregnancy and delivery occur. This should include full history examination initial blood tests and immunisation.

Antenatal care coverage is an indicator of access and use of health care during pregnancy. All women should have at least three antenatal visits during a pregnancy. These should start as early in pregnancy as possible.

Data Source	<p>ANC <i>under 19 years</i> shows proportion of teenage pregnancies and ANC booking in first trimester shows early care and level of awareness.</p> <p>Antenatal / maternal health registers. Maternal health card: Household surveys.</p> <p><i>Population data</i> – an estimate of the number of pregnant women is close to the number of children born (2.2 – 3.2% of population).</p>
Suggested level of use	National and below.
Other Useful Indicators	<p>Risk and continuity indicators are important in ANC.</p> <p>VDRL (syphilis) and HIV testing coverage shows quality for care. This should be taken at first ANC visit.</p> <p><i>Haemoglobin</i> testing and anaemia management rates</p> <p>ANC referral shows risk detection (and transport availability)</p> <p>% women getting <i>third ANC</i> shows continuity of care, which is often related to perceived quality.</p> <p>Unbooked deliveries at facilities is an accurate indicator of failure of ANC services.</p>
Common Problems	Attendance for pregnancy test or simple registration without history and examination do NOT constitute antenatal care.

numerator and denominator, and the rationale for its use. It also identifies other related useful indicators and common problems toward its articulation. This information assists the health planner to use of this indicator in local analysis and planning, and primarily for taking action.

*Capacity around understanding data element behaviour:* This capacity concerns the ability of health staff to understand the behaviour of data elements in relation to other related elements. This helps diagnosis of action points to improve data quality. Some specific skills in this regard include:

Identifying related data elements and their behaviour.

Identifying acceptable ranges of data elements, including “min” and “max” values to monitor data quality.

The line chart (Figure 10.8) represents a comparison between two related indicators, institutional (shown by blue line) and home delivery rates (depicted by red line), across districts of a state in a particular year. This helps to identify districts with low institutional delivery rates and design corrective measures to strengthen delivery services.

Figure 10.9 shows the data entry screen in DHIS2 depicting values of particular data elements for the past 13 months with respect to min and max ranges. This helps the person doing the data entry to view at the point of entry, whether the value lies in an acceptable range, which shows as red if out of range. Additionally, the user has the possibility to fill in a comment as a reason for out of range data, such as stating that the vaccine was out of stock or if a staff was on leave. This helps to distinguish between an abnormal value as a “data artefact” (such as a typing error) or representing a “health programme artefact.” Such a distinction is necessary given that the normal

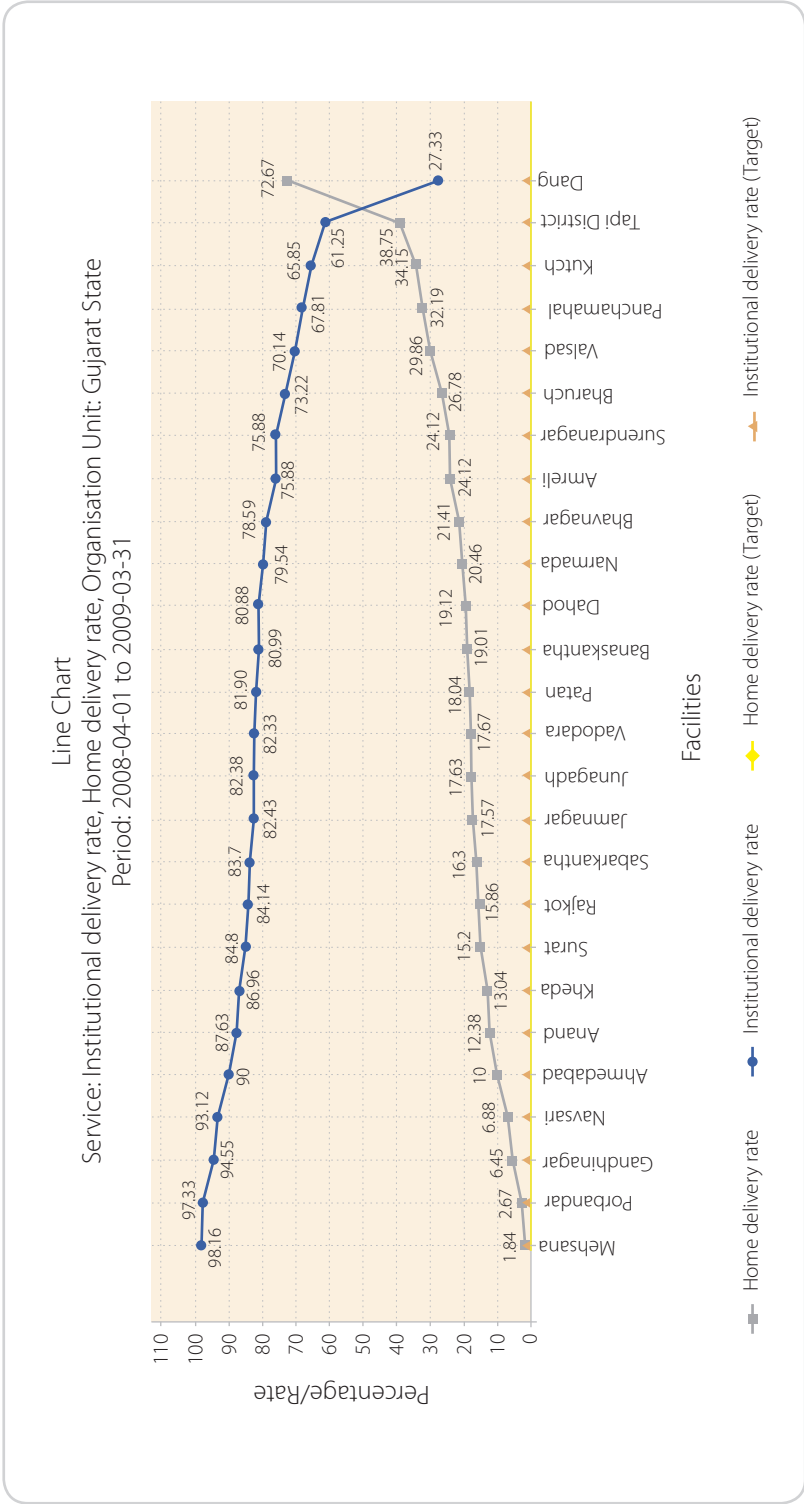


Figure 10.8 Comparison of institutional and home delivery rates across districts

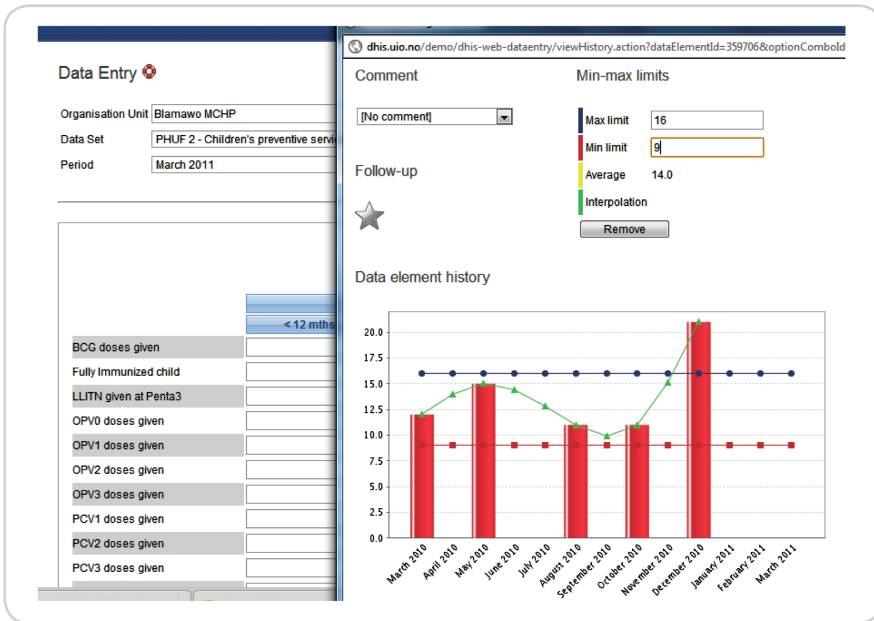


Figure 10.9 Screen shot of data entry screen with min and max range for data elements

tendency is to attribute all data related issues as data problems (due to manipulation or wrong entry), which draws attention away from health programme related problems which may require different kinds of interventions such as improving the cold chain supply of vaccines. This additional comment not only validates the data but also helps to provide useful local context to the raw data.

*Capacity to develop interpretations of data to help design local action:* This concerns the ability of health staff to develop a public health based interpretation of data to help design local action. For example: Figure 10.10 represents a chart depicting figures against related events of ANC cases, births, BCG and Measles. Further, the chart compares registered figures for a period in one district, and compares it with

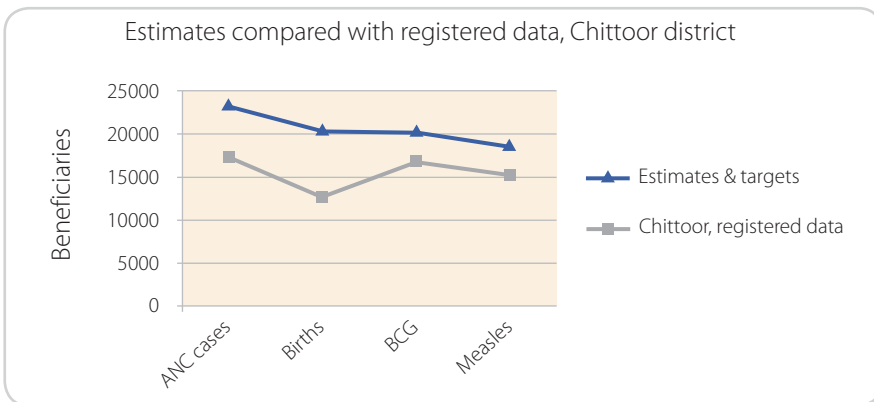


Figure 10.10 Data from one district plotted against the estimated target populations.

estimated figures for the same events. By looking at the two lines in conjunction, the staff can interpret that the registered figures are less than about 20% of the estimates, but however this gap is relatively reduced in the case of BCG and Measles. This graph helps the health staff to identify the specific points where she needs to strengthen action to improve her achievements with respect to what she is expected to do based on population estimates.

*Understanding target population and basic demography:* This capacity concerns how the health staff understands the target population she is dealing with, a concept fundamental for the analysis of indicators and of achievements (service given) against targets (what was supposed to be achieved). Some examples of target populations that are relevant for indicator analysis include:

Children under 1 year is a key denominator and is used for calculating immunisation coverage. For vaccines given right after birth, e.g. Polio 0 and BCG, the number of live births is used, for vaccines given after 9–12 months, such as measles, the number will be live births less the estimated infant mortality rate.

The number of live births per 1,000 population is a key demographic rate, also called Crude Birth Rate (CBR), used for estimating children under one, pregnant woman and population growth. Live births per 1,000 population varies strongly between countries, from less than 20 in Kerala to 35 in Uttar Pradesh, and from 23 in South Africa to more than 40 in most sub-Saharan Africa.

Number of pregnancies is an important denominator used for, e.g. calculating ANC coverage with number of First ANC visits as numerator. Pregnancies may be estimated as the number of live births plus the number of still births, miscarriages and abortions, which, for example, is estimated by UNFPA as being 15% in sub-Saharan Africa. Using this estimate, the estimated number of pregnant women in an area will be the number of live births + 15%.

Crude Birth Rate	15	20	25	30	35	40	45
Live births as % of population	1,5%	2%	2,5%	3%	3,5%	4%	4,5%
Estimated pregnancies As % of population	1,7%	2,3%	2,9%	3,45%	4%	4,6%	5,2%

Estimated numbers of pregnancies and live births are useful in assessing the quality of the data on registered births, and in calculating institutional delivery rates. Comparing institutional deliveries against reported and estimated pregnancies helps also to understand what percentage of the target population have been provided basic services.

Children under 5 years is used for calculating proportion OPD and hospital services given to children, and it will be between 4 and 5 times the Crude Birth Rate (5 X under one less child mortality rate). While in sub-Saharan Africa the percentage of the population under 5 years will be around 17 – 18%, in India the average is 10.5%.

Women in child bearing age is defined as women between 15 and 49, and is the target for family planning services and is used as denominator for calculating coverage of these services. In India “eligible couples” are used as denominator, which are defined as a currently married couple, the wife being in the reproductive age group. It is

estimated that there are 150 to 180 eligible couples per 1,000 population in India. The percentage of women between 15 and 49 in a population differ between countries depending on their demographic profile.

*Capacity to define locally relevant indicators:* While the technology can allow a user to define indicators relevant for them, public health knowledge is required to understand what these required indicators are. This understanding comes with an intimate sense of the local situation, including the ongoing problems that need to be addressed. For example: antenatal care, skill birth attendance and institutional deliveries arguably are key indicators to manage the problem of maternal mortality. For this, the following indicators are relevant:

ANC coverage rate which is defined as the percentage of pregnant women that were provided antenatal care service by the health worker at least once during pregnancy. And, ANC TT2 or TT booster coverage rate indicators are defined as percentage of pregnant women who received TT2 or TT booster vaccine. While the ANC coverage rate indicators provide an indication of coverage of care, the others indicate the quality of care.

Similarly, institutional delivery rate, which is defined as a percentage of institutional deliveries with respect to total delivery, provides an indication of coverage, while that of discharge rate within 48 hours after institutional delivery indicates the quality of institutional delivery services.

*Capacity to define local validation rules:* This capacity relates to the conduct of data quality analysis based on locally articulated validation rules. For example: Monthly reports of health data contain various inter-related data elements which could be cross checked to help analyse quality. For example, pregnant women registered for ANC under first trimester represents a subset of the total pregnant women registered for ANC, implying the subset cannot be greater than the total. Similarly, total deliveries reported should be equal to the number of live births plus stillbirths (notwithstanding the possibility of twin births). The ability of the health staff to identify such relevant local validation rules and how these can be used to make improvements in data quality is an important aspect of local public health knowledge.

### 10.1.3 Implementation related capacity

Technical and public health related capacity is inter-linked in a situated implementation context. For example, using information to identify children dropped out from the immunisation programme, plays out within a particular implementation setting, and demands both technology related (how to use and support the HIS) and public health capacities (how to interpret a data element and immunisation coverage indicator) to be combined. The implementation setting is defined by various conditions such as how work practices are organised, institutional arrangements for verification of data and providing feedback and supervision, the available infrastructure of registers, computers, and internet. The introduction of new technology undoubtedly has the potential to reconfigure this work context, and also the context itself helps shapes the nature of what HIS solutions designed. For example, the use of the mobile phone to send data directly by SMS to the central server will necessarily affect existing practices of manual recording and transmitting of data. And, whether the mobile solution developed is based on SMS or GPRS technology is shaped by the ability of the context to support particular kinds of technical solutions. Some specific capacities related to understandings of the implementation context include:



*Understanding how the HIS relates to work practices around information flows:* This capacity concerns the ability of health staff to understand how different types of health data are collected by institutions based on the services they provide. For example:

- The District Hospital, representing a tertiary care facility, reports on Comprehensive Emergency Obstetric Care Services (CEmOC) such as C-sections and blood transfusions which are not available at lower level facilities. So, such data should only reflect in the Hospital and not PHC datasets.
- Similarly, home deliveries would be reported by the outreach centres, and not by other health institutions which do not provide specific outreach services.
- Further, data elements for programmes like IDSP (Integrated Disease Surveillance Programme) are collected at a different frequency (daily or weekly) as compared to the routine monthly HIS data. The flow to support this data needs to be thus different from HIS reports.

*Procedures around data flows, data verification:* This capacity concerns the ability of health staff to establish, follow and understand procedures around data flows, data verification and providing feedback to field staff on data issues. For example:

District monthly reports comprise of data from different health programmes such as mother and child care, immunisation, blindness control, district stocks and so on. The concerned programme managers need to verify their respective data and endorse it with their signature, and the overall in-charge of the district health system (the district medical officer) needs to verify the integrated report before transmitting it to the state level, where a similar process of authentication is done before it is sent to the national level. The HIS must thus be able to reflect these work practices, and if the system demands changes in the practices, then these must be well understood by the health staff.

The process of feedback is important, such as providing comparisons of selected indicators across all children units (all districts in a state for example), across its parent unit, and across time periods (months in a year). Feedback reports not only help improve quality of data, but builds in an accountability as the reports are compared to specific performance indicators. In the absence of feedback, staff may doubt the utility of a HIS as they see no local value. The picture shows a feedback meeting from the state of Kerala in India (Figure 10.11).

