Global Standards and Local Health Information System Applications:

Understanding their interplay in the context of Tajikistan

by

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Dedicated to

my father,

who passed away tragically on July 13, 2003. I Still Miss You Dad.

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Dushanbe, March 29, 2013 Murodillo Latifov, Abdusamadovich

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ABBREVIATIONS AND ACRONYMS

ADB: Asian Development Bank, 22, 23
CRO: Civil Registry Office, 20, 21, 25, 47, 58, 59, 74, 78, 79, 94
CRS: Civil Registry System, 58, 59, 60
DHIS2: District Health Information System version 2, 2, 15, 18, 24, 25, 61, 62, 70, 73, 79, 80, 90
DICOM: (Digital Imaging and Communications in Medicine, standard for handling, storing, printing, and transmitting information in medical imaging, 14
DRD: Direct ruled districts, 58
DUNS: Data Universal Numbering System, 15
EC: European Commission, 23
EDI: Electronic data interchange, 33, 38
EHRcom: Electronic Health Record Communication, European data echange standard, 14
EPR: Electronic Patient Record, 61
FGP: Family group practice, 23
GBP: Guaranteed Benefit Package, 57, 58, 61
GDP: Gross domestic product, 51
HII: Health Information Infrastructure, 3, 20, 21, 26, 35, 36, 37, 88, 89
HIS: Health information system, 6, 10, 12, 13, 14, 16, 18, 19, 20, 24, 25, 27, 34, 35, 38, 57, 58, 60, 64, 86, 87, 88, 89, 92, 93, 94
HISP: Health Information Systems Programme, 10, 18, 22, 23, 24, 35, 63, 69, 70, 75, 79, 86, 89
HIV/AIDS: Human immunodeficiency virus infection / acquired immunodeficiency syndrome, 55, 64
HL7: Health level 7, data exchange standard, 14
HMIS: Health Management Information System, 5, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 28, 29, 31, 32, 35, 37, 39, 42, 44, 47, 52, 56, 58, 59, 60, 61, 62, 63, 64, 72, 73, 74, 75, 76, 77, 78, 80, 82, 83, 84, 87, 88, 89, 90, 91, 92, 93, 94, 95
HMN: Health Metrics Network, 58, 59, 60, 75
HospMIS: Hospital Management Information System, 22, 24, 47, 63, 64
HSRP: Health System Reform Programme, 22, 23, 61
IAD: Institutional Analysis and Development framework, 43
ICD: International Classification of Diseases, 11, 14, 19, 25, 34, 55, 70, 85, 89, 90, 91, 94
ICT: Information and communication technologies, 10, 12, 44, 64, 82, 85
II: Information Infrastructure, 23, 27, 28, 29, 33, 35, 36, 38, 43, 44, 45, 59, 85, 94
ILO: International Labour Organization, 50
IS: Information systems, 10, 12, 27, 37, 40, 80
ISO: International Organization for Standardization, 30, 33
MDG: Millennium Development Goals, 25
MoH: Ministry of Health, 2, 5, 15, 21, 25, 47, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 70, 76, 79, 88
NGO: Non-governmental organization, 15
NHS: National Health System, 25, 38, 57
NRHM: National Rural Health Mission, 62, 63
PhD: Doctor of Philosophy, 15, 16, 74
PHD: Provincial health department, 52
RCSMI: Republican Centre for Statistics and Medical Information, 2, 20, 60, 70
SSA: State Statistics Agency, 20, 25, 48, 59, 79
TB: Tuberculosis, 56, 64
UiO: University of Oslo, 2, 15
UNDP: United Nations Development Programme, 49
UNICEF: United Nations Children's Fund, 56, 61
US: United States of America, 14, 49, 51
USAID: United States Agency for International Development, 56
WB: World Bank, 49
WHO: World Health Organization, 25, 51, 56, 58, 85

ABSTRACT

This thesis presents the study of the dynamics of global/local interplay of standards related to the development and implementation of Health Information Systems (HIS) with a primary focus on Tajikistan. These standards come in form of software artifacts, classifications and guidelines, practices, procedures and many others. Implementing such global standards is challenged by the existing particularities in the context of implementation, but where also exist various similarities with global systems. The differences as well as similarities play out during implementation processes, spanning different institutional and technical dimensions embedded both in the global standards and also the national HIS. This raises the paradox of standards being both a uniform solution, whilst also containing elements of locality. Managing this paradox remains a clear challenge in HIS implementation initiatives.

This thesis thus tries to extend our understanding of the dynamics of standardization in the course of HIS implementation in a developing country context. Particularly it tries to address issues related to localization of global standards as part of a process of information infrastructure building which involves negotiation, cultivation, work-arounds and contextualization. The thesis takes a socio-technical perspective to understanding the interplay and draws upon theoretical concepts from the domains of information infrastructure, standards and standardization, and institutional theory. Together, the concepts provide an with an analytical lens to study the tripartite relation between the actors (human and non - human) involved, the standard, and the topic the standard seeks to address.

Empirically, this research has been carried out over the last 4 years, and a primary focus has been on the health sector in Tajikistan. I have been engaged in this reform process since 2007 as an action researcher in various tasks such as software development, capacity development, mediating between the international development partners and the ministry, and various others. An underlying focus has been around negotiating different standards, such as indicators, trying to localize and adapt them in the software, and training. Another component of my empirical work took place in a district hospital in North India, where I was involved in the design, development and implementation of a patient record based hospital information system, which gave me insights to a different class of standards relevant to HIS.

The empirical work was aimed at addressing two key research questions: One is related to understanding the nature of dynamics in the interplay between global standards and their local adaptations and the other studies challenges and opportunities arising from global/local interplay of standardization process, and how these processes are best managed. While first question helps to understand factors and entities influencing process of localization of global standards and their interplay, the second question helps to develop strategies for guiding implementation of global standards into the national HIS.

A key theoretical contribution has been the development of a conceptual framework to help analyze the relationship between actors, standards and the topic of interest to actors. This further allows the development of a perspective to understand the process of incremental and

transparent introduction of technology as supporting existing institutional arrangements. Another practical contribution has been the formulation of a three dimensional framework of completeness, fittingness, and actionability for analysing the data element - indicator linkage. The notion of facets of infrastructure proposed in this thesis helps to develop guidelines for creating teams to do a larger task of HIS implementation. These implications, although developed through empirical experiences from Tajikistan and India, can potentially be applied to other contexts of countries and functional domains such as Civil Registration.

PREFACE

This thesis is submitted as a partial fulfilment of the requirements for the degree of Doctor of Philosophy (Ph. D) at the Faculty of Mathematics and Natural Sciences, Department of Informatics, University of Oslo, Norway. The funding for this work has been provided by two sponsors whose kind support is duly acknowledged. The Norwegian Education Loan Fund (Lanekassen) provided my subsistence allowances in Norway and Tajikistan. The global Health Information System Program (HISP) project (under the Department of Informatics) provided me with funds for my fieldwork and covered expenses for my participation in various IS conferences.

This thesis consists of five papers as well as an introduction. The papers, as listed below, are included as appendixes:

Sahay, Sundeep; Latifov, Murodillo Abdusamadovich. (2009). "The Data to Indicator (mis)match: Experiences from trying to strengthen this link in the Health Information System in Tajikistan". In: Elaine Byrne, Yasar Jarrar, Brian Nicholson (editors): Proceedings of the 10th International Conference on Social Implications of Computers in Developing Countries *(IFIP 9.4.).* "Assessing the contribution of ICT to Development Goals". Dubai School of Government, Dubai, United Arab Emirates 26-28 May 2009.

Latifov, Murodillo Abdusamadovich; Mukherjee, Arunima; Chakravarthy, Vasudha; Sahay, Sundeep. (2011). **"**Practical Approaches to Designing Standards: the Case of a District Hospital Information System in Northern India". In: Maung K. Sein, Subarna Shakya, Bjorn Furuholt, G. Harindranath, Devinder Thapa (editors): Proceedings of the 11th International Conference on Social Implications of Computers in Developing Countries *(IFIP 9.4.).* "Partners for Development: ICT Actors and Actions". Kathmandu, Nepal, 22-25 May 2011.

Latifov, Murodillo Abdusamadovich and Sundeep Sahay (2012). Data Warehouse Approach to Strengthen Actionability of HIS: Experiences from Tajikistan. *The Electronic Journal of Information Systems in Developing Countries. Vol. 53, 2012. Available from http://www.ejisdc.org/ojs2/index.php/ejisdc/article/view/932*

Murodillo Abdusamadovich Latifov and Sundeep Sahay (2013). Challenges in Moving to "Health Information for Action": an Infrastructural Perspective from a Case Study in Tajikistan, *Information Technology for Development*, in print

Latifov, Murodillo Abdusamadovich (2013). Global standards and Local Applications: Case of Implementing ICD-10 Standard in HMIS of Tajikistan. Journal of Health Informatics in Developing Countries. Volume 7, issue 1.

Chapter 1

1. Introduction

This chapter introduces my research on processes of standardizing Health Management Information Systems (HMIS) in the context of developing countries more broadly, and Tajikistan in particular. The chapter is organized into seven sections. In section one, I outline the research problem and position my research within the larger body of research in information systems (IS) standardization. Section two outlines my personal motivation, after which I pose the main research questions addressed in this thesis. Sections three and four are dedicated to introducing the empirical approach and conceptual perspectives respectively. In section five, I provide a brief overview of the research settings. Finally, in section six, I present the theoretical and practical contributions of the research and outline the organization of this thesis in section seven.

1.1. Problem Setting and Positioning of the Research

Healthcare organizations in both developing and developed countries use information and communication technologies (ICTs) to try to lower costs, reduce paper, increase integration and better use information to strengthen health management. But introducing ICT supported health information systems (HIS) is not necessarily the "silver bullet" that solves the efficiency problems of the health services (Sandiford, Annett & Cibulskis, 1992; Avgerou, 2000; Raghvendra and Sahay, 2006). Many of the challenges are institutions and context dependent, such as inadequate numbers of appropriately trained staff, weak hardware and software maintenance mechanisms, and various cultural-political factors (Sauerborn and Lippeveld, 2000). Addressing these and other constraints have been key elements in efforts towards strengthening of HIS as a part of health system reform agendas in various developing countries. Despite the huge investments being made both in time and money, the results have been far lower than the potential for change that is promised (Braa, Monteiro & Sahay, 2004; Avgerou and Walsham, 2000; Heeks and Baark, 1999; Sanford, Kanga & Ahmed, 1994).

Although having many similarities across countries, HIS[1] tend to be idiosyncratic to the country where they are developed and used – universal and uniform models tend to be

[1] In this thesis HIS refers to computerized health information systems

limited: “There is no universal formula for a precise combination of data sources that will be optimal in every setting. Much depends on existing systems that are themselves products of history and social development” (AbouZahr and Boerma, 2005:579). “They differ from country to country depending upon historical accident and the interest of policy makers, administrators and researchers” (Foltz, 1993:347). One of the reasons for this, as Foltz argues, is the varying development levels across countries. There are also other variations with respect to infrastructure, human resources capacity, geography, governance systems and donor influences that prevent the application of uniform solutions. For example, in India a large part of inpatient care is provided by private hospitals, whereas in Tajikistan public hospitals are the main providers. While research has emphatically established that HIS implementation needs to be sensitive to local contexts (Avgerou, 2002; Walsham 2001; Avgerou and Walsham, 2000; Walsham, Symons and Waema, 1988), it also tends to be the case that these global/local collisions are over-emphasized, and that generification and localization of standards and applications are possible (Pollock, Williams & D’Adderio, 2007; Rolland and Monteiro, 2002). There are “*some common elements*” which could be “*adapted*” to different *contexts* (Foltz, 1993). For example, while routine health information flows across various levels from the community to the national ministry, the number of levels may vary across countries depending on policies, size of catchment population, disease profiles and availability of doctors. While there are some universal health programmes on which data is reported (such as Maternal and Child Health or Integrated Disease Surveillance Programme), there are others (based on environment and major infectious diseases, e.g. Tuberculosis programme in Tajikistan) which are specific to a country and the disease burden that they are grappling with, or the priorities that the donors have. The medium of data collection and level of data aggregation will also vary across countries based on national priorities, infrastructure availability, and human resource capacity. These variations, for example within countries where some districts can report data while others cannot because of infrastructural constraints, can be problematic for national managers who need data from all districts for their planning purposes. Given that we are often confronted during implementation (of global solutions) with both similarities and differences, the challenge becomes of how to reconcile the two, and build strategies for creating and managing “hybrids” (AHIMA, 2010; Kumar, Subramanian and Yauger, 1997) or of obtaining a “pragmatic balance” (Rolland and Monteiro, 2002) between global standards and local particularities.

These similarities and differences play out across different institutional and technical dimensions of the HIS implementation. A key techno-institutional element is that of "standards", which refers to a uniform solution, but which paradoxically also contains elements of locality and independence (Bowker and Star, 1999). In the health sector, standards are a key component of HIS, including data sets, data formats, periodicity, data exchange protocols, software, and various routines and practices around data collection and processing. Standards are not just technical artefacts, but include both technical and social dimensions, which seek to provide uniformity while also being sensitive to locality and context. In this way, standards are an integral component of the larger information system, their content and process of implementation, involving organisational rules, routines and procedures (formal and informal) as well as technological components.

The nature of standards vary across the kinds of applications, whether it is for use in statistics based reporting of a HMIS or a patient based hospital management system. Sauerborn and Lippeveld (2000) conceptually describe a HMIS as: "Health information systems integrate data collection, processing, reporting and use of information necessary for improving health service effectiveness and efficiency through better management at all levels of health services" (Sauerborn and Lippeveld, 2000:3). In such a HMIS, the standards in question would be related to the data sets composed of data elements and indicators generated from them, formats of reporting and their periodicities. In a patient based system, there are additionally different standards such as those for data interchange (e.g. HL7, EHRcom, DICOM) and disease diagnosis (ICD-10). Given my perspective on standards as techno-institutional artefacts, it is important to note what are the kinds of standards we are talking about; for what technologies are they developed for and the systems and practices that they support. While my primary focus is on standards for aggregate or statistical data, I have also studied patient based systems used within hospitals. This has helped to deepen my understanding of standards from various perspectives, and of different systems in the context of healthcare.

1.2. Personal Motivation and Research Questions

My interest in software implementation, especially with respect to the issue of standards and standardization, arose from the early days of my involvement with IT projects of various scales and contexts, in different roles, from a software developer, to a team coordinator and project manager. Working for a US based company in Tajikistan specializing in data

warehousing applications, which provided analytical services for Fortune 500 companies, I realized the need and importance of standardization in the development of large scale systems. One of the company's clients specializing in real estate business had branch offices in many countries in all continents. Operational data from these offices was periodically collected for data warehousing purposes in a variety of formats and involving different types of content. Some offices reported in Excel sheets, others used comma separated values and some even sent a copy of the operational database. The data cleaning process was most challenging and costly involving the Dun and Bradstreet cleansing service and required the assigning of a DUNS (Data Universal Numbering System) number. I was surprised to study how Dun and Bradstreet maintained the global database of enterprises, while the Real Estate Company could not implement a standard approach around their information systems in its branch offices.

I joined the Global Infrastructures group of the University of Oslo (UiO) as a PhD student in the autumn of 2008. In 2007, I received an invitation from a friend to meet with a group of researchers from UiO, who were working on a project related to HMIS design and implementation in Tajikistan and required some technical assistance from local staff. The next day, I came to the MoH office, where a Professor and three PhD students were engaged in a discussion with a local NGO, donor representatives and some MoH staff. The medium of conversation was between English and Russian (or Tajik), and I got pulled into the role of mediating in both – the global and local. In this meeting, the participants discussed strategies and approaches for customizing and piloting of the DHIS2 (District Health Information System version 2) as the national HMIS of Tajikistan. DHIS2 is an open source software application designed specifically for HMIS in developing country contexts. Further, DHIS2 is a modular application designed and built with high customizability considering varying needs and setups which are country specific. The efforts towards designing for universality in DHIS2 and its collision with the idiosyncrasies of Tajikistan healthcare provided an interesting arena to study various aspects of standardization including the global/local dilemma, and the challenges of implementation. As a person from the outside, relying on my past experience, I wondered if the ambitious plan of the MoH representatives could match with the proposal being made by the experts from UiO, or could it be implemented at all? Later after the meeting, I was given an assignment to support the customization of the MoH reporting forms in the electronic version, and the Professor also briefly explained me the

philosophy behind this intervention, while observing my interest to become a part of this initiative.

Working for a couple of months with this project, I realized the need for conceptualization of the whole process of change with regards to HMIS along with other ongoing health sector reforms of Tajikistan. The key idea was around standardization in terms of unifying data collection and reporting, bringing common tooling and techniques to play, while dealing with the vast amounts of data and formats. From a different perspective, the interaction of donor organization and the various national stakeholders took place through negotiations, often charged with strong political interests, where each side came up with its own arguments and visions, sometimes leading to consensus, but more often than not to conflicts and lack of agreements with adverse implications on the HMIS implementation. Donor organizations want to see appropriate use of allocated funds, sustainability, and compatibility with global efforts, while the local authorities are often concerned with issues, such as the loss of control of an existing system, and the implications of the new system failing or being sub-optimal. Such negotiations potentially could be useful in generating constructive solutions to challenging problems of standardization. Studying interactions between actors at different levels, and seeing outcomes of practical experiments from the field, helped me to develop an understanding that standards are not just a technological process or product, but are shaped by historical conditions; social and material values of organizations, and most importantly by people and their everyday practices.

During the course of my PhD journey, I have proceeded with my research focusing on the central role of standards in shaping processes of HMIS implementation. Being informed also by institutional theory, I have looked at issues beyond technology to also try and understand aspects of employee motivation, information needs and infrastructures. These issues have provided me with useful lenses to study and interpret the research challenge of standardization. Throughout the research period of four years, I have often formulated and reformulated my assumptions and hypotheses around the research problem, which have further shaped my empirical findings and theoretical framing of standards and standardization, and their interplay with national HIS implementation processes.

Implementing global standards could be seen as a process of generification (Pollock, Williams and D'Adderio, 2007) of local practices, where the characteristics of the local context gets progressively removed, while key core and common elements are maintained.

Local implementations take place together with ongoing processes of localization of these global standards (Pollock, Williams & D'Adderio, 2007; Braa et al., 2007). When standards are set and agreed upon at a supra-national level, they still may undergo sub-locale adaptation or cross-contextualization (Jarulaitis and Monteiro, 2011). Given the above scenarios, standardization processes could be termed as modes of "generification", "localization" and "contextualization". Large scale information systems are difficult to adapt to other contexts than that they are built for, because of being bound by 'time' and 'space' and idiosyncrasies of locales they are originally built for (Berg, 1997). This raises the need for efforts of local actors to make such a system work in the specific setting (McLaughlin et al., 1999). Standardization of HMIS (of any mode) as a complex socio-technical process is composed of sub-processes involving various human and non-human components, each having varying levels of relations with regards to other components and the whole process. I believe the study of these relations will help to better understand standardization process and the nature of the global/local interplay of standards. With this background, the thesis seeks to address the following research questions:

1. What are the nature of dynamics in the interplay between global standards and local adaptations within the context of an in country HMIS implementation?

2. What are the challenges and opportunities which both arise during the course of the above interplay, and how can we leverage upon the opportunities while mitigating the adverse effects of these challenges?

The key questions posed are further made more concrete and operational in chapter 2, after discussion of the theoretical grounds of the research and presenting the proposed analytical framework. A key focus point relates to my assumption that negotiation efforts underlie the standardization process, which in turn is shaped by the actors involved and their level of interests or not in the standard. While negotiation processes tend to be open and evolving with unpredictable outcomes, their particularities shape standardization processes in context. The knowledge which the above analysis generates will focus around the understanding of the issues that come into play while trying to implement global elements of standards (such as related to software or disease classification codes), and the efforts involved in trying to make it work in local settings.

1.3. Empirical approach

Standards are primarily meant to reduce complexities and lower costs of systems development, and standardization process aimed to reach these goals is generally approached through ongoing processes of negotiations. Direct participation and observations of these different negotiation processes around the various standards – software, data related, and classification systems – are important components of the empirical approach.

Empirically, the research questions have been studied from both the global and local perspectives through an action research approach guided within an interpretive tradition. Global and local represent two relative perspectives, where the global implies working on issues that have implications for a multiplicity of contexts, countries, simultaneously, and the local implies working in the context of a country, in my case Tajikistan and India.

My research is situated within the framework of the global Health Information Systems Programme (HISP), being coordinated by the University of Oslo, Norway, since the mid-nineties and active now in more than 25 countries. There are various activities in HISP that are global, such as the development of open source software capable of being adapted to different countries. Then there are activities specific to make the HIS work in particular countries, including software customization, training, implementation and dealing with the local politics. During 2009, I actively participated in global events, specifically global software development activities, being a member of global team of developers, located in Oslo. This group is responsible for the development of generic modules of the DHIS2 for multiple countries as a global product, and I was simultaneously involved in the process of customizing DHIS2 for Tajikistan. Working with the global team, I gained knowledge of the different requirements also of other countries where DHIS2 was being used, and how the needs for Tajikistan compared with these. At the local level in Tajikistan, I engaged in various activities from working with donors, software customization, design, implementation, training, and managing infrastructure. All these activities have involved me in different processes of negotiations with different sets of actors.

These different activities have taken place across various phases (starting 2008 up to the writing of this thesis) of the HMIS development and implementation process in Tajikistan. Also, during this period, I had four visits (each lasting more than a month) for participating in practical system design and development activities of a patient record based hospital information system in a district hospital in a state in north India. From the vantage point of

having empirical evidence across countries and also different systems, I could participate in both the global and local level activities, including standards of software and classification systems; both in their development and implementation. I could both come to understand the implications from the Indian experience for Tajikistan, and also understand how differently both countries were trying to adopt standards like the International Classification of Diseases (ICD) to their respective local contexts. The historical contexts matters, as I learnt during my empirical work and also readings, with significant implications on what standards are adopted and how they are localized.

Tajikistan broke away in the nineties from the Soviet Union as a "spontaneous transition" (Braguinsky and Yavlinski, 2000), whereas India has had a more stable socio-political landscape over the same period. The Tajikistan system lacks the established institutional arrangements of Western economies and democracy, creating major challenges in implementing HMIS, as there existed a weak common understanding amongst the actors involved of broader issues such as of how national norms relate to existing systems (such as definitions of health indicators). This then creates dependencies on external donors for expertise and money, infusing a set of global dynamics and tensions. In India, where institutions are more deep rooted, the flexibility to change or introducing new standards are less problematic as gain or loss from doing so are arguably more evident or better understood by the stakeholders. These processes are also more internally driven in India than being influenced by external donors as is the case in Tajikistan.

1.4. Conceptual perspective

My approach to studying HIS, standards, and the global-local interplay is informed by a theoretical perspective grounded in information infrastructure theory (Star and Ruhleder, 1996; Ciborra 2000; Hanseth and Ciborra, 2007), which seeks to study the mutual relations between technology, people, institutions, and the processes through which this ensemble evolves over time. This perspective pays special attention to the role of standards, their flexibility or not in change and in being changed, which are known to be influenced by existing institutional arrangements, and at the same time influencing the very processes which maintain it in an organization (Hanseth et al., 1996). This then requires implementation to be conceived as a strategic task, involving issues beyond the technology and including aspects of the organisational context, governance and resource management, where multiple actors such as field level health providers, district managers, administrators, and global

players are involved. This broad scope then encourages an adoption of an approach of a "Health Information Infrastructure" (HII), which explicitly examines the socio-technical networks around the system, rather than keeping the focus limited to the standalone HMIS. I strengthen the information infrastructure perspective with concepts drawn from Institutional theory, related to for example incentives, to help develop a broader understanding of standards, how these are introduced and maintained in organizational settings, and the opportunities and challenges that so arise.

Information infrastructures are conceived as spanning across geographic and organizational boundaries, providing the unique opportunity to study a phenomenon, such as the implementation of standards, from both the macro and micro perspectives at the same time. As such, in this thesis, the focus is on the HII and the underlying standards which are in the process of being designed and set up in the context of Tajikistan and India, and it becomes the unit of analysis in my research. Being connected to this HII, different organizations may have varying roles in the standardization process, including in their design and implementation. For example in Tajikistan, the HII spreads beyond single organizations, and involves multiple stakeholders, including agencies such as the Republican Centre for Statistics and Medical Information (RCSMI), the State Statistics Agency (SSA) and the Civil Registry Office (CRO). These different organizations have their own respective infrastructures, and systems of provision and demand. Together, these and other agencies can be seen as shaping an "*organization field"* (DiMaggio and Powell, 1983) representing a sphere of influence into the design, development, use and evolution of the HII and the underlying standards. This sphere of influence is defined by the different *institutional logics* – representing "*both supra-organizational patterns of activity by which individuals and organizations produce and reproduce their material subsistence and organize time and space. They are also symbolic systems, ways of ordering reality, thereby rendering experience of time and space meaningful*" (Friedland and Alford, 1991:243). The concept of institutional logics helps me to better understand the underlying patterns of activity in an organization, for example, the logic of statistics which underpin the design and use of HIS.

Another concept that is relevant for my analysis drawn from institutional theory is that of "*incentives*". The concept of incentives is mainly used to denote purposeful action of individuals both alone and as member of social groups, the choice of which is guided by the expectation of some sort of rewards (Armstrong, 2002). Incentives can be positive or

negative depending on an individual's perception of changes resulting from particular actions taken from within a set of rules in a particular physical and social context (Ostrom, Schroeder & Wynne, 1993; Campbell, 1995). The concept of incentives is used to understand behaviour in the accepting or not of standards, and their roles in shaping processes of negotiations.

One key objective of implementing standards is strong and robust HMIS, effectiveness of which is determined through measuring *incentives* organizations and individuals receive as a result of the actions they perform. These incentives can come in various forms such as reduced paperwork, strengthening accessibility to analytical data or others, or even in monetary terms (such as "Performance based Pay"). In my case, the Central MoH and CRO are seen (as supra-national bodies) to have more regulative influence, setting the overall agenda around what standards are to be used and how, while other sub-regional and district organizations are expected to only comply. The HII, in which the standards are an integral part, acts as the medium of interactions and *carrier of institutions,* including incentives, as a means to encourage the compliance to standards. When a new standard is commonly accepted and put into action, it is said to be *legitimate*. For example, in healthcare, "pay for performance" is a mechanism used by healthcare providers for improving quality of care through providing incentives to medical practitioners in the form of rewards for better performance (Garber, 2005).

The infrastructure and institutional perspectives also help to understand that the design and introduction of standards is not a standalone task, a process by its own, but is intertwined with other Ministry of Health processes such as decentralization, health financing, and administrative restructuring, which are in turn aligned with other aspects related to the national strategy for development. For instance, decentralization may seek to achieve high level of healthcare service delivery by empowering district level managers to take decisions for local action. These processes are fundamentally aligned with the HMIS strengthening tasks, such that the local manager can access relevant information to make appropriate decisions and also should have sufficient funds and resources to do so. Here it becomes important that while decentralization may result in the "blooming of thousand flowers" where each district health facility independently creates their own data sets and formats, if the entire process is not well coordinated, it may disrupt the national standardization process. Coordination of such efforts requires high level of expertise and competence, which in the case of developing countries like Tajikistan, normally comes through donor supported

technical assistance. This then tends to introduce further global solutions which will need to be negotiated for local use. Bringing these global solutions to local socio-technical realities then requires various standards to streamline implementation and future development of underlying solutions. Thus the entire HMIS implementation process is tightly coupled with other parallel processes, while having its own sub-locality, with various similarities and differences. An information infrastructure perspective helps to explicitly focus on understanding these inter-linkages.

After having introduced the research questions and the conceptual perspective to help approach these questions, in the next section, I present the research settings for my empirical work.

1.5. Research settings

The research reported in this thesis is based primarily on the study of ongoing reforms of the health sector of Tajikistan, particularly related to HMIS redesign, development and implementation. Also I was fortunate to take part in design, development and implementation of hospital management information system (HospMIS) in India. The development of the HMIS in Tajikistan started as part of larger project for health care reform called Health System Reform Programme (HSRP) with a loan from Asian Development Bank (ADB). The HSRP started in 2004 with goals to improve overall health conditions and in particular for woman, children and poor, with objectives to strengthen health system efficiency and health management capacity, with a key focus on the HMIS. In India, HospMIS was initiated and funded by the Ministry of Health and welfare of Himachal Pradesh State and HISP India as implementing partner, aiming at improved service delivery, reduced costs and better management of pharmacy at public hospitals.

In its design, the HSRP had three distinct components: institutional development of the health sector; drug supply and quality control; and efficient and sustainable delivery of a pro-poor health service package. These objectives and plan of actions were designed based on a comprehensive social sector study by ADB, which identified "major concerns in the health sector: (i) shrunken public health expenditures and inefficient use of resources, (ii) collapsed public health care system, (iii) increased out-of-pocket payment by beneficiaries, (iv) reduced access to and utilization of health services, in particular by the poor, (v) weakened and unreliable HMIS, (vi) high burden of diseases and precarious health status of the population, and, (vii) limited managerial, technical, administrative, and financial capacity at all levels of

the health sector" (ADB report, 2003). One of the key recommendations of this report was to strengthen HMIS, stating:

> "An effective health management information system (HMIS) is essential for planning, reforming, managing, and monitoring the health sector of Tajikistan. However, reliable and disaggregated information is currently lacking. The lack of reliable data on the existing workforce seriously hampers effective human resource development planning**.** Financing data is required to design financing strategies and develop mechanisms for performance-based budget allocations. HMIS needs streamlining. The Health Sector Reform Project (HSRP) aims to reform the health care delivery system by introducing the family group practice (FGP) and the capitation payment scheme. It is important to ensure that HMIS functions effectively in monitoring the new systems' performance and evaluating the impacts of changes." (ADB report, 2003:45)

In the fall of 2007, under the first component – institutional development of the health sector, the piloting of a redesigned HMIS started in 5 rural districts, which were selected for their severity of poverty and the high levels of infant and maternal mortality. Most of these districts are located in mountainous areas with limited transport and communication infrastructure, which made piloting extremely difficult. Despite these shortcomings, the pilot project was termed a "success", encouraging in 2008 the European Commission (EC) to take over the processes related to the future support of HMIS development and implementation. This project was based on grants and planned to be implemented in three phases solely dedicated to HMIS. Phase I (2009) was a comprehensive study of the existing HMIS, including vertical programmes and demography. Phase II (2010-2011) was preparatory and focused on planning the national strategy and roll out plan for HMIS implementation. The HMIS implementation strategy provided a detailed description of interventions required to reach a fully functional system by 2015. Phase III, which started early 2013, will be the actual implementation of HMIS. My empirical work covers both the ADB and EC project periods, where I have worked together with national and international experts providing technical assistance in terms of guidelines, trainings and also developing software solutions. Global HISP was engaged in one such intervention during 2007 – 2008, and has continued over the years in different degrees and responsibilities. As a member of Global HISP and a Tajikistan national working in my home country, I have been privileged in being able to

observe and engage with global and local developments, and also examine their dynamic interplay – a key focus of my thesis.

To briefly introduce HISP. HISP was initially started through the Department of Informatics, University of Oslo in 1994 as a small project in South Africa and gradually implemented nationwide. Since around 2000, HISP has rapidly expanded from South Africa to multiple African (such as Kenya, Ghana, Uganda, Tanzania, etc.) and also Asian countries such as India, Bangladesh, Sri Lanka, Vietnam and Tajikistan. The HISP experience is marked by an accumulation of various local successes (and also "failures"), which contributes to the global repository of HMIS knowledge, practices and material artefacts like the DHIS2 software, which today has evolved into a global standard, and is in the process of being implemented in Tajikistan, a process in which I have been integrally involved. My involvement in HospMIS implementation was organized through HISP India. My main activities were design and development of various modules for the system that are generic and easily adjustable to various locales. Through this exercise I learned dynamics global/local interplay of standards in design and development of HospMIS as system was intended to be scaled to other 20 hospitals in the state.

Action research, labelled as networks of action (Braa et al., 2005), is the underlying principle of the HISP approach, which has contributed to the development and evolution of DHIS2, and also in supporting implementation processes in various countries (Braa and Sahay, 2012). DHIS2 is a modular web based application, established as a de-facto standard for HMIS in many countries, it is flexible and able to be adjusted to different local requirements (more information could be found at dhis2.org and hispindia.org). The socio-technical efforts around the process of designing and implementing DHIS2 in the realities of Tajikistan were the focus of my practical involvement. I was particularly interested in understanding the interplay between global standards and systems and how these were adapted into local national and sub-national contexts.

There are different forms and types of standards relevant in a HIS, and this thesis focuses on issues related to software, data, indicators, and processes around their design and use. Table 1.1 below describes the type of standards used in the context of Tajikistan HIS, their global and local implications and processes that link the two. This table, in short, summarizes the scope of my analysis around the broad area of standards.

Table 1.1 Scope of HIS related Standards Studied in this Research

Type of Standard	What is Global	What is Local	Process of interplay between global-local
DHIS2	Data warehouse, best known practices	Localized user interface, customized or developed modules	Localization of user interface, customizing modules according to the local needs New and particular features/functionality development Contributing to global core
Indicators	International expertise, MDG, WHO indicators	Selection of indicators based on the National Health Strategy indicators, MDG	National set of indicators are aligned with NHS, negotiations between what to be selected and not Linking of indicators to be generated with data elements being collected – a gross mismatch
ICD-10	WHO	SSA, CRO and MoH collaboration	Use of ICD-10 for primary health records, reducing recording and reporting forms Use for recording cause of death and demographics. Standard for communicating information with other peer organizations
Data Elements	Meta-data standard	National priorities for improving healthcare	Revision of primary and reporting forms, reduction of data elements to the need of NHS indicators

1.6. Expected contributions

Motivated by the practical need to understand the sources and the nature of global/local dynamics in standardization processes in HMIS implementation, I have structured and focused the investigation through a combination of concepts drawn from the domains of information infrastructure and institutional theory. Through this analysis, I expect to make the following contributions:

- To deepen the understanding of scope, sources and dynamics of global/local processes of localization of global standards in HMIS implementation through the lens of institutional theory within an information infrastructure perspective.

- By developing the concepts of *incentives* and *facets of infrastructure,* formulate insights and recommendations on *how to manage negotiation processes in standard making*, in a manner in which the effectiveness of local systems can be enhanced.

- Develop practical strategies for guiding implementation processes of global standards in the context of national HII in Tajikistan.

1.7. Organization of the thesis

The remainder of this thesis is structured as follows. Chapter 2 provides a review of the relevant literature, and following this, the analytical framework is suggested. Chapter 3 provides an overview of the research context followed by research approach and methods and a detailed description of the fieldwork carried out. Chapter 4 provides a reflection on my process of data analysis. In chapter 5, I present my findings by summarizing each of the five papers that contribute to this thesis, and their synthesis. The papers themselves are placed as Annexes 1-5 of this thesis. Chapter 6 presents the theoretical and practical contributions developed in this thesis. The final chapter presents some concluding remarks, and future research directions.

Chapter 2

2. Literature Review and a Theoretical Perspective

My research focuses on understanding the process and dynamics of global and local adaptations and the interplay of standards from a socio-technical perspective around HIS in Tajikistan particularly, and in developing countries more generally. Given this focus, I draw upon three main bodies of research to inform my analysis. The first relates to the Information Infrastructure (II) perspective, enabling me to examine the challenge of standards from a socio-technical viewpoint, where a key concern is to see the infrastructure as something that evolves over time. The second domain concerns the literature on standards, the key object of my thesis, and which is particularly well handled by II theory. The third domain informing the analysis is related to institutional theory, especially to understand the role of history in shaping implementation processes, making it especially complex to change what already exists. Institutional theory has been criticized for under-emphasizing the role of materiality (technology), treating it largely as a black box and taken for granted. Arguably, II theory with its strong socio-technical focus helps to a certain degree to redress this balance. Institutional theory then emphasises the role of human agency as a key carrier of institutions (Orlikowski and Scott, 2008), which helps to understand where the stimulus for change is situated. The cross-fertilization of the II and institutional theory perspectives is beneficial to address issues of standards, their design and use in organizational contexts. While II and Institutional theories provide a holistic approach in doing research in standards and standardization, both highly emphasise and recognize social and technical compartments of IS research. In some parts of the analysis, I discuss social and technical aspects separately for analytical purposes. Being in the interpretive stance of IS research, this thesis follows Klein and Myers (1999) principles with key argument being hermeneutic circles, which implies that understanding of the complex whole is made up of a preconception of its parts and their interrelations.

In this chapter, I start by sketching out key concepts from the II perspective (section 1) and how these inform my analysis. Following from this, I focus on discussing the role of standards in IIs (section 2), which describes the object of my study within the framework of the global-local interplay. I then discuss some key concepts drawn from Institutional Theory (section 3) which helps to develop insights on processes of change within organizations. Institutional Theory and standardization are then discussed (section 4) and finally (in section

5), I bring together the concepts discussed to present a more comprehensive theoretical framework.

2.1. Information Infrastructure Perspective

Many authors have argued, and now it is an established "fact" that information systems should be treated not merely as technical systems (Lee, 1999), but rather as socio-technical networks (Walsham, 1998), constituted as a "web" of technical artefacts, people, and procedures immersed in a particular context (Kling and Scacchi, 1982). Especially, in the process of information systems implementation, it is of high importance to emphasize equally organizational, infrastructural and technological issues. Thus understanding how IT artefacts align with existing formal and informal institutional arrangements and also the underlying infrastructures becomes crucial. Standardization as such as a process of alignment is not isolated, but part of a larger process of II building (Nielsen, 2006), where new solutions are built on top of already existing ones (termed as the installed base) and influenced by the ongoing institutional arrangements (Hanseth et al., 2001; Cibora et al., 2000). An II is defined as a shared, evolving, open, and heterogeneous installed base (Hanseth and Monteiro, 1998b; Cibora et al., 2000; Hanseth and Monteiro, 1997), being evolved for and by a large user community across diverse geographical and functional areas. It is thus qualitatively different from a standalone system which is composed of a limited number of independent entities.

The *installed base* represents already existing organizational arrangements, both technical and non-technical, including standards and technologies, organizational structures, social arrangements and institutionalized routines. Because the installed base is deeply rooted in the organizational settings and institutionalized practices, the whole II cannot be changed in one go and cannot be designed from scratch. Changes can only be built upon the existing installed base, which influences the way changes enter the II ecosystem (Hanseth and Monteiro, 1997). It has thus been argued that an II is never "designed from scratch", and is instead 'cultivated' (Aanestad, 2002) as a process of incremental evolution.

Public healthcare is composed of administrative and health delivery systems, interlinked also through the use of HMIS, to help support both management decision making and also health care delivery. For the system to be effective, various institutional and technical dimensions need to be inter-linked across various levels of the health care administration. Bowker and Star (1998) have argued that information systems are necessarily both social and political, including the technical infrastructure (Bowker and Star, 1999). The HMIS needs to support

the full cycle of information management starting from data collection, report generation and the use of information for action. For each of these aspects of the cycle, different standards and procedures come into play, such as data entry forms for data capturing and the required indicators at the stage of information use. This involves a series of technical, social and political considerations that need to be taken up by the stakeholders through ongoing negotiation processes.

Use of networked and distributed technologies allows the HMIS to evolve by adding new nodes to the network, connected with affordable Internet or mobile connections and enforced using institutional rules and norms. The role of standards becomes increasingly important as systems become networked and complex (Fomin, Keil & Lyytinen, 2003) and the need for coordination increases. Similarly, Star and Ruhleder (1996) have argued that with the rise of decentralized technologies used across wide geographical distances for diverse applications, both the need for common standards and the need for situated, tailorable and flexible technologies grow stronger (Star and Ruhleder, 1996). Because IIs are constantly changing in relation to an organization's objectives and institutionalized work practices, these standards need to be flexible and easy to change (Hanseth, Monteiro and Hatling, 1996). However, making these changes is a non-trivial socio-technical challenge.

Timmermans and Epstein (2010) describe standards as socio-technical components aiming at rendering the world equivalent (universal) across cultures, time and geography. Universality and flexibility are two contradictory though important characteristics of standards, which needs to be balanced through changes in local practices and their global definitions. These changes and developments then necessarily take place around the installed base (Hanseth and Monteiro, 1997), and as it becomes increasingly deep rooted and impossible to change, they start to become *irreversible* (Hanseth and Monteiro, 1998).

In the next section, I discuss standards, their definitions and typologies, and how they are relevant to understanding IIs.

2.2. Standards - building blocks of Information Infrastructures

Standards are fundamental for an II to effectively function (Hanseth, Monteiro and Hatling, 1996), allowing the various components of the infrastructure to work at different levels and elements, enabling integration through standardized interfaces, components, and protocols (Hanseth and Monteiro, 1997). A popular definition of standards given by the American

National Standards Policy Advisory Committee is: "*A prescribed set of rules, conditions, or requirements concerning definitions of terms; classification of components; specification of materials, performance, or operations; delineation of procedures; or measurement of quantity and quality in describing materials, products, systems, services, or practices*" (ANSPAC, 1978:6). While this definition is quite generic and covers various aspects of standards, ISO/IEC Guide 2, definition 3.2 defines standard as formal and approved "... *document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context*" (ISO/IEC Guide, 2004:12). Bowker and Star's (1999) definition puts standard as "*any set of agreed upon rules for the production of (textual or material) objects*" (Bowker and Star, 1999:13).

Standards and standardization typically imply one another (Timmermans and Epstein, 2010:70). The subject of a standard establishes the standard and the standard shapes the subject. According to deVries (2003) standardization is "*the activity of establishing and recording a limited set of solutions to actual or potential matching problems directed at benefits for the party or parties involved balancing their needs and intending and expecting that these solutions will be repeatedly or continuously used during a certain period by a substantial number of the parties for whom they are meant*" (deVries, 2003:155).

While deVries' view fits well with the above listed definitions of standards, there are still other specific situations that require standards to be treated differently. For example, Brunsson and Jacobsson (2000) describe situations where standards take the role of regulatory and coordination activities, when organizations are weak and are not able to manage the process by direct orders. Or standards are often promulgated by expert knowledge, representing a form of 'embedded authority' (ibid, 2000:42). Hanseth and Monteiro (1997) empirically drawing upon an example from the Norwegian healthcare sector demonstrate how individual and (inter-) organizational behaviours get inscribed into standards (Hanseth and Monteiro, 1997) with the aim of enforcing desired behaviour.

Standards are categorized along different dimensions, and as three major types (David and Greenstein, 1990): product, document (minimum quality) and compatibility standards. While the first concerns products, the second refers to information codes, and the last to processes in both production and consumption, of health information in our case (David and Greenstein, 1990; Farrell and Saloner, 1987; Besen, 1990). Standards can further be classified as

mandatory and voluntary, respectively being mandated by public authorities or emerging through a market process. De-facto standards emerge ex-post in the market as a result of a process of interaction of various agents related to the standard. De-jure standards are elaborated ex-ante either by committees and agreements or mandated by standard setting authorities (David, 1987; David and Greenstein, 1990). In functional terms, a further distinction has been drawn between standards that perform a reference function and consequently reduce transaction costs, and those that perform a compatibility function to enable technical coordination (Hanseth, Monteiro & Hatling, 1996).

Further, Sahay (2003) in the context of global software outsourcing argues the need also for practice based standards, drawing from the notion of 'McDonaldization' (Ritzer, 1996). Sahay argues how different tasks at various stages of the software development life cycle are separated and implemented in different geographic locations, coordinated through the use of information infrastructures and standardized development processes, methodologies and the use of technical components. This standardization, he argues, minimizes to a certain degree the heterogeneity inherent in distributed software development, and is significantly greater than when compared with other production activities which are coordinated across time and space.

Bowker and Star (1999) distinguish classifications and standards as two sides of the same coin. The distinction being that classifications are containers for the descriptions of events - they are an aspect of organizational, social and personal memory - whereas standards are procedures for how to do things - they are an aspect of acting and being in the world. Every standard, for example, generates an implicit classification scheme, which must eventually be standardized at least as an "ad hoc, limited to an individual or local community, and/or of limited duration" (Bowker and Star, 1999:15). Data warehousing techniques, which are largely used in HMIS (Braa and Sahay, 2012) follows the same approach. Definitions of data to be processed and stored are dependent on local socio-political norms and data warehousing applications are set of standards developed to host codified patterns of relations, which are in turn product of social, technical and political memories of organizations and individuals. In data warehousing terminology, "classification" is often replaced with the term "data dictionary". A data dictionary is generated through local actions and interactions of actors and is codified in a standard way defined by metadata. Metadata determines formats, size, and properties of data and remains stable for longer time and can be applied to many locales,

while data dictionary is locale specific and subject to frequent changes depending on the socio-political environment.

Standards tend to be dynamic, reflecting their position with respect to broader organizational changes. Adaptation to changes requires infrastructures and standards to be flexible and aligned with the daily routines of organizations (Braa et al. 2006; Hanseth and K. Braa, 2000; Hanseth, Monteiro and Halting, 1996). The flexibility also allows a process of experimentation leading to improvements and building of users' experience (Hanseth and Monteiro, 1997). The openness of infrastructures implies that the range and scope of standards must change over time and with it their relationships to other standards. These evolving processes make infrastructures heterogeneous in the sense that they are composed of different kinds of components, linked with communication, procedures and data standards. Standards as such play an important role in the design, development and evolution of IIs (ibid). Fujimura (1996) in her study of cancer research demonstrates how standards evolve as package of theories, methods, concepts and material objects of the research findings, created and shared among and by communities of researchers, fostering compatibility and interoperability. "Standardized packages" according to Fujimura are stabilized and generally accepted "facts", which represent boundary objects with local research practices, restricting and enabling local actions (Fujimura, 1996). Data warehousing applications used in HMIS are also a kind of "standardized packages" built and tuned in the various contexts with varying level of economic, social and political constructs. Having many similarities and differences, such applications are often designed and developed in a modular way. Modularity of data warehousing applications provides flexibility where modules needed are picked from the package or version of module for a specific locale. Sharing core standards brings cost efficiency, time saving and avoiding possible design flaws, which have been tuned by other community members, to prevent "reinventing the wheel".

Implementing standards also has cost implications, with an underlying principle being that as the user community adopting the same standard increases, the cost of its deployment will be lower due to stronger economies of scale. The more the standards are in use and widespread, the more it needs to take on a generic nature, which requires them to be situated in different local contexts of use (Ciborra and Hanseth, 1998). Localization creates tensions between global standards and local imperatives, requiring balancing of external forces and internal regulations respectively. The dilemma of the "context" (flexibility) and the "core"

(universality) in standards requires often a form of an external force that ensures consistency in applying the global requirements locally (Antonelli, 1994). Common examples of such forces are government standards (tax laws, accounting regulations), broad industry standards (HTML standards for WWW browsing, ISO standards for mechanical drafting), or those coming from powerful industry groups (EDI standards for data exchange).

Rolland and Monteiro (2002) described implementation challenges of global standards into local realities empirically based on an example of a global maritime classification organization with offices in more than 100 countries, including many in the developing world. The authors use the term *information infrastructure* rather than information system, to emphasize the complex and interlinked nature of the application, which need different methods of development and management. The distributed nature of use highlights the standardization versus localization debates, where universal solutions require to be customized to different socio-political contexts. While they call for finding a pragmatic balance between global standards and local adaptations, they do not go further in elaborating how this balance can be found. Data warehousing techniques and principles relating to modularization and "standardized packages" provide solid grounds for developing such a pragmatic balance, where global solutions (boundary objects) are brought to local realities. This helps to provide control and autonomy at the same time, emphasizing aspects related to the process of standardization: "*While some of these "structures" will be implemented through technical specifications, others will appear more like informal agreements, institutionalized relationships and accepted practices*" (Nielsen, 2006:52). In line with Nielsen (2006), I argue for a more detailed study of standardization process, specifically the analytical splitting of the social and technical components of the information system (within the larger II and institutional frames) possibly reveals patterns of recurring relations, which then could guide micro-processes of developing the required pragmatic balance. Working at various analytical levels is encouraged by different researchers (Callon et al., 1981; Currie, 2009), where individual (micro level) actions are constrained by organizational institutions (macro level) and represent a product of actions of group of actors.

Given this wide variation in definitions of standards, their types and scope and areas of use, it is important that I make explicit my perspective on standards as used in this thesis. I articulate my working definition of standard as: "*an abstract and generalized or instantiated localized reproduction of certain aspects of practice, patterns of relations, knowledge,*

behavior and description detached/attached from/to context of use, inscribed into artifacts, rules, guidelines and procedures to address a certain problem in the domain of interest". In line with this, standardization is defined as "*a process of negotiation and aligning standards into the context (scope) of use resulting in one of the standardization modes of generification, localization or contextualization*". A standard represents one out of many possible means to solve a problem, and thus always involves a process of negotiation and consensus building to enable its acceptance and implementation.

2.3. Standards, Health IIs and Developing Countries

The topic of standards and interoperability is not new in the domain of information systems, but in case of healthcare (especially in developing countries) it is still in a rather nascent stage. Beale (2004) differentiates HIS from other kinds of information systems in the way that they treat persons: "*It is often asked: what is the difference between health IT and IT in other domains? One well-known answer is "the patient". Systems in other domains such as banking and airline reservation have "customers" or "travellers" but these are grossly simplified abstract versions of a person. "Patients" in clinical systems are anything but: their biological and social complexity is manifested directly in clinical information, posing a far greater challenge than in other domains. ...*" (Beale, 2004:301). Thus, healthcare standards inherit the complexity of human biology and their living environment as part of subject of their interests.

Over time, various standards have emerged in the health domain to address representations, data collection, storage, analysis and transfer of patient and facility based data. These standards embed clinical, procedural, and performance standards as well as including numerous classification schemes and terminologies (Timmermans and Berg, 2003). An example of a classification system is the International Classification of Diseases (ICD) - a terminology standard, implying its key function is to give stability of meaning over different sites and time (ibid, 2003). The contents of the ICD represents inscriptions of a series of technical, social, political and economic decisions taken at different moments in time (Bowker and Star, 1999). These global inscriptions represent a form of standard, which need to go through processes of local adaptations, while aligning with the purpose and context of use (Rolland and Monteiro, 2002). There are many occasions where there are different views on these standards, requiring local work-arounds and negotiations. For example, the cause of death as given on the death certificate by an attending physician is frequently not the cause of

death that enters into statistical records (Fagot-Largeault, 1989). The classifications entered, by their very nature and design, constrain the kind of story that the statistics tell (Bowker and Star, 1999).

Braa and Hedberg (2002) describe the process of developing new standards for health data in South Africa as a process of cultivation, in an incrementally evolving "bottom-up" process. This requires the aligning of actors by enabling the translation of their interests, through ongoing processes of negotiations. Their design strategy for the HIS is based on using the available infrastructure and enrolling the different actors to be involved in flexible negotiation processes while avoiding lock-ins and keeping the process open for future development. In another article, Braa and colleagues (2007) described the HISP strategy of flexible standards for the development of the HII and the associated standards. They abstract from the HMIS development and implementation experiences in three countries (South Africa, Ethiopia and Thailand), and identify complexity of the HII as a key challenge in the standardization process.

While pure technical and communication standards are easily accepted and data exchange is established, content and semantic standards of data may not be uniformly applied to all locales of an II. Meanings, volumes and formats of data require 'work-arounds' and necessitate greater standardization efforts. This is not easily achieved because of the socio-technical nature of knowledge embedded in such standards, as well as the number and variety of standards and their interrelations (Bowker and Star, 1999; Brunsson and Jakobsson, 2000; Fomin et al., 2003). In this regard, healthcare standards have their particularities coming from the complex nature of the healthcare system, including administration, financing, monitoring and healthcare delivery. This is further magnified by the fact that disease prevalence is locale specific and patient treatment can have many different routes based on its severity.

Braa and Sahay (2012) grouped standardization into three distinct and correlated levels depending on the type of standards and agreement of parties involved following Carlile's (2004) framework for managing knowledge across boundaries. These are: syntactic/technical, semantic/data and organizational/political standards. As depicted in figure 2.1, the triangular model shows the increase of complexity and viewpoints of HMIS users from lower levels up. The authors illustrated the model with an example of telephone conversation. First, both sides should have compatible devices in order to establish conversation (syntactic/technical level), then they should speak the same or common language to understand each other

(semantic/data level) and finally they should have interest in communicating such information to each other (organizational/political level). The highest level - organizational and political is more complex and accommodates differences between actors views, being a negotiation arena for reaching shared understanding and building an agreement on data standards, exchange and procedures. The figure 2.1 shows the complexity of standards across the different levels.

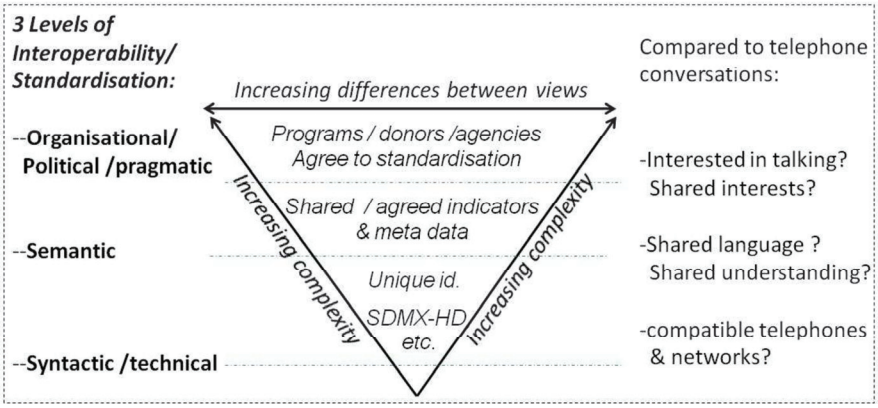

Figure 2.1 Three levels of standardization of the increasing differences and complexities (Braa and Sahay, 2012:67, adapted from Carlile, 2004)

Health II represents the intersection of the technical and social dimensions of organizations, including standards, people, institutions, procedures and technologies. The HII is the focus of my analysis, helping to develop a more holistic approach of the standardization challenge. A HII perspective helps to provide a focus on the scaling challenge, of how the systems move across different administrative levels, the resources required, and what are the other socio-technical networks they need to link up in this process. The HII perspective thus allows the analysis of the processes of standardization, and their inter-organizational linkages. Since a HII by definition spans across time and space, it allows the researcher to observe standardization process in various settings. Since the II emphasizes the heterogeneity of networks, and the negotiation processes that surround it at multiple levels (Rolland and Monteiro, 2002), it enables a rich analytical perspective. The next section is dedicated to Institutional theory, which broadly covers organizations and their institutional constructs.

2.4. Institutional Theory and HII

The process of IS implementation can also be seen as the conception and institutionalization of information systems (Silva and Backhouse, 2003). The institutional theory perspective helps provide a broader understanding of information systems from an organizational point of view. For example, it is important to understand the interplay between the various stakeholders in HMIS standardization process; giving due attention to the social dynamics of the standardization process; understanding the nature of standards in relation to the roles stakeholders play, and the mechanisms driving the implementation and diffusion of the information systems.

Institutional theory has been successfully applied in many disciplines such as economics (Aoki, 2001; North, 1990), sociology (Powell and DiMaggio, 1991; Streeck and Thelen, 2005), and political science (Immergut, 1998; Thelen, 1999). In IS research too, IT implementation in organisations has been subject of study by researchers from the domains of both organisation studies (Bijker and Law, 1992; Fulk, 1993; Prasad, 1993; Thomas, 1994) and information systems (Lucas, 1975; Bostrom and Heinen, 1977; Franz and Robey, 1984; Ginzberg, 1981; Robey and Sahay, 1996; Sahay, 2003, Noir and Walsham, 2007). These researchers have focused on understanding human behaviour in and between organisations and individuals, and the role of IT in shaping these relationships (Orlikowski and Baroudi, 1991). Orlikowski and Barley (2001) further argues that institutional analysis can help information systems researchers understand "*how technologies are embedded in complex interdependent social, economic, and political networks, and how they are consequently shaped by broader institutional influences*" (Orlikowski and Barley, 2001: 154).

Organizations are guided and constrained within their institutions, as Barley and Tolbert put it: "*organizations are suspended in a web of values, norms, beliefs, and taken-for-granted assumptions*" (Barley and Tolbert, 1997:93). These values, norms, beliefs and assumptions represent institutions - social structures that guide and constrain organizational and individual actions (Scott, 2001). Institutions thus represent "*multifaceted, durable social structures, made up of symbolic elements, social activities, and material resources*" (Scott, 2001:49), which are self-reproducing and repetitive in nature, thus exhibiting stability and order. Although institutions provide stability and order, they undergo changes, both incremental and revolutionary. From this standpoint, institutions are not only the 'property' or the state of the

existing social order, but also represent 'processes', including relating to institutionalization and deinstitutionalization (Tolbert and Zucker, 1996).

There are many applications of institutional theory in the context of healthcare, including in recent years about the role of technology in these settings. Currie and Guah's (2007) application of institutional theory as a conceptual lens to examine the National Programme of Information Technology project and the modernisation of the National Health System (NHS) in the United Kingdom is very instructive in the use of the theory. Currie and Guah used institutional theory to evaluate the wider organisational factors that influenced the modernization programmes, in the light of the complex and dynamic processes involved in the transformation of the NHS. Kimaro and Sahay (2007) drawing on institutional theory, proposed a theoretical framework that identified an organizational field in the context of the Tanzanian HIS. They defined formal and informal constraints arising in the co-relation of these entities in the organizational field in the process of decentralization of healthcare delivery. Applying this framework to the empirical data they identified gaps between the formal and informal routines that created a conflicting situation, negatively affecting the reform process. Such conflicting situations within and across health organizations at different levels are potential sources and causes of change (Piotti et al., 2006). These authors also argued for a better conceptualization of technology in the study of organizational fields by combining institutional and II theories.

The use of institutional theory has also been quite popular with researchers in examining the concept of inter-organisational electronic data interchange (EDI) standards. For instance, Damsgaard and Lyytinen (2001) have used institutional theory to study the different diffusion patterns of EDI in Finland, including alternative adoption patterns that operate beneath specific institutional incentives and programmes. They probe individual organisational cases within specific industrial contexts to dissect interactions between multiple factors that are likely to affect the diffusion of EDI. In a separate study, the same authors examined the impact of intermediating organisations (such as industry associations), and how they have contributed to advancing the EDI standard diffusion process in the grocery sector of Hong Kong, Denmark and Finland. While the trajectory of EDI adaptation and diffusion in all three countries were different, the intermediating organisations played critical and varying roles in the adoption and institutionalization of such technological innovations. A key analytical point

has been the role of local contingencies, history, and the strategies adopted by the trade and industry associations (Damsgaard and Lyytinen, 2001).

2.4.1. Organization Field and Institutional Logics

Studying the dynamics of global/local interplay of HMIS standards requires an analytical lens to examine various levels of institutions in organizational settings, "… *no concept is more vitally connected to the agenda of institutional processes and organizations than that of organization field.* […], *the concept of field – both as unit and level of analysis – figures sufficiently large in institutional approaches to organization to merit extended attention*" (Scott, 2008:181). The concept of *organizational field* incorporates all levels of organizational analysis, including the individual organization, organization set, and organization population (Porac, Thomas, & Baden-Fuller, 1989) that directly interact with one another and influence each other (Greenwood, Sudaby and Hinnings, 2002).

A founding definition by DiMaggio and Powell of an *organization field* is "*sets of organizations that, in the aggregate, constitute an area of institutional life; key suppliers, resource and product consumers, regulatory agencies, and other organizations that produce similar services or products.*" (1983: 148-149). Scott (1994) added the idea that patterns of interaction between organizational communities and their shared systems of meaning. These meaning systems establish the boundaries of each community of organizations, defining its membership, appropriate ways of behaving, and appropriate relationships between organizational members (Lawrence, 1999).

Collective beliefs are seen as emerging from processes of repeated interactions between organizations. Organizations develop categorizations of their exchanges, which achieve the status of objectification and thus constitute social reality. Organizations, initially at least, behave in accordance with this socially constructed reality because doing so helps to reduce ambiguity and uncertainty. Reciprocally shared understandings of appropriate practice permits ordered exchanges (Greenwood, Sudaby and Hinnings, 2002) within a framework of an *institutional logic*. Institutional logics constitute rules and conventions of organization field (Owen-Smith and Powell, 2008), becoming organizing principles and receipts for action. They have instrumental, normative and cognitive implications (Friedland and Alford, 1991; Thornton, 2004), providing rationales for action. Multiple competing logics in an organization field may trigger conflicts resulting in change or new account of activities, and their consistency brings stability to an organization field (Owen-Smith and Powell, 2008).

The concept of institutional logics has been used to describe contradictory practices and beliefs within institutions (Alford and Friedland, 1985; Jackall, 1988; Thornton and Ocasio, 2008), which create conflicting situations and consequent change processes resulting in weakening and erosion of institutions, deinstitutionalization and their reinstitutionalization (Oliver, 1992). Institutional logics provide the analytical link between individual agency and cognition and socially constructed institutional rules and practices (Thornton and Ocasio, 1999), which can provide insights on why there may be deviations from the "taken for granted" assumptions of bureaucratization (DiMaggio and Powell, 1983).