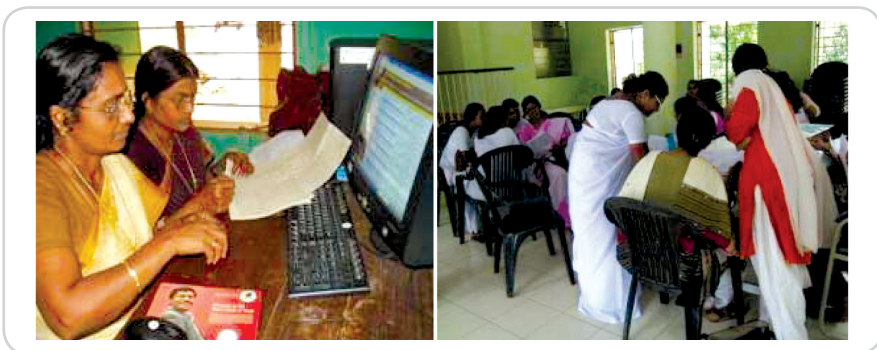


Figure 10.11 Health supervisors scrutinising routine data during monthly sector meeting at PHC in Kerala

The Table 10.1 summarises this discussion to show different facets of capacity relevant to strengthen local action, along with practical examples.

Table 10.1 Different facets of capacity and their functional values	
<b>Technology related capacity</b>	
Characterised by	<ul style="list-style-type: none"> <li>• Various features in the HIS application tool to allow the end users to use technology for their local benefits.</li> </ul>
Running example	<ul style="list-style-type: none"> <li>• Using the user interface to make correction in data elements, organisation units, its hierarchy, validation rules and indicator definitions.</li> </ul>
Functional value of knowledge	<ul style="list-style-type: none"> <li>• User can work with a locally relevant system which he/she can guide towards supporting local health interventions.</li> <li>• User builds capacity for carrying out local customisations towards dealing with the ongoing and changing needs of the health system.</li> </ul>
<b>Public health related capacity</b>	
Characterised by	<ul style="list-style-type: none"> <li>• Data elements and Indicator dictionaries which describe the nature and behaviour of data elements, indicators and their inter-relations.</li> </ul>
Running example	<ul style="list-style-type: none"> <li>• Identification of areas of concern requiring action, such as high drop-out rates from immunisation and low performance on service delivery.</li> </ul>
Functional value of knowledge	<ul style="list-style-type: none"> <li>• User built capacity towards interpretation of trends from graphs and charts, and being able to articulate this understanding towards designing local planning and action.</li> </ul>
<b>Implementation context related capacity</b>	
Characterised by	<ul style="list-style-type: none"> <li>• Work practices, culture towards data collection and understanding information flows.</li> </ul>
Running example	<ul style="list-style-type: none"> <li>• Understanding services deliveries by different health facility types and how these relate to the HIS.</li> <li>• Understanding the data collection and reporting frequencies of different health programmes.</li> <li>• Defining the role of health supervisors at different levels of the health administrative hierarchy to provide relevant feedback</li> <li>• Institutional procedures in place for data collection, verification and transmission.</li> </ul>
Functional value of knowledge	<ul style="list-style-type: none"> <li>• Capacity of health managers and planners in designing relevant data collection forms and their flows.</li> <li>• User built capacity towards scrutinising data quality and establishing constructive feedback processes.</li> </ul>

## 10.2 Participatory Approaches to Building and Scaling Capacity

Building capacity is a multi-level task inherently involving the challenge of scale from individual to facilities to the health system. Two approaches towards this are presented. The first is of building collaborative networks, and this is illustrated through an example from Kerala, India. The second is through the approach of master trainers.

### 10.2.1 Building collaborative networks: Example from Kerala, India

Collaborative networks have been described by Braa et al (2004) as a key strategy towards building and scaling of capacity. The underlying principle is that people learn more effectively in a collective rather than a singular mode, because of the potential that it provides to share and learn from each other, and to also circulate material, ideas, people and resources through the network to enable sharing without having to reinvent the wheel. From the participatory design tradition we bring in the need for users and other stakeholders to actively participate in the design and building of the system, by adapting solutions and best practices from elsewhere and by inventing new ways of doing things. Success will depend on the creation of a sense of ownership to the system from the local users, which maybe fostered through collaborative processes and through being given a say in the design of the system. Another key component of the participatory design tradition is to acknowledge and address the fact that knowledge about the system needs to be developed in a mutual process between the developers, users and the context of work and system practices. Typically, the users will have both concrete and tacit knowledge about their own situation, work practices and wider context of work, all of which the developers will be more or less oblivious to. The developers on their hand, however, will have knowledge about technical solutions and on how these can be adapted and used, knowledge which the users are lacking. Given this situation, the participatory approach is for users and developers to cooperatively engage with systems development on the ground and together develop the “new” combined knowledge about how new work practices and systems solutions maybe developed in a mutually learning approach; everybody will learn and a sort of new knowledge will be developed. Both users and developers will engage with the context and, typically, in a step-by-step and evolutionary process develop the new system – and by definition new knowledge.

Bringing networking into participatory design is to acknowledge that there are multiple actors and users with various relationships to the system at the local as well as at “higher” levels, such as in the district and state, and in different areas; from clients of the health services, to the local political bodies, and various health programmes. Various elements contribute to create enabling or constraining conditions for such networking to build and scale capacity. In Kerala, where HISP India has been active since 2006, the approach taken was to consciously develop collaborative networks that could support capacity development. The network involved the various health units, public health institutions, other training institutions, HISP India and HISP Global, with linkages being promoted by design to support capacity development.

The context of the health system helps to shape processes of capacity development and their scaling. The context in Kerala was provided through institutional conditions such as the political history of the Left government, state policy of support to free software for the public sector, and a strong culture of decentralised governance. This context has made it conducive for the ideology of information for local and decentralised action based on free and open source software to thrive, and the state took ownership to scale training and capacity building processes state-wide.

Within this enabling environment, HISP India played an active and operational role in building capacity – also their own capacity and learning! – around HIS, with a focus on strengthening information use towards taking local action. HISP India, through their technical support agreement with the state, established district teams who

were directly involved in building capacities of local teams at the health facility levels. This engagement generated positive implications mutually, for the health staff to gain knowledge of the HIS, and for the HISP team to better understand the *implementation context*. Various mechanisms were used for building capacity. During the initial development of DHIS2, workshops were held at a local public health institution with medical doctors from the health facilities of Trivandrum district, where the first prototype of DHIS2 was presented. Such workshops helped the HISP team to understand the nature of public health inputs needed to be incorporated in system design. For example, the doctors expressed concerns of security – a nurse should only be able to see data from her facility and not of others. DHIS2 itself played a key role in scaling capacity through the network. One, by its “free” nature, it could without the license restrictions be taken to all the facilities in the state. Local requirements understood through various participatory means could be inscribed in the DHIS2 process of continuous development and new releases.

The deployment model for the DHIS2 over time changed from a centralised to an increasingly decentralised model, as capacities were developed and scaled, and also raised the demand for new capacities. Initially, the configuration for deployment was of a district based system where the DHIS2 was deployed on the state server and data entry done at the district level because of internet restrictions for the sub-district levels. Later a hybrid model was adopted where offline DHIS2 was established in all the PHCs in the state, and data entry done offline there, and then the monthly data exported to the district into the online database. As the internet became more available, data entry started to be done online from the PHC level, making Kerala the first state in the country to have such a decentralised structure for data entry and reporting. The three different models of networks are given below.

#### Model-I: District based deployment model: Enabling rapid scale deployment (Figure 10.12)

The first phase of the district based deployment model enabled rapid scale deployment to the whole state by leveraging on the existing infrastructure and resources, such as internet availability in the different district headquarters in the state. By deploying

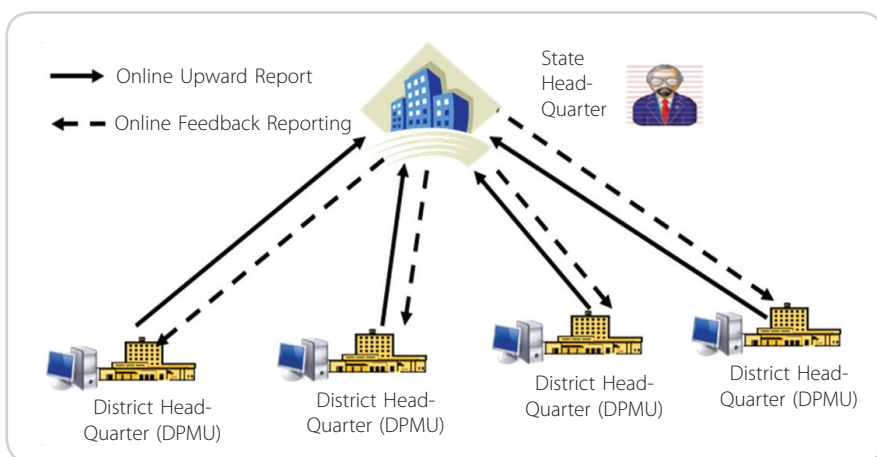


Figure 10.12 District based system model

DHIS2 at the state level with district access, staff could enter online their consolidated district data into the state database allowing state planners to view data with an overall state coverage. Further, this model helped to test out the technical system and build capacity of state level users, who could then become master trainers to spread of capacity to district and sub-district level users.

Model 2: Hybrid deployment model: Combination of offline and online systems (Figure 10.13)

Most of the health facilities, including in Primary Health Centres and District Hospitals had computers at their stations with limited or no internet access. The HISP facilitators installed the offline version of the DHIS2 on these computers, and the health staff was trained to enter their routine data in these systems on a monthly basis, and to transfer it electronically to the district level using either a USB stick or via email. The district staff then imported this data into the district database through the import/export module of the DHIS2, and was then made available to the state level through the online system. Further, the districts would generate feedback reports and send it to the facilities under them. This model helped to overcome the effect of lack of internet connectivity at the peripheral institutions.

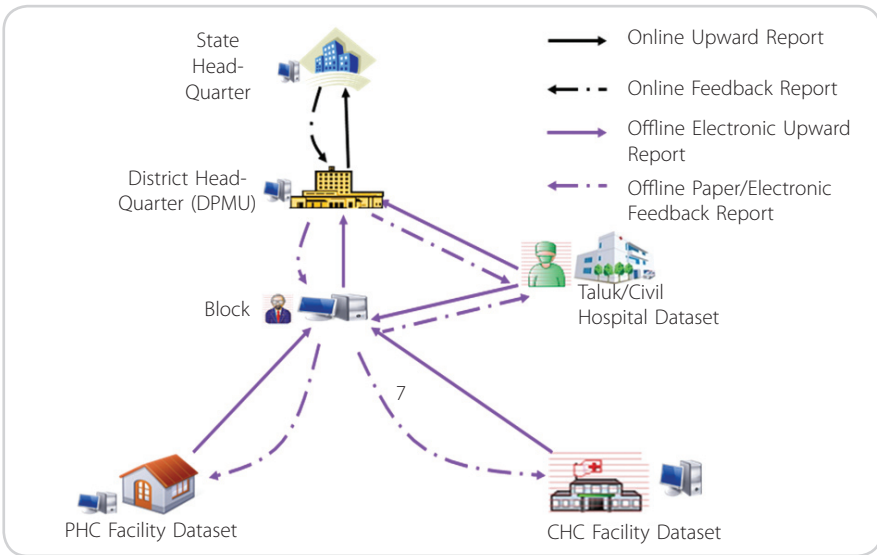


Figure 10.13 Hybrid deployment model

Model 3: Complete online deployment model: Complete and decentralised coverage (Figure 10.14)

As internet become more available at the peripheral institutions, the deployment model was also changed. The state HIS application was configured with all the health facilities and their hierarchy with respective username and access for each user from each facility. Through this, the health staff at the facilities could access the online application via internet and enter their routine data, generate their reports, and gradually over time through the support of the HISP coordinators be able to carry-out local level analysis of data quality and their performance.

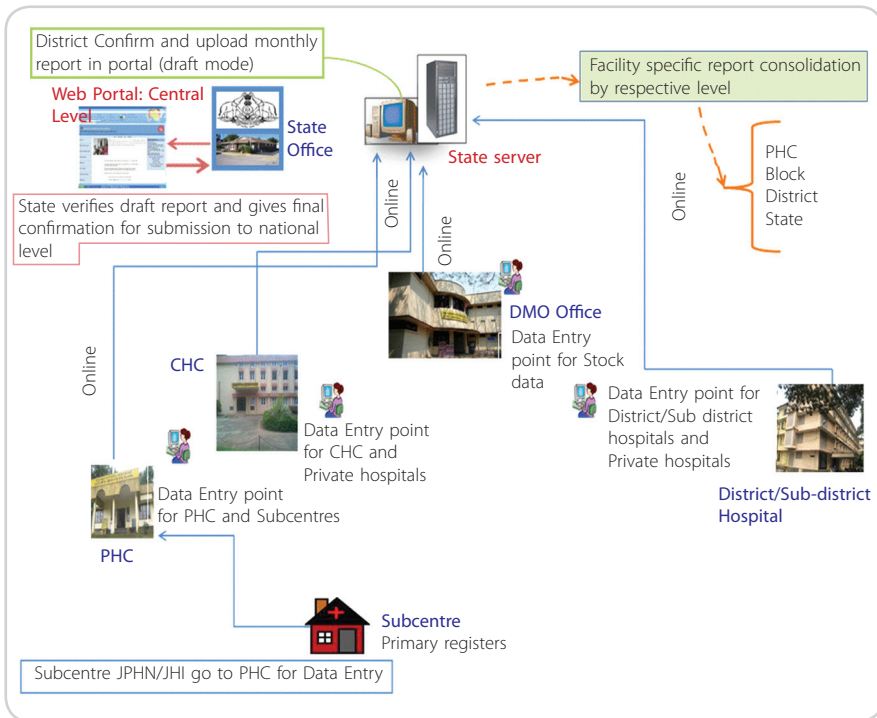


Figure 10.14 Complete online deployment model

The collaborative network was made increasingly robust through the creation of a sense of ownership to the system from the users emanating from the participatory processes, leading also to strong inter-personal relationships and “trust” between the HISP coordinators and the health staff, and also more formal means such as mechanisms such as workshops and seminars. Both these modes, helped to build and scale capacity in both the technical and public health dimensions. For example, a faculty member of the public health institution where the DHIS2 workshop was first hosted helped to help anchor HISP India to the local context, and build understanding of local knowledge. His public health expertise was often called upon by HISP to understand local or public health issues. Further, as HISP team members often went to this institution for giving lectures, their ideas around HIS were also circulated to the students who would hopefully use them to expand the networks in the future. Participation of health workers and field users were elicited in different kinds of settings, with the aim to make the mode of user participation to extend beyond its instrumental role of creating efficiencies and making system improvements to a more constitutive role where users started to take ownership of the system and direct the use of the system towards their needs.

While there were various ongoing and physical means of developing more formal participatory mechanisms such as workshops, training programmes, meetings and demonstrations, and informal relations with users, technology was also a key vehicle to foster these networks through forming an arena for mutual learning and collaboration. The use of websites, online resources, email and chats helped to develop the crucial

role of social capital as a means to both draw upon local support and to provide a way to spread local understandings. The DHIS2, which had by then developed a large community of users, served as a boundary object shared by multiple actors; users, developers, politicians and others, as a vehicle for shared learning to which social capital development and its transmission took place.

The collaborative network was made robust by strong political support received by both the state level administrators and also the Minister of Health who held a strong sense of pride for Kerala to maintain their primary status in the country with respect to Public Health indicators. A combination therefore of various processes and structural conditions contributed to the growth of a collaborative network, which arguably strongly contributed towards a strong capacity in Kerala, leading to it being ranked Number 1 in the country on “readiness to use information for action” in a national workshop in 2009.

In Table 10.2 the nature of the collaborative network is summarised for Kerala including the key actors and their role in the network.

Structure	Key actors	Role in the network network
Collaborative Network “Multi-level and decentralised”	Female health workers called JPHN	Creators and users of local knowledge
	Public Health educational institution	Strengthening of public health knowledge
	HISP India	Implementation and systems development intermediaries
	National Health Systems Resource Centre	Providers of national legitimacy to HISP India
	State policy makers	Support for open source software
	Oslo DHIS2 group	Translating local knowledge into systems solutions
	DHIS2	Software solution inscribing local knowledge

The Kerala example helps to emphasise the following aspects of the role of collaborative networks in the building and scaling of capacity.

1. Building of collaborative networks: The process of building participatory networks was partly a function of design, and also shaped by situational exigencies. The initial set-up was crucial in shaping future trajectories. HISP India played a crucial mediating role in the building of the network, using opportunities the context provided.
2. Context sensitivity: The context was extremely important in shaping both the initial set-up of the collaborative network, and also its growth. For example, in Kerala the history of the Left rule and culture of decentralisation and participation helped to set-up a network that was broad based, decentralised and pervasive. In such a context, the emphasis on local and public health capacity gained emphasis.
3. Focusing on larger scale HIS outputs to include multiple levels of users in the participatory approach – and not only on local participatory action: While the

prototyping methodology for DHIS2 was used extensively, it was not isolated from what was being tried to be achieved – which was to create a robust state wide HIS. The techniques were thus tied up with the outputs, and the nature of outputs shaped how the techniques were used. The end, and its integration into the context of use, was an important aspect of the participatory process followed.

4. Inculcating a judicious mix of both behavioural and structural aspects of participation: Enrolling various actors in the network required work both on the structural and behavioural dimensions. Without the structure of a network in place, actors could not link with each other, share experiences and ideas, and reach out to the peripheral workers. A primary behavioural focus was on building awareness on the notion of “information for local action” and show how this works in practice. Building such an orientation and acceptance of it is necessarily a long term task, as there are legacies of “upward reporting systems” inscribed in the institutional culture. But with the structural aspects of the networks in place, this process of behavioural change could be cultivated over time.

The above discussions help to illustrate the multi-dimensional efforts required towards building and scaling capacity to help facilitate the eventual translation of data into information and based on it, action. This translation is neither a simple linear “requirement input-application design – application adoption/use” activity as envisioned by most technocratic approaches, nor a tool providing “data on click of a button” as it usually relates to supporting the expectations at the user end. This makes implementation and its scaling a complex, often chaotic, process involving the interplay of stakeholder perceptions, understanding, agendas, contextual conditions, initiatives and pro-activeness that shapes what requirements are a priority, how they are ‘designed’ into the application and how the outcome of these development efforts are eventually utilised. This interplay is further compounded by the fact that stakeholders’ understanding and response to the HIS initiative is embedded in their respective knowledge domains, i.e. representing the know how of how to do things the ‘right way’ or understanding gained through experience and further enhanced and distributed in the process of appropriation and use. These expectations are hopefully effectively supported by the computer based systems. Broad based stakeholder involvement in ‘collaborative networks’ and such multi-levelled participatory design serves two broad purposes:

1. **Instrumental** in promoting the initiative through shared learning and building of the purpose and vision of the HIS initiative and in the process influencing stakeholders in the network. For example, in this case, the decentralised political vision in the state was compatible with the “information for local action” ideology of HISP, which shaped processes of state taking ownership and promoting the scaling of systems.
2. **Constitutive** by way of endorsing certain knowledge, practices, structures and use which in the long run contributed to shaping the knowledge domain of the concerned stakeholders, while ensuring the translation of data into action for purposes of making public health improvements. For example, the bottom up approach of creating and supporting local capacity was inscribed in the strategy for field nurses, who were not only taught about how to use the software but also on the meaning of the data elements, how they are converted to indicators, and how could data quality be strengthened locally.



Further, the cultivation of collaborative networks is facilitated and scaled through the role of Social Capital which represents a network ties of goodwill, mutual support, shared languages, shared norms, social trust, and a sense of mutual obligation that people can derive value from being a member of a society or community. By being a member, people have access to resources that are not available for non members (Huisman and Wulf 2004). This capital, though often coloured by informal vested interests, can be built by presenting the value a stakeholder can get in relation to their respective (formal) agendas and goals. By drawing upon social capital to address local problems, local capacity is both generated and transmitted.

### 10.2.2 Building and scaling capacities: the cascading approach of “master trainers”

Typically, a health system is structured in a hierarchical manner, with successive levels of the national, state/province, district and sub-district. Promoting local capacity requires reaching out to the sub-district facilities, and equipping them on the multi-faceted dimensions of technology, public health and implementation context. Given that the number of sub-district facilities in a health system would typically range in the thousands, building capacity at that level is nearly impossible for one agency to do and requires equipping the system itself to carry-out this task. This can be done through a cascading approach of “master trainers.” These master trainers are typically from the system, based at the national, state, district or block levels who are then imparted specialised and continuous skill building interventions from the external agency so that they can train others. By being part of the system and based onsite, the possibility of scaling efforts is much more feasible, and helps towards building stronger internal capacities in the system. The cascading occurs when the external agency may start by building capacity of a specialised group of national level trainers who in turn by equipping a larger group of trainers at the province/state level, and then they together build capacity of district trainers. Through such a process, at each level more and more trainers are enrolled.

There can be varying approaches to creating master trainers in the system. In the example of Kerala given earlier, the HISP India coordinators by virtue of being based in the district, even though not being internal to the state, served as master trainers. The idea being that gradually and over time, they would build capacities of a core group of district and sub district users, who could progressively take on the role of master trainers. The risk with this approach is that the state staff because they feel comfortable with the external trainers do not take on the responsibility for themselves playing the role, raising the challenge of ownership and sustainability. In an alternative approach, the strategy could be of creating a strong core group of internal state master trainers, who initially supported by an external agency could impart training to their state teams, but over time would gradually assume independent responsibility. The risk here is of very slow speed of scaling, especially, given the fact that they also have other responsibilities in the system, not just being master trainers.

While the above describes different structural approaches to creating master trainers, the further issue is of the specific content of training that needs to be imparted which should cover technical, public health and implementation related issues. For example, training content on the technical side needs to include skills to carry out DHIS2 customisation and how they could create users, manage servers and various other tasks. On the public health side, skills to be included related to understanding of data

elements, definitions, indicators, and how to analyse, interpret and use information. Further, master trainers need to be coached in how they can create similar teams at lower levels, and also the specific technical and public health related capacities. The success or not of such a strategy is also dependent on broader institutional conditions such as whether the system can manage to designate dedicated master trainers, and include this responsibility as a part of the formal job description. This, is often not possible due to reasons of bureaucracy, such as the challenges in changing formalisations of job descriptions, roles and responsibilities.

In Table 10.3 some focus areas of content for building capacity are summarised.

<i>Knowledge Domain</i>	<i>Content of training program</i>
Technical domain	<ul style="list-style-type: none"> <li>• Capacity on local customisation.</li> <li>• Capacity on using data analysis tools such as Dashboard and pivot tables.</li> <li>• Capacity to do basic troubleshooting of technical problems. such as allocating access roles to respective users.</li> <li>• Capacity to use visualisation tools such as GIS.</li> </ul>
Public health domain	<ul style="list-style-type: none"> <li>• Capacity to understanding data element and indicator, including their definition, correlation and significance in use.</li> <li>• Capacity around understanding data element behaviour with respective to other related data elements.</li> <li>• Building capacity around interpretation of data and its use in local planning.</li> <li>• Capacity to define locally relevant indicators and validation rules.</li> </ul>
Context of Implementation	<ul style="list-style-type: none"> <li>• Establishing procedures around the data flow and verification.</li> <li>• Understanding the work practices around different types of health facilities towards data collection and information process.</li> </ul>

This identified content needs to be packaged and distributed in the form of training manuals, a set of which can be designated as the “HIS Tool Kit.” This includes:

1. Data Dictionary – describing meaning, definition and use of data elements, and also including a comprehensive list of datasets in the national HIS. Basic principles of data, such as the difference between data recording and data reporting need to be articulated in this dictionary.
2. Indicator Dictionary – describing indicator definitions and how they should be used. The dictionary described key indicators identified for different levels (from national to facility) of the health system. The indicators need to be correlated to the data elements required, helping to design a more action led HIS.
3. Basics of computers – a user manual. Since many of the health users may have not worked with a computer before, a computer manual can be compiled to provide basic guidelines on computer use, describing different parts of the computer such as keyboard and mouse, and basic operations such as switching on and off the computer.
4. Using DHIS2 – training manual to provide a user guide on the HIS. A CD with the source code of the DHIS2 can be provided to users and with it an installation manual. Obtaining the source code can help the users to feel empowered with ownership of the application, in itself a unique experience.

Using information for local action – training manual which describes basic concepts (such as the information cycle) on how to move from data to action. The principle of the “information cycle” can be described, including the role of the software in supporting each step of the cycle – data collection, cleaning, analysis, visualisation and action.

Building and scaling of capacity will require the large scale dissemination of this tool kit to the user community. This tool kit can then become an effective mechanism in growing the collaborative network by it being used in training programmes both as a template for content, but also through the training to see how it can be further enhanced in new versions to better reflect emerging training needs. These documents would also need to be translated to the local language to increase its relevance in supporting larger scale use. The tool kit can become an important “boundary object” that can help to enrol and support diverse actors in the network, and strengthen their skills to become active participants.

### Summary

1. The three key facets of local capacity with respect to HIS include:
  - a. Technological,
  - b. Public health, and,
  - c. Implementation context.
2. Technological capacity includes skills to conduct some of the following tasks:
  - a. Capacity to carry-out local customisation.
  - b. Capacity to use data analysis tools.
  - c. Capacity to carry out basic troubleshooting of technical problemmes.
  - d. Capacity to use visualisation tools such as GIS.
3. Public health capacity includes skills to carry-out some of the following tasks:
  - a. Capacity to understand data elements and indicators, and their significance in use.
  - b. Capacity around understanding data element behaviour.
  - c. Capacity to develop interpretations of data to help design local action.
  - d. Capacity to define locally relevant indicators.
  - e. Capacity to define local validation rules.
4. Implementation related capacity includes skills to carry-out some of the following tasks:
  - a. Establishing procedures around the data flow and verification.
  - b. Understanding the work practices around different types of health facilities towards data collection and information process.
5. A key strategy to build and scale capacity is through the mechanism of developing collaborative networks.
6. Social capital is an effective mechanism to build capacity.
7. The strategy of master trainers is often used in the health sector to build and scale capacity at the system level.

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# 11

## HIS Policy – Role of National, Regional and Global Levels in Building and Promoting HIS in Countries

Health Policy as defined by World Health Organisation (WHO)

*“Health policy refers to decisions, plans, and actions that are undertaken to achieve specific health care goals within a society. An explicit health policy can achieve several things: it defines a vision for the future which in turn helps to establish targets and points of reference for the short and medium term. It outlines priorities and the expected roles of different groups; and it builds consensus and informs people.” [http://www.who.int/topics/health\\_policy/en/](http://www.who.int/topics/health_policy/en/)*

While there are many categories of health policies, in this chapter we focus on the role of the national, regional and global levels in promoting HIS in countries. As argued for in this book, the HIS should as a general rule, be built on a decentralised foundation; local use of information being a pre-requisite for quality data, even for the central level. There is of course a paradox here, as the aim of the state is often primarily to strengthen its “central gaze” over the health systems, leading to them promoting systems geared towards upward reporting, and responding to surveillance concerns. Since, the central ministry is necessarily always the controlling authority of the HIS in a country, including the power of assigning budgets, defining software and software vendors, and assigning different responsibilities to the staff, their policies stand apparently in a stark contrast to normative goals of promoting and supporting “decentralised information for decentralised action.”

While global and regional organisations such as the WHO and the West African Health Organisation (WAHO) represent a supranational level, ministries of health represent the national and state levels. The role of policy differs between the levels, and in this chapter we give examples of both, global and country/state level policies. As depicted in the figure, we regard policy making and implementation as an interrelated cyclic task, which in principle will never end, and remains ongoing and evolutionary in nature. The typical approach to policy implementation and its monitoring is to regard it as a linear process which passes through five phases – Input, Process, Output, Outcome, and Impact.

Contrary to this view, and as depicted in the figure below, we argue for feedback loops as being crucial both in the making and implementation of the policy. For example, proven and well documented impact of HIS will for sure lead to more funds, i.e., input, which may again increase the impact quickly.

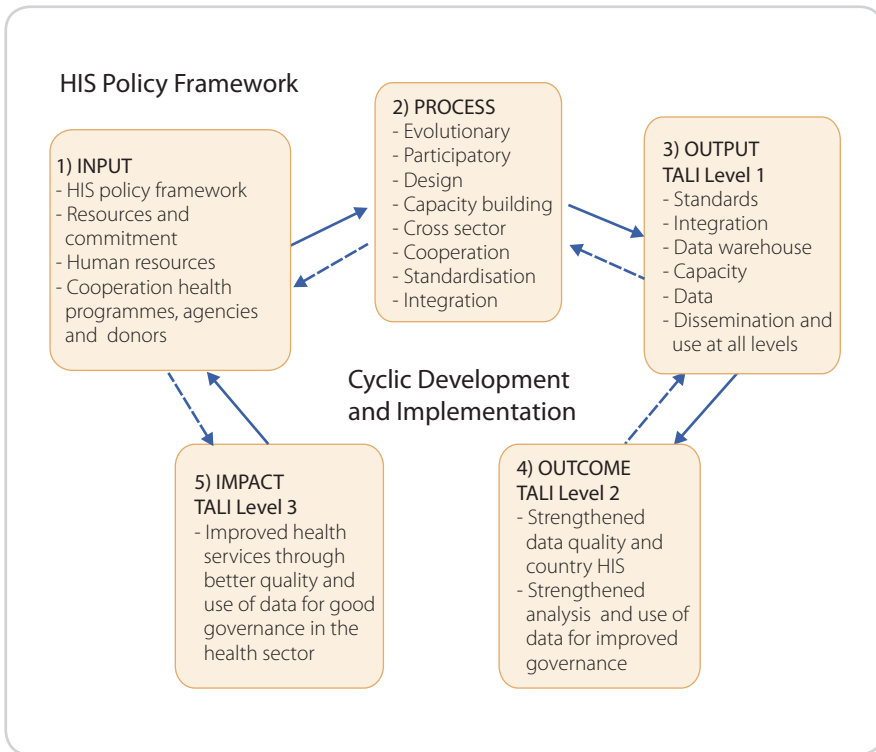


Figure 11.1 Cyclical and Iterative Process of HIS Policy Development and Implementation

This cyclical relation between policy development and implementation is sketched out in the phases from input, process, output, outcome and impact. While the HIS policy framework is an important input to HIS strengthening, the very process of policy development (such as processes of participation and capacity building) helps to shape the outputs (such as the creation of standards and integration), which influences outputs (such as strengthened and improved HIS). This can ultimately help to improve decision making which can shape health services and health outcomes. The TALI tool described earlier in this book (see Annexure 1) represents a methodology to measure three levels of data coverage and completeness (outputs), improved use (outcomes) and improved impacts. The framework depicted above is based on two key principles:

- There is a cyclical and mutual relation between HIS policy and its implementation. Effective policy shapes improved outcomes, which in turn can help shape more effective policy.
- Policy making and their implementation is based on principles of ongoing participation, capacity building, and strengthening the institutional framework, within which development and implementation is carried out.

This framework provides us with useful guidelines in understanding the role of policies in addressing inequities, strengthening the design and implementation of

standards, managing resource allocations, and coordinating technical support. These are discussed in the sections that follow. Policy making takes place at multiple levels, and we draw upon examples from the global level of the HMN to the national levels to illustrate the role of policy.

## 11.1 Role of Overall Policy: Addressing Inequities

Health equity can be described as the absence of health differences between relatively unequal socially disadvantaged groups. In the context of health equity, as asserted by the WHO Constitution in 1946, which argued that “the highest standards of health should be within reach of all, without distinction of race, religion, political belief, economic or social condition.” Significant health inequities are linked to social disadvantages instead of biological or genetic conditions.

The noted economist Amartya Sen has argued that health equity is a central dimension of overall social justice, and shapes the capabilities of individuals to participate in and benefit from social and economic development.

In the context of developing countries, as also in many other developed countries, inequities come in many forms and can be based on social, geographical, income, religious and also other considerations. In South Africa, the average household expenditure for Whites was five times the rates for Blacks in 1995. Female children are less likely to be brought into clinics than their male counterparts. In India, for example, the Constitution has categorised different social groups in terms of castes and tribes (Schedule Caste and Schedule Tribes), and have earmarked for them particular benefits, such as reservations and quotas for employment and for admissions to higher education institutions. This is an example of an intervention to try and address social inequities.

To be able to address problems of health inequities, authorities need to be able to firstly identify health inequities, and secondly, be able to differentiate random variations in these inequities from those that are systemic and which can be decreased through medical, public health or social policy interventions in a given context. Both these issues of identification and action are intricately related to conditions of health information.

The state can thus play two key roles in helping to address inequities:

- One is by defining standards for which data elements are to be captured, a measure which can help to correctly *identify* populations or areas that are marginalised and which contribute to health inequities. Addressing these conditions are then expected to make the situation more equitable. For example, in India till 2008, the national HMIS was designed to include data elements which were disaggregated into three sub groups of “Schedule Castes,” “Schedule Tribes,” and “Others.” While the aim of such a disaggregated design was arguably to identify and support disadvantaged groups, to support the mandate of the Indian Constitution, practically it was not possible to get quality data at this level of detail. For example, when a patient came to a health facility for a consultation with the doctor or the nurse, it was not possible to ask them to which social group they belonged. Further, since the proportions of these social groups remained relatively unchanged in the overall population in a given area, arguably better

quality and more relevant data could be achieved through annual surveys rather than as a monthly routine data which added tremendous workload to the data providers. In 2008, the Ministry of Health redesigned the national HMIS excluding the desegregations from the routine data.