Cavalluzzo and Ittner (2004) discuss how public organisations in the USA implement management control systems to meet governmental requirements but do not actually take advantage of these systems for internal improvements. The authors use institutional theory to demonstrate how inadequate perceived benefits realised from mandated organisational changes in public organisations tend to be symbolic, but have little effect on actual use of the systems. Butler (2003) uses institutional theory to explain how the commitments of social actors influence and shape the development of web-based IS. Butler describes a high degree of 'institutional tension' between the various actors involved in the development of web-based systems, mainly because of established commitments to their communities of practice and the need to maintain existing power relationships. Chatterjee and colleagues (2002) draw from institutional theory as a conceptual lens to examine the impacts of specific institutional factors (such as top management advocacy, strategic investment rationale and coordination) in the adaptation of Web technologies into e-commerce strategies and activities in firms. In particular, the authors test the relationships among these factors using quantitative measures and their impact on the organisational assimilation of Web technologies.

Despite similarities and being part of the same organizational field, organisations often deploy different patterns of action to similar set of organisational routines (Pentland et al., 2010). Studying log records in invoice processing routines in four organisations in Norway, Pentland and colleagues argued that using the same software application, these organisations adopted different patterns of use. This could be explained by the cultural-cognitive dimension of institutions, which influences individual and group interpretation of actions.

2.4.2. Carriers of Institutions

Organization fields are "*[...] formed around the issues that become important to the interest and objectives of a specific collective of organizations*" (Hoffman, 1999:352). These

objectives then need to be propagated among field members, aligned and acted upon. Institutions of any type, whether normative, regulative or cultural-cognitive are communicated by various vehicles or "carriers" (Jepperson, 1991:150). Scott (2008) distinguishes four types of institutional carriers: symbolic, relational, routines and artefacts (Scott, 2008:140). Institutional changes are largely affected by institutional carriers, which represent fundamental mechanisms that allow transfer of ideas through time and space and who and what are transporting them.

Travelling across contexts, ideas, artefacts and standards get altered, modified, and combined with other ideas and objects. Sahlin-Andersson describes the process this way: "*the models are told and retold in various situations and told differently in each situation*" (Sahlin-Andersson, 1996:82). How this transformation takes place is dependent significantly by the type of carriers (Scott, 2008).

According to D'Adderio (2003), knowledge and practices embodied into software standards are codified representations of routinized patterns of work performed by actors. In such standardization processes, informal patterns are in danger of being omitted, creating failure points for cross-contextual implementation or localization of these standards (Jarulaitis and Monteiro, 2011). She demonstrates how the implementation of new ICTs failed to re-establish informal patterns of communication, and enabled the emergence of new patterns of communication. D'Adderio concludes that following the introduction of new software, evolution of routines demonstrates mechanisms of new knowledge creation and reproduction at the organisation level (D'Adderio, 2003).

2.4.3. Institutional Theory and Standardization Process

The problem of bridging the gap between micro and macro perspectives has received considerable attention in studies of management, policy, economics, and social organization (Callon et al., 1981; Fomin et al., 2000a). What is likewise important is the reciprocal interaction between levels, where macro structures in society are bridged by organizational fields to micro structures in organizations or even "down" to the individual actor level. Institutional creation and diffusion thus takes place, where top-down processes allow higher level structures to shape the structure and action of lower levels, while bottom-up processes shape, reproduce and change the context within which they operate (ibid., :190-195). Scott's argument is mirrored by Currie (2009) who encourages information systems researchers to work with multiple levels and stakeholders which is fundamental to institutional theory.

Currie argues: "*IT-related constructs, such as adoption intention, assimilation and implementation, without considering wider environmental and inter-organizational levels*" are problematic, because important tenets of institutional theory are based on multi-level and multi-stakeholder analyses (Currie, 2009: 66).

From an organizational viewpoint, standards align diverse interests of participating groups (Fomin et al., 2000b; Hanseth et al., 1996). In fact, interests of these social groups (government organizations, engineers, entrepreneurs, consumers, etc.) *must* be aligned if the development of the technological system is to proceed (Latour, 1999). Standards provide a means for system builders and entrepreneurs to share their perspectives, and to gain understanding of how the technological potential can be leveraged to meet diverse ends. By doing so, participating groups can better negotiate the desired technical and economic properties of the technology (Bekkers and Liotard, 1999). Hence, standards inscribe and embed large socio-technical networks of developers, users, and government institutions, and provide a powerful means to analyse the relational aspects of infrastructures.

Many theories give "the state", or political actors such as judges and politicians, an independent role in the rule-making process. Alston (1996:26-7) outlines the general framework: "*Institutional change can be thought of as the result of supply and demand forces in a society. We can think of demanders as constituents and suppliers as the government ... Institutional change results from the bargaining actions of demanders and suppliers.*" Here, we might imagine a continuum of possible theories, depending on the degree of autonomy attributed to political actors. On one extreme, such actors can be viewed as simply reflecting the interests of groups they belong to, so that their individual interests are relatively unimportant and the political process remains essentially a battleground in which interest groups compete to mould formal rules to their own advantage. I use the concept of *incentives* as a driving mechanism in understanding the global/local interplay of standardization and institutionalization of new norms and procedures in the HMIS. This serves as an important symbolic (and also material) representation of group and individual interests.

The concept of *incentive* is mainly used to denote purposeful action of individuals and as part of social groups, choice of which is guided by expectation of some sort of rewards (Armstrong, 2002). Incentives can be positive or negative depending on an individual's perception of changes resulting from particular actions taken from within a set of rules in a particular physical and social context (Ostrom, Schroeder, & Wynne, 1993; Campbell, 1995).

Social arrangements have influence on the actions of individual members, thus examining practices, rules and norms at social level are important. For example, in healthcare, "pay for performance" is a mechanism being increasingly used by healthcare providers for improving quality of care and at the same time providing incentive to medical practitioners (Garber, 2005).

The Institutional Analysis and Development (IAD) framework (Kiser and Ostrom, 1982; Oakerson, 1992; E. Ostrom, Gardner, and Walker, 1994) makes extensive use of the concept of incentives to examine rule structures and collective choices related to the management and use of common pool resources. Institutions, serving to streamline incentives in situations where problems of collective action emerge, are based on a convergence of expectations. Such expectations can be undermined when poor coordination among participants makes the efforts an unreliable organizational resource.

Integrating past research from the fields of public administration, institutional economics, and policy analysis, Ostrom and colleagues (1993) show how institutional arrangements and the incentives they generate can help or hinder development efforts. The authors present a method for systematically comparing alternative institutional arrangements for the development of rural infrastructures. Their analysis reveals the special strengths and weaknesses of polycentric as compared to the centralized or decentralized institutional arrangements. Descriptions of a variety of infrastructure projects - including roads, bridges, and water resources - in diverse geographical settings are used to illustrate "institutional incentives", contributing practically to the understanding of sustainable development, infrastructure maintenance, and institutional arrangements.

2.5. The Proposed Analytical Framework

This chapter has reviewed the theoretical concepts drawn from the II perspective and institutional theory as well as from relevant literature related to standards and standardization. My proposed theoretical framework elaborates upon the tripartite relationship between actors, standards and the problem addressed by the standards, reflecting its content or topic (from now on I use the term 'topic'). These relationships are guided by formal rules and informal constraints (North, 2001) embedded into these components and its context-sensitivity can give rise to multiple contradictory influences in the process of standardization. Key to this relation is the diversity and heterogeneity of the member entities, both humans and non-humans, the nature of the relationships and their distinctive attributes. A standardization

process as was mentioned earlier, involves various actors including health managers, IT specialists, medical doctors, and funding agencies with their different interests. This diversity supports alternative interpretations, for example standards as seen by developers are not the same to the health manager or the medical doctor.

Building large scale IIs requires complex set of social, technical and organizational decisions to be taken (Hanseth, 1996), including relating to standards and standardization. Such information systems became carriers of institutions, provided that decisions and new procedures are made at a high level and implementation is propagated to lower levels. Conflicting institutional logics create tensions at multiple levels, including at that of the individual actors. Actors with varying level of expertise have different understandings of the standardization process guided by their institutional and individual incentives. Actors' use of standards depends directly on their cognitive, social, cultural, and institutional structures. From the other side, standards are often built a priori with predefined assumptions of specific configurations of actors, tools, and actions, which vary significantly with different contexts (Millerand and Bowker, 2009). This necessitates the coordination of work among different social worlds, for example of health managers, standards development teams, and health statisticians, all of whom are concerned with the implementation of HMIS.

In order to explore this aspect of multiplicity of standards and actors, I use the concept of "facets of infrastructure". The idea here is to *divide the parts of ICT development and implementation environment into smaller correlated facets from technological, organizational, technological and other considerations.* This helps to reduce complexity and at the same time follow a holistic approach to the II development. Another use of "facets of infrastructure" is that small local problems (within individual facets) could be solved internally, not disturbing the larger system and institutions. Thus, a set of related actors, standards and topics could be grouped, managed and studied in a certain level of isolation from the rest of II processes, to help identify the consistency of actions and their outcomes.

Different viewpoints of actors create tensions for which they start negotiations to try and reach a consensus. In the standardization process, actors are often confronted with constraints and affordances coming from: 1) installed base, 2) global standards, and 3) the current local practices including of actors having similar constraints. Actors seek incentives, both material and moral, from the actions they perform in balancing between these constraints. If incentives received are positive and a group of actors deliberately accept the same line of decisions, it

could be effective in helping to acquire a high level of acceptance and legitimacy (Markus and Gelinas, 2006). Negative incentives, representing lack of effective consensus among actors, can lead to further negotiations, local workarounds (Rolland and Monteiro, 2002) or even the abandonment of the standards.

My proposed theoretical framework is depicted schematically in figure 2.2 below. The inner circles depict the tripartite relations among actors, standards and topics. Combining the family of standards, actors and topics together we can see the holistic picture of relations between institutions, II and the social reality of the context (outer circles). This perspective helps to formulate the following questions to focus the research questions that were presented in chapter 1:

1. What are the facets of infrastructure which shape the interplay between global standards and their local adaptation?

2. What is the nature of the tripartite relation between actors, standards and the topic addressed by the standards? And how does this shape the standardization process?

3. What are the specific and distinctive patterns in such relations that could help in developing strategies to deal with challenges and benefit from the opportunities offered?

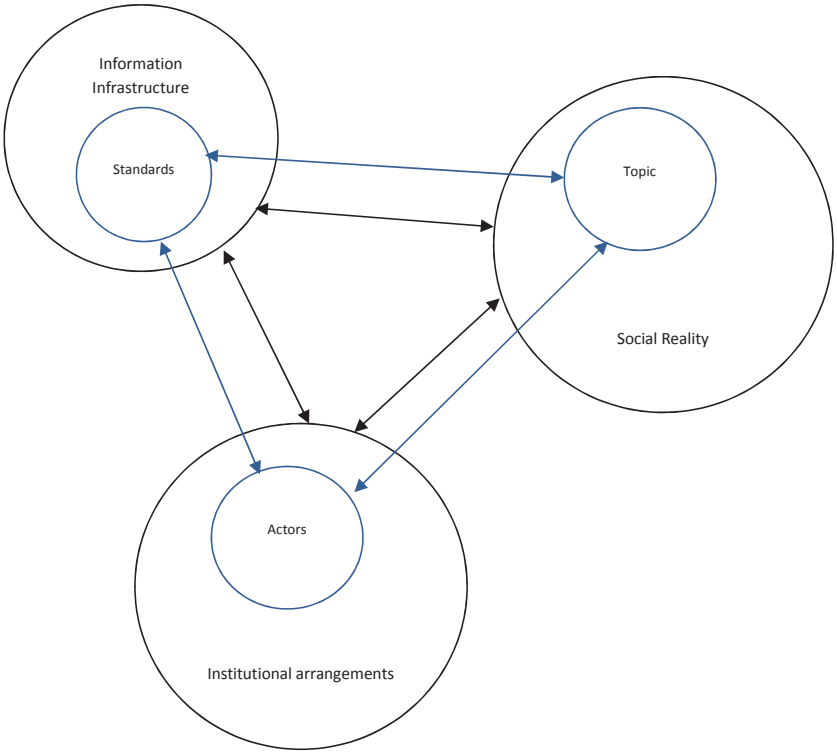

Figure 2.2 Relationships between Actors, Standards and Topics

This perspective permits a better understanding of the social and organizational dynamics of global/local interplay of standards during development and implementation of large-scale IIs. Implementing global solutions often follow institutional changes that are introduced at a central level which are then negotiated and appropriated by actors at lower levels. Organizational and institutional arrangements (characterized by routines, standards, norms, and politics) mediate the implementation and the use of the information systems, which in turn contributes to the restructuring of these arrangements. Analysis of the different aspects of these relationships of actors, standards and topics is further explained in chapter 6.

Chapter 3

3. Research context

This research was conducted primarily in the Republic of Tajikistan, and partly in (the Republic of) India. In Tajikistan, two decades of independence after the Soviet breakdown have changed the political and socio-economic landscape and trajectory of the country's development. India's socio-political transition from pro-Soviet to market economy (also starting 1991) was comparatively smoother. New political settings, emergence of private property and market economy rules and regulations have affected all areas of everyday life, including public health care. For that reason, it is important to provide a brief overview of the latest political and economic developments in the countries along with its geographical location and demographics, which helps to paint the landscape of the context and contribute to a better understanding of the object of my research. An overview of the public health care system of Tajikistan is presented followed by a discussion of the ongoing reform processes in health care policy and management with a particular focus on the HMIS. Then I briefly introduce India's healthcare system with a limited scope of the context of hospital management in the state of Himachal Pradesh, where I was involved in design, development and implementation of a Hospital Management Information System (HospMIS).

The chapter is divided into 6 sections. In the first section, the political and demographic context of Tajikistan is presented. In section 3.2, the overall health system of Tajikistan is discussed providing detailed information of the Ministry of Health (MoH) administrative divisions and their roles and responsibilities with the health system, including the HMIS. Section 3.3 discusses the Civil Registry Office (CRO) structure of Tajikistan, its role in the healthcare system, along with an overview of existing problems and challenges. This is followed by a brief overview of the Himachal Pradesh State case in India and its attempt to improve healthcare service delivery at facility levels in Section 3.5. Finally in section 3.6, I conclude with a discussion on key challenges and gaps in the HMIS of Tajikistan and HospMIS in Himachal Pradesh.

3.1. Political and demographic context of the Republic of Tajikistan

The Republic of Tajikistan is a landlocked country located in Central Asia bordering Afghanistan to the south, Uzbekistan to the west, Kyrgyzstan to the north, and China to the

east. Figure 3.1 shows an administrative map of Tajikistan and its location in Central Asia, its main roads and rivers. 93% of Tajikistan's land is high mountains, thus making transportation and other forms of communication difficult. As of 2011, the population of the country was 7.6 million (Census 2011, SSA) with an annual growth rate of 1.37% and around 80% of population living in rural areas (World Bank, 2011).

Figure 3.1. Administrative Map of Tajikistan

The Republic of Tajikistan was formed in 1929 as a constituent state of the Soviet Union and is currently amongst the least developed of the former Soviet Republics. Tajikistan announced its independence on 9th September of 1991 shortly after the collapse of the Soviet Union. Following independence, ideological and regional conflicts broke out into a civil war,

which lasted till 1997. During the civil war, reported as one of the most violent conflicts in the post-Soviet countries, approximately 50.000 people lost their lives and more than one million fled to other countries (EU, 2006). According to a report by the World Bank (2007), damages to public and private property were significant, amounting to US $7 billion. This devastating civil war continued the prolonged economic depression, and 83% of the population in 1997 were reported to be below the poverty line, which in 2009 was down to 47% (WB, 2007). Significant improvements in poverty reduction in a short period of time have taken place, with increased stability contributing to growth of public income.

In 1994, a new constitution was adopted defining Tajikistan as a presidential and secular state. Administratively, Tajikistan is divided into five main divisions: Khatlon (25 districts), Sogd (18 districts), Region of Republican Subordination (13 districts), Autonomous Badakhshani Kuhi (7 districts), and the capital city of Dushanbe (4 districts) (see Figure 3.1). The lowest level of administrative divisions are Jamoats (municipalities), subordinating to districts.

Tajikistan, as other former Soviet republic countries, faced a "spontaneous transition" from a planned to an open market economy with inherent inefficiencies, as the country lacked the organization, institutions and culture that characterized established Western democratic economies (Braguinsky and Yavlinski, 2000). Many existing economic and infrastructure links were abandoned, like the common Central Asian power grid linking all four countries of the region for load balancing of power supplies. The united power grid was broken by Uzbekistan and followed by other countries in the region. This contributed to an already adverse situation with respect to power supply in Tajikistan, and with it, escalated also political tensions with Uzbekistan. Uzbekistan tried to block Tajikistan's initiative to build a hydro-power plant to eliminate power shortages in the country and to also supply excess energy to other neighbouring countries like Afghanistan and Pakistan. Uzbekistan motivated the opposition with possible ecological effects the new dam may have in the region, which has till date been proved to be minimal (WB, 2012).

Table 3.1 shows some of the human development indicators for selected countries (highest ranked, bordering and lowest ranking countries selected for comparison) before the Tajikistan civil war – 1990 and also as of 2011 (most recent available data).

Table 3.1. Human Development Indicators (adapted from UNDP reports for 2011 and 1990)

HDI rank 2011/1990	Country	Human Development Index (HDI)		Life expectancy at birth		Mean years of schooling		Gross National Income (GNI) per capita	
		Value		(years)		(years)		(Constant 2005 PPP$)	
		2011	1990	2011	1990	2011	1990	2011	1990
VERY HIGH HUMAN DEVELOPMENT									
1/3	Norway	0.943	0.979	81.1	77.1	12.6	11.6	47,557	5,044
HIGH HUMAN DEVELOPMENT									
66/37	Russian Federation	0.755	0.862	68.8	69.3	9.8	9.0	14,561	4,941
68/54	Kazakhstan	0.745	0.802	67.0	68.8	10.4	5.0	10,585	4,716
MEDIUM HUMAN DEVELOPMENT									
101/101	China	0.687	0.566	73.5	70.1	7.5	4.8	7,476	1,990
102/66	Turkmenistan	0.686	0.746	65.0	66.4	9.9	5.0	7,306	4,230
115/80	Uzbekistan	0.641	0.695	68.3	69.5	10.0	5.0	2,967	3,115
126/83	Kyrgyzstan	0.615	0.689	67.7	68.6	9.3	5.0	2,036	3,114
127/86	Tajikistan	0.607	0.657	67.5	69.6	9.8	5.0	1,937	2,558
134	India	0.547		65.4		4.4	10.3	3.468	-10
LOW HUMAN DEVELOPMENT									
145	Pakistan	0.504	0.311	65.4	57.7	4.9	1.9	2,550	1,862
172	Afghanistan	0.398	0.066	48.7	42.5	3.3	0.8	1,416	714
187	Congo (Dem. Rep. of)	0.286	0.372	48.4	53.7	3.5	2.1	280	2,382

Table 3.1 clearly indicates that Tajikistan and Kyrgyzstan were more adversely affected with respect to their economic growth as compared to other neighbouring countries. Despite being more politically stable, the neighbouring Kyrgyzstan has an equal gross national income (GNI) as Tajikistan. The transition process, particularly the privatization of public enterprises, lack of knowledge of open market economy, and the immigration of qualified experts from Tajikistan and Kyrgyzstan to other more successful countries have contributed to this situation (Dana, 2000). During and after the civil war in Tajikistan, many left to the Russian Federation, Kazakhstan and other countries as labour migrants (Olimova and Bosc,

2003). According to the International Labour Organization (ILO, 2010) there are about 2 million Tajik migrants in Russian Federation and their annual remittance to Tajikistan in 2008 was US$ 2.6 billion, which was 49% of the gross domestic product (GDP), and thus significantly contributing to the national economy.

The economic downturn, civil war and high migration rates have also contributed to further deterioration of the public health conditions. This is heightened with a rampant rise in communicable and non-communicable diseases, and an overall worsening of access to health services, particularly for the poor (Khojamurodov and Rechel, 2010). While Tajikistan had an excessive number of medical professionals and an oversized network of health facilities in the early 1990s (McKee et al., 2000; Geddik et al., 2002), the situation changed dramatically in the years after independence. Damages brought to the health facilities, and the migration of doctors led to their non-functioning (Mirzoev et al., 2007). The government expenditure on public health care declined (Vargas and Clary, 2002; Mirzoev, 2004) and remains the lowest in the WHO European region (Khojamurodov and Rechel, 2010). This makes the country heavily dependent on external aid (Cashin, 2004). The largest portion of health expenditure is covered by formal and informal out of pocket payments that patients are forced to make for services that they receive in public health facilities. (Falkingham, 2004; Cashin, 2004). In 2006, 70% of healthcare expenditure was covered by private (formal and informal), 16% by government and the remaining 14% through donor funding (Republic of Tajikistan, 2006).

To summarize, Tajikistan's transition after independence was challenged by major political tensions, civil war and economic downturn during the first decade. The second decade of independence was remarkable with limited economic growth and a gradual shifting from relief to development. This helped to create a more favourable climate for reform of the public sector. New initiatives towards better health and education were initiated, which required changes in institutional and organisational arrangements, governance, financing and delivery of services.

3.2. The Health System of Tajikistan

It has always been a priority for the national government to provide high quality and affordable health services to the population. During the Soviet period, such decisions were centrally developed in Moscow and national ministries had marginal influence on the process, except to follow up on its implementation (McKee et al., 2002). After the fall of the Soviet Union, Tajikistan had to develop its own national strategy for health, making the MoH

as the key decision maker (McKee et al., 1998). This transformation in the midst of the turbulent civil war was a major challenge in terms of building capacity for policy-making (McKee et al., 1998, 2002; Mirzoev, 2004, 2007). There was a reorganisation of the Ministry's structural and administrative hierarchy, where new organizational rules replaced old ones, including inter-ministerial linkages. Core to this reorganization was the shift from centralized towards decentralized management with the aim to give more budgetary control to lower level organizations. The state budget of Tajikistan was compiled by the Ministry of Finance and approved by Majlisi Oli (Parliament), with the MoH playing a recommendatory role. The Ministry of Finance distributed budgetary funds for the health sector from central government to provincial governments and funds were further allocated to provincial and districts health departments (see Figure 3.2 below).

The Provincial health department (PHD) is responsible for health care service delivery at the province level and directly reports to MoH, but with limited budgetary control, except to provide medical supplies and equipment. The PHD has direct control over the district health departments, giving them advice on health matters, managing health policy and planning, but with limited budgets to support them. The district health departments are directly financed from the provincial Finance department of the Ministry via the district Finance department. The PHD has a limited number of staff, mainly dedicated to inspection of health policy implementation (Khodjamurodov and Rechel, 2010), with limited influence on HMIS.

Until recently, structural changes happened mostly at the national and provincial levels with little impact on the district and peripheral levels. District health was managed by the head of the central district hospital and his/her deputies, who were in charge of hospital services and outpatient facilities. Financing of the district health was managed by the central hospital, which had the accounting department working closely with the district finance department. This schema of financing was aimed at promoting hospital centric health services delivery, paying more attention to curative care, while neglecting primary healthcare. A significant proportion of the budget – 60% was allocated to hospitals in 1999 and 56% in 2003 (Cashin, 2004a). To strengthen preventive healthcare, the MoH reorganized health care provision with a new governance mechanism including the establishment of district health departments starting in 2011 (MoH Order #41). Since public funding of health care was insufficient compared to requirements, 76.2% of funding came from informal out of pocket payments (WB, 2007). The MoH divided primary and secondary health care at the district level into

separate divisions having their own budgets, giving higher priority to primary health care (see Figure 3.3). Also, the appointment of head of district and province health departments were shifted from local government administrations to the MoH with a decree of Parliament (Number 652 from 18th May 2009). This "Amendment to the law on public health care in Tajikistan" gave the MoH more power to manage its regional divisions.

The organizational chart of the health system of Tajikistan starts with the MoH, coming under the Prime Minister's office run by the President and Parliament. The MoH closely collaborates with the MoF and the Ministry of Education (MoE). The MoF is responsible for delivering public funding of health facilities at all levels through local governments (hukumats), while the MoE manages medical educational institutions and colleges and is responsible for personnel training. Figure 3.2 below shows the organizational chart of MoH Tajikistan in more detail.

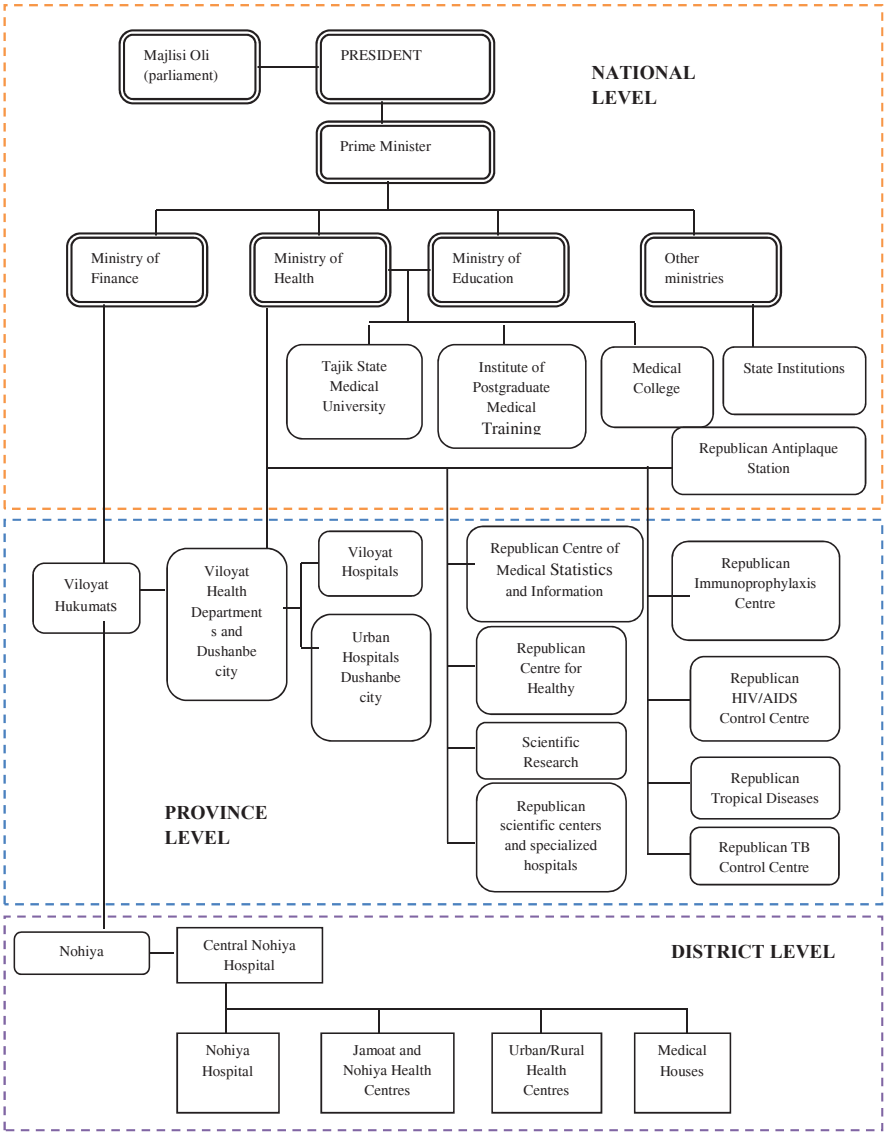

Figure 3.2 Organizational Chart of MoH Tajikistan (adapted from Khodjamurodov & Rechel, 2010)

The healthcare service delivery of Tajikistan strictly follows its administrative divisions consisting of three major levels: national, provincial and districts. Each of the levels has

various facilities directly linked to them. MoH has seven directorates, six departments and

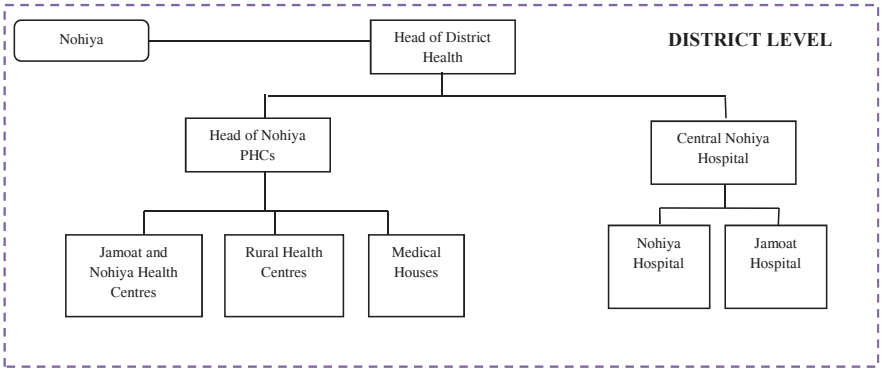

Figure 3.3 Organization chart of public district health care after reform

seventy four national centres of various purposes, including scientific, educational, treatment, pharmacy, statistics and publishing. The provincial level of the MoH runs the hospitals at that level and plays an inspection role for the district levels. The district level is the largest part of the health service sector, composed of the district central hospital, PHCs, municipal hospitals, and village health centres.

3.2.1. Data Collection and Reporting Systems

Data collection starts from the peripheral facilities at various levels of public healthcare; from village health centres to national hospitals. Data is collected on patient visits to PHCs, hospitals, outreach, and various campaigns. There are 259 forms for recording primary care data, including 25 forms being used in hospitals, 54 in PHCs, 34 in both PHCs and hospitals, 84 forms are used by epidemiology service and other 62 forms by various laboratory tests and formal and legal reporting. All these forms are designed to use ICD-10 as the standard for the classification of diseases, but those which are rarely used in practice.

These data are then compiled into reporting forms for upward reporting. In addition to this mandatory data collection and reporting forms, there are other donor supported vertical reporting systems organized by specific programmes like HIV/AIDS, Tuberculosis or national services like sanitary and epidemiology. While data are collected on a daily basis and compiled monthly into the log books; most of these data are reported annually. 37 reporting forms out of 41 are annual, 2 are quarterly and the other 2 are monthly forms. Varying reporting periodicity and programme specific reporting have historically created

fragmentation of data across the various healthcare programmes. Addressing them is a key focus of national reform efforts.

3.2.2. Healthcare Reforms

Tajikistan has made profound success in reforming its healthcare system to respond to urgent needs by adopting new policies. Although progress made in the past two decades of independence are significant, there are still many issues that need to be addressed at different levels of the health system (Khodjamurodov and Rechel, 2010), including strengthening of the HMIS.

Analysing healthcare reforms in the past two decades, Khodjamurodov and Rechel (2010) have identified three distinct stages in the historical timeline of health sector reforms in the country. These include:

The First stage (1993 - 1996) was dedicated to the formation of short and long term strategies for health care reforms.

The Second stage (1997 - 2001) was primarily concerned with the implementation of consecutive action plans with regards to above policies, a process which was sub-optimal due to resource constraints.

Stage three (2001 - onwards) is mainly regarded as the implementation period. MoH in collaboration with international partners like European Commission, World Bank, WHO, UNICEF, USAID, the German Government, the Asian Development Bank, the Aga Khan Foundation, the Swiss Agency for Development and Cooperation and the Swedish International Development Cooperation Agency, started to implement various projects. These projects were aimed for strengthening the different aspects of the healthcare sector, including primary health care, hospital care, institutional capacity, medical information systems, involvement of the public, immunization programmes and health financing mechanisms. In this stage, the issue of fragmentation, something inherent in the national healthcare system, and aggravated by the escalation of donor funding of specific programmes, was one of the key challenges in ushering in reform. State sanitary services under the MoH, TB hospitals and many other parallel health service facilities run by other ministries have been organized in a largely vertical fashion. The government realized the need for coordination of donor funded projects, to efficiently allocate resources and to assure sustainability of efforts

(Republic of Tajikistan, 2005a) and in 2008 they created a department for the coordination of reforms.

Table 3.2 below summarizes various events and significant actions taken place during three stages of healthcare reform in Tajikistan.

Table 3.2. Three Stages of Health Reform in Tajikistan

Reform stage	Year	Event
1993 - 1996	1994	An essential drug list was adopted
	1996	Policy for "Health care reform in the Republic of Tajikistan for 2001" was adopted
1997 - 2001	1997	Private medical practice was legalized
	1998	National drug policy was adopted
	1999	The Faculty of Family Medicine opened
2001 - onwards	2002	Two strategic documents for the reform of the Tajik health system were launched – the Poverty Reduction Strategy Paper and the Conception of Health Sector Reform
	2004	Some policy-making authority was delegated to the province administrations.
	2004	The National Drug Procurement Agency was established to ensure quality control of imported drugs
	2005	A state-guaranteed benefit package of services and official co-payments was introduced countrywide, but suspended after two months
	2007	The basic benefit package was reintroduced in four pilot districts, with the simultaneous introduction of per capita financing in eight pilot districts
	2010	National Health Strategy (NHS) of the republic of Tajikistan for 2010 - 2020 and implementation mechanism of NHS approved by Government Decree (Aug. 2, 2010, #368). NHS includes (i) an Action Plan to implement the strategy, (ii) a Framework for monitoring and evaluation (iii) a Capacity Development Action Plan and (iv) Dissemination Plan for implementation of the strategy
	2011	Strategic plan of health information system development for Tajikistan – "HIS Strategic Planning for Sustainable Results for 2012-2015"

A major event that gave rise to many efforts listed above was the amendment to the National Constitution that removed the clause stating "free guaranteed health care service" for citizens. The amendment was approved in June 2003 following a national referendum, recognizing the mutual responsibility for government and citizens towards health care delivery (WB, 2004b).

One initiative following the amendments in the National Constitution was the Guaranteed Benefit Package (GBP) or the so called "basic benefit package", introduced on August 1, 2005 throughout the country. This sought to ensure equal access to health care and eliminate

out of pocket informal payments. GBP was a form of insurance based on co-payment schema, with both the government and patients having to share the cost of service, with some categories exempted, while others (such as foreign citizens) having to pay for services partly or in full (Rechel and Khodjamurodov, 2010). Despite being successfully piloted in two districts (Varzob in DRD and Dangara in Khatlon), the GBP failed to perform as expected and was halted shortly after two months in October 2005.

In June 2007, the GBP was re-launched as a pilot project in four districts (Dangara, Rasht, Spitamen and Tursun-Zade), trying to incorporate lessons learned from the previously failed attempt. The 2008 survey showed that GBP had sufficiently decreased out of pocket payments in pilot districts, but did not solve the problem with respect to remuneration of medical personnel (Bobokhodjaeva et al., 2010). The MoH postponed the rollout of the GBP from 2011 to 2014 based on the progress and difficulties experienced in pilot sites.

Another significant reform initiative was to strengthen HMIS with an objective to develop tools for monitoring and evaluation of other reform initiatives and strengthening healthcare management in general. Monitoring was performed by measuring indicators, calculation of which in most cases was based on population data. The next section discusses the Civil Registry System (CRS) system, which records and reports on demographics.

3.3. Civil Registry Office – National Registrar of Demographics of Tajikistan

A health information system needs to draw upon a strong civil registration system that provides full coverage of birth and death registration, including accurate medical certification of birth, death and the causes of death. This then becomes the main source of information to generate key demographic and health indicators including crude birth rates, crude death rates, age and sex specific death rates, life expectancy, patterns of causes of death and disease prevalence or incidence for the catchment population. This requires the generation and use of reliable indicators to measure performance. The CRS provides necessary inputs to the State Statistics Agency to update the inter-census population by age and sex estimates which are used as denominators in many, if not most, of the core health indicators. It makes sense, therefore, for serious investments to be made by the health sector to ensure that the vital registration data provided by the CRO to the HIS is as complete, accurate and timely as possible.

In the past, several assessments have been done on vital registration data from the CRS in Tajikistan. The HMN Assessment rated the CRS as "highly adequate" (HMIS II, 2009, see Table 3.3). However, three in-depth studies carried out in 2011 present less favourable results. These studies include two qualitative studies funded by the World Bank: "Assessment of Child Birth and Death Registration in Tajikistan" (Chikovani et al., 2011) and "Improving Statistics for Children's Births and Deaths" (WB, 2011). Another study carried out by the SSA includes both a qualitative and quantitative assessment, "Results of a survey on infant, child and maternal mortality" (SSA, 2011). These studies provide detailed accounts of the prevailing shortcomings, including the deterioration of reporting coverage of births and deaths. This decline in the quality of the CRS started in the 1990s due to the loss of mechanisms that were in place during the Soviet times due to the onset of the civil war. Key points that can be inferred from the different evaluation studies include:

- Lack of data reconciliation between MoH and CRS. CRS fails to capture a large share of deaths during early neonatal and neonatal periods (SSA, 2011). MoH captures a larger share of these early deaths, but unless this information is shared with CRO, these are not registered. This problem is especially evident in the indicators calculated from this information: early childhood mortality is significantly underestimated, life expectancy is overestimated, and crude death rates are implausibly low.

- For these reasons, the country relies on information from national surveys which are more expensive, labour intensive, untimely, and usually dependent on donor timing and funding. An important part of the solution to this problem is to ensure that data, especially on early deaths, are reconciled between MoH and CRS at local levels.

- Obstacles for individuals to register births and deaths include payment requirements which are modest but could deter very poor families from registering. Further deterrents include the documentation formalities required, especially the lack of marriage certificates, lack of knowledge of how/where to register, and the requirement to report the event in the district of residence regardless of where the event occurred.

- Disincentives for reporting (e.g. punishment for reporting[2] early infant deaths or maternal deaths) discouraged honest reporting.

Overall, Tajikistan can be said to have a functioning CRS, and one which arguably worked well in terms of completeness of reporting of births and deaths during the Soviet period. The CRS system is paper based with minor use of computerized office applications. A major concern of CRS management is related to registry books, which are old and make it difficult to access information easily.

3.4. Information Systems in the Healthcare sector of Tajikistan

HIS in Tajikistan largely continues to be influenced with its Soviet legacy of a centrally managed economy apparatus with few changes introduced during the last decade of independence. An assessment provided in 2009 by applying Health Metrics Network (HMN) framework (Table 3.3) shows the most recent status of HIS resources of Tajikistan.

Table 3.3 Assessment of the HIS resources of the Republic of Tajikistan (HMN, 2009)

Summary of Result	Max	Score	%	Result
Policy and Planning	15	9,2	62%	Adequate
HIS institutions, human and financial resources	39	17,3	44%	Present but not adequate
HIS infrastructures	15	5,4	36%	Present but not adequate
Overall results	**69**	**32**	**46%**	Present but not adequate

There have been many global and local attempts to strengthen HMIS of Tajikistan. In 2001, the MoH RCSMI (Republican Centre for Statistics and Medical Information) developed an in-house application for data collection, called MedStat which was built on Microsoft FoxPro with dBase tables on the backend. MedStat is an offline application with import/export functionalities and limited aggregation functions. It lacks ad-hoc analysis and reporting functionalities. As of 2010, MedStat was implemented in almost 90% of the districts. Despite being nationally implemented and sustained, MedStat did not effectively respond to the present needs of health managers. It was designed to be a reporting tool, not an analytical

[2] It has been reported that in some hospitals infant mortality data are manipulated and adjusted to show better performance

tool. MedStat represents an electronic copy of the paper based system, which is also in use. Districts and provinces are submitting both the electronic and paper versions of reports.

Tojikinfo is a website, developed in three languages by the State Statistical Committee under the President of Tajikistan with the support of UNICEF, to disseminate information products available in Tajikistan. Tojikinfo is based on DevInfo software, is a powerful database system which monitors progress towards the Millennium Development Goals. It generates tables, graphs and maps for reports and presentations. DevInfo has been developed in cooperation with the UN system and has been adapted from UNICEF ChildInfo technology. The database maintains indicators by time periods and geographic areas to monitor commitments towards sustained human development.

The *Community based health project*, financed through a World Bank loan amongst other activities is developing an Electronic Patient Record (EPR) system, called Form 66, implemented from 2008 onwards. Form 66 is also based on Microsoft FoxPro and is a standalone application, which is a register for all records related to patient discharge from hospitals. Its development and implementation started in line with co-payment and GBP. According to the MoH officials, it has been completely installed and made functional in all districts of Khatlon and Sogd provinces. This system has a module for co-payment mechanism – insurance schema where patients also contribute to health care services.

The Health System Reform Project (HSRP) is directly linked to health system reform launched in 2005. HSRP developed a National HMIS Development Plan for 2006 – 2010. Despite these efforts, poor planning and coordination led to fragmentation of these projects with little integration between them. In the fall of 2007, through HSRP, a technical team from the University of Oslo introduced in five pilot districts the DHIS2, a free and open source computerized health care data warehouse and analytical tool. The DHIS2 has been developed on a global architecture and subsequently has been adapted in many different countries in Africa and Asia (Braa and Sahay, 2012). The DHIS2 has been developed by a global community of developers coordinated through a core team in Norway and supported by Norwegian government funds. This system has been consciously designed with a high degree of both standardization and flexibility in mind to enable both global development and local customization. Simultaneously, there have been attempts to develop local applications (such as MedStat2) that can at some level "speak" to the global DHIS2, in contrast to the existing hardcoded system - MedStat. While the MedStat can be described to be technologically

obsolete and institutionally inadequate to meet the current needs (say of monitoring national progress on the Millennium Development Goals (MDG) which is a stated national priority), the system cannot be scrapped as it is deeply embedded in the political and institutional structures of the national health system.

While on the one hand, there were forces favouring the continued life of the MedStat, the forces of reform positioned DHIS2 as the system to tackle the current inadequacies of MedStat and the overall HMIS in general. The forces of global legitimacy and funding may have contributed to DHIS2 being welcomed by the stakeholders and a pilot project was run during 2008 in eight remote districts in the country at the district level. Prior to this pilot run, an intensive process of customization of the global DHIS2 to the local needs of the country was carried out by a team of Oslo researchers. Understanding the dynamics experienced during the customization process and how they were addressed (or not) is an important focus of my research.

3.5. India and its Healthcare System

The Republic of India is situated in South-Asia with the seventh largest territory and is the second most populous country in the world with a population of more than 1.21 billion people (NFHS-3, 2011). 50% of its population are below the age of 25 and more than 65% are below the age of 35; and only 25% of population are urban habitants. India's economy is ranked as the tenth largest in the world.

Despite profound economic achievements and significant progress in improving various healthcare indicators such as life expectancy at birth, reducing mortality due to malaria, and reducing infant and material mortality (Kapil and Choudhury , 2005), the overall health status of the Indian population has remained unsatisfactory. One reason for this is the disparity between the top 18% (socio-economically high) and the bottom 36% (socio-economically low) households. There is a high concentration of public curative and hospital services in urban areas, whereas 75% of the population lives in rural areas. In rural areas, public healthcare is mostly limited to preventive and promotive care such as family planning and immunization. Private healthcare dominates in curative care and hospital services both in the cities and remote areas, but are not always being able to provide quality services. Further, a very large proportion of private providers are not qualified to provide modern health care because they are either trained in other systems of medicine (traditional Indian systems like

Ayurveda, Unani, Siddha, and Homoeopathy) or worse, do not have any training (Gangolli et al., 2005).

In 2005 the Government of India launched the National Rural Health Mission (NRHM) with the goal to provide effective healthcare to rural people with a focus on 18 states which have poor public health indicators and/or weak infrastructure (Kapil and Choudhury, 2005). NRHM have set 14 key priority areas for improvements, with the aim to establish fully functional, community owned, decentralized health delivery systems. The NRHM is expected to bring improvements in the health system by making architectural changes in the entire health system. NRHM has focused on developing a fully functional health system at all levels from the village to district by promoting decentralization and at the same time fostering accountability. HMIS and Hospital information systems improvements are thus set as priority areas for monitoring and evaluation of progress of reform objectives.

The district hospital in the Shimla city of Himachal Pradesh State of India, where the design, development and implementation of new HospMIS is taking place, is my primary research site. The population of Himachal Pradesh is about 7 million and it has relatively good health indicators compared to other states of India. With larger success in aggregated data reporting and use in decision making, the State NRHM, decided to improve the hospital management system. With decentralization and ongoing increase in hospital autonomy, there was a strong need for a well-functioning management system in public hospitals. I was part of the team (HISP India) engaged the design and development of such a system.

3.6. Challenges and gaps in the Health Information System of Tajikistan

I have provided a historical overview of the socio-economic, cultural and political aspects of independent Tajikistan, including its healthcare system. Also a brief overview of the Indian healthcare system and particularly hospital management issues in Himachal Pradesh State was presented. This provides the background for the empirical settings of this thesis, including how the HMIS initiatives are situated within the wider context of healthcare reforms in the countries. For example, in developing and implementing HospMIS in India, many changes were iteratively introduced into the new system along the line of discovering new relations and factors such as willingness of medical doctors to use ICTs in their daily work. Furthermore, a broad description of the healthcare delivery system and HMIS is useful to understand existing work practices, infrastructures and challenges of the HMIS implementation in the developing country context.

Many of the challenges to HMIS and HospMIS are related to the institutional changes introduced by the administrative, financing and healthcare delivery changes in Tajikistan. While many areas of healthcare have been reformed, HMIS to a large extent remains in its initial paper based form and does not fulfil current needs. A number of attempts to reform the HMIS have had little success due to influences arising from existing formal and informal institutional arrangements. For example, underreporting is an informal practice directly affecting the quality of underlying data, which possibly leads to inappropriate decisions. Aggregated data recorded in reporting forms, each containing from a few to dozens of tables with varying columns and lines, sometimes consisting of several pages. Most of the forms were designed based on a facility profile format, containing diverse data ranging from disease profiles to staffing, hospital beds and equipment. The mish-mash of data makes it difficult to be used for decision making. While several ICT applications have been developed, no attempt has been made to link them through standardized interfaces avoiding repetitive data capturing and other redundancies. Lack of coordinated and standardized data reconciliation among various HMIS stakeholders has also affected timeliness and quality of data.

As the healthcare system has become increasingly aid dependent, donor organizations have contributed to the fragmentation of data reporting by supporting specific programmes like TB and HIV/AIDS in the absence of a health systems framework. This fragmentation is very clearly evident in the HMIS. In an effort to standardize, donor organizations, within global frameworks, are continuously providing technical and financial support for strengthening HIS, building proposals for global guidelines, building technical capacity, developing infrastructure, and the injection of technical expertise. The technical assistance originating from these sources need to be aligned and developed within local frameworks, including local language, human resources capacity and infrastructure in order to make the evolving HIIs sustainable and scalable.

In summary, a lack of coherence between the information collected and information needed; limited use of the generated information; reliability issues of the collected information; weak standards in data definitions; poor capacity and infrastructures have all grossly contributed to suboptimal functioning of Tajikistan's HMIS. In India, HospMIS was an attempt to build a fully functional hospital management system based on open source medical record system, a complex task in a primary paper based environment. The potential use of this system in other hospitals in the state and potentially in other states raised the demand for using standards and

making the system generic. In Tajikistan, the aim too was to learn from global experiences and standards, which come with their own challenges and opportunities. This thesis thus attempts to develop a perspective to better understand the interplay of globally developed standards as how they are introduced into the local settings.

Chapter 4

4. Empirical research approach

After providing an introduction to the thesis in Chapter 1, in Chapter 2, I have provided a discussion on the theoretical underpinnings. Chapter 3 has provided details on the empirical setting by describing the contexts of Tajikistan and India, with a focus on the health sector and the supporting health information systems, and hospital information system in case of India. In this chapter 4, I further go into the empirical details by discussing the research design, data collection and analysis methods.

This chapter is organized as follows: Section 4.1 provides the philosophical basis for the research approach, from which the research design and empirical methods deployed in this research are elaborated upon in section 4.2. Section 4.3 briefly describes data sources and finally in section 4.4, the data collection and analysis methods are presented.

4.1. General approach to empirical work

The choice of research approach largely depends on philosophical assumptions around theory, the problem context and the research problem at hand (Oates, 2006). In information systems research, three broad research approaches have been identified: namely positivist, interpretive and critical (Orlikowski and Baroudi, 1991; Klein and Myers, 1999).

The positivist approach, having its roots in natural sciences, focuses on establishing formal hypothesis, quantifiable measures of variables, hypotheses testing and making statistical generalizations from a sample where the phenomenon is studied to increase predictive understanding (Orlikowski and Baroudi, 1991:5). A positivist approach assumes that the objective physical and social worlds exist independent of the researcher, and its nature can be apprehended, characterized and measured (Johari, 2009:25). Thus methodological assumptions of positivism rest on reductionism, repeatability and refutation (Oates, 2006). This provides the basis for the ontological assumptions of the researcher being detached from the objects of research to avoid "biases" (Orlikowski and Baroudi, 1991; Levin, 1994). Epistemologically, the assumption that objectively collected data represents the real world, and theory is applied in an attempt to increase the predictive value rather than developing a descriptive understanding of the phenomenon (Walsham, 1995b). Generally speaking, in a

positivist belief, knowledge is created by generalization of different samplings or experiments that produce unique results, which then could be applied to other settings and larger populations (Oates, 2006).

Contrary to the positivist worldview, an interpretivist approach assumes that reality is socially constructed. An interpretive researcher seeks to develop an understanding of the phenomenon within a particular contextual situation. The researcher is seen as part of and influencing the phenomenon of study, which is examined in its natural settings and from the perspective of the participants (Orlikowski and Baroudi, 1991:5). Interpretive approach rests on the philosophical assumptions that reality can only be understood through social constructions, such as language, consciousness, shared meanings, documents, tools, and other artefacts (Walsham, 1993; Klein and Myers, 1999; Myers and Avison, 2002), emphasizing multiple subjective realities, where the focus is on understanding how inter-subjective meanings are constructed (Oates, 2006). Subjective reality emphasizes that the same situation might be interpreted differently depending on who provides the account of it (Walsham, 1993), based on their backgrounds including culture, education and experiences. In other words, interpretive research does not predefine dependent and independent variables, but emphasizes the complexity of human sense-making as the situation emerges (Kaplan and Maxwell, 1994).

Interpretive research has been used and gaining increased popularity in contemporary information systems research, including studies of health information systems (Walsham, 1993). Walsham (2006) provides a detailed account of conducting interpretive research starting from the selection and justification of a research site and style of involvement, maintaining access to the site, working in multiple sites, data collection, choice of theory, data analysis, and formulating a research contribution. Klein and Myers (1999) likewise have proposed seven principles to guide interpretive information systems research. They start with the core principle of the hermeneutic circle which implies that understanding of a complex whole is made up of a preconception of its parts and their interrelations. Having the hermeneutic circle as a meta-principle, they list other important principles of contextualization, subject-researcher interactions, abstraction and generalization, dialogic reasoning, multiple interpretations and sensitivity to possible biases. These principles are not only useful for doing interpretive research, but also for evaluation of credibility of the results. Walsham (1995) has defined four mechanisms for knowledge generation (generalization)

from interpretive research, which are giving "specific implications"; "rich insights"; "concept development" and "theory generation", which can be applied to other settings.

Critical research builds on the epistemological assumption that social reality is shaped by people:

"Critical research seeks to be emancipatory in that it aims to help eliminate the causes of unwarranted alienation and domination and thereby enhance the opportunities for realizing human potential (Alvesson and Willmott 1992; Hirschheim and Klein 1994). To make this possible, critical theorists assume that people can consciously act to change their social and economic conditions. They do, however, recognize that human ability to improve their conditions is constrained by various forms of social, cultural, and political domination as well as natural laws and resource limitations" (Klein and Myers, 1999: 69).

While the critical approach is methodologically close to the interpretive approach, they differ in the way that the critical approach tends to focus on macro-social studies, emphasizing the role of power, opposition, conflicts and contradictions in societal life, and how objective aspects also influence researcher perceptions. Examples of critical research can be found in Foster (1992), Ngwenyama (1991), Ngwenyama and Lee (1997). Ngwenyama and Lee (1997) provided a detailed account of the critical approach compared to positivist and interpretivist approaches by elaborating on the concept of 'emancipation' as a distinguishing feature from the other two. They claim that the positivist approach and for the most cases interpretivist do not count for validity or rightness of what has been communicated, while in critical approach the listener does not accept the speaker's utterance at face value, but questions its validity claims and sees that it is incomplete, false, unclear, or inappropriate.

Each of the three research approaches presented here are used in the mainstream information systems research, with their relative strengths and weaknesses. Therefore the choice of a research method always bears both a gain and a loss (Schulze, 2003), and these need to be explicitly understood. My choice of research approach is based on the following assumptions. Firstly, the research questions I address in this study do not involve the search for a single generalized "truth", as advocated for from a positivist position. Secondly, as presented in the introduction, information systems implementation tends to be context sensitive (Avgerou and Walsham, 2000; Walsham, Symons & Waema, 1988), there are commonalities and difference between different contexts (AbouZahr and Boerma, 2005; Foltz, 1993), and implementations

are also dependent on cultural cognitive aspects of social life. With the assumption that reality is socially constructed, it is important to understand subjective reasons and meanings that lie behind such social action in order to understand a phenomenon within the context. The interpretive approach is well suited to this philosophical assumption, where knowledge and meanings are acts of interpretation and there is no objective knowledge and meaning without human reasoning (Gephart, 1999). Access to reality is only possible through social constructions such as language and shared meanings (Myers, 2009). In order to gain such knowledge and understanding, the researcher acts as a participating observer (Henning, Van Rensburg and Smit, 2004), and engages in activities to help discern the meaning from actions as they are expressed in context.

The interpretivist approach extends to the research context and helps develop subjective understanding of the phenomenon as a socio-technical process. This involves a complex correlation of technology and various actors with their assumptions, beliefs and practices. In my case, actors included global partners to national (central ministry) and local (in the district and peripheral facilities) entities, each with their respective interests and interpretations of reality around the health information system and the underlying standards – the objects of my study. My approach focused on understanding these complexities of human sense making and how they change or not over time (Kaplan and Maxwell, 1994).

4.2. Research design

After discussing the philosophical foundations of this work, which is based on an interpretivist approach, I now focus on describing the selected empirical research methods. The empirical approach combines case study and action research, each of which are discussed in more detail in respective subsections of this chapter. The choice of these methods is based on my perspective of information systems implementation in organizations not being static but evolving and dynamic in nature: making both the process as well as the outcome important: Following the line of Fujimura (1996), where she achieves a "creative balance" between several methods and styles with an argument that "The production of knowledge is a multidimensional process whose traces can be followed through multiple cultures, institutions, actors, objects, and practices" (Fujimura, 1996:17). The primary research site for this study is the Ministry of Health, Tajikistan, spanning its national, regional and district levels units. Although not in my original plan, I had the opportunity to participate briefly in an ongoing initiative of HISP in India. This opportunity came by virtue of me being part of

the global HISP network, and that I was supervised by a professor who was also responsible for HISP India. This opportunity was in the form of the design and development of a patient based district hospital system for a facility in the northern state of Himachal Pradesh. This effort helped me to gain some understanding related to the issue of standards in hospital information systems, and provided the empirical basis to write one paper relating to standards in hospital systems that is included in this thesis.

4.2.1.Case studies

The empirical work consists of two case studies, both related to the study of standardization processes of health information systems. The first, and the primary one (Case 1), was in Tajikistan and conducted during 2007-20011 in the Republican Centre for Statistics and Medical Information (RCSMI) of the MoH. The second case (Case 2) study (May-July and September – November 2010) was in a public hospital in Himachal Pradesh, a state in northern India. In both cases, global open source solutions (DHIS2 and OpenMRS respectively), were under processes of local adaptation. In Case 1, I was part of a global team of developers and local implementers, whereas in case 2 I was only part of local team of developers and implementers.

In both case studies, efforts were towards understanding the interplay between global standards and their adaptation in local contexts, with a focus on how the institutional context shapes and at the same time are influenced by this interplay around standardization processes. As discussed in chapter 2, my approach for the analysis was socio-technical, paying due attention to associated inter-connected institutional and technological challenges. In Case 1, I did an in-depth analysis of existing data collection procedures, paper based reporting forms, and electronic databases used to store and retrieve the data, and the challenges being experienced by the users. Case 2 which focused on a different domain of hospitals, helped to broaden my knowledge on the typology of standards, how and at what levels they are used, and the nature of local 'workarounds' that are required to make these standards practically work. While Case 1 helped me to develop an understanding of healthcare in general and gain an entry point for doing action research in Tajikistan, Case 2 helped me to understand processes of negotiations between global teams of OpenMRS designers, the local HISP India team of developers and implementers, the hospital staff, and the various artefacts and standards in contention. These included the software, standards like ICD-10, the chain of procedures and practices in the hospital from the stage of patient enrolment to discharge and

various administrative and clinical processes. This exposure helped me to gain a rich understanding around the complexity and working of a district hospital. Table 4.1 provides a summary of the two case studies, pointing to the scope, period and main topics of the research.

Table 4.1 Case Studies in thesis

Case Study	Period	Scope	Main topics
Case 1. The Data to Indicator (mis)match: Experiences from Trying to Strengthen This Link in the Health Information System in Tajikistan	2007-2008	National and sub national (districts)	Data quality, information use, data standards, data aggregation, indicators
Case 2. Practical Approaches To Designing Standards: The Case of a District Hospital Information System in Northern India	May-July and September – November 2010	Single organization (Hospital)	Standards and their typology, emergence of standards, adaptation of global standards

While both cases involve the global/local interplay of standardization, as table 4.1 shows, they have different scopes, in terms of geographic coverage. This brings various socio-technical aspects into play that are then analysed to find influence they have on the trajectory of global/local standardization processes. For example, in the Case 2 where a single hospital was the recipient, it was much easier to discuss the day to day interventions and action plans due to the geographically availability of actors at all levels, from the hospital manager to the data entry clerk. While doing the first case study (Case 1), I had to travel to various destinations of pilot districts to perform evaluations and obtain feedback. Another directly comparable example is how global and local collaborations are set up. In Case 1, I was part of both the local and global teams of developers and implementers. This relation had many advantages as I served a link between the two, providing me access to understand both perspectives. In the Case 2, it was comparatively challenging to communicate with the global team, where the local team had no strong link with global team and communications were limited to weekly Skype calls, mailing lists, versioning and bug tracking systems.

The analysis of both these case studies has resulted in me developing a deeper understanding of the challenges of standardization within information systems implementation in the

healthcare domain, in two contexts which also helped me to develop implications for developing countries more generally. Knowledge gained through these case studies also helped to carry out my action research interventions, such as related to the design of the database for the HMIS in Tajikistan.

As a researcher, I have been directly involved in the process of data collection and analysis (Creswell, 1998; Klein and Myers, 1999); and through close interaction with other actors, I have also become a "passionate participant" (Guba and Lincoln, 1994, p. 115). Such engagement provided me with the opportunity to gain deep insights into the problem under the study, and develop meaningful interventions that were instrumental to create change, and at the same time study how it came about and its effects (Avison et al., 1999; Avison, Baskerville & Myers, 2001; Miles and Huberman, 1994). This process is discussed next.

4.2.2. Action research

My action research approach can be described as elaborated by Braa and Vidgen (1997):

"In some forms of research, such as action research, the aim is to gain learning and knowledge through making deliberate interventions in order to achieve some desirable change in the organizational setting. Thus, a researcher working in the organizational laboratory is both constrained and enabled by the context while at the same time the researcher has the potential to initiate change (to a greater or lesser extent) in that organizational context" (Braa and Vidgen, 1997:2).

Action research tries to solve practical problems bringing research findings to the practical use and at the same time contribute to the generation of knowledge. Unlike other research methods, where the researcher seeks to primarily study and describe a phenomenon without bringing change, action research is concerned with enabling organizational change and simultaneously studying the process (Baskerville and Myers, 2004). In this way, the researcher brings his/her knowledge and theories into action along with situated practical knowledge of practitioners, while assuming reality as situated and socially constructed (Baskerville, 1999). The process involves continuously evaluating the intervention and associated interpretations allowing for a better understanding of the situation from different points of view (Miles and Huberman, 1994).

Baskerville and Myers (2004) have divided action research into two main stages: diagnosis and therapeutic. Cardno (2003:13) describes action research as "a spiral of steps, each of

which is composed of a circle of planning, action, and fact-finding about the result of the action", thus one cycle leads to the next. This is translated into the following four phases of the action research process: (1) issue identification, (2) investigation and analysis, (3) planning and action, and (4) evaluation and reflection. The inter-connected cycles of action is broadly reflected in my experience of piloting DHIS2 in remote districts of Tajikistan, which led to learning about what worked and what did not, feeding into the next phase of national DHIS2 implementation. Since action research involves multiple viewpoints and is emergent in nature, it is often beyond the control of the researcher (Baskerville, 1999), not always following an ideal path, and will often be non-sequential in nature (Bate, 2001). Thus, action research provides a framework of continuous improvement and change, while also enabling the generating and validating of social theory (Baskerville, 1999; Mumford, 2001), which are amenable for continuous improvement (Avison et al., 1999:95).