- Another example of inequities, again drawing from India, is the efforts of the government in trying and addressing the rising “Naxalite Problem” in the country through the agenda of development. Naxalite is a generic term used to refer to militant communist groups operating in different parts of India under different organisational envelopes. In the eastern states of the mainland India (Bihar, West Bengal and Orissa), they are usually known as, or refer to themselves as Maoists and have other names in other states. They have been declared as a terrorist organisation under the Unlawful Activities (Prevention) Act of India (1967). The Naxalites are considered to be extreme-left radical communists, supportive of Maoist political sentiment and ideology. As of 2009, Naxalites were reported to be active across approximately 180 districts in ten states of India accounting for about 40 per cent of India’s geographical area, especially concentrated in an area known as the “Red corridor.” The strategy of the government to counter this rising problem of extremism has been to strengthen the development platform including health in the affected districts. In this regard, in 2010 the ministry of health identified thirty-seven “Left affected districts” and sought to identify key health indicators here so that additional budgets could be earmarked in order to strengthen health related interventions which aimed at mitigating inequities.

While in Western countries, personal identification numbers (such as Social Security Number or National ID) have been in use for many years, the same has historically not been the case in developing countries. However, in recent years many countries in the South are also attempting to design personal number systems for ensuring better identification and also to strengthen national security systems. For example, a large initiative ongoing in India concerns the issuing of UIDs (Universal Identification Number – also called Aadhar) based on biometrics to all residents of the country. This initiative potentially has implications for the health sector, especially for the implementation of schemes that target individual beneficiaries. An example of this is the ministry of health scheme (called JSY – Janani Suraksha Yojna meaning Woman Protection Scheme) which provides cash incentives to “Below Poverty Line” (BPL) mothers who have their deliveries conducted within government institutions. This is a policy intervention by the ministry to try and enhance institutional deliveries and through this contribute to reduce the percentage of maternal deaths. Potentially, the Aadhar numbers could be used by the JSY scheme to ensure better targeting of mothers receiving benefits.

The supporting HIS can serve two key purposes at the level of the individual and also of the health facility:

- At the individual level, the HIS can help to authenticate whether the correct beneficiary is being paid the required benefits.
- At the facility level, the HIS can be designed to generate indicators such as the percentage of BPL deliveries to whom cash incentives have been paid, so as to help alert administrators whether the programme is meeting its first level objective – to pay the right people. A higher level objective would be to assess whether the JSY scheme has contributed to enhance institutional deliveries and reduce maternal mortality.



Addressing inequities is also inscribed in the “rights” based approach to HIS. The HMN has recently established the Equity Working Group which made recommendations outlining the content of equity-sensitive information systems, identified opportunities for reducing collection burdens, and suggested strategies to foster an equity-oriented decision making culture. The box 12.1 outlines some principles to guide the integration of equity concepts into HIS. The state can play a major role in adopting such principles which can help make explicit and acknowledge the normative values on which HIS need to be designed.

## Box 12.1

## Integrating Equity Into Health Information

1. Each person has dignity and each one matters
  - Count everyone in the society from birth to death
2. Everyone should have opportunities for health and the means to improve health; vulnerable populations need special attention
  - Collect and analyse information related to health inequities in health status and determinants of health among better-off and worse-off sub-population
3. Governments are accountable to the public, communities have a right to the information they need, to make health decisions, and individual autonomy should be supported
  - Release information to the public in a meaningful form
4. Governments, communities and individuals are all responsible for promoting health and health opportunities
  - Support capacity for and cultures of human rights oriented decision making, based on health information

(Source: Laxi Bambasi, Integrating equity into health information systems: A human rights based approach to health and information – URL: [www.plosmedicine.org/article/info](http://www.plosmedicine.org/article/info))

Each of the above principles has direct implications on the design and implementation of HIS, for example:

- “Every individual matters” requires that each and every birth must be registered with significant implications for a vital registration system that is complete and provides for full coverage.
- The principle of “opportunities and the means of health to all” require minimally acceptable level of data in HIS – a core set of quality indicators – as well as the conditions surrounding the release and use of data.
- Populations as units of analysis as contrasted to individual based information are especially useful for scrutinising the achievement against human rights considerations which indicate patterns of inequities across various strata in society.
- The implication of “accountability and autonomy” has implications not only related to particular content of the health information, but also mechanisms related to promote the effective use of information, including the public release of data in a useful form. Confidentiality and privacy issues are paramount, especially in relation to information disaggregated by equity stratifiers.

- The principle of “mutual responsibility” has various implications including those related to the strengthening of research to understand health inequities, building capacity for the analysis and use of information, setting up mechanisms to enhance demand for equity sensitive information in civil society, and promoting broader participation in equity related processes.

HIS policy can play a key role in strengthening equity in the HIS as a strategy to try and address health inequities. While such policy is designed at the “top”, at the level of the national ministry or global HMN, for it to be effective in practices, this design necessarily must seek to strengthen the decentralisation of health information, and its use for decentralised action. In line with the cyclical approach to policy development and implementation sketched in Figure 11.1, inequities can be better identified through more effective (upwards) flow of information towards policy makers. This can contribute to better policy, and their implementation on the ground requires the enablement and capacity towards decentralised action. Effective implementation can on one hand help to address the inequities which the policy sought to address, and on the other, it can contribute to “better policy” for the future.

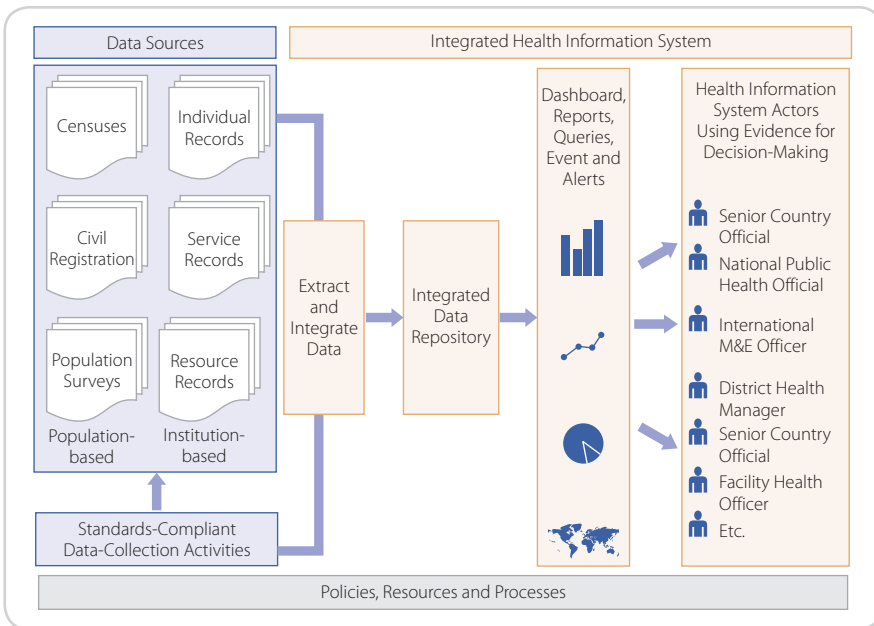
## 11.2 Policy Setting at the Global and Local Level: Health Metrics Network

Adequate HIS policies are lacking in most of the developing countries, in terms of both legal frameworks which govern the information and its principles of organisation and funding, and more specific guidelines related to the day-to-day running of the HIS. Often, what exist are limited to specific information systems for health programmes, which fail to take into account pivotal issues such as data sharing, standards, interoperability, and the development of a centralised HIS organisation. To address this situation, the HMN was established to both help countries develop their own policies, as well as drive this work also at the global level by promoting the HMN integrated framework for HIS, which could potentially be used as a model for HIS policies by donor organisations, national development agencies, and others.

The HMN was established in 2005 as a partnership organisation with the WHO, operating as a network of international organisations, countries, and other organisations involved in HIS strengthening. The HMN had an explicit strategy to assist countries through developing tools and standards for assessment and planning, and to provide financial support to implement these tools in countries. At the core is the HMN Framework and Standards for Country HIS Strengthening (“the Framework” – See Figure 11.2), a document that spells out the various components of a HIS, as well as a normative “golden standard” on how they should be organised, with a central data warehouse as the glue. To work towards this model, HMN calls for a three-step process:

- Assessment of the current HIS.
- Making a strategic plan to improve towards the framework model, and,
- Securing funding and implementing the plan.

For this, HMN also developed an assessment tool, and a guidelines document for strategic planning. For the implementation of the plan, that is the third step, HMN has only helped countries in writing proposals for external funding, save for a handful



**Figure 11.2** The HMN Framework, Outlining the Golden Standard of HIS Organisation. (Various configurations are possible, the central aspects are integration of data in a data repository, and a wide range of different users accessing this repository.)

of the so-called “wave-one” countries (such as Sierra Leone), which were selected to implement their plans to provide learning for other countries.

The strategic plan that a country makes, based on their HIS assessment, often represents the first policy document on HIS in the country. The role of HMN in policy making is thus one of assisting each country in developing their own national policies (strategic plan), based on an assessment of their current system *in relation to* the HMN framework. The framework is thus a global policy document, which guides the development of national policies, and over eighty countries have done the assessment.

While a substantial amount of countries have applied the HMN tools, they are almost exclusively from the lowest income classifications (using the World Bank classification). A few countries can be termed upper middle income, but all in all the majority of countries adopting the HMN framework as a base for their HIS policies are relatively poor. HMN has thus had limited impact on the so-called developed world. This has been quite intended, given the little emphasis HMN has placed on this. However, the framework model is a general one, and represents a vision that richer countries are also striving towards.

The HMN tools included the following six components of HIS:

- HIS resources.
- Indicators.
- Data sources.

- Data management.
- Information products, and,
- Dissemination and use.

The process of strengthening these starts with the assessment, a process meant to be done through wide participation of various stakeholders, including health programmes, central statistics office, and owners of various health information sub-systems. Graded answers to around 200 questions help provide an overview of the situation, as well as an evaluation of where the system is the weakest. The strategic plan is then expected to be negotiated among the same actors, aiming at both implementing the model HIS as laid out in the framework, and to address the challenges and weaknesses revealed by the assessment.

The primary reason for the assessment process is to convene multiple stakeholders and enroll them in a joint process towards improved HIS, rather than producing exact statistics of the strengths and weaknesses of the HIS. The assessments were thus done by the countries themselves, and often the guidelines for this process were not followed strictly. Given that the assessments were subjective, performed by using varying methodologies and with different stakeholders from country to country, the results do not lend themselves to strict comparative science. However, some general trends can be seen across countries, continents, and income levels. The Figure 11.3 below shows the overall scores for the six domains (each consisting of many questions), for all countries which, by 2010, had completed the assessment using the latest version of the HMN tool. An analysis based on income levels (mostly low and lower middle income), and regions (Sub-Saharan Africa, Eastern Mediterranean, South-East Asia, the Asia-Pacific region, and the Americas), reveals the same findings that countries consistently score the least in the domains of HIS Resources and Data Management (below 50 per cent of maximum score). Within these domains, the

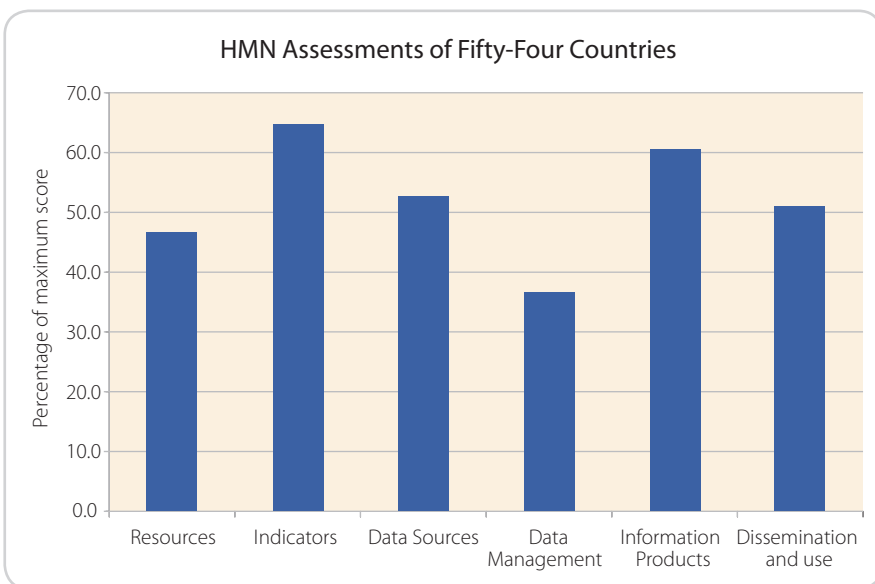


Figure 11.3 Overall HMN Assessment Scope Across Six Dimensions

sub-domains of HIS Policies, and existence of integrated data warehouses, stick out as the weakest. The assessment evaluation of Moldova provides an example:<sup>1</sup>

*A less promising situation shows the policy and planning component, where there are great discrepancies: there is no written HIS strategic plan, no active coordination mechanisms between MoH, NHIC and NBS, as well as no written policy to promote a culture of information use throughout the health system.*

Most of the country strategic plans have been made available through HMN's website, <http://www.who.int/healthmetrics>, which often represents the only policy on HIS available for many of the countries. While they may not carry the formality and details, expected of finished policies, they nonetheless include normative guidelines for the development of these. For example, in the strategic plan for Georgia:<sup>2</sup>

*The first step in the design process is to agree on minimum set of national health indicators. There is need in a strategic framework to guide indicator selection. The framework should be consistent with the National Health and Health System Performance Frameworks 2, relate to national health objectives and priorities, clearly define the purpose of the information system and the indicators derived, and maximise stakeholder participation. Indicator development and use should be embedded in management planning and resource allocation. Selection of indicators should build on best practices and local experience, be appropriate for each level, be simple and clear, and be linked to action.*

Another example is the strategic plan for Uganda, which among other action points, include the following:<sup>3</sup>

- Set up HIS committees (national and district).
- Draft institutional arrangements for setting up HIS unit (one-stop centre for data management).
- Set up partnerships for HIS implementation and funding at national and district levels.
- Set up and update HIS web-page for all sub-systems to feed into and be able to obtain data.
- Set up web-based linkages for production and accessing health information between the HIS sub-systems (including the private sector and research institutions).

These action points, which have been approved by the ministry of health, clearly have implications at the policy level, for instance the inclusion of private sector health data into the overall HIS, and the goal of having web-enabled access to this.

In addition, HMN has made strong attempts towards promotion and advocacy around this framework at the global level. Both regional and global conferences have been held, like the 2010 Global Health Information Forum held in Bangkok. The conference brought together countries and organisations working on HIS, and signified the conclusion of HMNs work towards many international organisations:

<sup>1</sup> [http://www.who.int/healthmetrics/library/countries/HMN\\_MDA\\_StrPlan\\_Final\\_2007\\_11\\_en.pdf](http://www.who.int/healthmetrics/library/countries/HMN_MDA_StrPlan_Final_2007_11_en.pdf)

<sup>2</sup> [http://www.who.int/healthmetrics/library/countries/HMN\\_GEO\\_StrPlan\\_Final\\_2009\\_06\\_en.pdf](http://www.who.int/healthmetrics/library/countries/HMN_GEO_StrPlan_Final_2009_06_en.pdf)

<sup>3</sup> [http://www.who.int/healthmetrics/library/countries/HMN\\_UGA\\_StrPlan\\_Draft\\_2009\\_05\\_en.pdf](http://www.who.int/healthmetrics/library/countries/HMN_UGA_StrPlan_Draft_2009_05_en.pdf)

*Leaders from WHO, the World Bank, The Global Fund, UNICEF, UNAIDS, UNFPA, GAVI and the Bill & Melinda Gates Foundation called for ‘new ways of working and a more systematic approach by all partners.... to better monitor and evaluate progress and performance,’ emphasising the need to strengthen country capacity to collect, process, analyse and use health data.<sup>4</sup>*

To summarise, the role of HMN has been to work at both the global and national level to strengthen HIS, including policies. The HMN framework is the most successful and distributed policy document for HIS globally, with more than eighty countries adapting tools to assess and plan their HIS according to this framework.