Figure 4.1 below depicts the two cycles of action research I carried out during the implementation of HMIS in Tajikistan representing a spiral model of Cardno (2003). While reforms in HMIS are ongoing, dividing the process into two action research cycles is based on key issues identified, analyses, actions taken and evaluation of the achievements and output of actions. The output of the first cycle has fed into and was basis for the next cycle of action research, which is also in line with the HMIS implementation project which had at its foundations the learning from the pilot project. The two phases of the action research include:

1. Pilot testing of the DHIS2 application with the aim to address issues of data anomalies and redundancies in the national HMIS. During the piloting of computerized HMIS many shortcomings of the existing system were discovered, a key one being that the existing system is "data driven", and not "action led". Piloting also revealed a range of institutional challenges contesting the creation of a sustainable and actionable HMIS.

2. The second phase of action research was mainly driven by the outputs from the first intervention, with clear implications for higher level structural changes spanning all levels of and some beyond healthcare, including technical capacity and organizational arrangements. A key reform agenda of the government was to strengthen the health system, with a key focus on expanding the analytical functionalities of the supporting HMIS and making it more relevant to the new institutional changes in process since Tajikistan's independence. The first and foremost important task was to standardize indicator definitions and streamline them with the national health strategy. Taking this as the point of departure, the revision of data

elements and corresponding recording and reporting forms were targeted. The focus was on building consensus among stakeholders, and towards the development of the implementation plan.

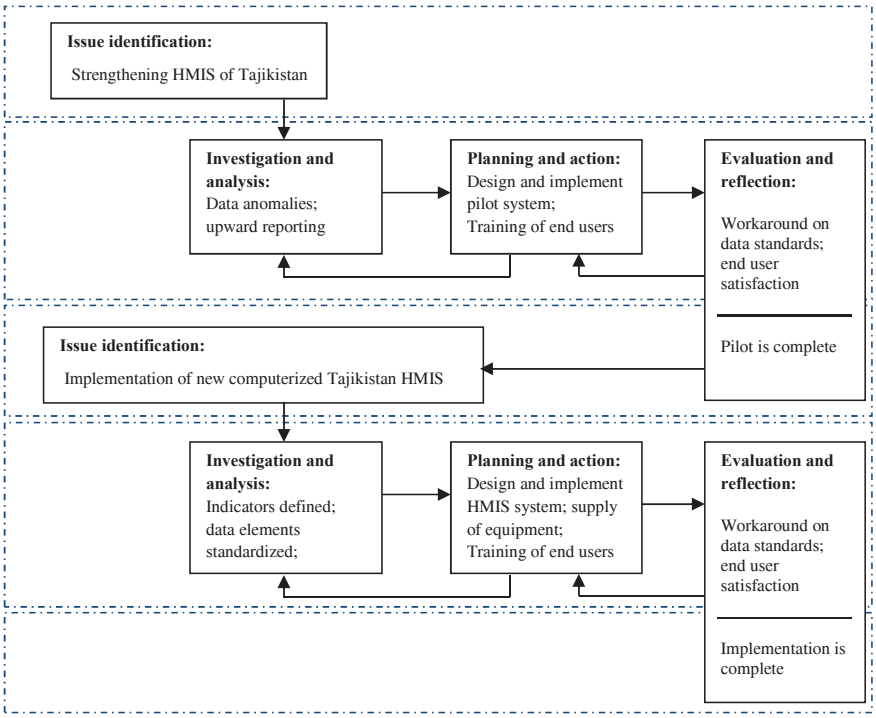

Figure 4.1 Two cycles of action research in Tajikistan HMIS

In 2012, most of the decisions were made with regards to the implementation, such as details of the roll-out plan was agreed with stakeholders; ordering the required networking and computing equipment, and preparing of training and capacity building materials. The stage is thus set for the nationwide roll-out to take place starting 2013. Slow progress and administrative barriers have delayed the timely completion of the second cycle of my action research due to my PhD term coming to an end. The implementation is complex, and such delays are inevitable, for example bringing the CRO into the HMIS arena, which comes under the Ministry of Justice, is a highly complex process on its own.

4.3. Data sources

Data collection involved both primary and secondary sources for both the Tajikistan and India contexts. Primary data sources included interviews with key stakeholders of the HMIS and hospital in Himachal Pradesh state of India; active participation in working group meetings in the hospital; participant observations in capacity building and training, and direct actions performed such as the design and development of the database and modules for HMIS and hospital systems. In the case of India, sometimes translation and interpretations were required, when meetings or discussions spontaneously shifted between English and Hindi languages. Other colleagues from HISP India generously helped me to overcome this language barrier. Secondary data sources involved mainly the study of government orders and publications; technical documentation and analysis of paper based and electronic health data. Valuable insights were gained from studying consultancy reports such as the "Tajikistan Health System Review" from *European Observatory on Health Systems and Policies*, which provided a detailed study of the current situation around HMIS of Tajikistan (HMN, 2009, Khojamurodov and Rechel, 2010). For example, these authors divided Tajikistan's HMIS into three distinct time periods: Soviet period (up to 1991), post-Soviet transition period (1992 - 2005), and finally the reform period (2006 - ongoing). Each of these periods involved significant socio-political and economic changes, including improvements in information infrastructure at national and ministerial levels. Secondary data was useful for me to triangulate information that I gathered in interviews, to understand background information on historical events and who the key players were in the HMIS and hospital information systems reform processes. Also secondary data was used in the preparation of questionnaires used in interviews, for example the knowledge of electricity shortages affecting HMIS performance in Tajikistan led to inclusion of questions regarding electricity supply.

4.4. Data collection and analysis

Data collection methods were primarily qualitative, and involved "*a variety of theories, methods, observers, and empirical materials to produce a more accurate, comprehensive and objective representation of the object of study*" (Silverman, 2006:201). Richardson and Saint-Pierre (2005) termed the use of multiple sources of data as *crystallization*, allowing the researcher to carry out multi-faceted analysis from a variety of perspectives. "*Crystallization provides us with a deepened, complex, thoroughly partial, understanding of the topic. Paradoxically, we know more and doubt what we know. Ingeniously, we know there is always*

more to know" (Richardson, 2000:934). For example, findings from the case study from India were useful in comparing with the Tajikistan case in many aspects, such as the institutional structure driving reforms. For example, in the India case, the medical doctors were interested in the computerized system, where some sort of assistance to them was directly available from the system, like electronic X-Ray imaging. They always pointed to high load of patient per day as a reason for not being able to use the system for data capturing. In case of Tajikistan, in the districts and areas where Pay for Performance (P4P) mechanism was being piloted, I observed high quality and accurate data collection as compared to other districts that did not practice P4P. This was due to personal gains, in terms of the salary increment that the medical doctors received from collecting and recording data at the same time contributing to provision of better healthcare services. Analysing both cases, I came to an understanding that institutional changes can enable or create barriers to information systems implementation and sustainability, no matter how good the underlying system is. These analyses are based on qualitative data, collected through observations which demonstrate how meanings residing in social practices are mediated mainly through language and action (Dey, 1993). The concept of incentives from institutional theory was used to theoretically study these empirical findings where some sort of driving mechanism enables or disables actor's actions.

Throughout the course of my empirical intervention, I was actively involved in various events, including participation in various meetings, formal and informal discussions, prototyping of a new system, site visits and observations, and in conducting capacity building programs both in India and Tajikistan. In so doing, I gained a broader in-context and practical understanding of the phenomenon as situated within the real context. As Sayer (1993) notes, knowledge does not develop in vacuum, but is always embedded within social practices, to fully understand the former one must know the latter. In the process of doing action research, I also collected various forms of qualitative data using different techniques. Through continuous evaluation of the interventions and the associated interpretations of myself and my research and MoH colleagues, I sharpened my understanding of the situation from different points of view (Miles and Huberman, 1994), which helped to orient me on how to improve the focus of my further interventions.

HMIS implementation is a complex socio-technical process, requiring the complex interaction of many components, including humans, technology and politics. Thus the assessment of a project implementation, be it HMIS at national level or the hospital

information system in a single hospital boundary is better understood by observing how participants contribute and make progress with respect to various socio-technical issues.

My broader focus was to understand the issues of standardization, and specifically different standard types and how they evolved over time. I wanted to understand these issues from the perspective of users and within the context as perceived and described by different individuals at various capacities. I tried to develop a clear understanding of how the processes of "localization" and "contextualization" of standards take place and how these contribute back to "generification" of the same at the global level. Following the interpretive approach, my position as a researcher was to build a "common understanding" with participants without filtering and applying judgement to users' interpretations being right or wrong, and constructing a picture of the context in the complexity of the daily routines of the people involved.

As is the case in most interpretive research, data analysis even started during the process of data collection helping to refine the next cycle of the data collection (Miles and Huberman, 1994) or intervention. I tried to understand historical events and processes, such as the Soviet legacy; both in material and institutionalized forms, physically existing and in the minds of actors, and how they shaped current HMIS data flows and standards. I analysed the differences between India and Tajikistan for major political changes in the recent past and associated major institutional changes. This required an understanding of different perspectives to these historical events. For instance, I tried to understand how formal rules and norms around the HMIS and corresponding standards were established and institutionalized. For example, the mandatory national indicators, their periodicities and data sources, and the purposes they were used for. India's political stability in the past decades has brought fruitful changes in almost all areas of life, making India one of the biggest economies of the world. On the other hand, Tajikistan has suffered from instability and civil war affecting rapid development, while both countries shifted from a centrally managed economy to more liberal and democratic structures starting 1991. This had actually many influences starting from individual to organizations and the national. For example, in India a large portion of hospital services are run by the private sector, while in Tajikistan this process is just taking place and related institutional changes are coming to the fore.

Being a person from outside of the health sector by profession, some of the issues were difficult for me to understand, and I sought help from the staff to develop deeper insights into

the issues. Special attention was given to the understanding of the institutional context, norms and practices embedded into information infrastructure at different time periods from users' perspective. This helped me in gaining knowledge of how these institutional arrangements shape current actions and meanings that users give to HMIS in general.

Interviews conducted in Tajikistan and India, were of two types: semi-structured and structured. Structured interviews helped me to assess the infrastructure in the district health and CRO offices, including the availability of electricity, Internet connectivity, computing hardware, personnel and computer literacy, and the impressions of the respondents on the adequacy of the same. Structured interviews were conducted also during the situation analysis phase, sometimes through telephone calls and often involving random visits to some districts. Telephone interviews were recorded with the aid of a pre-printed questionnaire, where possible answers were provided to the respondents and their responses marked on the sheet. There were also some open-ended questions. Informants were notified that their responses were being written down, and that no voice recording was done. The interviews conducted in Tajikistan and India are summarized in the table below, and the questionnaire used is inserted in Annexure 6.

Table 4.2 List of interviews conducted

Roles	**Level**	**Face to face interviews (semi-structured)**	**Telephone interviews (structured)**	**Duration (hours)**
Tajikistan				
District Health Management Unit (DHMU) and hospital and PHC Managers	District	12	0	1.5 – 2 (0.10 - 0.15 phone interviews)
Health statistics (Manager and Staff)	District	14	19	
	Province	2	0	
	National	3	0	
State statistics Agency	District	2	0	~1.5 (0.10 - 0.15 phone interviews)
	Province	2	0	
	National	1	0	
Civil Registry Officer	District	5	65	

(Head of district CRO or senior specialist)	Province	2	3	
	National	1	1	
ISPs (customer relations department)	National	6	0	
India				
Hospital staff and senior hospital managers, software developers	Himachal Pradesh, Shimla, India	7	0	~2

Semi-structured interviews were also performed during formal and informal meetings with staff from various levels in the CRO, SSA and MoH offices (see Table 4.2 above). A series of formal interviews were conducted during pilot phase involving visits to the following provinces:

- Sogd (10 districts were visited)
- Khatlon provinces (5 districts) during the middle of 2010 and the other 2 during fall 2011. In 3 of the districts visited DHIS2 was piloted

In each district visited, I tried to meet with the CRO, SSA and health managers and health statisticians jointly. Sometimes due to time and logistical constraints, this was not possible. These interviews helped me to understand how these independent units collaborated on health related information, for example, how data flows were taking place (or not) from one organization to another.

In India, I interviewed hospital staff and senior managers, other software developers from HISP India (see Table 4.2 above) related to the development of modules for the hospital information system, where I thought their input would be most valued. My approach to semi-structured interviews was to initiate discussions around processes of data generation, collection, and aggregation and to see how local managers and statisticians actually carry out their work, and deal with challenges. Participants were encouraged to raise their own issues and questions related to the subject of our discussion, some of which I had not even thought of. I recorded the responses in my diary, which often represented a “wish list” of the respondents, with respect to the information systems strengthening they required.

The core principle in my data analysis was inductive reasoning that is to construct or evaluate general topics (themes), which were derived from specific facts gathered during data

collection. While the collected data represented the interpretations of participants, during the analysis I filtered data through my understanding of socio-technical dimensions of the underlying context. Through action research, I participated in the design, development and implementation of the new HMIS in Tajikistan and the hospital information systems in India with a primary focus on the topic of standards. This helped me to gain more knowledge of the existing systems and their relations to the institutional context, as it involved closely working with the HMIS and hospital staff at various levels. In the course of prototyping of the DHIS2 system for the HMIS in Tajikistan, I had the opportunity to also discuss with the staff many aspects of the healthcare system in general that led to finding useful information closely linked to their experiences.

Data analysis was performed by interpreting the data and summarizing them as compact and accurate representations, resulting in the identification of key themes. This guided my design strategy and generated new perspectives and questions for the consequent data collection. For example, finding that data elements in the existing HMIS were excessive and many had zero or null values led to the examination of indicator to data element linkages. This guided me to use "indicator to data element linkages" as a perspective to revise dataset standards. The themes then were subject to further discussions, involving many other activities including the reading of related literature, direct interventions, formal and informal discussions with my research supervisors, faculty and colleagues, presentations in international conferences and writing of research papers. Feedback received from the larger research community helped me to revisit and refine my approach in data analysis and expand the scope of my interventions. Analysis of empirical data contributed to the development of research papers dealing with the standardization process in HMIS implementation.

Summarising this chapter, the research design approach adopted in this thesis helped in developing an in depth understanding of the IS implementation process employing various data collection methods forming "thick descriptions". This provided me an access to subtleties of changing and multiple interpretations (Walsham, 1995) to study the phenomenon at its real context. Exploring the nature of dynamics of global/local interplay of standards and standardisation in information systems implementation through my active participation and interpretations of various perspectives of actors involved, a number of significant factors were identified, analysed and discussed.

In the next two chapters, chapter 5 and 6, I provide more detailed accounts of the research output.

Chapter 5

5. A summary of empirical Findings

This chapter summarizes the empirical findings from the five research publications included in this thesis. The papers are presented in a chronological order, indicating also the nature of my research progress. The first two papers (one case study from Tajikistan and other from the Himachal Pradesh) reflect the interpretive case study approach that I adopted which served as the entry point for conducting the action research, related to the subject of standards and standardization process of the HMIS implementation in Tajikistan.

In section 5.1, the summary of each paper is presented describing the specific research questions addressed, which broadly relate to different facets of the process of standardization, and the nature of their global/local interplays. In section 5.2, a synthesis of the findings from the individual papers is provided. This synthesis helps to deliver a more holistic understanding of the challenges and approaches related to the role of standards and the dynamics around standardization of HMIS. These are related to the overall research questions addressed in the thesis, and also provide the foundation for discussing the contributions and implications (chapter 6) arising from this research.

5.1. Summary of individual papers

Paper I: *The Data to Indicator (mis)match: Experiences from trying to strengthen this link in the Health Information System in Tajikistan*

Reference

Sahay, Sundeep; Latifov, Murodillo Abdusamadovich. (2009). "The Data to Indicator (mis)match: Experiences from trying to strengthen this link in the Health Information System in Tajikistan". In: Elaine Byrne, Yasar Jarrar, Brian Nicholson (editors): Proceedings of the 10th International Conference on Social Implications of Computers in Developing Countries *(IFIP 9.4.)"*Assessing the contribution of ICT to Development Goals". Dubai School of Government, Dubai, United Arab Emirates 26-28 May 2009.

Summary

This paper addressed issues of data quality in the existing HMIS of Tajikistan, and the challenges related to balancing between national (or local) standards (such as related to data elements and indicators) and global standards like MDGs. A key argument made in this paper is that Tajikistan and other nations, who are signatories to the MDGs need to improve data quality if they are going to meet the promised goals. The starting point for the argument is that regardless of the fact that the Tajikistan HMIS is collecting huge volumes of data, with a rich potential to support the process for monitoring and evaluation at various levels, including of the three MDGs directly related to healthcare, analysis and action is not taking place. The potential for conducting analysis and based on it, taking actions towards health sector improvements remains unrealized. The paper particularly examines how issues of data quality shape this phenomenon of data non-use.

The analysis is based upon empirical material drawn from the existing HMIS of Tajikistan and is used to develop two sets of contributions. First, it empirically identifies discrepancies, anomalies and (mis)matches in data standards of Tajikistan's HMIS. Second, it suggests a practical approach on how to improve this (mis)match through the rationalization of data elements and strengthening their linkages with indicators.

The study was based on number of interviews, secondary document reviews and analysis of database containing historical routine data. Analysis of this data helped in the identification of various themes with respect to the HMIS, especially related to issues of standardization. A key theme concerned how the existing HMIS was primarily data driven and not action led, implying its primary focus to be on reporting for meeting the needs of the bureaucracy rather than on the analysis and use of information for action. The focus on the collection of aggregate statistics, which at the end of the year was used for the annual compilation of a comprehensive health statistics book, was largely not useful to support timely action taking. Upward reporting lent itself to almost no feedback aimed at informing action and also increasing the motivation of staff that only saw their task to collect and transmit upwards huge amounts of data. Extreme fragmentation of information, with multiple parallel and uncoordinated flows inherent with redundancies and duplications was another common theme that was identified through the analysis.

We developed a three-dimensional analytical framework, which was then applied to analyse the legacy data in the database to discover overlaps, duplications and ambiguities that adversely influence data quality. This included the dimensions of:

"completeness" : if all the data needed for indicator calculation are available and of good quality,

"fittingness" : refers to the presence of such complete data required for indicator generation in the HMIS.

"actionability": points back to the indicators, with a focus on their usability. To provide indicators with the property of sufficiency in relation to be being able to take action, the indicators should be easy to understand, well presented, and the decision makers should have the capacity and the will to understand and use the indicators.

This three dimensional framework was based on the normative aim that the HMIS should be clearly focused on strengthening the definition and use of health indicators to operationalize decision making targeted at health service improvements. The collection of data which was not linked to the generation of indicators was arguably not a productive exercise.

The analysis of the legacy database showed that the existing data elements being generated by the HMIS are largely not useful, relevant and actionable with respect to the operationalization and use of indicators. To achieve prescribed MDGs, Tajikistan and other nations, require for their national HMIS to support a more effective monitoring of the progress on specified parameters. This requires the strengthening of the data-indicators match on the three key dimensions identified in the proposed analytical framework.

On applying the tripartite analytical framework, we could identify various missing links in the process of data collection, reporting and use in the HMIS of Tajikistan. For local actors (district level), the entire process was seen as largely symbolic, because they do not receive any direct benefits from their actions; they find limited use of data for local decision making. The primary purpose is thus towards fulfilling imposed requirements and responsibilities for upward reporting. At the national level, the data are used for planning, budget forecasting and measuring performance, although on an annual rather than action needed basis. We found that actors are neither interested in standards, or of standards fulfilling the other side of the tripartite relation. Tensions coming from competing logics of centralized (embedded into existing standards) and decentralized (current trends) management, where local actors are given larger autonomy will trigger changes and reformation of relations and remain unless actor-topic-standard relations are built on the basis of mutual benefit.

Paper II: *Practical Approaches to Designing Standards: the Case of a District Hospital Information System in Northern India.*

Reference

Latifov, Murodillo Abdusamadovich; Mukherjee, Arunima; Chakravarthy, Vasudha; Sahay, Sundeep. (2011). **"**Practical Approaches to Designing Standards: the Case of a District Hospital Information System in Northern India". In: Maung K. Sein, Subarna Shakya, Bjorn Furuholt, G. Harindranath, Devinder Thapa (editors): Proceedings of the 11th International Conference on Social Implications of Computers in Developing Countries *(IFIP 9.4.)*. "Partners for Development: ICT Actors and Actions". Kathmandu, Nepal, 22-25 May 2011.

Summary

This paper analyzed the issues related to the designing of standards within the setting of a district hospital system in the context of Himachal Pradesh, a Northern State in India. The paper described the development of a practical approach to the design and implementation of standards during the course of the evolution of a hospital management information system first in one hospital, and later to be scaled to a total of 20 such district hospitals in the state. It was argued that standards developed and implemented in a top-down manner, seeking universality are doomed to fail, as there are always local particularities that the global standards need to be adjusted to. Standardization is conceptualized as a socio-technical process, influenced by different elements including the interaction of system developers and health workers, the distances between service locations, and the decision making styles of managers.

The conceptualization of standards as socio-technical provided a firm foundation to approach the complex issue of standardizing systems within the context of a district hospital setting. The research approach adopted did not attempt to impose standards from the top, but evolve them through a practice based and participative approach. This approach, arguably, provides a higher potential of acceptance of the standard and enhancing its usefulness. For example, the ICD-10, a global standard maintained by WHO was used as the basis for the generation of subset of ICD-10 codes used in the hospital. The future challenge would be to take these standards into the other hospitals, where undoubtedly local practices and traditions will challenge these standards, which may be then seen as being "imposed from the top". The empirical analysis helped to argue how global standard (such as ICD-10) gets introduced into

the local context, and how this 'local' standard becomes 'global' for other similar contexts, reflecting a process of scaling.

A three level framework of health information standards comprising of information needs, software and interoperability, formulated and evolved through the HISP research network, based on Carlile's (2004) framework for managing knowledge across boundaries, was drawn upon to approach this issue of standards. While this framework, originally used in the context of the primary health care domain, was indeed useful to understand standards; the empirical analysis helped contribute to its extension by additionally focusing on issues relating to the process of development, implementation and scaling of standards within a district hospital system.

This case differs from others presented in this thesis in a number of ways. First, the scope of the research and data collection is limited to a single hospital, whereas in other cases, standards are from the national down to the facility level. Secondly, there is no previously deployed computerized hospital information system, which makes the case special in the study of standardization process. This allows us to compare the dynamics of negotiation processes in standard building, where the installed base is computerized or is in a paper format. Third, there are cultural and historical differences in national contexts of the cases from Tajikistan and Himachal Pradesh, which help develop insights into how standardization processes are shaped by the social and historical contexts.

Paper III: *Data Warehouse Approach to Strengthen Actionability of HIS: Experiences from Tajikistan*

Reference

Latifov, Murodillo Abdusamadovich and Sundeep Sahay (2012). Data Warehouse Approach to Strengthen Actionability of HIS: Experiences from Tajikistan. *The Electronic Journal of Information Systems in Developing Countries. Vol. 53, 2012. Available from http://www.ejisdc.org/ojs2/index.php/ejisdc/article/view/932*

Summary

This paper builds and adds to the findings of the first paper described in this chapter, including the three dimensional analytical framework, and expands the socio-technical approach to the design and development of a data warehouse for the national HIS in

Tajikistan. In particular, this paper addressed the following research questions: What are socio-technical approaches relevant to the design and development of a data warehouse to support the national HIS in Tajikistan?; and how can the data warehouse based HIS help to develop an action-led HIS for Tajikistan?

Findings revealed that the existing data being collected are products of realities of their times (Soviet era) and they hold institutional arrangements embedded in various formats, whether they are paper based HMIS or their later computerized version. Paper based systems represent the installed base, and can be seen as the point of departure by health workers, when it comes to the discussion on data formats, the transformation of data to indicators and their actionability. Thus the approach taken for the development of the data warehouse was to keep the look and feel of the existing system (pre-existing logic) and wrap it inside the standardized data formats (new computer based logic), creating a transitive and transparent (to end user) shift from one to another competing institutional logic. Furthermore, this shift had to be aligned with the national health strategy, and carried out in the framework of a data warehousing methodology. With the new data analysis logic seeded through the use of business intelligence tools, gradually support could be made available for supporting the transition to a culture of evidence based decision making (shifting from one based on upward reporting).

Actors at different levels of the public healthcare system have varying needs for data collection and use. Their relation to data comes from the nature of their functional duties, for example the medical doctor needs most detailed data about the patient, including information about tests, diagnosis, past medical history; the hospital manager is interested to know more on prevalence of diseases, bed occupancy, etc. These relations, which are social by nature, have to be represented in the computerized system, in a way that every actor maintains at least similar levels of information needs. Recurring patterns of these relations are then embedded into global standards. Local legacy data also inscribes patterns of data non-use; many of the data elements have zero or null values during entire period. While hospital managers' interest in monitoring disease prevalence is common; which diseases are important to monitor are specific to the particular health manager in his or her local setting. In terms of standards, 'disease prevalence' is generic and its instance is the localized representation of this prevalence.

There is high resistance from national and sub-national actors to reduce the number of data elements. Implementing the system in a data warehouse framework, allows the analysis of data values with zeros, for which elements and periods. So, the relation of standards, actors and the context of their use are always balanced in the process of actions and takes place over time. This demonstrates that HMIS standards and standardization processes are socio-technical, where one is relative to other and also to other actors and their respective social settings.

Paper IV: *Challenges in Moving to "Health Information for Action": an Infrastructural Perspective from a Case Study in Tajikistan*

Reference

Murodillo Abdusamadovich Latifov and Sundeep Sahay (2013). Challenges in Moving to "Health Information for Action": an Infrastructural Perspective from a Case Study in Tajikistan, *Information Technology for Development*, in print

Summary

Drawing on a longitudinal action research of the design, development and implementation of HIS in Tajikistan, this paper argue that the reason for weak progress towards "actionable data" is due to the rather narrow focus on technology, ignoring the broader issues that influence its uptake and use. Health information systems in developing countries are mainly characterized as being "data led", with vast amounts of data being routinely collected, but with limited evidence of it being used "for action". We explored this through an "infrastructure" lens to enable a more holistic perspective to understand how complex socio-technical networks with multiplicity of interests, actors, technologies are in play and which need alignment. A key contribution of this paper is to identify facets of a health information infrastructure (HII), including both the constraints and opportunities in making a transition from a "data led" to an "action led" system.

Initially, the proposed strategy of "flexible standards" (see paper 1) was rejected by MoH officials, preferring a more "top down" approach of HMIS implementation. The strategy adopted then was to implement existing data sets "as is" to make visible to the decision makers the inefficiencies and contradictions in the existing data sets. Bringing resources and

expertise into action from the global HISP community and development partners, contributed to significant progress being made in the revision of indicators and data elements.

A key finding from this research was that existing HMIS was deeply rooted in the organizational and individuals' daily routines, creating an installed base that influences the trajectory of HIS reforms. Based on empirical data, we codified various aspects of the HMIS into internal and external facets of the HII. Analysis revealed that internal facets of HII could be managed by HIS stakeholders, while external facets were largely beyond their control, creating dependencies on other entities and events, requiring also the adjustment of the HII. Other findings of this research showed that organizational changes that motivated individual health workers and provided them with positive incentives also influenced the actionability of data. Internal facets of the HII can support this positive actionability, and we further need to be able to identify shifts in the external infrastructure, and how these may enable or constrain internal development.

Paper V: *Global standards and Local Applications: Case of Implementing ICD-10 Standard in HMIS of Tajikistan*

Reference

Latifov, Murodillo Abdusamadovich (2013). Global standards and Local Applications: Case of Implementing ICD-10 Standard in HMIS of Tajikistan. Journal of Health Informatics in Developing Countries. Volume 7, issue 1.

Summary

The intent of this paper was to contribute to the on-going discussion on the interplay of global and local standardization processes. The specific object of study was the global ICD-10 standard, and the attempts to make it as an integral part of the Tajikistan's national HMIS.

A key theme identified from the study of empirical data was that reporting forms for the most part were consolidated reports of facility or districts rather than being data for further aggregation and report generation. Many forms had a mix of administrative, financial, human resources and health related data. This format of consolidated data reporting is useful in paper based systems, which reduces repetitive manual calculation of totals and counts; in computerized system this may create unnecessary redundancies or even miscalculations. The findings generally indicated the lack of standardized data sets and their definitions. Overall,

data-overload adversely affected quality and timeliness of data, which are the key criteria for a successful HMIS.

From the very beginning of the national HMIS reform in Tajikistan in 2007, the dilemma of standardization was confronted between two systems: the existing HMIS and the newly proposed data warehouse based on the open source application (DHIS2). The conflict between the systems was set off by the competing institutional logics embedded in these systems, requiring institutional shifts both at the local and national levels. Some of the national health managers insisted on the redesign of the existing system. Numerous meetings and discussions led to the formulation of three distinct approaches towards the redesign of the HMIS. How the gap between the "old" and "new" systems should be addressed was high on the agenda of the working group. The first approach was to adjust the data elements being collected to the national health indicators that needed to be generated from this data. This approach fulfilled the national needs, but variations or additions required by the district health administration were not accounted for. The second approach was to analyse the districts' needs for analytical data in some selected districts and to apply that to the national data sets. The third approach was to record data at the patient level that is to register every occurrence of confirmed clinical cases, into the database and generate aggregate reports from this data. While the latter approach did not reduce the number of data elements, it provided other advantages like reduced data entry forms, and avoiding unnecessary zero and blank records in the database. ICD-10 was proposed to be used in capturing individual patient recordings as the globally accepted coding standard for classification of diseases. The ICD-10 approach also does not tie up reporting to predefined forms with pre-set data elements, but serves as a kind of free form for data collection marked with ICD-10 codes, age, location, and number of visits. The aggregated values then could be easily computed for reporting from the individual records, based on the defined set of criteria, linking data elements to the corresponding record values. Moreover death records could be easily exchanged with the Civil Registry Offices.

With a networked and central database server, the HMIS application becomes the medium for conducting various negotiations between stakeholders and their regional and sub-regional offices. When new standards were implemented, they become immediately available to all. Each system user and group of users will be interested in gaining more profit from use of the system. This driving mechanism is termed as "incentive seeking". If user(s) receive positive incentives using the system and newly implemented standards, these standards become

accepted and institutionalized. In the reverse case, such implementations run the danger of becoming obsolete or just remain symbolic.

The third approach – use of ICD-10 for recording data plays an intermediary role between the other two approaches which are respectively implemented "top down" and "bottom up". The district records every occurrence of a disease in its catchment area, avoiding lengthy forms and reducing the burden of data collection. In doing so, it also balances between global and local data needs through locally situated actions in space and time.

This paper reinforces earlier research findings that implementing global standards into a local context is a complex and challenging task, involving various actors, each coming with their interests and cultural and organizational constraints. Together this socio-technical ensemble – the information infrastructure becomes a carrier of institutional changes applied by global standards and localized into specific contexts through negotiations and incentive seeking of actors.

5.2. Synthesis of empirical findings

The different papers presented above tackle various aspects of standards and standardization processes from both global and local perspectives. They cover issues involved in the HMIS implementation of Tajikistan from the early pilot phase to the planning and implementation of systems. The second paper comes from the context of a single hospital and India. The studies and the findings of the papers add up to provide a picture of issues and approaches towards HMIS standardization coming from local imperatives and global experiences. The last two papers, which are based on the longitudinal analysis of HMIS standardization, clearly demonstrate tensions coming from processes of global standards and how they are being absorbed, adapted and customized to local realities. These two papers demonstrate how the HMIS implementation has incrementally reached a higher level of maturity, where standards and standardization are seen as key to this successful process of change. In the earlier papers presented, we see the emergence and necessity for the revision of national standards, discovering socio-technical problem areas through piloting computerized systems and data warehousing techniques as possible ways to address the challenges.

The evolution of HMIS standards, as seen in the papers represents a complex socio-technical process, where institutions, organizations, individuals and technologies develop and evolve in a mutually agreed and negotiated environment. Global standards, coming from external

sources are not always in-line with local settings, thus triggering change processes. Local adaptations of global standards are always based around negotiations among global/local actors in situated contexts. Best practice of local experiences or findings which are reoccurring in the context and other contexts are drawn as recurring patterns and added to the global repository.

The different empirical findings summarized in the papers above help to illuminate different aspects of standardization in the process of HMIS implementation in Tajikistan, which also can be useful to draw implications for other developing country contexts from. Although the different papers have tackled various perspectives in discussing the implementation of standards ranging from macro and micro levels, they all contribute to highlight the interconnected challenges related to the HMIS standards and their standardization process. Four themes were identified summarizing the findings from these five papers:

1) Overloaded data and lack of standardized definitions and guidelines for collection, storage, transmission and interpretation of data - due to various socio-technical-political circumstances, result in inefficiencies of the HMIS, and serve as an installed base to hold back further improvements;

2) Lack of adequate revisions and agreements on HIS standards historically, resulted in significant gaps between existing formal and informal institutional arrangements and organizational strategic objectives. These gaps were embedded in the paper based HMIS and later to its computerized version. This contributes to make the systems 'data led' and useful primarily for annual statistical reporting. There is limited local analysis and decision making based on the data being collected;

3) Weak information infrastructure supporting HMIS: lack of trained and qualified technical specialists at all levels of healthcare; limited use of networking services provided by the national telecommunication operators; and insufficient financial means contributes to reporting on an annual cycle rather than on a monthly basis required for making health systems improvements.; and,

4) There is an urgent need to design institutional changes that rationalizes HMIS use among stakeholders by providing incentives, dissemination of knowledge related to local capacity building, self-management, and decentralization.

Furthermore, empirical analysis at the macro level suggests that there is always a tight link and interdependencies between standards (both: global and local), organizational arrangements and the existing HMIS (installed base), each having their respective influences on the dynamics of the standardization process. At the micro level, these relations are seen as individual or group based actions, and their interrelations with local data needs (standards) and their functional duties are dictated by institutional arrangements and organizational objectives.

Findings from the above described papers have helped me to address the key research aims of this thesis in understanding the nature of the dynamics of interplay in global/local standardization process and the challenges and opportunities that arise from this process.

The first research question, as introduced in chapter 1, was broad in scope and subdivided into three other questions. These questions have helped me to analyse various relations in standardization process, the nature of standards and how actors position themselves in the process and related to particular standards. In the table below, I summarize the key findings, challenges and suggest strategies related to the three research questions.

Table 5.1 Addressing research questions through findings of five papers

Research question	**Findings**
What are the nature of dynamics in the interplay between global standards and local adaptations within the context of an in country implementation of HIS?	Local adaptation of global standard in the context of an in-country implementation of HIS is situated and dependent of many aspects of the context of use, such as social, political, technical and the level of abstraction and flexibility of the said in the global definitions and development of the standards. Dynamics of global/local adaptation of standards are concerned with changes over time, which come in the form of evolution and extension of underlying information infrastructure through implementation of new standards and institutionalization of new practices, which is emphasized by the role of the dynamic feedbacks received in the form of incentives by users from the actions taken. (**Papers 2, 3 and 4**)
What are the challenges and opportunities which both arise during the course of the above	**Key challenges:** • Problems of fragmentation, excessive data, minimal indicators, poor quality have been reported to be significant in developing

interplay, and how can we leverage upon the opportunities while mitigating the adverse effects of these challenges?	country context. A key challenge facing the process of generation and use of indicators in developing countries is that there tends to be a significant indicator-data mismatch implying that either indicators are not or can't be calculated with the data (not) being routinely collected or the poor quality of the underlying data which makes the generated indicators unreliable. (**Papers 1and 3**) • The challenge of scaling the standards developed in the context of one hospital to other hospitals, where undoubtedly local practices and traditions will challenge these standards, which may be then seen as being "imposed from the top". The empirical analysis helped to argue how global standard (ICD-10) gets introduced into the local context, and how this 'local' standard becomes 'global' for other similar contexts, reflecting a process of scaling. (**Paper 2**) • The challenges of 'installed base' was magnified as the staff did not really distinguish between reporting and recording forms, which reflected an adherence to the underlying paper based rather than the computer based logic in which a smaller set of data could generate a larger set of reporting forms. (**Paper 4**) • Managing the interaction between the introduction of global standards and local appropriation. (**Paper 5**) • Institutional fragmentation of healthcare stakeholders, where linkages among HIS stakeholders are not supported by direct and standardized data exchange and procedures. (**Papers 4 and 5**) **Key opportunities:** • Flexibility provided by data warehousing applications, which provides look and feel of the old system, while in the background manages data in a standard way. (**Paper 3**) • Introduction of new institutional practices and organizational rearrangements at peripheral level, like 'evidence based

	financing' and 'pay for performance' have contributed to the local use of data for action. (**Paper 4**) • Advancements in external facets of II, namely communications and electricity grids have opened new horizons for distributed and networked HIS. (**Paper 4**) • Use of ICD standard for primary data collection was attractive for CRO. Building CRO application for vital events could be easily accomplished using already existing infrastructure provided by data warehousing application of HIS. (**Paper 5**) • Developed standards in one hospital settings serves as reference standards while scaling to other similar hospitals. (**Paper 2**) **Key strategies:** • A holistic approach in design and implementation of HMIS as socio-technical process. II as design and implementation strategy. (**Papers 3, 4 and 5**) • Balancing local and global requirements through negotiation process by incentive seeking of actors as driving mechanism. (**Papers 4 and 5**) • 'Top down', 'bottom up' and 'primary level data capturing' approaches in standardization of data formats, volume and procedures, or combination of all approaches for the maximum optimization. (**Paper 5**)

The table above summarizes significant challenges and opportunities arising around the HMIS standardization process. Following this, I will in the next chapter raise the level of abstraction of my analysis to articulate my theoretical and practical contributions arising from this thesis.

Chapter 6

6. Contributions and Implications

In this chapter, synthesizing the findings from individual papers presented in Chapter 5, I develop the theoretical and practical contributions related to understanding the process of how global standards and the interplays that emerge while being adapted into local contexts.

The basis for the contributions comes from my theoretically informed analysis, drawing upon concepts from information infrastructure and institutional theories framed within ongoing debates around standards and standardization process in the IS research, with a key focus on HIS in developing countries. This chapter is structured in two main sub sections - the theoretical and practical contributions.

6.1. Theoretical contributions

This section discusses key theoretical contributions arising from my analysis. Previous research has conceptualized the interplay of global and local standards as a process of negotiation and discussion (Rolland and Monteiro, 2002; Besen, 1990; Farrell and Saloner, 1988), involving a hybrid of a technical and institutional issues (Farrell, 1993). While the outcome of such negotiations remains largely unpredictable, there are also simultaneously particularities that influence standardization processes, which both constrain and enable the adoption of standards. These are discussed in the form of theoretical contributions. Three key contributions include:

1. Conceptual framework: Analyzing the relationship between actors, standards and the topic of interest to actors and standards

2. Facets of infrastructure – a perspective to narrow down the different aspects of the standardization process

3. Perspective for understanding the incremental and transparent introduction of technology as supporting institutional arrangement

6.1.1. Conceptual framework: Analyzing the relationship between actors, standards and the content of standards

The conceptual framework is developed on the basis of broader conceptualizations and theoretical assumptions derived from information infrastructure and institutional theories, and informed by my empirical analysis. The proposed framework emphasizes the particularities of the standardization process, while keeping the larger picture of the II development at focus. Through emphasizing the relationship between the actors and the content of standards, the framework tries to equally address both the technical and social significance of standards, and the degree of flexibility required by the II (Hanseth and Monteiro, 1997). This requires understanding the diversity and influences the members have with each other, emphasizing both the standards and also human agency.

Attributes and 'interests' (embedded knowledge, reality of context) of heterogeneous members involves varying types of relationships, not only between members at the two ends of the relationship, but also between the similar (see figure 6.1). For instance, different actors may have varying perspectives depending on their respective organizational responsibilities and institutional constraints with regards to the standards and the topic. For example, the developers are mostly interested in the design and technical representations of the standard (relation A in figure 6.1), the health manager (end user) in the content (B), while implementers have a degree of interest at both ends of the relations (C). Similarly, standards should have the ability to talk to other standards and parts of the II in technical terms and to maintain flexibility to address the topics of 'interest' in any given contextual setting. Topics provide the content (semantics) to standards, which has global and local implications. This knowledge resides in varying degrees at different ends of the relation. For example, radiologist (end user) deals with small subset of ICD codes related to his duties; standard provides metadata definition (syntax) for handling ICD; and implementer is concerned with both: radiologist needs and metadata for handling ICD for any other use.

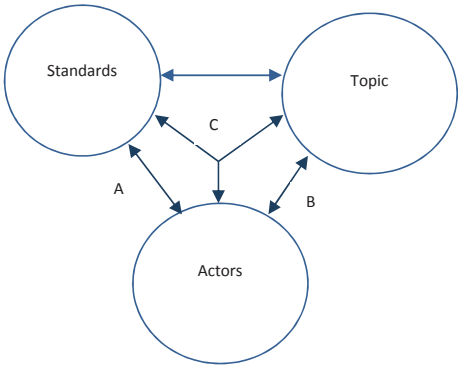

Figure 6.1 Tripartite relation of standards, actors and the content of standard's topics

In HMIS indicators, data elements and ICD are type of semantic standards, which require local adaptation. In Tajikistan, the process of defining standard indicators was relatively straightforward. Group of experts at the ministry level and regional representatives in a short period of time agreed on the format and number of indicators. They used the national health strategy (NHS) as the point of departure and radically reduced the number of indicators. But the revision of data elements did not yield similar success to the indicator revision process. The reason for this, arguably, was the heterogeneity of the context (types of facilities - hospitals, clinics, PHCs), the installed base consisting of the formal and informal institutional constrains guiding the actors and the standardization process. Actors at various healthcare levels, representing heterogeneous health facilities could not agree on the formats and what data to collect. At first glance, following the logic of indicator revision, it seemed an easy task requiring an identification of what data elements are needed for calculating the given set of indicators. But this assumption did not hold, as the process was confronted by varying locally situated position of actors, who had other priorities than that of just meeting the requirements of the indicator calculations. The complex relation of actors involved a prolonged revision of forms without any consent and agreement of what is coming next. At first, it looked like the indicators and data elements were similar from a technological point of view, but experience shows that the degree of the relation with the context (topic) dictates what is needed at periphery, which is not the same as what is needed at national level.

There are also cases when one member of the relation is muted or becomes passive (A from figure 6.2), if the standard is purely technical, and the topic is marginal or (B) if the topic is purely organizational then the standard is muted. For example, for the DHIS to function it

does not matter how many indicators are adapted as the national standard, and the primary concern is the metadata, representing globally accepted standards. Multiplicity of viewpoints and attributes associated with varying socio-technical understandings of context and the diversity of human and/or organizational actors requires a context-sensitive and socially informed working solution (Rolland and Monteiro, 2002).

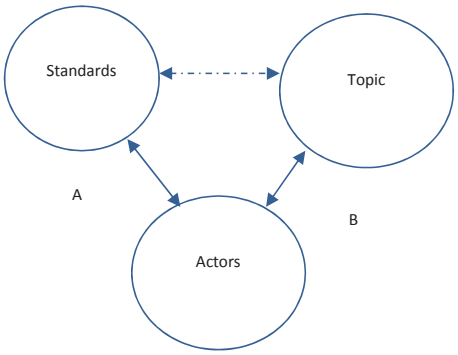

Figure 6.2 Muted relation of Standards and topics

The above depicted framework provides an analytical lens to analyze the standardization process from different perspectives in the IS implementation process. More precisely, it allows not only to 'blame' idiosyncrasies characterized to different locales, but also to question if the intended standard rightly addresses the topic?; Is the topic changing from context to context that does not fit the standard's definition or is that a new case not addressed by the standard? This opens a perspective to analyze the nature of standards and the standardization process, bringing debate of "standard and flexibility" and consequently to "global/local dilemma" into focus in the discussion.

The IS research has posed the question "Where should the balance between the global and the local be drawn" (Roland and Monteiro, 2002:90)? I reframe the question as "Where should the boundary between the information infrastructure and the application using the very infrastructure be defined"? While both questions try to address the same issue, they have different perspectives with regards to the II. The key difference between the two perspectives is that the former refers to the entire ensemble as an II, while the latter divides the II into support infrastructure and the application that is being supported. I argue that the boundary between the II and application should start where the generic nature of the II gets lost and becomes localized to the context of use. It does not further fulfill the requirement of being an

II such as being “open” and “enabling”, but rather becomes a tool or a final product for use. An II is defined as being open, shared, evolving and supportive (Hanseth, 2002; Pironti, 2006), and not a readymade or turn-key solution. This division of II is relative too, because it becomes real in organized practice and the perspective that actors have (Star and Ruhleder, 1996; Jewett and Kling, 1991). For example, for software developers and implementers it is the final product - an application, for health managers it is still an II, who make use of system to process information. “One person’s infrastructure is another’s topic or difficulty” (Star, 1999:380).

Similarly the ICD has been denoted in many ways: standard, list, schema, categorization, classification. This variety of ICD denotations comes from their use in particular context and varying actors’ perspectives. ICD is seen as a standard when it is localized in “standardized paper forms” for recording causes of death, a tool when used by different healthcare administrators and medical practitioners (Bowker and Star, 1999), as communication and control structure when applied to computerized systems, hybrid of work practices and information medium as an II (Star and Ruhleder, 1996). These definitions could well be described from the perspective of actor – standard – topic relationships. What is important for us is to find the borderline at the point where the standard should be included into the II, and at what point it should be application specific. From the definitions above ICD is seen as standard when it is put into paper based form, defining formats of recording ICD codes. These formats implemented in the paper form represent metadata definition of ICD, leaving semantics of ICD open to users’ discretion. We can see now that metadata part of ICD classification is kind of generic and abstract, but local use of it is contextualized and adjusted to local needs and is no more generic.

Thus, standards are built around their topics of interest and topics are managed by the standards. Depending on the topic, standards can fall into one of the three levels: The lowest level – syntactic - is pure technical and is always context free. The second level – semantic - has a dual nature; it is partly technological and partly contextual, and can be termed “semi-generic” (Webster and Williams, 1993). The third level is pure contextual and has limited technological implications, largely dependent on organizational and institutional arrangements arising from the context. These different characteristics of standards determine their relations to the topic, which in turn has implications on actors’ relations to standards depending on actors’ roles in the process of standardization.

The tripartite relationship of actors, standards and topics helps to provide insights into the complexities of standardization process. Conceptual framework also helps in defining approaches for development and implementation of standards in national HMISs and possibly in a large-scale IIs too.

6.1.2. Facets of infrastructure – a perspective to narrow down the different aspects of the standardization process

The concept of facets of infrastructure could be described as *dividing parts of IS development and implementation into correlated facets from organizational, technological and other considerations or the combination of some of them, which could be dealt with in a relative isolation from other parts of II*. It assumes bringing together actors, who directly deal and are experts in particular settings of actor - standard - topic relations, as we so earlier multiplicity of actors and diversity of topics makes the process slow, requiring negotiations across diverse communications and viewpoints. Facets of infrastructure are very close in the sense of a layered architecture to the concept of modularization involving different criteria than those of modular approach. While modularization is a solution for adding new features to II without affecting other parts of the system, facets of infrastructure are a way of looking at various aspects (organizational, technical) of II and discovering areas that could be best dealt with in isolation from other facets of an II. Facets of infrastructure can span across different modules, which have relative concerns, involving smaller group of experts in that domain, while adhering to the consistency with the boundary facets of II.

One way of identifying facets of infrastructure is through thematic division, other is prioritization of task to be completed. This involves identification of actors, topics and standards that we can term as *who* and *what* and *how*. These relations can be studied and similar actions, compositions or events could be drawn as recurring patterns, if the same task have been accomplished in similar manner in various locales and resulted in similar outcomes, it can thus easily be predictable to say what possible output of such an action would be. Also generalization of recurring patterns can lead to formation of standard for doing things, composing teams, etc., especially if recurring patterns have global scope (have wider geographic coverage).

Depending on the level of control, facets of infrastructure can be grouped into internal and external. While internal facets are under fuller control of the implementers, the external facets of infrastructure are managed by external entities. In my example, while data, software and

capacity building are largely internal facets and can be shaped by policy development and standardization efforts of the MoH and funding organizations, other facets of the larger infrastructure (e.g. roads, power supply, transport, Internet) are externally shaped under the control of different external actors. Not one actor has control over the entire infrastructure.

With development of concept of facets of infrastructure I have tried to address issues of managing complexity in the process of development and implementation of IIs. Complexity, which is inherent in IIs, grows as the number of components and their integration increases and consequently contributes to the escalation of risk (Hanseth, 2007). Adding new stakeholders to an existing system also exponentially increases complexity, even while benefit from such integration is marginal (Edwards, 2006). Noticeably, inclusion of Civil Registry Office (a subordinate of Ministry of Justice, not MoH) to HMIS of Tajikistan introduced socio-technical complexities and raised political tensions around donor funding. In the large and integrated information infrastructure spanning across organizational boundaries, the number of links and types of links, between the technical systems and the social/organizational also grows. Technical standardization as a means to solve inter-organizational complexity entails its coordination challenges, as the number of such standards increases (Bygstad and Hanseth, 2011). Bygstad and Hanseth (2011) have thus posed the question of "*how can we reduce complexity, both in the development and implementations of large information infrastructures?*"

The concept of facets I believe serves as a possible response to the above question. II development and implementation involves complex set of socio-technical decisions to be taken, taking into account varying needs of heterogeneous actors coming from their situated roles. According to Star and Ruhleder (1996), an infrastructure is a fundamentally relational concept, for example while stairs can serve as infrastructure for ordinary people, it can be a potential barrier for handicapped people (Star, 1999). Concept of facets of infrastructure builds on top of above understandings, addressing complexity as an inherent characteristic of IIs. These complexities of IIs are dependent on the number and the nature of the links connecting heterogeneous actor and components, and as such cannot be reduced, unless dropping the links or breaking the whole into parts, which violates the core concepts of II.

Facets of infrastructure tries to address issues related to efficiency of II development and implementation, isolating to a certain extent possible areas of concern from the larger whole while ensuring that the relations between the components of the system are intact.

In HMIS of Tajikistan, the obvious examples are II facets related to data formats and collection, information sharing and ICT. The first concerns with the formats, volumes and content of the data to be collected and their sharing between different actors. The former two are concerned with storing, transmitting and sharing of these data. Now, we can see that two different categories of decisions need to be taken. One is primarily organizational and the other is technical, each requiring specific knowledge of the respective fields. For making data semantics (content) aligned to organization strategies objectives, no much consideration of underlying technology is required, but considered important on the other hand, which is obviously agreed at level of standards ensuring consistency.

Given that the boundaries of responsibility and the necessary steps in maintaining the consistency between intertwined facets is clearly defined, negotiation of involved actors in particular facet of infrastructure could be carried out independently (single facet boundaries). Actors, depending to their roles, can be involved in more than one facet, for example implementers can participate in as many facets as possible, becoming a linking point among the facets they have input in. These relations are explained in section 6.1.1 above.

6.1.3. Perspective for understanding the incremental and transparent introduction of technology as supporting institutional arrangement

I use the concept of "intermediary" to refer to the state of the II where many features of the system are made invisible from direct user access to keep hidden the radical changes embedded in the new technology initiative. The alternative is to try and enable a process of gradual transformation from one state to another. This shift requires time and efforts to adjust organizations through the various degrees and types of institutional changes. Institutional changes do not occur overnight, they are rather results of longer socio-political negotiations among various stakeholders of HIS, who are constantly seeking benefits from it. They are long processes involving deinstitutionalization of old and reinstitutionalization of new practices, which inherently are long term processes (Currie and Guah, 2007). Implementing through short term user trainings are inadequate, as the need is for the underlying technology to be objectified and become deep rooted into organizational routines. Indeed, as Douglas puts it: "*although we can say the same thing a hundred different ways over a span of years, there is no way message can be heard until the organizational changes have taken place such that reception is possible*" (Douglas, 1986).

Placing existing paper based forms into standardized meta-data definitions, helps creating an intermediary that can comply with the conflicting institutional logics in play. In our case, the system was designed so as to continue the existing system's look and feel and its centralized logic, while the data is however stored in the standardized definition in the background. This allowed users to analyze data at different organizational levels (logic of "data for action"). Interplay of system users with competing logics, which comes from their organizational principles and external forces, will gradually guide them to build the culture of evidence based decision making.

In the context of health information system in developing countries, a key challenge is around managing the interaction between the introduction of global standards and their local appropriation (Braa et al., 2007; Braa and Hedberg, 2002; Shaw, 2002). A key research finding concerns the use of a "flexible standard" strategy to meet the diversity of information needs, representing a defined set of obligatory data sets for all levels (Jacucci, Shaw & Braa, 2006), while simultaneously giving each level the flexibility to add standards for their local use. While this strategy is best suitable in a context with little or no previously routinized and institutionalized practices for data collection and aggregation, it falls short in a context with a strong existing installed base, where old practices inhibit users from using new features of the proposed system. How to act in this case when a new software solution could be installed in a few mouse clicks, but bringing it to action requires corresponding institutional changes, which are not as easy as this.

According to Star (1999), a smallest obstacle creates barriers to the user of the computer system. This could be a small button click or a link to follow or even a simple lookup on the screen. One of the findings from the studies of users in the Illinois Digital Library Project (Bishop et al., 1999) was that seemingly trivial alterations in routine, or demands for action, will act to prevent users from using the system. This magnification is explained to be related to two simultaneous processes involved: one is users' action with the computer terminal and the other is assembling these actions within organizational routines (Star, 1999).

Implementing global standards into situated local context is of this nature, especially when implementation is "top down". "Top-down" approaches typically respond to national needs or to the demands of global agencies (Sahay, 2011), but will necessarily need to interact with local processes and conditions during implementation (Ciborra, 1994). These appropriation

processes are shaped through negotiations amongst actors, often representing diverging interests and needs, with implications on the acceptance or not of the standard.

For the end users of the system, two things are important: input and output, which are definitely linked with their task at hand and is in line with their routinized and organizational goals. Adding additional features or introducing new ways of doing the same thing will challenge system users. During the pilot phase of the HMIS of Tajikistan, many of the new features of the system were ignored. For example, users complained that new system is more complex, while they only wanted to capture, store the data and produce reports, when the new system was meant to provide analytical capabilities. Reducing national data sets to match National Health Strategy (NHS) goals and actual areas of healthcare needing more attention also was rejected by senior ministry officials during the piloting phase. Two competing institutional logics became apparent, users not ready to accept or they got lost in using analytical functionalities of the new system. Despite the fact that the installed base of the existing data standards and system were not satisfactory in terms of functionality, the new system was transparently downgraded, hiding advanced features of the system. The look and feel of the new system also was made similar to the old system and the corresponding reports were designed. While the input and output of the old system was supported by the new system, the standard ways of data handling, storing and analytical functionalities were made invisible to the user. Invisible in a sense that the user will not be disturbed while performing his or her routinized actions, but in case more was needed to be done, it was possible. Other features of the system were available from menu options, and kept voluntary.

Standards and standardization typically imply one another (Timmermans and Epstein, 2010), similarly the topic of standard establishes the standard and the standard shapes the topic. It is important to highlight that not only does global standard impact the local context, but also the local context impacts the direction and quality of global standard. At the very least, this happens because local experience and practice of use of standard provide the fuel for the development of the global standard, but also because social and strategic responses to global standardization challenges constrain and influence the context in which global standards are developed. This happens, for example, through the control structures established at the global level and through the assemblage of stakeholders and stakeholder interests that construct key strategy debates. It also happens through the transfer of social norms and organizational routines, aspirations and ideas that appear in the global network to formulate present and

emergent social engagements, including local improvements of the standards. In short, not only are the local context and global standards intrinsically linked, they are so deeply welded together that we simply cannot address the global standardization challenges. For this, we need to understand and harness the dynamics of local realities that influence them. By the same token, those who wish to capitalize on the potential of uniform solutions will not be able to do so unless they are able to understand and address the great local challenges, which are part of the larger context within which global standards are made.

In our example of Tajikistan HMIS, revision and standardization of indicators took much less time than that of reporting and recording forms, which is yet ongoing. The first reason for this is that recording and reporting forms have been institutionalized and embedded into paper based and later computerized IS, becoming an installed base. But indicators have been calculated on ad hoc basis and there was no any standardized procedure for handling them. The second reason is that revision of recording and reporting forms involved many different stakeholders from the diverse and heterogeneous actors at various levels of healthcare, including hospital managers, statisticians, nurses and medical professionals. Multiplicity of links between various stakeholders creates complexity, each of which requiring consensus and agreement before any change is made.

6.2. Practical implications

Three practical contributions arise from this thesis. One contribution comes directly from my involvement in HMIS design and implementation in Tajikistan through the action research. Other two contributions emerged from theoretical framework and based on empirical findings of this research. These practical contributions are listed below and further elaborated on in subsequent sections:

1. Using three dimensional framework of completeness, fittingness, and actionability for analyzing the data element – indicator linkage
2. Guidelines to composing the right team for the right task
3. Considerations for gradual implementation of software artefacts

6.2.1. Using three dimensional framework of completeness, fittingness, and actionability for analyzing the data element – indicator linkage

The framework of three dimensions of (1) completeness, (2) fittingness, and (3) actionability is specifically designed to analyze data to indicator (mis)matches in HMISs, but could also be used in any other contexts where data warehousing applications are used to find anomalies in the content, quality and quantities of data being analyzed.

The purpose of building and maintaining an information system is to improve the effectiveness of organizational performance. The decisions for the improvements come from the knowledge which resides in the data. Analyzing these data knowledge is generated for taking decisions. For these decisions to be accurate and reliable, data sources and their granularities need also to be accurate and reliable. But this not always the case, public healthcare organizations are constantly changing adapting to the environment, their objectives and strategies also change. Ministries at national level thus prioritize some of the areas that address new realities. In doing so, time by time data of various natures becomes part of HMIS knowledge base, some of which will loosen their actuality.

Three-dimensional framework is designed to analyze anomalies hampering data quality, in other words metadata for collecting health data will be examined. Taking national healthcare priorities, which are monitored and evaluated by indicators as point of departure, framework classifies data at various levels for usability.

The dimension of “actionability” refers to usefulness of indicators themselves. If indicator is used for measuring actual performance of strategic goal of healthcare, such indicator is than classified as actionable. Criteria for actionability come from measurable indicators in NHS and other priorities that are not explicitly shown, or those which appear ad hoc.

Now, that decision on actionable indicators is made, one can find what data are needed for calculating indicator values. The dimension of “completeness” refers to the condition where all data elements needed for calculating indicator value are present in the system. Applying this dimension, new data elements are added and unused are marked for deletion. Once, this process is complete, the third dimension of “fittingness” is applied. In this dimension compliance of data elements for fulfilling indicator(s) criteria are assessed. At this stage various dimensions of data, like periodicity, data element category division, etc. are matched with indicator formulae. Completing these three stages of framework helps to revise metadata definitions for HMIS.

Framework is quite similar to "data cleansing" technique used in data warehousing in ETL (extract, transform, and load) but works at metadata level, not actual data. Framework could be used by health managers and possibly by other professionals dealing with data warehousing as a tool to periodically perform prophylactic analysis of the data being collected and processed.

6.2.2. Guidelines to composing the right team for the right task

Conceptual framework which I presented earlier in this chapter, helps in distribution of tasks among teams and team members in implementation of large scale IIs. In a larger picture, team formations are decided by work requirements and organization objectives, but also there is a need to group people for some concrete tasks. There are permanent teams that work together on a day-to-day basis and the cross-functional teams who work on specific tasks. Then there is the situational task force created to handle a special task. Implementation teams basically bring in change, they are at the heart of IS implementation. They are comprised of individuals who have the skills and knowledge to implement a new tools or processes within an organization either across single or multiple locations. In general, implementation teams have to integrate the specifications developed by the functional experts into a process or facility.

Implementation team does not only include experts in the field, it also includes end users, facility managers, who also participate in the process. Setting a team for situated task could follow understandings coming from concept of "facets of infrastructure", which also refers to tripartite relationship of actors, standards and topic (in this case implementers, software, context). Following this logic various team members could be grouped to work together for accomplishing specific task in IS implementation.

Balance between members of the teams with regards to tripartite relation ensures competency to address all issues in the particular task. Underrepresentation or overrepresentations are penalizing. Absence of expert in one of areas of interest within the team badly influences the trajectory of implementation. Too many people in the team add more communication and collaboration, complicating the process, even contributing to the delays in implementation. As Brooks' law says: "*Adding manpower to a late software project makes it late. Adding people to a software project increases the total effort necessary in three ways: the work and disruption of repartitioning itself, training the new people, and added intercommunication. (Brooks,1995:232)*".

It is important to set up teams with over mentioned criteria in mind to avoid failures and delays in large scale IS design, development and implementation. Core to composing teams is to correctly identify relations of members to tools and context.

6.2.3.Considerations for gradual implementation of software artefacts

Processes of socio-technical change that are triggered by implementing new software solutions do not occur over short periods of time, subsequently leading to new periods of technological, institutional and organizational change. When software solutions brings in radical changes from both technological and organizational perspectives, it becomes hard to impossible to implement such software product in one go. Such an attempt may result to abandonment of entire process by end users being unable to rationalize them with their daily work practices. There is a need to divide implementation into smaller sets of tasks and introduce them in a gradual way. This technique is actually is foreseen in many modern software product, which are intended to be used by broader community practicing similar things.