### 11.3 Policy Initiative for Improved Mother and Child Health

THE UN motivation for strengthening HIS, with key focus is on good data quality. The UN “Post Accountability and Information Commission Work plan” (CoIA), which is supported by various countries including Norway, aims at strengthening HIS and M&E systems for better accountability for Maternal, Neonatal, and Child Health (MNCH) resources and results in developing countries. The first three of the CoIA recommendations are of particular importance to this chapter:

- **Recommendation 1:** By 2015, all countries have well-functioning HIS (...) and “at least twenty countries” by 2013, and “at least fifty countries” by 2015, have timely and accurate core coverage indicators data.
- **Recommendation 2:** By 2012, a core set of eleven indicators on reproductive, maternal and child health, disaggregated for gender and other equity considerations, are being used for the purpose of monitoring progress towards the goals of the global strategy (this represents core information content of the HIS).
- **Recommendation 3:** By 2015, all countries have integrated the use of ICTs in their national HIS and health infrastructure.

These recommendations emphasise the need for a “strong and well-functioning HIS” including: timely and accurate data; core data and indicator sets on reproductive health; and integrated use of ICT. As discussed earlier, the TALI tool (see Annexure 1) developed under the HISP framework, provides a framework to make such an assessment:

- **Level 1 – of the TALI tools HIS assessment framework: *the technical level.***
  - ◆ **The information system is working technically according to its specification.** At this level of maturity, it would be seen that data flows are established with high levels of completeness of data reporting and data are of reasonable quality and basic data quality control procedures are in place. There are designated “Information officers” in place with job descriptions, placing responsibilities for information handling, data reporting and data management at all levels. At the central level, a HIS unit is in place. Integration of data flows and reporting from the different health services and health programmes and establishing a data repository as a shared resource at national, sub-national and district levels are key steps in improving information practices at this level. ***Data completeness*** and ***timeliness*** are key indicators for assessing this level.

<sup>4</sup> [http://www.who.int/healthmetrics/news/weekly\\_highlights/ghif\\_2010\\_call\\_to\\_action/en/index.html](http://www.who.int/healthmetrics/news/weekly_highlights/ghif_2010_call_to_action/en/index.html)

- ♦ **Motivation for strengthening health sector governance through improved information use.** In the action plan of the CoIA, however, in-country use of information and capacity building, is directly and indirectly referred to in most activity areas, such as on “Monitoring of eleven core indicators (2.1)” and “Annual review and action (2, 6)” and “Dissemination, interpretation and use of data (7)”. Achieving this, necessarily requires the strengthening of the use aspect of HIS, which is more complex than establishing technical systems. Research has established well why this is the case, identifying reasons such as existing legacy systems, socio-cultural-institutional conditions, and a near absence of an information culture that supports “information for action.” The TAL tool has identified two levels of such an information culture, one dealing with the use dimension and the other with the impact level.
- **Level 2 – Data is analysed, disseminated, fed back, and used: *the institutional use level.*** At this level, the HIS would be characterised through the use and display of summary reports employing graphical tools and maps (where appropriate) on key indicators for the facility, district or state/national levels which are produced every month and disseminated to all relevant stakeholders and fed back to the facility level. Information is used and discussed, and indicators are assessed against performance targets on a regular basis at review meetings, staff meetings, and the like. Indicators to assess this level of information usage are the availability of analysed and disseminated information; graphs on the wall, monthly/quarterly bulletins, presentation of information at review meetings, and the creation and dissemination of feedback reports. In short, there are “conversations” taking place around data.
- **Level 3 – Information used for planning and evaluation of achievements of prior plans and carrying out impact assessment: *the level of institutional impact.*** This level is about moving towards active use of information in planning and evaluation, and the institutionalisation of these processes in the practices of the health system. While of course it is hard to assess such impact of information, we would expect such information usage to be documented in the evaluation of achievements as according to annual plans, and the using of information to follow up on planned activities. This level of maturity is also reflected in information use for diverse and higher levels of sophisticated impact assessment such as budgeting, resource allocation, equity management, and performance measurement. Bringing together a comprehensive analysis of the health situation and trends with data on health inputs, such as health expenditure and health system characteristics is particularly important.

In line with the cyclical framework (Figure 11.1) linking HIS policy and its implementation, through the TAL tool we have tried to show how global policy such as the CoIA can be made more “measurable” on the ground, and be monitored to see if its aims are being achieved.

## 11.4 Role of Policy: Making and Implementing Standards

A key focus in this book has been on the key role of standards in establishing effective HIS and IHAs. This importance is greatly heightened, especially in the contemporary context, where we are confronted with a multiplicity of systems, and where governments and international donors are keen to promote the establishment

of IHAs. For example, the HMN has published a book titled “Framework and Standards for Country Health Information Systems”. In this, they describe six components of standards of a HIS:

- HIS resources.
- Indicators.
- Data sources.
- Data management.
- Information products.
- Dissemination and use.

We can try to unpack the nature of standards within each of these components, which is summarised in the table below.

<i>Component of standards</i>	<i>Types of standards – examples</i>
HIS resources	<ul style="list-style-type: none"> <li>• Software platforms – e.g. use of open source platforms within the health sector.</li> <li>• Open standards to ensure all technology/software used are inter-operable allowing any technology platform or software to be able to read documents, maps, images and data sheets.</li> <li>• Hardware platforms – e.g. use of particular configuration of machines at the district or facility levels.</li> <li>• Compliances for vendors with respect to system interoperability when undertaking new software development.</li> <li>• Data entry medium – e.g. use of particular configuration of mobile phones to facilitate data entry and transmission from peripheral facilities.</li> <li>• Recording formats – e.g. structure of primary registers in facilities for recording service data.</li> </ul>
Indicators	<ul style="list-style-type: none"> <li>• Defining particular indicators for monitoring health programmes (such as maternal health, child health, family welfare etc.).</li> <li>• Defining what indicators should be received by different administrative levels, e.g. monitoring indicators for districts and impact indicators for the national level.</li> <li>• Defining indicators for other domains such as hospitals, infrastructure, human resources etc.</li> <li>• Defining the action taking protocols against these different indicators.</li> </ul>
Data sources	<ul style="list-style-type: none"> <li>• Defining sources of data for primary recording in primary registers.</li> <li>• Defining data sources for the generation of different indicators.</li> <li>• Defining standards on how different data sources must “speak” to each other such as vital registration and HMIS.</li> <li>• Defining validation rules for scrutinising data quality.</li> <li>• Defining institutional protocols for dealing with quality issues.</li> </ul>
Data management	<ul style="list-style-type: none"> <li>• What is the level of aggregation of data required for different levels of the hierarchy?</li> <li>• Defining the institutional mechanisms for verification of data.</li> <li>• Defining periodicities of reporting and associated responsibilities.</li> <li>• Defining the institutional procedures for addressing data quality issues.</li> </ul>



Information products	<ul style="list-style-type: none"> <li>• Defining standards for different reports for various administrative levels.</li> <li>• Defining formats and procedures for feedback reports.</li> <li>• Defining media and format in which data should be made available to public at large.</li> </ul>
Dissemination and use	<ul style="list-style-type: none"> <li>• Defining policies for dissemination of data to civil society, including media.</li> <li>• Defining policies around issues of data privacy and confidentiality.</li> <li>• Ensuring principles of equity are maintained by enabling flows of information.</li> <li>• Defining policies for accessing data by different government departments both within and external to the health department</li> </ul>

As indicated in Table 11.1, standards can be of various types, including relating to hardware, software, registers, data elements and indicators. Additionally, and very importantly, standards are also in terms of processes and procedures. For example, a guideline that all data of a month from facilities should be consolidated at the district level by the fifth working day of the following month represents a standard around a process. Establishing procedures around what data in what format should be made available to whom and when, also represents important standards.

While the scope of standards is wide, a key focus area remains on concerning data elements and indicators, including definitions of what data elements should be captured, the uniform nomenclature for naming the data elements, which indicators need to be generated from each element, what is the periodicity of data collection, and the protocols to enable data exchange. Important in this regard, is the need for policy to define particular principles around standards, which can help in the development of operational standards. For example, adhering to the hierarchy principle helps in emphasising that information needs to vary with the different levels of administration. While the national level needs to focus on indicators that can help the state to discern the impact of different programmes and make appropriate policy interventions, the lower levels (e.g., the district and below) need to focus more on indicators useful for monitoring activities. Often, as our examples through this book have tried to highlight, if the central state focuses on detailed monitoring indicators rather than on evaluation and impact related, this then draws their focus away from their core task, that is policy level impact evaluation.

We have discussed in earlier chapters how at the global level, the WHO is playing a lead role in establishing a framework of standards for data exchange called the SDMX. HD. This standard seeks to establish protocols for interoperability between patient level and aggregated facility level data, and similarly between human resources and aggregated facility data. The state, through policy interventions, then has the responsibility to adopt these standards with the necessary customisations to ensure that their systems are compatible with global benchmarks. Standards by no means imply that “one size shoe fits all,” and principles such as of “flexible standards” and the “hierarchy of standards” can help implement standards that are simultaneously interdependent and also customisable to meet different needs.

Problems in keeping the framework of standards are:

- The situation in the health departments (and also other public sector departments) in most developing countries is that different standards (or none at all) are used

for managing documents, maps, images, spreadsheets and databases. A majority of these are on proprietary platforms and do not necessarily interoperate, so documents and data of one department or health programme or state cannot be read or accessed by another. In the absence of a common thread, every time the Centre or the State asks for data or information from particular facilities or other levels, it has to be converted into a common format, which takes time and runs the risk of data loss.

- Further, since many of these applications have been developed by external vendors or international donors without adequate documentation or release of source code, often such data interoperability is not even possible. To address such challenges arising out of lack of open standards, in India, in a recent initiative which has been described as historic, revolutionary and a victory for the open source movement, concerns the decision to announce a policy that will make it mandatory to have an open and royalty-free standard for all technologies and software used in the government. This potentially implies the creation of a uniform standard for all government work to enable all documents or databases to be accessible through any technology platform. The policy has been cleared by the Department of Information Technology and the National Informatics Centre and is likely to be made official soon. This effectively means the technology used in all government departments and offices, including the health department, would need to shift to an open standard contributing to more cost-effective data exchange.
- We have in the earlier paragraphs outlined the scope of standards that need to be established in order to make HIS more effective in promoting local action. In the absence of a central authority that is defining, managing, and updating these standards, there is a real danger of the HISs disintegrating, especially in the context of donor dependencies where different agencies tend to establish their vertical and compartmentalised information systems which do not speak to each other. An important challenge is around the processes by which standards are established and implemented. Often, the tendency at the top – both international donors and the central ministries of health – is to create “standards from nowhere” and just mandate lower levels to follow. Such an approach has historically proven to be recipes for disaster. Participation of stakeholders is important in the process of defining standards, and the central ministry needs to play a key role in enabling stakeholder participation and in establishing consensus.

The Nobel Prize winning economist Douglas North in his theory of institutions (1990) has forcefully argued that policies made at the “top” have little chance of successful implementation if they do not adequately overlap with the informal institutions that exist on the “ground” where they need to work. For example, a policy declaration in 2009 in India to carry out electronic tracking of every pregnant mother and newborn child across the country has been significantly stalled in its implementation. It is because its design is incongruent with the situation on the ground, such as the availability of primary registers, high existing work load of the health service providers, weak computer based infrastructure including internet connectivity at the peripheral facilities, and the absence of a uniform identification numbering system for individual beneficiaries. In light of this deep lack of overlap between the mandated policies or formal institutions and the informal constraints which exist in the implementation domain, the policy implementation has been far from being effective. This example

raises the important concern of policies needing to be developed through appropriate participatory mechanisms, and in also ensuring the practical feasibility of its acceptance and implementation. This resonates with the framework presented in Figure 11.1 which emphasises the linkage between policy development and its implementation.

## 11.5 Role of Policy: Focusing Resource Allocation Where Needed Most

An effective HIS requires adequacy in the provision of various resources including related to infrastructure, manpower, training budgets, and various others. Developing countries, by definition, present resource constrained environments, and available resources need to be managed judiciously amongst different competing requirements, stemming from various health facilities, districts, and health programmes. There are also various competing interests of various actors including donors, diseases, politicians with self-interests in particular geographical constituencies, and health programmes which makes resource allocation a complex and politically charged task. Most often, resource allocation decisions are controlled by the National Ministries of Health who have the responsibility to prepare sound and robust guidelines to create enabling environments in which HIS can thrive in supporting decentralised action. These principles and guidelines are as follows:

- A first guiding principle is that of establishing processes to support “need-based resource allocation,” as contrasted with the concept of all concerned to be provided equal allocations, as is often the case. For example, if resources from the central level need to be provided to facilities in different institutions to help promote institutional deliveries, then the state has the option of either supporting each health facility equally or differentially. This decision of the state is based on criteria of whether well performing facilities are better and further supported, so that they can build upon their strengths, or that the poor performing facilities be given additional resources to help transcend their constraints. These questions do not have straightforward answers, and criteria need to be established and applied in a context-sensitive manner within a framework of consistent and transparent policies. State policy becomes an important vehicle to establish such a resource allocation framework, and to ensure allocation takes place in line with its stated policies.
- Another guiding principle for resource allocations is that it is based on a framework of “evidence based decision making”. The HMIS itself becomes a tool to define and promote such a framework, where for different facilities or districts the indicators of performance, efficiencies of prior resource utilisation, and existing capacities are provided weightings to define resource allocations. This helps to make the process objective, transparent and linked to needs. In India, for example, states are entitled to a total monitoring and evaluation budget of 4.5 per cent of their overall annual state budget, and the state budget is comprised of district budgets, which in turn are constituted of sub district budgets. Therefore based on annual health action plans which are defined based on the HMIS generated indicators, at each level budgets need to be made, and then consolidated at different levels to finally come up with the state annual plan.

- Another key component of the task with respect to resource allocation concerns the conduct of concurrent evaluation of how prior resources have been utilised, both with respect to the volume and purpose of use. Building systems of accountability and transparency is key to this, and many governments are orienting their e-governance initiatives towards achieving these goals. In contexts where corruption is rampant and resource allocation is made based on political and other subjective considerations, evaluation is often not easy to conduct in an objective manner. Often, whistle blowers are punished rather than rewarded, giving staff little or negative incentive to buck the trends. The state thus has the responsibility to clearly define systems of accountability around reporting on resource utilisation, and to ensure that people are not penalised for trying to be accountable.
- Standards can be used to help provide guidelines on resource allocation. For example, the state can establish norms of what kinds of equipment, infrastructure or human resources, different health facilities should have. Then resource allocation could be based on a comparison of what are the existing holdings on these facilities, and conducting a gap analysis in relation to the norms. The identified gaps then provide a concrete basis to help define required resources in different facilities. The facility survey carried out by the WHO in various countries is an example of an effort to help identify gaps. Similarly in India, the government has established a very extensive network of norms – Indian Public Health Standards (IPHS) – for different types of health facilities in the country, which are now being used as a basis for carrying out district health planning. These norms are not necessarily “appropriate,” as they represent desired norms and in many cases may be infeasible to attain. However, by constantly engaging in dialogues around them between the state and facilities, with respect to what is feasible and practical to attain, these standards can be fine tuned and made more realistic.
- Many governments, such as in Brazil, South Africa, and Kerala in India, have made policy statements to support the use of open source software in the public sector. Many other governments are interested in following this path, but often do not know how to operationalise such a policy. For example, it can be difficult to set up tender documents for enabling the procurement of open source applications in systems where proprietary systems have historically been the norm. An important role that the state can play, then, is to set up policies and procedures both to support the uptake of open source systems, and also to help make them work in practice. This helps to highlight the particular challenge with respect to resource allocation decisions in the matter of open source software. In general, often capacity in governments to assess costs and resources around software application is limited and more so in the case of open source where the assumption is that the state should get “everything free.” This of course is a misconception and there are various factors around open source software which need to be costed (such as customisation and capacity development costs) and incorporated in resource allocation decisions. Making these cost factors explicit, and building frameworks within which they can be objectively assessed is an important aspect to help enable the evaluation of open source systems.

## 11.6 Role of Policy: Coordinating Technical Assistance Including Donor Support

In the context of HIS, technical assistance can take on many forms, including establishing and managing infrastructure, design and development of software applications, managing its implementation, employing public health domain skills in the analysis, interpretation, and use of information for helping to make improvements in health services delivery. Based on the wide variety of skills which need to be technically supported, the diversity of competencies available, and the geographical spread of people, the function of technical support needs to be managed effectively.