In gradual implementation of software it is important for implementers to pay attention to the relation of different parts of software package, user base and primacy of tasks, to determine which features should come first, which one should follow. Piloting DHIS2 in Tajikistan, we have faced such difficulty. For health statisticians in the districts, it was hard to shift from old desktop application called MedStat to the much advanced analytical tool – DHIS2. MedStat had limited data collection and reporting functionalities only. Also these limited set of actions were institutionalized, at the districts level data was collected for upward reporting. No data was analyzed for local decision making and actions. Indicator calculations and managing hierarchies of subordinates among the other features of DHIS2 were new to them.

Knowing that introducing new IS requires much longer time for technology acceptance and organizational changes to take place, we - group of implementers configured DHIS2 in a way that it acts as previous system - MedStat. Even default look and feel of DHIS2 was adjusted for data entry to resemble old system to mitigate the shift. At the same time other features of DHIS2 were active, though not directly visible to end users. When new demands from district health managers were issued, some of new features were taken into use by district statisticians. These demands came from institutional changes at district level through introduction of new financing mechanisms, reorganization of healthcare management system.

Chapter 7

7. Conclusions

The aim of this thesis was to study the nature of the dynamics of local implementation of global standards as a socio-technical phenomenon. A key focus was to focus on understanding issues that come into play and opportunities that rise to draw practical and theoretical insights. The empirical context for this research is primarily the MoH of Tajikistan, a developing country where implementation of the global software solution - DHIS2 is ongoing. Actually, the context is that makes a significant difference in the global/local standardization processes. A large body of IS literature has emphatically established that HIS implementation needs to be sensitive to local contexts (Avgerou, 2002; Walsham 2001), it has also been argued that these global/local collisions are over-emphasized, and that generification and localization of standards and applications are possible through processes of negotiation and discussion (Pollock, Williams & D'Adderio, 2007; Rolland & Monteiro, 2002).

Two key questions posed in this research were wide in scope and required making concrete the unfolding of the described problem into smaller observable parts in the context of standards at global and national levels. In line with this assumption, and the fact that negotiation processes tended to be open and evolving with unpredictable outcomes, I argued that there were particularities that shaped standardization processes, patterns of which could be drawn and reused. Standards studied in this thesis included data sets, data formats, periodicity, data exchange protocols, software, and various routines and practices around data collection, processing, presentation and use. These standards represent techno-institutional components referring to uniform solutions, but paradoxically also contains elements of locality and independence (Bowker & Star, 1999).

Theoretically my research was guided by broader conceptualization drawn from II and institutional theories and standardization literature in IS, which enabled me to examine the challenge of standards from a socio-technical perspective, where information infrastructure is seen as something that evolves over time and also links many institutional and organizational boundaries through the means of standardized applications and procedures. Having this as the "big picture" of the standardization process during an in country implementation of global standards, I tried to decompose this relation into smaller subset of relations, which in turn resulted in a theoretical framework comprised of a tripartite relation of actors, standards and the topics addressed by the standards.

The theoretical framework developed in this thesis proposed a conceptual linkage between the actors, standards and the problem addressed by the actors and standards, reflecting its content or topics. The relationship between actors (as human agency) to standards and topics was embedded in various kinds of institutions and infrastructures and shaped by incentives they receive from doing (or not) of certain actions. These relations are shown by splitting and unpacking of technological, social parts from reality for analytical purposes; they are nevertheless are a "single whole", including political and cultural dimensions. The theoretical framework allows the study of how this "single whole" is made up?; what relations hold it strong or make it weak?, and the knowledge of which then could be used to formulate approaches and strategies for standardization process in the course of IS implementation.

As such, the theoretical framework tries to reduce complexity (reduction through isolation) of the standardization process by unpacking the techno-social dimensions and examining various relations drawing patterns of recurring events and structures as a proven way of doing. Perhaps these patterns are not specific to the locale but rather to the composition of actors involved and tasks they perform or problem they address, and may hold potential to under similar issues in other contexts. This complexity of the IS implementation within the large II is characterized by heterogeneity of actors, and especially human actors having different viewpoints and coming from various institutional contexts and carrying varying political agendas. The same equally applies to global standards that require aligning to the local settings. The general strategy developed here is to deal with complexity by isolating smaller parts (have higher inter-relations) from the "single whole", while the holistic approach of II remains intact. Small correlated parts interface with the larger whole by

"boundary objects", which in turn could be the topic of other problems, actors' interests, and standard setting and so on.

Strategies and approaches developed here are grounded in theoretical insights and empirical findings of this thesis that are useful in the study of global/local interplay of standards, especially when it takes place inside the larger II of multilevel organizations. The theoretical framework provides for an analytical lens allowing formulations of approaches and strategies for practical use in IS standardization, including assessing its sustainability. This is possible through mechanisms of incentives, arising from domain problems and actor satisfaction. For example, key benefits for practitioners would arise from reduced time through avoiding unnecessary communications, and making common mistakes.

REFERENCES

Aanestad, Margunn. 2002. "Cultivating Networks: Implementing surgical telemedicine." Ph.D. Thesis. University of Oslo, Faculty of Mathematics and Natural Sciences. Norway.

AbouZahr, C. and Boerma, T. 2005. Health Information Systems: the foundations of public health, Bulletin of the World Health Organization, 83(8).

ADB report. 2003. Report and recommendation of the President to the Board of directors on a Proposed loan and technical assistance grants to the Republic of Tajikistan for the health sector reform project. RRP:TAJ 33036

AHIMA. 2010. "Managing the Transition from Paper to EHRs." (Updated November 2010). Available online in the AHIMA Body of Knowledge at www.ahima.org.

Alford, Robert R. and Friedland, Roger. 1985. Powers of theory: Capitalism, the state, and democracy. Cambridge University Press, Cambridge Cambridgeshire and New York

Alston, William P. 1996. Epistemic Justification: Essays in the Theory of Knowledge, Ithaca, N.Y.: Cornell University Press

ANSPAC. 1978. National Policy on Standards for the United States and a Recommended Implementation Plan. National Standards Policy Advisory Committee, Washington, D.C., December, 1978, p.6.

Antonelli, Cristiano. 1994. "Localized Technological Change and the Evolution of Standards as Economic Institutions." Information Economics and Policy 6: 195-216

Aoki, Masahiko. 2001. Toward a Comparative Institutional Analysis, Cambridge, Mass.: MIT Press.

Armstrong, Michael. 2002. Employee Reward (People & organizations). Chartered Institute of Personnel and Development; 3rd edition

Avgerou, C. and G. Walsham, Eds. 2000. Information Technology in Context - Studies from the perspective of developing countries. Hants, UK, Ashgate Publishing Ltd

Avgerou, C. 2000. “Recognizing Alternative Rationalities in the Deployment of Information Systems”, Electronic Journal on Information Systems in Developing Countries, Vol. 3, No. 7, pp. 1-15

Avgerou, C. 2002. Information Systems and Global Diversity. Oxford, Oxford University Press

Avison, David E., Francis Lau, Michael D. Myers, and Peter Axel Nielsen. 1999. Action research. *Commun. ACM* 42, 1 (January 1999), 94-97

Barley, S. R. and P. S. Tolbert. 1997. Institutionalization and structuration: Studying the links between institutions and actions. Organization Studies, 18: 93-117

Baskerville & Myers. 2004. Special Issue Foreword. MIS Quarterly Vol. 28 No. 3, pp. 329-335

Avison, D., Baskerville, R., and Myers, M. 2001. "Controlling Action Research Projects," Information Technology & People (14:1), pp 28-45

Baskerville, Richard L. 1999. "Investigating Information Systems with Action Research,"Communications of the Association for Information Systems: Vol. 2, Article 19. Available at: http://aisel.aisnet.org/cais/vol2/iss1/19

Bate, S.P. 2001. Synthesising research and practice: using the action research approach in health care settings. In: Finer, CJ, (ed.) The Business of Research. Issues of Policy and Practice. Pp. 113 - 128. Blackwell: London

Beale T. 2004. The Health Record - why is it so hard? IMIA Yearbook of Medical Informatics. Ubiquitous Health Care Systems. Haux R, Kulikowski C, editors. Stuttgart: Schattauer; 2004. pp. 301-304

Bekkers, R. N. A., & Liotard, I. 1999. The tense relation between mobile telecommunications standards and IPR. European Intellectual Property Review (3), 110–126

Berg M. 1997. Rationalizing Medical Work: Decision Support Techniques and Medical Practices. Cambridge, MA: MIT Press

Besen, S. M. 1990. The ETSI: A preliminary analysis. Telecommunications Policy, 512–530

Bijker, W.E., and Law, J. 1992. Shaping Technology/Building Society: studies in sociotechnical change. Cambridge, MA: MIT Press

Bishop, S.A., Klein, T., Martinez Arias, A., Couso, J.P. 1999. Composite signalling from Serrate and establishes leg segments in Drosophila through Notch. Development 126(13): 2993--3003

Bobokhojaeva Zamira, Benoit Mathivet, Farrukh Egamov, Salohidin Miraliev, and Saidali Kodirov. 2010. Reducing the financial burden of patients during hospitalization. Results from the introduction of the Basic Benefit Package in Tajikistan. Bilt-ekon organ inform zdrav 2010; (26)3. Pp. 80-85. Available from http://temena.famnit.upr.si/files/files/TJK.pdf

Bostrom, R., Heinen, J. S. 1977. MIS Problems and Failures: A Socio-Technical Perspective, MIS Quarterly, Vol. 1, No. 3

Bostrom, R. P., and J. S. Heinen. 1977. “MIS Problems and Failures: A Socio-Technical Perspective, Part 1 - The Causes”, Management Information Systems Quarterly, 1, pp. 17-32

Bowker G.C. and Susan Leigh Star. 1998. Building Information Infrastructures for Social Worlds – The Role of Classifications and Standards. T. Ishida (Ed.): Community Computing and Support Systems, LNCS 1519, pp. 231-248, 1998. Springer-Verlag Berlin Heidelberg 1998

Bowker, G.C., Star, S.L. 1999. Sorting Things Out, The MIT Press

Braa, J., Hedberg, C. 2002. “The Struggle for District-Based Health Information Systems in South Africa”, The Information Society, Vol. 18:113-127

Braa Jorn and Sahay Sundeep. 2012. Integrated Health Information Architecture. Power to the Users. Matrix Publishers. ISBN-10: 9381320063, 384p

Braa, K., & Vidgen, R. 1997. An IS Research Framework for the Organizational Laboratory. In: Kyng, M., & Mathiassen, L., editors, Computers in Context: Joining Forces in Design. MIT Press, Cambridge, MA

Braa, J., Hanseth, O., Mohammed, W., Heywood, A., Shaw, V. 2007. Developing health information systems in Developing countries. The flexible standards strategy. MIS Quarterly, Vol. 31 No. 2, pp. 381-402

Braa Jorn, Eric Monteiro, and Sundeep Sahay. 2005. Networks of action: sustainable health information systems across developing countries. MIS Quarterly Vol. 28 No. 3, pp. 337-362

Braa, J., Monteiro, E., Sahay, S. 2004. "Networks of Action: Sustainable Health Information Systems Across Developing Countries", MIS Quarterly, Vol. 28, No. 3, 337-362

Braguinsky Serguey and Grigory Yavlinsky. 2000. Incentives and Institutions: The Transition to a Market Economy in Russia, Preston University Press

Brooks, Frederick P., Jr. 1995. The mythical man-month : essays on software engineering - Anniversary ed. Addison Wesley Longman, Inc

Brunsson, N., Jacobsson, B. 2000. A World of Standards, Oxford University Press

Butler, T. 2003. An institutional perspective on developing and implementing intranet- and internet-based information systems. Information Systems Journal, 13(3), 209-231

Bygstad, Bendik & Hanseth, Ole. 2011. Complexity and Risk in Health Information Infrastructures. An Options Analysis . Proceedings of the Annual Hawaii International Conference on System Sciences. ISSN 1530-1605. . doi: 10.1109/HICSS.2011.121

Callon, M. and B. Latour. 1981. Unscrewing the Big Leviathan: how actors macrostructure reality and how sociologists help them to do so. In K. D. Knorr-Cetina and A. V. Cicourel (Eds.) Advances in Social Theory and Methodology: Toward an Integration of Micro- and Macro-Sociologies. Boston, Mass, Routledge and Kegan Paul: 277-303

Campbell, Donald E. 1995. Incentives: Motivation and the Economics of Information. Cambridge, Cambridge University Press

Cardno, C. 2003. Action research: A developmental approach, Wellington: New Zealand Council for Educational Research

Carlile, P.R. 2004. "Transferring, Translating and Transforming: An Integrative Framework for Managing Knowledge across Boundaries." Organization Science, 15, 555-568

Cashin, C. (2004), "Tajikistan health sector note: health financing report", The World Bank, Washington, DC, unpublished

Cavalluzzo K.S. and Ittner, C.D. 2004. Implementing performance measurement innovations: evidence from government. Accounting, Organizations and Society, 29: 243-267

Chatterjee, D.D., Pacini, C., and Sambamurthy, V. 2002. "The Shareholder-Wealth and Trading-Volume Effects of Information Technology Infrastructure Investments," Journal of Management Information Systems (19:2), pp. 7-42

NFHS-3. 2010. International Institute for Population Sciences and Macro International (September 2007)."National Family Health Survey (NFHS-3), 2005–06" (PDF). Ministry of Health and Family Welfare, Government of India. pp. 436–440. Retrieved 5 October 2012

Chikovani Ivdity, Ketevan Chkhatarashvili, Natia Rukhadze. 2011. Assessment of Child Birth and Death Registration in Tajikistan. Curatio International foundation, Dushanbe, 2011

Ciborra, C., Braa, K., Cordella, A., Dahlbom, B., Failla, A., Hanseth, O., Hepsø, V., Ljungberg, J., Monteiro, E., Simon, K. 2000. From Control to Drift. The Dynamics of Corporate Information Infrastructures, Oxford University Press

Ciborra, C., Hanseth, O. 1998. "From tool to Gestell: Agendas for managing the information infrastructure", Information Technology & People, Vol. 11, No. 4, pp. 305-327

Ciborra, Claudio. 1994. T. Jelassi (eds), Strategic information systems - a European perspective, NY: J. Wiley

Creswell, J. W. 1998. Qualitative inquiry and research design: Choosing among five designs. Thousand Oaks, CA: Sage

Currie, W. L. and Guah, M. W. 2007. Conflicting institutional logics: a national programme for IT in the organizational field of healthcare, Journal of Information Technology 22(3): 235-247

Currie, W. 2009. Contextualising the IT artefact: towards a wider research agenda for IS using institutional theory, Information, technology & people 22(1): 63-77

D'Adderio, Luciana. 2003. Configuring software, reconfiguring memories: the influence of integrated systems on the reproduction of knowledge and routines. Industrial and Corporate Change, 12/2, ICC Association

Damsgaard, J., Lyytinen, K. 2001. "The Role of Intermediating Institutions in the Diffusion of Electronic Data Interchange (EDI): How Industry Associations Intervened in Denmark, Finland, and Hong Kong", The Information Society, Vol. 17, pp. 195-210

Dana, L. 2000. "Change & Circumstance in Kyrgyz Markets," Qualitative Market Research 3 (2), April, pp. 62-73

David, Paul A. and Shane M. Greenstein. 1990. "The Economics of Compatibility Standards: An Introduction to Recent Research," Economics of Innovation and New Technology, 1(1&2): 3-42

David, P.A., 1987. Some New Standards for the Economics of Standardization in the Information Age, in Economic Policy and Technology Performance, P. Dasgupta and P. Stoneman (eds). Cambridge: Cambridge University Press

deVries, H. J. 2003. Standardization: A Business Approach to the Role of National Standardization Organizations. Kluwer Academic Publishers

Dey, Ian. 1993. Qualitatitve Data Analysis. A User-Friendly Guide for Social Scientist. Routledge. 11 New Fetter Lane, London EC4P 4EE, ISBN 0-415-05851-1

DiMaggio P, Powell W. 1983. The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. Am. Sociol. Rev. 48:147–60

Douglas, M. 1986. How Institutions Think. Syracuse, N.Y.: Syracuse University Press

Deming, W. E. 1986. Out of the crisis. Cambridge, MA: MIT Center for Advanced Engineering Study

Fagot-Largeault A. 1989. Les causes de la mort. Histoire naturelle et facteurs de risque, Paris, Vrin

Falkingham J. 2004. Poverty, out-of-pocket payments and access to health care: evidence from Tajikistan. Social Science and Medicine, 58:247–258

Farrell, Joseph; Garth Saloner. 1988. Installed Base and Compatibility: Innovation, Product Preannouncements, and Predation. The American Economic Review, vol. 76, no 5 (Dec., 1986), 940-955

Farrell, Joseph and Garth Saloner., 1987. "Coordination Through Committees and Markets," Economics Working Papers 8740, University of California at Berkeley

Foltz, A.M. 1993. Modelling technology transfer in health information systems. Learning from the experience of Chad, International Journal of Technology Assessment in Health Care, 9, (3), 346-59.

Fomin, V.V., and Keil, T. 2000a. "Standardization: Bridging the Gap Between Economic and Social Theory," The Twenty First International Conference on Information Systems (ICIS 2000), ICIS, Brisbane, Australia, pp. 206-217

Fomin, V.V., and Lyytinen, K. 2000b. "How to distribute a cake before cutting it into pieces: Alice in Wonderland or radio engineers' gang in the Nordic Countries?," in: Information Technology Standards and Standardization: A Global Perspective, K. Jakobs (ed.), Idea Group Publishing, Hershey, pp. 222-239

Fomin V.V. 2003. The role of standards in the information infrastructure development, revisited. Standard Making: A Critical Research Frontier for Information Systems MISQ Special Issue Workshop, December 12-14

Fomin, V., Keil, T., Lyytinen, K. 2003. Theorizing about Standardization: Integrating Fragments of Process Theory in Light of Telecommunication Standardization Wars, Case Western Reserve University, USA. Sprouts: Working Papers on Information Systems, 3(10). ttp://sprouts.aisnet.org/3-10

Foster, W.T. 1992. Topics and methods of recent graduate student research in industrial education and related fields, Journal of Industrial Teacher Education, 30(1), 59-72

Franz, C.R. & Robey, D. 1984. "An Investigation of User-Led System Design: Rational and Political Perspectives." Comm.of the ACM, 27 (1984), 1202-1209

Friedland, R. and Alford, R. R. 1991. Bringing Society Back In: Symbols, Practices, and Institutional Contradictions, in W.W. Powell and P. DiMaggio (eds.), The New Institutionalism in Organizational Analysis, Chicago: University of Chicago Press, pp. 232-263.

Fujimura, Joan H. 1996. Crafting Science: a Sociohistory of the Quest for the Genetics of Cancer. Cambridge, Mass: Harvard University Press

Fulk, J. 1993. Social construction of communication technology. Academy of Management Journal, 36, 921-950

Gangolli, Veena; Duggal, Ravi; Shukla, Abhay. 2005. Review Of Health Care In India. Mumbai : CEHAT , 2005, 330 pgs

Garber, Alan M. 2005. Evidence-Based Guidelines as a Foundation for Performance Incentives. Health Affairs, 24, no.1 (2005):174-179

Gedik, G., Oztek, Z. and Lewis, A. 2002. “Modernizing primary health care”, in McKee, M., Healy, J. and Falkingham, J. (Eds), Health Care in Central Asia, Open University Press, Buckingham

Gephart, R. P. 1999. Paradigms and research methods. Research Methods division forum, vol. 4. On line issue. Research methods division, Academy of Managemen. Available from aom.pace.edu/rmd/1999_RMD_Forum_Research_Paradighms_and_Methods.htm

Ginzberg, M.J. 1981. Key recurrent issues in the mis implementation process vol June MIS Quarterly pp.57-59

Greenwood, R., Suddaby, R., and Hinings, C. R. 2002. Theorizing Change: The Role of Professional Associations in the Transformation of Institutionalized Fields, Academy of Management Journal 45(1): 58-80

Guba, E. G., & Lincoln, Y. S. 1994. Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), Handbook of qualitative research (pp. 105-117). London: Sage

Hanseth, Ole & Braa, Kristin. 2000. Who's in Control: Designers, Mangers - or Technology? Infrastructures at Norsk Hydro., In From Control to Drift. The Dynamics of Corporate Information Infrastructures. Oxford University Press. Pp. 125 - 147

Hanseth, Ole and Claudio Ciborra. 2007. Risk, Complexity and ICT. Edward Elgar Publishing, 240p

Hanseth, Ole, and Monteiro, Eric. 1997. Inscribing behavior in information infrastructure standards. Accounting, Management & Information Technology. Vol. 7, No. 4, pp. 183-211

Hanseth, Ole, and Monteiro, Eric. 1998. Changing irreversible networks: Institutionalization and infrastructure. In Kristin Braa and Eric Monteiro. Proceedings from 20th IRIS. p. 21 - 40

Hanseth Ole, Monteiro Eric. 1998. Understanding information infrastructure. Manuscript. Available at: http://heim.ifi.uio.no/~oleha/Publications/bok.pdf.

Hanseth, Ole, Claudio Ciborra, and Kristin Braa. 2001. "The Control Devolution: ERP and the Side-Effects of Globalization." The Data Base for Advances in Information Systems, 32:4 34-46

Hanseth, Ole. 1996. Information technolgogy as infrastructure, PhD thesis, Gøteborg Univ.

Hanseth Ole. 2002. From Systems and Tools to Networks and Infrastructures- from design to cultivation: Towards a theory of ICT solutions and its design methodology implications‖, working paper, Department of Informatics, University of Oslo. Available from: http://www.ifi.uio.no/~oleha/Publications/.

Hanseth, Ole. 2007. Complexity and risk , In Ole Hanseth & Claudio Ciborra (ed.), Risk, Complexity and ICT. Edward Elgar Publishing. 4. Pp. 75 - 93

Hanseth Ole, Eric Monteiro, Morten Hatling. 1996. Developing Information Infrastructure: The Tension Between Standardization and Flexibility, Science, Technology, & Human Values, Vol 21 No 4, 407-426

Heeks R. & Baark E. 1999. Evaluation of Donor Funded Technology Projects in China, Working Paper, Institute for Development Policy and Management (IDPM), University of Manchester

Elizabeth Henning, Wilhelm Van Rensburg, Brigitte Smit. 2004. Publisher, Van Schaik, 2004. 179 p.

Hoffman, A. 1999. "Institutional evolution and change: Environmentalism and the US chemical industry," Academy of Management Journal, 42 (4): 351-371

International Labour Organization. 2010. Migrant remittances to Tajikistan : the potential for savings, economic investment and existing financial products to attract remittances / ILO Subregional Office for Eastern Europe and Central Asia, International Labour. Moscow: ILO, 2010. 74 p.

International Monetary Fund. 2012. http://www.imf.org/external/pubs/ft/weo/2012/01/weodata/weorept.aspx?pr.x=51&pr.y=6&sy=2009&ey=2012&scsm=1&ssd=1&sort=country&ds=.&br=1&c=534&s=NGDPD%2CNGDPDPC%2CPPPGDP%2CPPPPC%2CLP&grp=0&a=. Retrieved 2012-08-06

Immergut, E. 1998. AThe Theoretical Core of the New Institutionalism.@ Politics and Society 26(1): 5-34

Jackall Robert. 1988. Moral Mazes: The world of corporate managers. New York: Oxford University Press

Jacucci, Edoardo; Shaw, Vincent and Braa, Jorn. 2006. Standardization of Health Information Systems in South Africa: The Challenge of Local Sustainability. Information Technology for Development, Vol. 12 (3) 225–239

Jarulaitis, Gasparas and Monteiro, Eric. 2009. Cross-contextual use of integrated information systems. ECIS 2009: 2073-2084

Jepperson, R. 1991. Institutions, institutional effects, and institutionalism. In Powel, W., & DiMaggio, P. (eds.). The New Institutionalism in Organizational Analysis. London: University of Chicago Press. pp. 143-163

Jewett, Tom and Rob Kling. 1991. "The Dynamics of Computerization Social Science Research Team: A Case Study of Infrastructure, Strategies, and Skills." Social Science Computer Review. 9(2)(Summer):246-275

Johari Juliana. 2009. Interpretivism in Information System (IS) Research. Putra: University of Putra Press

Kapil, Umesh and Panna Choudhury. 2005. National Rural Health Mission (NRHM): Will it Make a Difference? Indian Pediatrics Vol. 42 (2005): 783

Kaplan, B. and Maxwell, J.A. 1994. "Qualitative Research Methods for Evaluating Computer Information Systems," in Evaluating Health Care Information Systems: Methods and Applications, J.G. Anderson, C.E. Aydin and S.J. Jay (eds.), Sage, Thousand Oaks, CA, 1994, pp. 45-68

Khodjamurodov G, Rechel B. 2010. Tajikistan: Health system review. Health Systems in Transition, 2010; 12(2):1–154

Kimaro, H. C. and S. Sahay. 2007. An Institutional Perspective on the Process of Decentralisation of Health Information Systems: A Case Study from Tanzania. Information Technology for Development, 13(4): 363-390

Kiser, Larry L., and Elinor Ostrom. 1982. "The Three Worlds of Action: A Metatheoretical Synthesis of Institutional Approaches." In Strategies of Political Inquiry, ed. Elinor Ostrom. Beverly Hills, CA.: Sage

Klein, Heinz K., and Michael D. Myers. 1999. "A set of principles for conducting and evaluating interpretive field studies in information systems." Management Information Systems Quarterly 23: 67-94

Kling, Rob and Walt Scacchi. 1982. "The Web of Computing: Computing Technology as Social Organization," Advances in Computers. Vol. 21, Academic Press: New York

Kumar, K., Subramanian, R, and Yauger, C. 1997. "Pure vs. Hybrid: Performance Implications of Porter's Generic Strategies Among Hospitals." Health Care Management Review, 22(4): 47-60

Latour, Bruno. 1999. Pandora's Hope: Essays on the Reality of Science Studies. London, England: Harvard University Press

Lawrence, T. B. 1999. Institutional strategy. Journal of Management, 25: 161-187

Lee, A. 1999. "Rigor and Relevance in MIS Research: Beyond the Approach of Positivism Alone," MIS Quarterly (23:1), 1999, pp. 29-34

Levin, M. 1994. Action Research and Critical Systems Thinking: Two Icons Carved Out of the Same Long? Systems Practice 7(1), pp. 25-41

Lucas. 1975. "An Equilibrium Model of the Business Cycle", Journal of Political Economy, 83, 1113–1144

McKee, M., Figueras, J. and Chenet, L. 1998. "Health sector reform in the former Soviet republics of Central Asia", International Journal of Health Planning and Management, Vol. 13, pp. 131-47

McKee, M., Zvi, A., Koupilova, I., Sethi, D., and Leon D. 2000. Health policy-making in central and eastern Europe: lessons from the inaction in injuries? Health Policy and Planning. 15(3), 263-269

McKee M; Healy J; Falkingham J. 2002. Health care in central Asia. Open University Press, Buckingham, European-Observatory-on-Health-Care-Systems-Series, 0-335-20926-2

McLaughlin, J., Rosen, P., Skinner, D., Webster, A., 1999. Valuing Technology; Organisations, culture and change. Routledge; Abingdon, Oxon

Miles, M.B, and Huberman, A.M. 1994. Qualitative Data Analysis, 2nd Ed., p. 10-12. Newbury Park, CA: Sage

Millerand, F., & Bowker, G. C. 2009. Metadata standards, trajectories and enactment in the life of an ontology. In S. L. Star & M. Lampland (Eds.), Formalizing practices: Reckoning with standards, numbers and models in science and everyday life (pp. 149–167). Ithaca, NY: Cornell University Press

Mirzoev T., Green, .A, and Newell, J. 2007. Progress towards health reform in Tajikistan. Journal of Health Organization and Management, 21, 495-505

Mirzoev, T. 2004. Sector-Wide Approach in the health sector of the republic of Tajikistan: Prospectives and Constraints. Leads, UK. MA dissertation, University of Leads, Nuffield Centre for International Health and Development

Mumford. 2001. Mumford E. 2001. Advice for an Action Researcher. Information Technology & People, 14(1), pp. 12–27

Baskerville, R., & Myers, M. D. 2004. Special issue on action research in information systems: making IS research relevant to practice – Foreword. MIS Quarterly, 28(3), 329–35

Myers M, Avison D. 2002. An introduction to qualitative research in information systems. In Qualitative Research in Information Systems: A Reader. M. D. Myers and D. E. Avison (Eds), London, Sage

Myers, M.D. 2009. Qualitative Research in Business & Management. Sage Publications, London, 2009

Ngwenyama, Ojelanki K. 1991. "The Critical Social Theory Approach to Information Systems: Problems and Challenges." Pp. 267-280 in Information Systems Research: Contemporary Approaches and Emergent Traditions, edited by H.-E. Nissen, H. K. Klein and R. A. Hirscheim. Amsterdam: North-Holland

Ngwnyama, O. K. and Lee, A. S. 1997. Communication Richness in Electronic Mail: Critical Social Theory and the Contextuality of Meaning, MIS Quarterly, 21, 2, 145-167

Nielsen, Petter. 2006. A conceptual framework of information infrastructure building: A case study of the development of a content service platform for mobile phones in Norway, PhD thesis, Univ. of Oslo

Charles Noir, Geoff Walsham. 2007. The great legitimizer: ICT as myth and ceremony in the Indian healthcare sector. IT & People 20(4): 313-333

North, D. C. 1990. Institutions, Institutional Change and Economic Performance. Cambridge: Cambridge University Press.