Here, state policy has a key role to play. Some of these roles include:

- **Establishing quality standards for technical assistance** – For example, support for strengthening software use, identifying what are the different levels of competencies which need to be established, as well as also the training levels required for each extant occupation in the health system to reach the desired competency levels.
- Policies around quality standards then need to **establish what kind of people should reach particular competence levels and how**. In the context of technical assistance for strengthening HMIS; the state can perhaps specify that field nurses should be at level “1” of competence where they are capable of doing data entry, while a data manager at the sub district facility should be at level “2,” where, in addition to data entry, he or she should be capable of generating reports, validating data, generating and uploading reports to required repositories. At level “3” it could be required of the district level team member to display capability levels to carry out basic programme management decisions based on HMIS, and with respect to the application be capable of adding or removing data elements and indicators, creating local reports, and other similar tasks. The state, then, has the responsibility to establish such competency standards and policies concerning on who should be at what level, and what are the training levels required to attain these competencies.
- Another responsibility of the state could be in **establishing standards for agencies** which are providing technical assistance and certifying their methods used. For example, the state could empanel a set of agencies that are considered competent to provide training to the health department of HMIS. The methods of these empanelled agencies would need to be standardised and certified which would include a formal accreditation of the curriculum used for the training, and also the faculty, methodology, and the assessment methods. Associated costs of each of these components would also need to be negotiated with and agreed to by the state. Such systems of certification would not only help to contribute to a uniform level of quality in training across the whole system, but also to ensure the systems by which agencies are selected to be objective and transparent.
- Another important role of policy is to help **establish procedures and systems** for identifying needs for technical assistance, recruiting vendors, developing and monitoring their contracts. In Table 11.2, we summarise key roles which policies should seek to address in coordinating technical assistance.

Table 11.2 The Role of Policy in Coordinating Technical Assistance

<i>Activities around technical assistance</i>	<i>The role of policy</i>
Defining needs for technical assistance	<ul style="list-style-type: none"> <li>• Facilitating stakeholder participation in needs assessment for technical assistance.</li> <li>• Facilitating the reaching of consensus in multi-stakeholder meetings.</li> </ul>
Identifying competent agencies to provide required technical assistance	<ul style="list-style-type: none"> <li>• Maintaining databases of approved agencies which can provide different forms of technical assistance.</li> <li>• Maintaining databases of approved individual consultant that can provide different forms of technical assistance.</li> <li>• Develop methodologies for evaluating agencies based on their performance.</li> </ul>
Managing technical assistance contracts	<ul style="list-style-type: none"> <li>• Defining formats for tenders, RFPs, contracts.</li> <li>• Approving processes of rate contracts.</li> <li>• Arbitrating in times of disagreements.</li> </ul>

Technical assistance is, often provided by donor agencies, coordinating that which is extremely complex, considering the fact that these agencies have their own specific agendas which they want to pursue, and are often incompatible with national frameworks of health systems strengthening. For example, one agency may be focusing only on human resources information systems, while another could have its focus on the malaria component of the HIS. Coordinating the activities of these agencies is vital because they may often tend to duplicate work, and sometimes initiate projects which may run counter to what the state is doing. Since donor assistance is normally governed as political decisions, and come with significant amounts of independent money, the state is hard pressed to coordinate them or even have a say on how it is used and for what. Some governments set up donor coordination committees where through periodic meetings of the respective donors, efforts are made to coordinate and harmonise activities. However, often these meetings tend to be largely bureaucratic exercises with no one really having the authority to steer things in a particular direction. So, it becomes important for the Ministry to have someone senior and with the required authority to chair such a forum and be able to give it direction and meaning.

### Summary

1. Policy plays out at multiple levels, such as the global, regional, national and sub-national levels.
2. Normally policy efforts are ineffective as they are made at the “top” with little sensitivity to the practical constraints on the ground. This therefore requires policy frameworks to be intimately inter-linked in a cyclical relationship with efforts to make them work on the ground – concerning their implementation.

3. The HMN has played a key role in trying to harmonise global policy efforts around HIS with national policy efforts.
4. Policy can play a key role in supporting the strengthening of decentralised HIS for decentralised action. But this requires a shift from traditional roles of central ministry of surveillance and control towards trying to create enabling environments in which decentralised HIS can thrive.
5. Policy can play four key roles:
  - Addressing inequities.
  - Setting and implementing standards.
  - Coordinating resource allocation, and,
  - Managing technical assistance, including donor support.

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# 12

## Technology, Health and Development

In this chapter, we discuss two different perspectives on development which is implicitly underlying the topics on technology and health discussed in this book.

- The first of these perspectives is linked to the basic human needs of “good health” and may be summed up in the WHO slogan from the Alma Ata declaration on Primary Health Care in 1968: “Health for all”.
- The other perspective on development is linked to the basic need for social and economic development, and more precisely, the need for economic growth in poor countries, regions and communities in the world, so as to counteract the otherwise increasing economic divide. This latter perspective on development, in our context, is also directly linked to the topic, although it will need some explanation: New perspectives within economic theory emphasise the role of technology in economic development. The “technology-gap approach to economic growth”, sees technological differences as the prime cause for differences in economic growth across countries (Fagerberg, 1994). Further, this perspective now sees technology as rooted in people – knowledge, not things, and technology development being linked to use and learning, by people, and through that, innovation.

Our rationale for bringing in these two different perspectives on development is that by combining them we can formulate the following hypotheses:

- **Hypotheses 1** – IT for a better world: Information systems and related technologies are needed in order to improve health services and health status in a population. While this hypothesis has been argued for, throughout the book and stands well without further arguments, the second hypotheses will need some explanation by way of assumptions. The assumption is that our social system perspective on HIS states that the system is made up of people handling data and tools, procedures and technology that is making up the system, not the artefacts alone. Key parts of technology development are therefore linked to learning through use and implementation of technology in context.
- **Hypothesis 2** – Empower communities’ learning through use. Development and use of HIS following the IHIA approach in developing countries and with emphasis on the use at local and district levels will at the same time lead to technology learning through use, knowledge and innovations. Considering the “technology growth” perspectives, investments in IHIA will contribute to economic growth, and consequently empowerment. Further, by focusing on implementation and



use at local levels, learning, development and empowerment will include poor and deprived communities. We will further explore these two perspectives in the chapter.

## 12.1 Technology for Development

Geoff Walsham (2001) posed a pertinent question to information systems researchers, whether they are directing the use of ICTs to “create a better world?” Walsham’s vision of a better world was not about more automated systems with greater efficiencies or less paper and better surveillance and control mechanisms. Rather it was for a world characterised by more relevant and humane development which transcended concerns of economic development measured by indicators such as Gross Domestic Product. Our own answer to this question posed by Walsham, within our context of health, has been to explore approaches whereby information can be managed and used to improve health services delivery at health facility level, to strengthen management at facility and district levels, and policy making at higher level. In short, how information and technology can be used for shaping a better world, through better health. In this book, we have tried to develop and discuss principles and guidelines for developing systems within an integrated framework which may best serve this purpose.

## 12.2 What Does it Mean to Use Information for Better Health?

Poor quality data and little use of it are typical characteristics for HIS in developing countries. While this may be largely true, it might also be that much data use for managing health services are not really identified as being “good data use”, because it is part of the normal routine work. Let’s look at some “fresh” examples from Liberia where we, both the authors, are currently located and doing fieldwork, while at the same time finalising this chapter.

- **Example 1** – “Routine” use of data at facility level. While visiting the Unification city Health Centre, just outside Monrovia, the capital of Liberia, and discussing with the in-charge who took us around to all departments, we were struck by how well data was supporting the activities. All patients and clients coming to the health centre were registered in a book used to make a total head-count for the month, which again was used to calculate workload (patients per health workers). In various departments, such as – Outpatients, Inpatients, Mother & Child Health including Maternity, and EPI – patients were registered in specific ledgers, which again were used to make the monthly summaries. By the end of each month, the in-charge circulated the integrated reporting form, where each health programme had their section or sheet(s). Data was then compiled for reporting, but also for local use. Target populations for immunisation and ante natal care were displayed on the wall and used for calculating coverage of these services, which again, were displayed graphically on the wall – updated till the last reported month. Our impression was that the facility was well run, the importance of data was well understood and data was used to support services delivery in different departments. Data quality seemed to be good, both because data was actively used at the source, and because our limited checks on the numbers in the ledgers did not reveal any errors.

This routine ubiquitous analysis and use of information is part of the day-to-day running of many health facilities. It is done because it is helping the health workers to do their job. Since such use of data is buried in routine work and not seen as extraordinary, it may to a large extent go un-noticed with relation to the debate on data use and non-use. To contrast this good example, it must be noted that we also visited facilities where we detected many errors in summing up data and where there was very less commitment to data use. These errors will of course have implications on how the health of the catchment population is managed.

- **Example 2** – Data used for county management and raising awareness. In Margibi County, Kakata town, we met with the county team including the county health officer. An interesting fact here is that there is a County Board of fifteen members from the health services, other government structures and the community that is meeting every quarter. To these meetings, a county report with data and key indicators from the HMIS is presented. The board is then used to create awareness on important health issues, such as the very high level of maternal deaths in the county. Various traditional beliefs are preventing pregnant women to deliver at facilities with skilled birth attendants. “When your mother delivered you at home, and your grandmother delivered your mother at home, why should you go to a health facility to deliver?” is a common attitude. To get more women to attend ANC services and to deliver in a facility has been a key issue were the board has been used to create awareness and mobilise communities. These efforts have been successful, as in 2010, twenty-one maternal deaths were reported and in 2011 this was reduced to eleven. This is of course still an extremely high figure in a population with an annual estimate of 8,000 deliveries, and it only includes maternal deaths which are reported. Four ANC visits is the policy in Liberia and it is seen as being important in ensuring that women come to the facilities to deliver. It has therefore been a main target also in Margibi county where awareness raising has been pursued through the board, health facilities and also outreach services in the communities. As a result of these efforts, the ANC fourth visit coverage has increased from 24 per cent to 48 per cent, as reported in the report from the fourth quarter 2011 to the board meeting in January 2012. All data in this example are from the county HMIS, where they use DHIS to capture and manage data and where facility level data management and reporting is paper based.

The point we are making through this case is that this is a noteworthy example of active use of data from the HMIS. Data is used to set targets, raise awareness, deliver services and to monitor achievements of the targets – which will all contribute to “better health”. Furthermore, also this practice of information use was regarded, by those involved, as only being part of the normal routine – or ubiquitous data use. It was not something that was explained to us when we asked “how do you use data?” The story had to be derived through several rounds of discussion.

These two examples illustrate how data management and use may contribute to “a better world”, contributing to reducing maternal mortality by 50 per cent. Of course, numbers are small and we only have data for two years, so whether the data represent a trend or not we are not yet sure. The trend is encouraging though.

### 12.3 What is “Appropriate” IT for Better Health and Community Empowerment?

What about technology, its role in strengthening data use and empowering communities? While the first example above was from a fully paper based system at the facility level, in the latter example, data was derived from the county database.

Due to poor infrastructure and relative poverty, the aim of empowering communities by bringing information and tools for its proper handling close to the people and local users, has traditionally been difficult to achieve. The typical setting so far has been that most health facilities and community health workers in developing countries have had limited access to appropriate computer based tools and the internet. Local and primary level data management has basically been paper based, and even at the district level, availability of appropriate computer based database applications have been limited.

Looking at the history of empowering the community level through capacity building and developing useful computer based applications, it is necessary to start with the term “appropriate” technology. In the seventies and even later the term appropriate technology was used in development aid circles to denote technology “simple” enough to be used in developing countries – a rather patronising attitude. Here we will revisit the term and see whether the term “appropriate” can be given a new meaning in the age of internet and cloud computing.

When initiating the project in Sierra Leone, described earlier, sustainability of hardware and software was a major concern. At that time, there were those arguing that computer technology was not appropriate for rural Sierra Leone. An initial survey showed that literally all computers were seriously affected by viruses. In order to address this problem, a Linux based infrastructure was implemented in the districts; a computer without screen was used as a dedicated “no touch” Linux server running the DHIS software and accessed by users in the district headquarters through the wireless network by using their browser. This infrastructure turned out to be very successful, and indeed appropriate. Despite limited initial Linux knowledge, the trade-off was a running system without viruses. Early in the process, an additional smart technology was also tried; low powered twelve volt computers running on batteries and, the plan was, solar power. This experiment, however, turned out to be not so “appropriate” because the low-powered server did not have sufficient capacity and speed, and users were not happy with screens, performance, and various technical problems put that pilot effort to a standstill.

In Sierra Leone, the internet is not universally available across the country, a situation which is still similar in most parts of Africa. The norm when implementing country HIS in Africa has therefore been, as in Sierra Leone, until today (2012), to capture the data in stand-alone databases implemented in districts, hospitals and health facilities around the country, and to report data electronically by e-mail attachments or physically on a memory stick to the next level. It is complicated to maintain numerous standalone database applications with fragile flows of data between them. Building a web-based data warehouse on a central server, as is the norm in industrialised countries, and even using a cloud infrastructure, is much simpler technically and in terms of human capacity and needed support structures, for hardware, software and data and database management. Ironically, however, as discussed earlier in the book, Africa would need more human capacity for support and maintenance when implementing a “traditional”

country HIS than would, say for example Norway, when implementing a similar system. In Africa, they would need to maintain numerous standalone implementations and complicated flows of data, whereas in Norway only one central implementation would have to be maintained. Cloud based infrastructure using a central server with universal access would therefore be a very appropriate infrastructure in Africa. Based on the rapid increase in mobile coverage and new cables for internet, in both the East and the West coasts of Africa, the situation regarding internet infrastructure is about to change. So, the more modern cloud based technology is markedly “appropriate” for developing countries which runs contrary to the “appropriate is simple” argument of the seventies.

The semi-online solutions developed in DHIS enabled by the new HTML5 standard which is allowing for offline data storage in the browser, is, as described earlier, been successfully implemented in Kenya. During a field visit in the remote western parts of Kenya, the most interesting finding was that the users in districts and health facilities said they had now easier access to their own data, as well as data from the rest of the country, than they had had any time before, including the paper based system. The argument was that they could access their data regardless of power-cuts (when they used their laptop), viruses or computer problems, because the data was, as one user said, “up there”, always available, “in the internet”; “While before it was difficult to find the data you needed, now everything is there.” Furthermore, they really appreciated the dynamic updates of data, both their own and from around the country. The messaging system in the DHIS was also greatly appreciated as it allowed for instant communication between users across Kenya, as well as serving as a direct “open” line for feedback, reporting bugs and to get help from the system support team when having problems. “Just like Facebook” as one user said. Manuel Castells (1996) in his treatise on the Network Society has interestingly argued the same point: if marginalised people and areas do not become active members of “network society,” they will continue to be systematically excluded and marginalised.

We see that the rapid spread and improvement of the mobile network and improved internet are factors that are greatly improving the potential of communities to enter the network society – both through the ability of health services to carry out data management at local and community levels, and these make health problems visible, which previously remained invisible. Only when problems become visible, can they be acted upon and this will lead to better health and development. These examples of new and cutting edge technologies, including the local wireless network running on a dedicated Linux server in the districts in Sierra Leone, are all characterised by – firstly, being very appropriate for even rural communities in Africa, and secondly being very modern and even cutting edge. Therefore, the term appropriate technology for developing countries needs to be given a new and different meaning in the age of the internet and cloud computing. To exaggerate a bit, the more “modern” and “cutting edge”, the more appropriate is the technology for Africa and other developing countries. Furthermore, the current rapid development of mobile network and internet infrastructure in developing countries is significantly contributing to the closing of the “digital divide”. Of course, the issue of poverty and poor economic development remain key issues maintaining the combined economic and digital divide. We now turn to our second hypothesis stating that implementation and use of HIS may contribute to economic uplifting of deprived communities.

## 12.4 Technology, Health and Development

The current state of the world is that differences between the rich and the poor are huge and increasing. We now turn to the role of technology in uplifting deprived communities by applying perspectives within economic theory which emphasize the role of technology in economic development. The “technology-gap approach to economic growth”, sees technological differences as the prime cause for differences in economic growth across countries (Fagerberg, 1994).

*“Technology is central to regional change, positive and negative, and to economic change, job-creating and job-destroying. It is the most obvious cause and effect of cumulative wealth of rich nations. Technology also promises, more than any other phenomenon, to bring poor nations out of poverty.” (Malecki, 1991, pp. 6-7).*

The important assumption behind these perspectives is that technology is regarded as rooted in people – knowledge – and not in things. Technology is basically not an exogenous factor, but rather an endogenous one; related to the behaviour of people and the accumulation of knowledge – learning. Technology then is seen as being embedded in people in the institutional and cultural context, and therefore “more often than not difficult and costly to transfer from one setting to another” (Fagerberg, 1994).

*“Much of what we call technological change is the process of learning by people and, through them, by organisations and nations. The skills embodied in people result in some companies – and some regions and nations – being more prosperous and successful than others.” (Malecki, 1991, p. xi).*

Information technology is linked to economic development and therefore tends to be concentrated in the most modern sectors of the economy and regions of a country – and of the world. For this reason, a side effect of IT might be a worsening of the gap in development between sectors and regions within a country, and between countries. Sectors and areas where IT is poorly applied will tend to lag increasingly behind sectors where IT is highly (and more effectively) applied. This is where development of the HIS, IHIA and related infrastructure may play a significant role. Contrary to general technology development, targeting the most developed areas in a country, development of health services, HIS and IHIA are equally targeting disadvantaged communities and thereby directing technology development and learning to these areas.

## 12.5 Health Sector as an Arena for Technology Learning

The perspectives on economics emphasising technological learning as captured in the policy labelled “National innovation systems” which was also endorsed by the OECD in 1996 (Lundvall, 1992), is based on the following assumptions:

- **First**, it is assumed that the most fundamental resource in modern economy is knowledge and, accordingly, that the most important process is learning.
- **Second**, it is assumed that learning is predominantly an interactive and, therefore, a social embedded process, which cannot be understood without taking into consideration its institutional and cultural context.
- **Third**, when ‘knowledge’ is used in the production process it is called technology, and new, recombined or rediscovered knowledge, introduced into the economy, is called innovation.

Central issues in the policy of National Innovation Systems include the fact that national policies on technological learning are seen as important in economic and technological development. Innovation is not seen as ‘products’, or discrete events uniquely localised in space and time, but as processes. It is seen as a ubiquitous phenomenon resulting from on-going processes of learning in all parts of a modern economy. Learning and innovation are emanating from routine activities in the prevailing economic structure. The areas where technical advances will take place will then primarily be where the national economy is engaged in routine activities, oriented towards addressing intrinsic problems.

Learning is used in a broad sense, including both processes leading to new knowledge or new combinations of old knowledge, and processes putting old knowledge into new heads. Key to these processes are *Learning-by-doing* (improving efficiencies in production), *Learning-by-using* (creating new practices in use of technology), and *Learning-by-interacting* (addressing linkages between users and producers). All these processes take place in context, and country-specific factors influence the process of learning and innovations. Thus technological change unfolds in systems of innovation, covering a country at all levels from national to village. Countries that are rich today sheltered their national economy and markets while they were developing their economies and technologies. They created de facto national innovation systems. During the current reign of globalism, however, poor countries are expected to develop their economy and knowledge in an open global market economy. Haiti and Burkina Faso are expected to compete with the US and Europe in an open global market on equal terms. In chapter six, the ecosystem of innovation which we have described, provides a suggested policy framework in which countries like Haiti and Burkina Faso can engage in the context of technology, health and development. They can learn about technology while at the same time engage in solving their health problems.

## 12.6 Mobile Network in Kenya – Example of Endogenous Learning and Innovation

M-Pesa developed in Kenya represents one of the first systems for mobile transfer of money in the world. Its development and spread to about one third of the population in Kenya is an excellent example of innovation through use and learning. The first version of the system, under a different name, aimed at allowing microfinance borrowers to receive and repay loans using the network of Safaricom airtime resellers. What happened when the system was implemented, however, was that users started to use the system in a variety of new and unexpected ways, such as for general money transfer. This led to the creation of M-Pesa which was re-focused to allow money transfers across the country and for making payments. But again users invented alternative usages and started to use the system as a “normal” bank account to deposit and withdraw money, and also to pay bills.

M-Pesa is now developed as a branchless banking service enabling users to complete basic banking transactions without the need to visit a bank branch. It is argued that this banking service is now closer to poor communities than any other banking service in the world. The threshold to start using the “bank” is very low in terms of formal income, amount of money and formal paper, factors which, for example are blocking potential users from banking services in the US. A good mobile network and a large

number of mobile users provide the prerequisite for the successful “flow” of this new innovation. When literally millions of users are engaged, new patterns of use and innovations inevitably develop.

At a smaller scale, but still significant, the innovative implementation of DHIS using modems over the mobile network in Kenya, also demonstrate how innovations are “emerging” through use and learning. Even to use the mobile network for implementing a countrywide HIS is a first of its kind in Africa. The messaging feature in DHIS started as a way to inform users about new features and quickly developed into a more general interactive messaging system for feedback, support and problem reporting. Despite good coverage in Kenya, in rural areas network connection is an issue and the semi-online features allowing users to enter data in the browser while offline was an innovative approach addressing that problem. The system is gradually being spread to new users and health facilities in a way that they all will have access to the network. Therefore many facility managers and staff will have access to a laptop and will start entering data and generate reports for their facility. In this way, the user base is rapidly increasing and alternative usages will inevitably emerge. This is what we mean by using the health sector as an arena for learning, diffusion and innovation of IT based solutions for health. While the goal of better health remains, the intended “side” effect is capacity development and innovative use of data and IT solutions, which again will feed back and contribute to better health.

### Summary

Our suggested IT for development policy in the area of health represent an effort, although small, to counteract the tendency of marginalisation in terms of technology learning and innovation, of poor countries in the open global market by urging these countries to work together in networks. Developing countries should develop and engage in collaborative networks of technology learning, sharing and support in an area sheltered from the brutal global market forces in the health sector:

- Countries should use the health sector as an arena for technological learning and for diffusion of IT in areas sheltered from market forces. Learning about technology while at the same time improving health i.e., developing and implementing HIS and IHIA as a cyclical process as described in this book.
- Establish South – South-North collaborative networks of action for developing, sharing and learning about technologies for health, such as the HISP network and collaborative network for implementing and supporting the DHIS.
- Free and Open Source Software is a prerequisite for developing collaborative networks as suggested here.

Our approach to development is to engage with it, in concrete areas of technology development and its application, to address problems of health – one of the largest “unfreedoms” to development.

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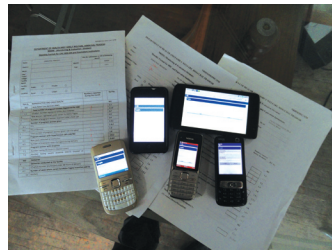
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# Annexures

- Annexure 1: Tali tool to assess levels of information usage
- Annexure 2: Readiness Matrix for Information for Action
- Annexure 3: National HIS Assessment Tool – HMN





## Annexure 1: Tali Tool to Assess Levels of Information Usage

Level	Broad description	Detailed description of criteria
Level 1	<p><b>The information system is working technically according to its specification:</b> timely and accurate data is submitted to the district; district manages data in database, reports to region and feedback to facility. Similar at regional and central levels.</p>	<p>Clearly defined Essential datasets for all compulsory reporting have been defined?            Has an information manager been identified?            Have all the expected routine reports been submitted?            Have feedback reports been issued?            User friendly guideline including information handling at that level is available?</p>
Level 2	<p><b>Data is analysed, disseminated and used:</b> Summary reports of data produced and disseminated regularly            Indicators are being assessed against performance / targets on a regular basis.</p>	<p>Are summary reports available            Are indicators graphed?            Are indicators discussed in management meetings?</p>
Level 3	<p><b>Information from the system used for planning and evaluation of achievements:</b>            Indicators and information are used by managers to inform their action plans. Indicators and information used to document performance in all written reports</p>	<p>Are indicators interpreted and understood?            Are problems identified based on available information?            Have any problems been addressed, and can these steps be documented, and an improvement shown using indicators and data?</p>

## Annexure 2: Readiness Matrix for Information for Action

Note: Please mark each sub dimension on one of four levels moving from "least ready" to "most ready".

Dimension	Sub-dimension	Level	1	2	3 (institutionalised)	Comments
Technology:		0				
	Software customisation requested:	No additional customisation requested	Minimum customisation requested	Significant customisation requested and carried out	Established institutional procedure in place for dealing with customisation requests	
	Server capacity:	No server used	NHSRC shared server used	Own server used	Own server self managed	
	Internet access:	Only available at state level	Available in most cases at District level	Available in most cases at Block level	Available in most cases at PHC-level	
Information system processes:						
	Regularity of upward reports:	Not being submitted without external intervention	Partial submission taking place, but not completely independently	Significantly completion rate being done independently	100% complete, timely and independently	
	Practice of feedback reports:	No practice existing	Some practice of feedback, mostly informal	Regular systematic feedback through written communication	Well established institutions for feedback including discussions	
	Procedure for data verification:	No procedure existing	Only taking place at district level	Some verification also taking place at Block level	All levels systematic procedure in place, including feedback on changes made	
Data Quality:						
	Completeness:	No reporting	Very low level of completeness (< 40%)	Significantly complete (> 40%)	Fully complete	

	Accuracy:	No checking being done	Significant validation queries raised (>25%) during checking	Minimal validation queries raised (<25%) during changes	No validation queries raised during changes
	Verification procedures in place:	No procedure in place	Informal procedures existing	Detailed written procedures signed, distributed.	Detailed written procedures signed, distributed and followed
Human Capacity:					
	Adequacy of team:	State team not established	State team in place	Public health components in state team	District team also in place
	Adequacy of training:	Limited training at state and district levels	Primarily technical focus in training	Use of information training carried out	State trainers in place who are capable of conducting training
	Advocacy on information for action:	No advocates at state level	Some external advocates at state level	Internal advocates	Advocates also present at district level
Institutional collaboration:					
	Involvement of program management:	No involvement of programme officers	Limited involvement of programme officers	Significant involvement of programme managers	Program manager formally part of the HMIS-team
	HMIS budgets in place:	No clear budget line for HMIS	Only state budget defined for HMIS	District offices also have HMIS budget in place	MO at PHC-level also have HMIS budget in place
	Integration of systems:	Stand alone HMIS	One or two systems integrated with HMIS (RIMS, IDSP)	More than two systems integrated	All systems under one institutional structure
Use of Information for action:					
	Data analysis:	Not carried out	Externally being done	Frequently done internally	Systematically done internally
	Feedback reports being generated:	Not carried out	Externally being done	Frequently done internally	Systematically done internally
	Action taken:	No action	Limited action	Some regular action	State PIPs being made based on HMIS

### Annexure 3: National HIS Assessment Tool – HMN

Note: The grading is from 0 representing No/None to 3 representing Yes/fully adequate. As far as possible, each situation that the four values 0-1-2-3 should represent has been specified.

1. CONTEXT AND RESOURCES

*Legal and regulatory framework*

		Score (0= No to 3= Yes)
	The country has recent legislation providing the framework for integrated collection, processing and use of health data, development planning, and HIS infrastructure development e.g. access to information, e-governance, electronic exchange of data, and electronic security measures (0: No, existing legislation is outdated or woefully inadequate; 1: Basic legislation exist, but not the regulatory framework; 2: Basic legislation and a regulatory framework exist, but not the resources and/or political/administrative will to implement them; 3: Yes)	0 1 2 3
	There is a written HIS strategic plan in active use that emphasises integration of different data sources a) at the national level b) in a modified form at most sub-national areas and districts (0: No; 1: The strategic plan exists, but it is not used or is not pro-integration; 2: The strategic plan exist, but the resources to implement it are not available; 3: Yes, it exists and are being implemented)	0 1 2 3 0 1 2 3
	There is a representative national HIS committee that actively encourages and supports research and development, innovation and an “entrepreneurial spirit” at all levels, thereby creating a balance between innovation and standardisation (0: No, all important decisions are centralised; 1: Local innovation and R&D are allowed, but must be authorised on beforehand; 2: Local innovation and R&D are generally sanctioned, but the national HIS committee are mostly following external advice (“stargazing”); 3: Yes)	0 1 2 3
	The national sets of goals, objectives, indicators and data elements are following international standards (0: No; 1: International standards and objectives are only considered in an ad-hoc manner; 2: Yes, but national innovations and views are generally not used as input to the same international standardisation processes; 3: Yes, work on standards are flowing both ways)	0 1 2 3

*Human resources*

	There are adequate numbers of dedicated <b>HIS staff</b> in approved posts at each level a) Full time Epidemiologist in HIS office in each subnational area b) District <b>Information Officers</b> (DIOs) functioning in every district (0: No; 1: Up to 40% have epidemiologist / permanent DIOs; 2: 40-80% of have adequate staff; 3: >80% have adequate HIS staff)	0 1 2 3 0 1 2 3
	There are one or more “ <b>hot-lines</b> ” for HIS and IT support available at national, sub-national, and district levels (0: No hotlines available; 1: Hot-line(s) available only at national level; 2: Hot-line(s) available at all levels, but response time is slow; 3: Hot-line(s) available at all levels during HIS systems uptime hours (up to 24/7), providing on-the-fly support)	0 1 2 3

HIS staff at sub-national/district level are able to <b>modify and improve their HIS</b> when changed circumstances (e.g. new programmes, new information needs) make this relevant (0: No, such skills are sorely lacking; 1: Huge variations in such skills are typical; 2: The majority have good knowledge, but still needs significant external support and further training; 3: Yes)	0 1 2 3
<b>Capacity building</b> activities has occurred over the past year at <b>district</b> level a) for HIS staff (statistics, software and database maintenance, and/or epidemiology) b) program managers (epidemiology, report writing, information management) c) health facility staff (data collection, self-assessment, analysis, presentation) (0: No; 1: Limited capacity building; 2: Significant capacity building, but largely depending on external (e.g. donor) support and input; 3: Significant capacity building occurred as part of a long-term government-driven HRD plan)	0 1 2 3 0 1 2 3 0 1 2 3
Capacity building activities has occurred over the past year at <b>national</b> level for program managers (epidemiology, report writing, information management) (0: No; 1: Limited capacity building; 2: Significant capacity building, but largely depending on external (e.g. donor) support and input; 3: Significant capacity building occurred as part of a long-term government-driven HRD plan)	0 1 2 3
Written <b>guidelines</b> exist defining how facility supervisors and district managers should use information and integrate it into overall health service management (0: No guidelines exist; 1: Written guidelines exist but are not implemented/used; 2: Written guidelines exist and are used, but not integrated into overall service supervision; 3: Yes)	0 1 2 3

#### Finances

There is a specific national <b>government budget</b> for core funding of HIS activities (0: No; 1: Yes, but mainly covering salaries and basic recurrent expenditure for existing staff; 2: Yes, but the budget allocations are not based on a long-term strategic HIS plan 3: Yes, with both recurrent and capital budgets based on a long-term strategic plan)	0 1 2 3
<b>Donor funds</b> for HIS developments are “untied” and channelled through a consolidated fund within the national ministry (and/or sub-national ministries in federal systems) (0: No, donors pick projects with limited co-ordination and funds are often tied to goods and services from the donor country; 1: There is no consolidated fund(s) and often tied aid, but mechanisms for government co-ordination are in place; 2: There is a consolidated fund, but not all donors participate and/or significant funding are “tied”; 3: Yes)	0 1 2 3
There is a specific <b>district budget</b> for HIS activities in at least 80% of all districts (0: No, HIS expenditure (if any) are centrally controlled; 1: Yes, but mainly covering salaries and basic recurrent expenditure for existing staff; 2: Yes, but the budget allocations are not based on a long-term strategic HIS plan 3: Yes, with both recurrent and capital budgets based on a long-term strategic plan)	0 1 2 3



	The district budget is able to cover the cost of providing facilities with locally customised primary <b>data collection tools</b> (registers, summary sheets, etc) (0: No, many facilities do not have primary data collection tools; 1: There is a budget line for it, but it is not sufficient to satisfy the needs; 2: Districts rely on higher levels to provide all data collection tools (i.e. no local customisation) 3: Yes)	0 1 2 3
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*Health Information Infrastructure / Computerisation*

	A complete and up to date national facility list exists for the public sector a) in regular use at national level b) data on infrastructure and human resources for each facility c) geographic coordinates available for each facility (0: none at all, 1: list very out of date or covers <50% 2: Up to date for 50-80% 3: yes)	0 1 2 3 0 1 2 3 0 1 2 3
	The basic computerised information communication infrastructure (PCs, email, Internet & Intranet access ) are in place a) at the national level b) at the sub-national level c) at the district level d) at facility level (0: Only a minority of managers have access to a PC; 1: Most managers have access to a PC but no email; 2: Nearly all managers have access to a PC and the Internet; 3: Yes)	0 1 2 3 0 1 2 3 0 1 2 3 0 1 2 3
	Technical IT support (networks, installation, repairs, general hardware/software maintenance) is available and functional with acceptable response times (0: Technical IT support generally not available; 1: Technical IT support available, but response/repair/replacement times are often 2 weeks or more; 2: Technical IT support available, but response/repair/replacement times are usually from 3 days to 2 weeks; 3: Technical IT support available with response/repair/replacement times usually less than 3 days)	0 1 2 3
	Routine, semi-permanent, and survey data are in generally captured at the district level and submitted electronically via email or other networks a) to higher levels b) to the national level (0: No, generally reports are on paper; 1: Data is captured and submitted on diskettes; 2: Data is captured and submitted by email or similar; 3: Data is captured locally but stored in or automatically submitted to national servers)	0 1 2 3 0 1 2 3
	Integrated HIS data and analysed information are readily accessible by managers through Internet / intranet (0: No; 1: Some published reports etc are available; 2: Both raw data and processed information are available, but only to users physically connected to the government Intranet; 3: Both raw data and processed information are available, either via the government Intranet or via the Internet with appropriate access control/firewalls)	0 1 2 3
	The HIS unit at national level is running one integrated HIS database or "data warehouse" containing data and information from all key health programmes (0: No; 1: There is no integration, but key health data/information are presumably available from the HIS unit in whatever format available; 2: There is a "data warehouse", but its content are not functionally integrated/streamlined to support transparent, integrated analysis; 3: Yes, there is a "data warehouse" containing most relevant health datasets with common format and identifiers.	0 1 2 3

Integrated systems equivalent the national HIS database or "data warehouse" are running at sub-national and/or district levels (0: No system integration at sub-national and/or district levels; 1: Limited system integration at sub-national and/or district levels; 2: Equivalent system integration at sub-national and/or district levels; 3: Equivalent system integration at sub-national and/or district levels <b>and</b> sub-national/district managers have access to the national "data warehouse" via the Intranet/Internet enabling vertical collaboration via ICT)	0 1 2 3
The unit is formally, legally and practically able to modify by adding/ changing data elements and indicators, reports etc. to the national and sub-national HIS database or "data warehouse" without external support (0: No, programs aren't flexible; 1: ; 2: ; 3: Yes)	
A patient based Electronic Health Record system is running at facility level in the public health sector for key MDG programs (e.g. EPI, PMTCT, ARV, TB) (0: only by private company/international consultants; 1: minor modifications can be done within limits prescribed by software owner/ consultant; 2: Significant modifications, but within limits; 3: Any modification can be done because software is open source or software owner has provided source code.)	0 1 2 3

## 2. PROCESS

*Data management*

	Score (0= No to 3= Yes)
There are written guidelines for how information from HIS should be used at different levels a) in the annual planning processes b) in the annual budget process (0: No; 1: Yes, but they are outdated and/or not suitable; 2: Yes, but there are several often contradictory sets of guidelines and regulations from different ministries; 3: Yes, up-to-date streamlined guidelines are in use)	0 1 2 3 0 1 2 3
Up-to-date HIS Data from all subsystems and programs (including MDGs) is easily available at one point in the ministry of health (0: Data not available 1: Data available, but with difficulty 2: Data available, but not systematically 3: Yes)	0 1 2 3
The ministry is actively promoting integration of data/information from different sources and programmes under the HIS unit at all levels (0: No; 1: Integration is only pursued at the (sub-)national level; 2: Integration is pursued from the district level and upwards; 3: Yes, integration is pursued at all levels including facility levels)	0 1 2 3
There are written procedures for dissemination of reports/information "horizontally" to all programme areas and management at the same level at least on a quarterly basis (0: No written procedures and negligible "horizontal" dissemination; 1: There are no <b>written</b> procedures, but dissemination are common practice; 2: There are written procedures, but they are not fully implemented; 3: Yes, written procedures exist and are largely followed)	0 1 2 3
Health managers are generally demanding complete and validated HIS information delivered on time (0: Negligible demand from managers; 1: Demand from managers are ad-hoc, usually as a result of external pressure (e.g. questions from politicians or the media); 2: General strong demand from managers, but they do not have the skills and experience to evaluation completeness and quality; 3: Yes)	0 1 2 3

	Anonymous HIS data and indicators are in principle regarded as belonging in the public domain, i.e. it should be available to all interested citizens (0: Access is strictly controlled; 1: Public access accepted in principle, but not implemented in practice; 2: Public access accepted in principle and largely implemented; 3: Public access and availability are guaranteed by law/regulations and fully implemented)	0 1 2 3
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*Plans and indicators*

	A national Essential/ <b>Minimum Indicator and/or dataset</b> has been implemented in the public health sector (0: None exist; 1: Exist but not implemented; 2: <b>Dataset</b> only implemented; 3: Yes)	0 1 2 3
	All indicators in the national Essential/Minimum Indicator Set are linked to the relevant short (1 year), medium (3-5 years), and long-term (10-15 years) targets (0: No targets; 1: Under 40% of indicators have targets; 2: 40-80% of indicators have targets; 3: All indicators have relevant targets)	0 1 2 3
	The national Essential/Minimum Indicator and/or dataset has also been implemented in the private for-profit and private not-for-profit health sectors (0: No; 1: Exist but not implemented; 2: Dataset only implemented; 3: Yes)	0 1 2 3
	The national Essential/Minimum Indicator Set contains all the 15 health-related MDG-indicators (0: None; 1: Eight or less; 2: Eight or more but not all; 3: Yes)	0 1 2 3
	Program Managers at all levels have to get broad acceptance for any extensions or additions to the accepted Essential/Minimum Indicator/Dataset via a consensus-building process (0: Each programme demands data as they see fit; 1: There is a policy or guidelines in place, but it is not enforced; 2: Most, but not all programme managers have accepted the consensus-building process as a pre-requisite for introducing new data/indicators; 3: New indicators/data elements cannot be introduced without such a process and formal acceptance by the responsible management team)	0 1 2 3
	All key indicators, with numerators and denominators, are known and understood by programme staff a) at the national level b) at the sub-national and district levels (0: No; 1: Limited knowledge/understanding, need continuous support; 2: Good knowledge/understanding, but need backstopping; 3: Yes)	0 1 2 3 0 1 2 3

*Data sources*

	All managers at the national level have easy, regular <b>access</b> to the Health Information Systems data and analysed information (0: No or very limited access; 1: Access to data/information for their own programme area only; 2: Sector wide access, but only to processed data/indicators and not "raw" data; 3: All managers have access to all data and information)	0 1 2 3
	There are user-friendly <b>guidelines</b> and formats for data analysis using indicators at each level, customised to support the paper-based or computer-based systems in use (0: No guidelines or formats; 1: Brief guidelines exist, but not user-friendly and/or outdated; 2: User-friendly guidelines exist for <b>technical</b> analysis only; 3: User-friendly guidelines and formats covering both <b>technical</b> analysis and <b>use</b> of indicators for planning and decision-making exist and are in regular use)	0 1 2 3

	<b>Population mid-year estimates</b> for use as denominator data are available electronically for facility, district and sub-national level (0: No mid-year estimates available in electronic format; 1: Mid-year estimates available at sub-national level; 2: Mid-year estimates available at district level; 3: Mid-year estimates at facility level (facility catchment and/or target populations);	0 1 2 3
	Data from non-ministry of health surveys is easily available in the ministry of health within the HIS framework a) Household surveys e.g. Demographic and Health Survey b) Vital registration (births and deaths) c) Socio-economic and poverty reduction data d) Literacy and Universal Basic Education (0: Not available 1: Limited availability or out of date 2: Available, but not directly in HIS framework 3: Yes – used for denominators)	0 1 2 3 0 1 2 3 0 1 2 3 0 1 2 3

### 3. RESULTS

#### *Analysis and Use of Information*

	Score (0= No to 3= Yes)	
Summary <b>reports</b> covering key indicators and programme areas are produced regularly (monthly/quarterly) at a) district/sub-national levels b) at national level (0: No reports produced during last year; 1: Few reports; 2: Regular reports, but usually too late for routine management; 3: Yes, always)	0 1 2 3 0 1 2 3	
Graphs are widely used to display information: a) Each health programme has at least two <b>up-to-date graphs</b> of relevant indicators displayed publicly in the national office b) The national health Information office has at least 6 up-to date graphs of relevant indicators from different MDG programme areas c) Subnational / District offices have up to date graphs displayed (0: No graphs; 1: Some graphs, but not up-to-date; 2: Up-to-date graphs displayed, but only for some programmes; 3: Yes)	0 1 2 3 0 1 2 3	
<b>Maps</b> (GIS or hand drawn) are widely used to display information: a) A GIS is used and maps of relevant indicators are displayed publicly in the national office b) Sub-national offices have up-to date maps of relevant indicators from different MDG programme areas c) Subnational / District offices have up to date maps displayed (0: No maps; 1: Some maps, but not up-to-date; 2: Up-to-date maps displayed, but only for some programmes; 3: Yes) GIS / Maps are used at every level	0 1 2 3 0 1 2 3 0 1 2 3	
There are incentives for good information performance, such as awards for the best service delivery performance, for the best/most improved district, or for the best HIS products/utilisation (0: No; 1: Sporadic use of incentives only; 2: Institutionalised use of incentives in some areas; 3: Yes)	0 1 2 3	
Managers are held accountable for performance, based on routine and/or survey-based health indicators at a) National level b) District level (0: Management positions not performance related; 1: Managers have performance agreements, but nobody are <b>actually</b> held accountable; 2: Managers have performance agreements, but <b>actual</b> accountability are determined by other factors; 3: Yes)	0 1 2 3 0 1 2 3	

	<p>Available and relevant data from census, household surveys, ad-hoc surveys and research reports are used in an integrated way for indicator evaluation and cross-checking</p> <p>(0: No cross-verification done; 1: Occasionally; 2: Commonly done, but only as a “manual” process because data formats and identifiers do not match; 3: Commonly done using multiple data sources that have been aligned to a common framework and format for ease-of-use in integrated analysis)</p>	0 1 2 3
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*Dissemination of Indicators and Interpreted Information*

	<p>There is a written <b>data/information flow policy</b> in active use that includes integrated collection and dissemination of indicators and interpreted information from all key subsystems</p> <p>(0: No data/information flow policy; 1: Data/information flow policy exists, but is not adhered to; 2: Data/information flow policy in use, but it does not include dissemination of indicators and interpreted information ; 3: Yes)</p>	0 1 2 3
	<p>Integrated HIS <b>summary reports</b> covering (at least) key MDG health indicators and programme areas are distributed regularly (at least every 3 months) to</p> <p>a) other ministries and elected bodies at national level</p> <p>b) to the media and the general public at national level</p> <p>(0: No integrated reports; 1: Occasional reports, but less frequently than quarterly; 2: Regular integrated reports at least quarterly, but mainly targeting the National Assembly and Cabinet; 3: Regular integrated reports at least quarterly to the National Assembly and all other relevant ministries)</p>	0 1 2 3 0 1 2 3
	<p>Management teams are producing regular written <b>feedback</b> from</p> <p>a) National to sub-national managers</p> <p>b) Sub-national to district</p> <p>c) District to facility</p> <p>(0: No feedback; 1: Under 40% of sub-national units receive regular written feedback; 2: 40-80% of sub-national units receive regular written feedback; 3: All sub-national units receive regular written feedback)</p>	0 1 2 3 0 1 2 3 0 1 2 3
	<p>Key data and indicators from across programme areas are readily available through an <b>integrated database</b> framework</p> <p>a) within the health sector</p> <p>b) within the government sector (a “National Statistics Framework”)</p> <p>(0: No data warehouse; 1: Data warehouse exist, but not web-enabled; 2: Web-enabled data warehouse exist, but only internal ministry access; 3: Web-enabled data warehouse exist, with at least partial public access via the World Wide Web)</p>	0 1 2 3 0 1 2 3
	<p>Anonymous data and indicator sets from the health sector (public and private) are <b>generally available</b> (at a reasonable price) to any interested user (patient-identifiable datasets obviously excluded)</p> <p>(0: No data available 1: Annual report of ministry available in all districts 2: Data available on paper, but have to make major effort to get it 3: Most data easily available via web )</p>	0 1 2 3

*Information for action*

	<p>Managers at all levels are able to, and actually use information from HIS for local programme <b>management</b>, planning and monitoring</p> <p>(0: All key decisions are centralised; 1: Information used for monitoring, but no real planning done; 2: Programme planning and monitoring done, but not resource allocation; 3: All resource allocation (budgets, staff allocations) are supposedly based on HIS data/indicators)</p>	0 1 2 3
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HIS data/information has during the last 5 years resulted in significant changes in annual <b>budgets</b> and/or general resource allocation (0: Budgets are not activity/result driven; 1: Some shifts, but links to information not clear; 2: Information driven resource allocation adopted in principle, but not yet fully implemented; 3: All resource allocation (budgets, staff allocations) are based on HIS information, resulting in major shifts)	0 1 2 3
At least five problems/challenges from different program areas have been addressed through a <b>written action plan</b> based on HIS data/indicators (0: No; 1: Addressed yes, but not via a written action plan; 2: Written action plan, but no clear use of HIS data/indicators; 3: Yes)	0 1 2 3
The effects of the written action plans have been demonstrably <b>monitored</b> using integrated HIS data and indicators from different subsystems (0: No; 1: Partially; 2: Yes, but not documented; 3: Yes, documented)	0 1 2 3

#### Advocacy

HIS information are widely used to advocate for targets and resource allocation in the annual budget processes	0 1 2 3
a) by national management teams with <b>Cabinet and the National Assembly</b>	0 1 2 3
b) by <b>district and sub-national</b> management teams	0 1 2 3
(0: very few targets/budget proposals are backed up by HIS information; 1: Some (10-40%) of targets/budget proposals are backed up by HIS information; 2: Most (40-80%) of targets/budget proposals are backed up by HIS information; 3: Over 80% of targets/budget proposals are backed up by HIS information)	
HIS information is readily available in a written annual (or biannual) report that pulls together and analyses critically health information from all subsystems (0: No report 1: Report out of date or poor quality 2: Report made but analysis weak 3: Yes)	
HIS information are being used to advocate for <b>equity</b> and increased resources to disadvantaged groups and communities by e.g. documenting their disease burden as linked to socio-economic indicators (e.g. poverty) and poor access to health services and other public services (0: Not used for equity purposes; 1: HIS information are used for equity purposes on an ad-hoc basis; 2: HIS information are regularly used to promote equity, but not explicitly linked to quantifiable socio-economic indicators; 3: HIS information are systematically used to pursue equity and linked to socio-economic and/or access indicators as part of a National Statistical Framework)	0 1 2 3
The key national performance indicators on MDGs are well known among politicians and regularly used by the media	
a) Under 5 mortality rate is well known	0 1 2 3
b) National immunisation coverage is well known	0 1 2 3
c) Maternal mortality rate is well known	0 1 2 3
d) HIV prevalence rate is well known	0 1 2 3
(0: No; 1: Known by a few "specialists" only; 2: Known among health-focused politicians, but generally not in the media; 3: Yes)	
Members of the <b>National Assembly</b> have regularly used HIS information to evaluate government performance on health during the last year (0: No; 1: HIS information used occasionally, but with clear reservations due to completeness or quality of data; 2: HIS information used frequently, but with reservations or disagreements due to completeness or quality of data; 3: Systematic use of HIS information, with most Assembly Members accepting the HIS information as largely reflecting the real situation)	0 1 2 3



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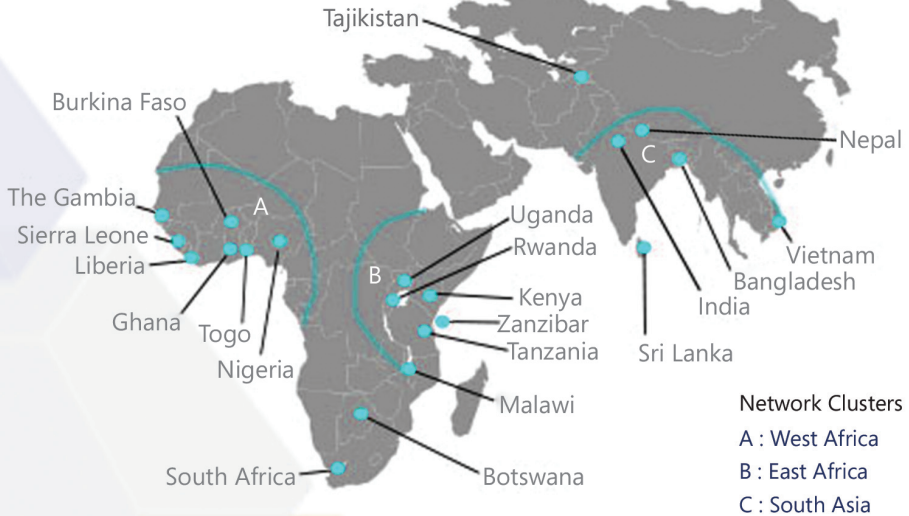
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## HISP NETWORK: Key Nodes



Health Information Systems Programmes (HISP) is a global research and development network around Health Information Systems in the South. This network was initiated by the Department of Informatics, University of Oslo, in 1994 in collaboration with University of Cape Town, South Africa. From its initiation in post-apartheid South Africa, the network has grown to span more than 20 countries across Africa and Asia. The network, is responsible for three core activities:

1. Supporting implementation of HIS in participating countries
2. Capacity building of health staff; and
3. Research and education around HIS in developing countries.

DHIS2 is a flagship product of HISP, and currently significant developments are made in other domains such as Hospital Information Systems, Mobile Health Information Systems, and Human Resources Information Systems.

The current focus is on how these systems, and others, can *speak* to each other in an integrated architecture perspective, which is the focus of this book.



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