North, Douglass C. 1991. "Institutions." Journal of Economic Perspectives. 5: 97-112

Kapil, Umesh and Panna Choudhury. 2005. National Rural Health Mission (NRHM): Will it Make a Difference? Indian Pediatrics Vol. 42 (2005): 783

Oakerson, Ronald J. 1992. "Analyzing the Commons: A Framework." In Making the Commons Work: Theory, Practice, and Policy, ed. Daniel W. Bromley. San Francisco, CA: Institute for Contemporary Studies

Oates, Briony J. 2006. Researching information systems and computing. Publisher, SAGE

Olimova Saodat , Igor Bosc. 2003. Labour migration from Tajikistan. International Organization for Migration (IOM). 2003. ISBN 92-9068-163-2

Oliver, C. 1992. The Antecedents of Deinstitutionalization, Organization Studies (Walter de Gruyter GmbH & Co. KG.) 13(4): 563-589

Orlikowski, W. J. and Barley, S. R. 2001. Technology and institutions: What can research on information technology and research on organizations learn from each other, MIS Quarterly 25(2): 145-165

Orlikowski W, Baroudi J. 1991. Studying Information Technology in Organizations: Research Approaches and Assumptions, In Information Systems Research **2**(19): 1-28

Orlikowski, W.J. and Scott, S.V. 2008. Sociomateriality: Challenging the Separation of Technology, Work and Organization, Annals of the Academy of Management, 2, 1, 2008: 433-474

Ostrom, Elinor, Roy Gardner, and James Walker. 1994. Rules, Games, and Common-Pool Resources. Ann Arbor: University of Michigan Press

Ostrom, E., Schroeder, L. & Wynne, S. 1993. Institutional Incentives and Sustainable Development: Infrastructure Policies in Perspective. Boulder, CO: Westview Press

Owen-Smith, J. & Powell, W.W. 2008. Networks and Institutions. In R. Greenwood, Oliver, C., Sahlin, K. & Suddaby, R. (Eds.) The SAGE Handbook of Organizational Institutionalism. Sage Publications, Thousand Oaks, California

Pentland, Brian T., Thorvald Hærem and Derek Hillison. 2010. Comparing Organizational Routines as Recurrent Patterns of Action. Organization Studies 31(07): 17– 40

Piotti, B., Chilundo, B., and Sahay, S. 2006. An Institutional Perspective on Health Sector Reforms and the Process of Reframing Health Information Systems: Case Study From Mozambique. The Journal of Applied Behavioural Science, 42(1): 91-109

Pironti, John P. 2006. Key Elements of a Threat and Vulnerability Management Program. Online, http://www.isaca.org. Availablle from http://www.isaca.org/Journal/Past-Issues/2006/Volume-3/Documents/jpdf0603-Key-Elements.pdf

Pollock, Neil; Williams, Robin and D'Adderio, Luciana. 2007. Global Software and its Provenance: Generification Work in the Production of Organizational Software Packages. Social Studies of Science 37/2 (April 2007) 254–280

Porac, J., Thomas, H., & Baden-Fuller, C. 1989. Journal of Management Studies [JMS], 26(2), 397 - 415

Powell, W. W., & DiMaggio, P. J. 1991. The new institutionalism in organizational analysis. Chicago: University of Chicago Press

Prasad, P. 1993. Symbolic processes in the implementation of technological change: A symbolic interactionist study of work computerization. Academy of Management Journal, 36, 1400-1429

Raghvendra, R.C. and Sahay, S. 2006. "Computer-based Health Information Systems - Projects for computerization or health management?: Empirical experiences from India". In M. Gascó-Hernandez, F. Equiza-López, M. Acevedo-Ruiz (eds.), Information Communication Technologies and Human Development: Opportunities and Challenges. Idea Group Publishing

Richardson, Laurel, and Elizabeth Adams St. Pierre. 2005. Writing: A method of inquiry. In Handbook of Qualitative Research, 3rd ed., ed. N. K. Denzin and Y. S. Lincoln (959-78). Thousand Oaks, CA: Sage

Richardson, L. 2000. Writing: A method of inquiry. In N. K. Denzin & Y. S. Lincoln (Eds.), Handbook of qualitative research (2nd ed., pp., 923-943). Thousand Oaks, CA: Sage

Ritzer, G. (1996). The McDonaldization of Society. Revised ed. Thousand Oaks, Calif. : Pine Forge. 265p

Robey, D., and Sahay, S. 1996. Transforming Work Through Information Technology: A Comparative Case Study of GIS in County Government, Information Systems Research (7:1), 1996, pp. 93-110

Rolland, Knut and Monteiro, Eric. 2002. Balancing the Local and the Global in Infrastructural Information Systems. The Information Society, 18:87–100

Sahay, Sundeep. 2003. "Global Software Alliances: the Challenges of 'Standardization'." Scandinavian Journal of Information Systems, 15:1 3-21

Sahay, Sundeep. 2011. Making Health Information Systems Public Health Friendly: Case Study from India, Master thesis at the University of Western Cape, South Africa

Sahlin-Andersson, K. 1996. 'Imitating by Editing Success: the Construction of Organizational Fields', in Czarniawska and Sevón (eds.), pp. 69–92

Sandiford P, Annett H, Cibulskis R. 1992. What can information systems do for primary health care? An international perspective. Soc Sci Med. 1992 May; 34(10):1077-87

Sanford, P., Kanga, G. J., & Ahmed, A. M. 1994. The management of health services in Tanzania: A plea for health sector reform. The International Journal of Health Planning and Management, 9, 295–308

Sauerborn, R., and Lippeveled, T. 2000. Design and implementation of health information systems. Geneva, Switzerland

Sayer, A. 1993. Postmodernist thought in geography: a realist view. Antipode 24, 320±44

Schulze, S. 2003. Views on the combination of quantitative and qualitative research approaches. Progressio 25(2), pp. 8-20

Scott, W. R. 1994. Conceptualising organizational fields: Linking organizations and societal systems. In H. U. Derlien, U. Gerhardt, & F. W. Scharpf (Eds.), Systemrationalitat und partialinteresse [Systems rationality and partial interests]: 203-221

Scott, W. R. 2001. Institutions and Organizations, (Second ed.). Thousands Oaks: Sage

Scott, W. R. 2008. Institutions and Organizations: Ideas and Interests, (Third ed.). Thousands Oaks: Sage

Shaw, V. 2002. The development of an information system for district hospitals. In S. Krishna & S. Madon (Eds.), Proceedings of the 7th IFIP 9.4 Working Conference, Bangalore, India

Silva, L. and Backhouse, J. 2003. The Circuits-of-Power Framework for Studying Power in Institutionalization of Information Systems, Journal of the Association for Information Systems 4(6): 294-336

Silverman, D. 2006. Interpreting Qualitative Data: Methods for Analysing Talk, Text and Interaction, Third Edition. London: Sage

SSA, State Statistics Agency, Tajikistan. 2011. Tajikistan in figures. Available from http://stat.tj/en/img/2342f4d3bcc13e5b6247c13f8e1fe06c_1311130128.pdf

Star, Susan Leigh, and Karen Ruhleder. 1996. "Steps toward an Ecology of Infrastructure: Design and Access for Large Information Spaces." Information Systems Research, 7:1 111-134

Star, Susan Leigh. 1999. "The Ethnography of Infrastructure." American Behavioral Scientist, 43:3 377-391

Streeck, Wolfgang and Kathleen Thelen. 2005. Introduction: Institutional Change in advanced Political Economies. Pp. 1-39 in Beyond Continuity: Explorations in the Dynamics of 29 Advanced Political Economies, edited by Wolfgang Streeck and Kathleen Thelen. New York: Oxford University Press

Thelen, K. 1999. AHistorical Institutionalism in Comparative Politics.@ Annual Reveiw of Political Science (2): 369-404

Thomas, M. 1994. 'What You Need to Know About Business Process Re-engineering' Personnel Management, 26(1), pp.: 28-31

Thornton, P. H. and Ocasio, W. 2008. Institutional Logics, The Sage Handbook of Organizational Institutionalism. Los Angeles, London, New Delhi, Singapore: Sage Publications): 99-129

Thornton, P.H. 2004. Markets from Culture: Institutional Logics and Organizational Decisions in Higher Education Publishing. Stanford, CA: Stanford University Press

Timmermans S, BergM. 2003. The Gold Standard: The Challenge of Evidence-Based Medicine and Standardization in Health Care. Philadelphia, PA: Temple Univ. Press

Timmermans, Stefan and Steven Epstein. 2010. A World of Standards but not a Standard World: Toward a Sociology of Standards and Standardization. Annual Review of Sociology Vol. 36: 69-89

Tolbert, P.S. & Zucker, L.G. 1996. The institutionalization of Institutional Theory. In. S. Clegg, C. Hardy & W. R. Nord (Eds.). Handbook of Organization Studies (pp. 175 – 190), Thousand Oaks, CA: Sage

Vargas V. and Clary B. 2002. Tajikistan: Sources and Uses of Health Expenditures & Public Health Financing of a Pre-Poor Health Package. SMEC, Dushanbe. Ref Type: Report. Unpublished document

Walsham, Geoff. 2006. Doing Interpretive Research, European Journals of Information Systems, 15: 320-330

Walsham, Geoff. 2001. Making a World of Difference: IT in a Global Context‖, John Wiley

Walsham, Geoff. 1993. Interpreting information systems in organizations. Chichester: Wiley

Walsham, Geoff 1995. "Interpretive Case Studies in IS Research: Nature and Method." European journal of Information Systems 4: 74-81

Walsham, Geoff. 1995. The emergence of Interpretivism in IS research, Information System Research 6(4): 376-394

Walsham, G., Symons, V. & Waema, T. 1988. Information systems as social systems: implications for developing countries. Information Technology for Development, 3(3), 189-204

World Bank. 2007. Integrating Environment into Agriculture and Forestry Progress and Prospects in Eastern Europe and Central Asia. Volume II, tajikistan, Country Review, November 2007, unpublished, available from http://www.worldbank.org/eca/pubs/envint/Volume%20II/English/Review%20TAJ-final.pdf

World Bank. 2011. Improving Statistics for Children's Births and Deaths. Human development sector unit, Central Asia Country Unit Europe and Central Asia Region, World Bank, 2011

Webster, J. and R. Williams. 1993. Mismatch and tension: standard packages and non-standard users, in: P. Quintus (Editor), Social Dimensions of Systems Engineering: People, Processes, Policies and Software Development (Ellis Horwood, New York, London) pp. 179-196

APPENDIXES

APPENDIX I

Sahay, Sundeep; Latifov, Murodillo Abdusamadovich. (2009). “The Data to Indicator (mis)match: Experiences from trying to strengthen this link in the Health Information System in Tajikistan”.

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THE DATA TO INDICATOR (MIS)MATCH: EXPERIENCES FROM TRYING TO STRENGTHEN THIS LINK IN THE HEALTH INFORMATION SYSTEM IN TAJIKISTAN

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Abstract: In the context of health systems generally, and public health in particular, indicators are a specific tool for programme management, including for the analysis and diagnosis of problems and to guide the formulation of relevant corrective action. A key challenge facing the process of generation and use of indicators in developing countries is that there tends to be a significant indicator-data mismatch implying that either indicators are not or can't be calculated with the data (not) being routinely collected or the poor quality of the underlying data which makes the generated indicators unreliable. Drawing on case material from Tajikistan's existing HIS we applied framework of three dimension of (1) completeness, (2) fittingness, and (3) actionability to define ways to improve indicator-data match. The key argument being made in this paper is that if nations are to meet the promised MDGs, then they need to improve this indicator-data match. With this in mind, the aim of this paper is thus twofold: 1. To understand the nature of this indicator-data mismatch; and, 2. To develop practical approaches on how this mismatch can be improved.

Keywords: Indicator, MDG, Health Information System, Framework, Actor Network Theory

THE DATA TO INDICATOR (MIS)MATCH: EXPERIENCES FROM TRYING TO STRENGTHEN THIS LINK IN THE HEALTH INFORMATION SYSTEM IN TAJIKISTAN

1. INTRODUCTION

On September 6th, 2000, at the Millennium Summit a large gathering of world leaders adopted the UN Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets, with a deadline of 2015 that have become known as the Millennium Development Goals (MDGs). Three of the 8 MDGs identified were directly related to health care: reduce child mortality (MDG4); improve maternal health (MDG5); and, combat HIV/AIDS, Malaria, and other diseases (MDG6). Each of these goals are measured through specific indicators, which have to be accurately measured and monitored in order to evaluate how respective nations are achieving their MDGs. However, in order to do this, the specific numerators and denominators that go into the formula for the calculation of the indicators need to be accurately captured, aggregated and computed using the formula. The generated indicators then need to be interpreted and analyzed by the concerned health programme managers to take appropriate interventions in order to make timely corrections. The data which make up the numerator and denominator are usually provided by the national routine Health Information System (HIS) of a country. A key challenge facing the process of generation and use of indicators in developing countries is that there tends to be a significant indicator-data mismatch implying that either the indicators cannot be calculated with the data being routinely collected or the poor quality of the underlying data means that the indicators generated are not reliable. A key argument made in this paper is that if nations are to meet the promised MDGs, then they need to improve this indicator-data match.

With this in mind, the aim of this paper is twofold: 1. To understand the nature of this indicator-data mismatch; and, 2. To develop practical approaches on how this mismatch can be improved. The empirical setting within which these issues are explored is the Tajikistan health system, which is also a signatory to the MDG declaration. Specifically, an analysis has been conducted of their national HIS to understand its capability in being able to provide the necessary numerators and denominators required for the generation their key indicators. This analysis is carried out at two levels. Firstly, a broader analysis of the national HIS to study the existing structure and flows of the information within the health system. Secondly, and more concretely the database comprising of the national HIS is carried out to understand specifically the nature of the indicator-data mismatch. This analysis then provides the basis to develop practical strategies on how to address these gaps to strengthen the systems such that more accurate and actionable indicators are made available to health managers responsible for strengthening health services delivery.

2. THE NATURE OF THE INDICATOR-DATA LINKAGE

In the context of health systems generally, and public health in particular, indicators are a specific tool for programme management, including the analysis and diagnosis of

problems and also for taking corrective action. Indicators are abstracted knowledge from broader information sets and composed of comparison on different relevant factors, or sometimes single units of information to support decision making processes or for measuring levels of achievements. For example, the indicator of full immunization coverage is broadly a measure of the effectiveness of the immunization program indicating what percentage of live births taking place in a particular catchment area have got all their vaccination shots (BCG, TT, DPT etc) in a pre-specified time period (less than 12 months). The national level for example can take the immunization coverage of a state and compare it with other states and also over time as a measure of performance and use this analysis to take decisions like which state needs what kind of vaccine stocks and when. These figures have to be also reported by the national level to international agencies like GAVI and WHO that monitor a nation's progress with respect to the MDGs. Similar analysis can be conducted at the state and sub-state levels, where the immunization coverage indicator may also be supplemented with some other specific monitoring indicators such as BCG-TT drop out rate which reflects what percentage of the children who took their BCG shot did not take their TT shot. Such detailed monitoring indicators like drop out rates are required to better manage service delivery while immunization coverage is used more as an "impact" indicator to study how the overall program is doing with implications for health policy.

The above examples illustrate at least two points. Firstly, with different levels of the health administration (from sub district to district, state, national and international), the types of indicators used vary, and also to the kind of use they are put to. Secondly, each indicator has a specific numerator and denominator. In the first example, the numerator used in "total number of children fully immunized" while in the second the numerator is "Total number of children who received TT shots MINUS Total number of children who received BCG shots." Similarly, the denominators also vary with the first example using "Total number of live births" and the latter "Total number of children given BCG shots." In both cases the factor used in %. Given this, it is imperative that the numerator value is being provided by the HIS, implying that the data element "Total number of children fully immunized" is included in the forms being filled in every month by the health workers, and the data being filled against this data element is of good quality. If that is the case, we can say one dimension of the indicator-data match, let us call it "completeness," is adequate.

Another dimension of this match can be identified when we take the health systems perspective whereby we look at all the health programs say that a particular district has to administer. Suppose, there are ten such programs and each of them have 2 indicators, then at least 20 numerator and 20 denominator values would need to be provided by the HIS. And if we further assume that each numerator and each denominator is made up of one data element, the HIS should periodically provide data on 80 data elements on a timely basis to the health program managers. If the HIS is providing data on exactly these 80 elements, then it can be seen to be a precise and actionable HIS. However, if it provides data on say 200 data elements (including the above 80) then the HIS can be described as a "redundant" system. And if some or all these 80 data elements are not

included (in the 200) in the HIS, it can be described as both a "redundant and inefficient" system. Let us call this dimension of the indicator-data match as "fittingness."

While the dimensions of completeness and fittingness give us a sense of the data supply end, another key facet concerns how the indicators are understood and used by the health program managers for supporting their everyday action. Let us call this dimension "actionability" of the indicator-data match. While the generation of indicators can be seen as a necessary condition for their use, they are not sufficient. To provide it with the property of sufficiency, the indicators should be easy to understand, well presented, and the decision makers should have the capacity and the will to understand and use the indicators. This may be the hardest aspect of the indicator-data match, as building it requires large and sustained investment in building capacity of the information users on the use of information. This involves a cultural shift from using data just for the generation of tables of aggregate numbers for upward reporting to the generation and use of indicators for local action (Braa et al 2004).

The three identified criteria of completeness, fittingness, and actionability, taken together provide us with the basis of an analytical framework to examine the indicator-data match. Further, these three criteria are interconnected, because for example if fittingness is poor, so will be its actionability because if the indicator cannot be generated in the first place, it inherently cannot be used and be actionable. This analytical framework is applied to the empirical data on the indicator-data match drawn from the Tajikistan study.

3. RESEARCH METHODS

The research methods adopted were aimed at firstly gaining an understanding of the broader situation of the HIS in Tajikistan, and then, secondly, to concretely analyze the indicator data linkage.

3.1 Situation analysis

With regards the situation analysis, the empirical setting was defined by an existing initiative by the Asian Development Bank (ADB) that was supporting the Tajikistan Ministry of Health through the creation of an institutional structure called Health Sector Reform Project (HSRP). The HSRP became the focal point through which technical assistance was being channeled to the Ministry on various areas, including HIS which is the focus of this paper. One of the authors of the paper was invited by the ADB to support this process of HIS reform which had been ongoing over the last couple of years. The various previous efforts, such as studies by consultants or project reports of HSRP were studied in depth to get a sense of the status of the existing efforts. The national HIS consultant at HSRP was a crucial link in this process that could provide continuity to the events and narrate the past and help to focus on the current needs. Numerous discussions, formal and informal, between the first author and this consultant helped to gain a sense of coherence to the various pieces of the story. For example, she described how a Pakistani consulting group had been hired by HSRP to develop the strategic conceptual framework for the national HIS reform. The mandate now was to take this framework as the point of

departure, and try to move towards actually developing and implementing a computer based HIS. Reading the report of the Pakistani group proved invaluable in getting an understanding of the framework. Similarly, reports of the HSRP efforts, such as around the rationalization of the indicators which involved a reduction from 1300 to 833 indicators provided concrete information on which indicators were relevant to the national ministry. Some of the other reports referred to were: "Health for all to 2005" national strategy (1997), National programme of health care reform (1998), AIDS prevention (1993), and the Law on Health Protection of the population (1997).

After gaining an overview of the background, personal interviews were conducted with various program level managers at the national level, plus staff at the Medical Statistics division who were responsible for the operation of the HIS. The program level managers included immunization, maternal health, HIV/AIDS, tropical diseases, epidemiology and TB. In total, about 15 interviews were conducted, each lasting about 90 to 120 minutes, and involving a translator. Each interview was conducted in Russian, and the translator first translated the questions posed by us, and then the answers. The translated answers were noted in a diary that was then subsequently elaborated upon as field notes. It is interesting to point out that while the native language of the respondents was Tajik, their medical education had been carried out in Russian. So, they were much more comfortable in answering technical questions in Russian rather than in Tajik. Also, contributing to the situation analysis was a detailed study of the existing data recording and reporting formats. There were nearly 37 data recording formats each of them containing multiple sub formats. For example, one of their reporting formats had more than 50 sub formats running to more than 100 pages. The bulk and redundancies of the formats and data were a potent reflection of the existing data-indicator mismatch. At least three sets of presentations were made by us to audiences at the HSRP, the national Ministry of Health, and at a national workshop. The comments received during these presentations and the ensuing discussions helped in the fine tuning of the situation analysis. A final report of more than 150 pages submitted to the HSRP and ADB elaborated in detail on the overall analysis.

3.2 Database analysis

A copy of the database was obtained through HSRP which included the data being entered in the HMIS from 6 pilot districts were the HMIS was being implemented. This database was analyzed firstly for identifying duplicate data elements (same data being recorded in different forms) and also redundant data elements (for example, data elements that recorded "Totals" of a particular category and also the various "Totals" of the different sub-categories. To identify the data-indicator (mis)match, we took the 833 indicators and their respective formulas (numerator and denominator) as the starting point. Then working backwards, we tried to identify whether the numerator and denominator required for the calculation of the indicator were included in the database or not. Following from this, we could also identify which of the data elements that were currently included in the database were actually being utilized for the calculation of an indicator. Interestingly, this led to an estimation of a figure of nearly 90% of "un-utilized" data elements, reflecting the gross data-indicator mismatch.

Following this brief description of the research methods employed, the case study is presented.

4. CASE STUDY

4.1 Case setting

The empirical setting for this research is Tajikistan, a country located in Central Asia with a territory of 143,100 square kilometers, population of 6.7 million (UN, 2007) that shows an annual growth rate of 3.0%. Nearly half of population is below the age of 15 years. The Republic of Tajikistan is governed by the President and an elected Parliament, and is administratively divided into the capital – Dushanbe city, four regions (called "viloyat"), which in turn are divided into sixty seven districts (called "nohiya"), that have further smaller municipal areas called "jamoat". After independence from Soviet Union in 1991, Tajikistan faced a grueling civil war in which up to 50,000 people were killed and over one-tenth of the population fled the country. This unrest ended in 1997 with a United Nations-brokered peace agreement. The abrupt breakdown of the centrally managed Soviet system and the consequences of the civil war contributed to a poor economy, damage of the public utility systems of water supply and heating, which magnified the spread of various communicable diseases. A recent WHO report indicated a decrease in life expectancy owing to poor nutrition, polluted water, and increased incidence of malaria, tuberculosis, typhoid, cholera, and cardiovascular diseases (WHO 2008).

Despite the independence from Soviet Union, it can be said the health system has continued thus far with few structural changes, and still comprising of the Ministry of Health, and its regional and district offices. There are specialized hospitals at the national level for more complex care, hospitals at regional and district levels, with health centers and health stations at the municipality level. Some ministries and government agencies have their own specific hospitals. Even with respect to the HIS, we see the legacy of the Soviet system still dominant with a high focus on the collection of statistics and their centralized compilation and reporting as an annual statistical exercise at the national level. While the Soviet legacy lives on in terms of this focus on statistics, the supporting systems of expertise required for statistical analysis is much more limited than what existed pre-1991.

In the existing HIS, the existing information flow started with the primary instruments of recording forms (258 in number) which provided the basis for the generation of 37 reporting forms, which were then sent up various levels to the national statistics and the State Statistical Committee for the calculation of various required statistics. The reporting forms were designed for the historically existing paper based systems underlying the Soviet system logic of centralized management. Redundancies were rampant, for example there were data elements for "Total" of a particular disease under different age categories, while also having different total figures for each of these age categories. This

made the Total figure (of all categories) redundant as it should be calculated rather than a manually entered field.

Through the interviews conducted, various common themes were identified with respect to the HIS. A key theme concerned how the existing HMIS was primarily data driven and not action led, implying its primary focus on reporting for meeting the needs of the bureaucracy rather than on the analysis and use of information for action. The focus of the HIS was on the collection of statistics, which at the end of the year was used for the annual compilation of a comprehensive health statistics book. While there were approximately more than 30,000 data elements being collected through the information system, very few indicators were generated. While through the reform process undertaken by HSRP, a total of 833 indicators were identified, these had still as yet not been operationalized into the HMIS.

There was extreme fragmentation of information flows, with multiple parallel and uncoordinated flows inherent with redundancies and duplications. For example, under the TB program some provinces (Oblasts) entered data in EpiInfo and sent it to the national level TB centre. Since the data format in which the national Medical Statistics division wanted was incompatible with EpiInfo,, the national TB center manually copied the data from EpiInfo into a paper format, transmitted it manually where it was entered into the MedStat program. Further, there was no hierarchy of information recognized, and all the data collected at the lower level flowed to the Republic level with limited abstraction and analysis. The focus on upward reporting lent itself to almost no feedback aimed at improving action and also increasing the motivation of staff who only saw their task to collect and transmit upwards huge amounts of data. Table 1 shows number of data elements contained in each form. As pointed out earlier there are 37 forms (for data entry and which also server as report formats), and in each form there are multiple categories, or what can be described as “sub-forms.” In the table below, the first column gives the form number (from 1 to 37), and the second column enumerates the number of data elements by all categories.

Form Number	Number of Data Elements X Categories	Form Number	Number of Data Elements X Categories
1	1298	17	406
2	208	18	13495
3	156	20	412
5	134	30	1836
7	1157	31	269
7H	156	32	475
8	336	33	311
9	340	34	348
10	220	35	994
10A	76	36	375
11	200	37	272
12	3027	39	249
12A	153	40	43
12O	132	41	56
13	96	42	22
14	1266	45	10
15	68	47	2886
16	60	71	12
Grand Total	**31554**		

Table 1. Number of data elements by form for all categories.

As the above table indicates, a vast amount of data was expected to be collected by the field staff. However, on an examination of the data in the Messtat database provided to us (for 2005/6), we found a high percentage of this data being left as blank or filled as zero. The table below gives an example of the high percentage of such blank/zero values.

Form Number	Table Name (multitable forms)	Number of entries	Number of zero/missing values	% of zero/missing values
	Infectious disease	76370	66153	86.62
	Parasitic diseases	8576	6913	80.61
1	Hospital acquired diseases	11286	11127	98.59
	Reproductive health facility activities	1360	148	10.88
	Contraceptive resources	3060	1483	48.46
	Contraceptive health	3672	1426	38.83
5	Contraceptive assistance	3264	627	19.21
7		91403	82645	90.42
8		22848	16158	70.72
9		26928	23352	86.72
10		16214	13243	81.68
10D		7548	6702	88.79
11		15488	14303	92.35
12		692736	542084	78.25
12D		17226	13306	77.24
12O		11154	6741	60.44
13		11232	8920	79.42
Total		**1020365**	**815331**	**79.91**

Table 2. MedStat database zero/null values

As the above table indicates, the percentage of missing/zero values is approximately 80% with Form 7 and 11 even indicating an average of greater than 90%. This extraordinary high percentage raises the question of whether this data is required and if they are used for any indicator calculation and identification of action points.

The formats for reporting were poorly designed, containing numerous tables, sub-forms and sometimes even a thousand data elements. In the same form, no distinction was made between annual and monthly data, or between data required for diseases and those on infrastructure and staff. Such data was hard to be used for formulating actions for correction. Same data was reported in different forms, for example Form 30 and 32 had identical data elements regarding maternal health and child mortality.

The current HMIS software being used at the national level was called MedStat, which was developed using Microsoft Visual FoxPro and deploying .dbf tables for data storage. MedStat was poorly designed and represented just an electronic reflection of the paper based system, with all its existing inefficiencies. The example of "Total" provided above, although originally designed to support the logic of a manual system, was also mirrored in the software. The software had no functionalities for indicator calculations and other visual analysis tools such as graphs and charts. In summary, the software was outdated, poorly supported, and grossly inadequate for the generation of indicators, and their linking to specific organizational units.

For the analysis of the database to understand the data-indicator linkage, we first studied the list of indicators mandated by the Ministry. There were 834 indicators grouped into 6 main categories: demography, healthcare resources, environment, healthcare services, MDG and life style. In general we found that the data available from the 37 report forms could be used to calculate approximately 40% of these indicators. For example, the indicator *"Obstetric aid rate with the participation of specially trained health workers," related to MD*G5, required data from different sources: Forms 30 (Report on treatment of prophylactic activity of facility), 32 (Report on medical aid to pregnant, parturient and puerperal women) and 16 (Report on collective farm medical centers). Form 30 contained from both facility and service data, while 32 contained data elements related to maternal and child health. There were duplications of data leaving the situation ambiguous of what data should be used for which indicator calculation. Many indicators in the list were based on surveys (and not routine data) or were the responsibility of other State Agencies, mainly from the Republican Statistical Bureau (RSB). Table 3 below demonstrates percentage of data coverage of indicator needs, to summarize the indicator data mis(match):

Indicator Groups	Qty of indicators in group	% of data availability from existing data elements (apr.)
Demography	353	30
MDG	12	50
Life Style	28	20
Environment	89	5
Health Conditions	224	90
HC Resources	128	70
Average		**44.17**

Table 3. Indicator data match by indicator groups

After presenting the results of the situation analysis and the database analysis, we now move to the discussion section where we examine the indicator-data match, using the three dimension framework of completeness, fittingness, and actionability.

5. DISCUSSION

5.1 Completeness

The dimension of completeness refers to the gap between what data is required for the generation of indicators and whether that data is being provided for by the routine HIS. The data presented in Table 3 indicates that only about 45% of these data needs are met. This gap is especially high with respect to indicators on Environment, Lifestyle and Demography. The reason for this could be these indicators are not directly the mandate of the health department who are therefore not capturing the data. Only about 50% of the data required for the generation of the MDGs are currently being collected.

5.2 Fittingness

Our analysis reveals an extremely poor fit with respect to the data-indicator linkage. On an average, the number of data elements used in an indicator calculation is 2. So, for the currently defined 834, we need a total of about 1668 data elements. Further, if we assume that each data element has on an average 8 categories (taken on the higher side), we require a total of 13,344 data element units, which represents 42.3% of the current Tajikistan HIS size (31,544). This implies that 57.7% of the existing data elements have no value for indicator calculations, and are hence redundant. This redundancy reflects a very poor fit between data and indicators. Further, in many cases, the data collected is not relevant with respect to the indicators being generated. For example, the MDG6 indicator calculation (United Nations 2001) requires data on women in age category of 15-24 years, whereas the Tajikistan HIS provides 15-19 years data.

5.3 Actionability

The current HIS is extremely poor on the dimension of actionability on at least two counts. One, no indicators are currently generated from the existing Medstat system. However, from this system, some of the data elements are extracted and fed into another system (called DPS – Data Presentation System), and about 5 indicators are generated

which are uploaded on a WHO system. These indicators are not made available to the lower level program managers to support their everyday monitoring and evaluation purposes. These 5 indicators may be using less than 50 out of the 31,544 data elements (less than 1%) reflecting the high degree of non-use of data for action. Two, all the data which is collected by the lower levels are fed to the national level with no degree of abstraction and aggregation. If we go by the basic principle that the lower levels are responsible for monitoring related action, and the national level for evaluation and impact analysis, then they should receive different kinds of data and indicators for their respective action. However, that is not the case in the existing system, implying a high degree of lack of actionability. Furthermore, the number of indicators proposed by MoH (834) covers too large a spectrum to be directly relevant to the health care system, such as related to lifestyle. From the perspective of, for example, the monitoring of MDG related indicators, the existing ones are only peripherally actionable.

6. CONCLUSIONS

We have explored existing data used in the Tajikistan HIS using a proposed framework of interdependent dimensions in order to discover overlaps, duplications and ambiguities that adversely influence data quality more broadly and with it the data-indicator linkage more specifically. The analysis shows that the existing data elements being generated by the HIS are not useful, relevant and actionable with respect to the operationalization and use of indicators. If Tajikistan, and also other nations, need to achieve the prescribed MDGs (MDG 2004), the HIS should support a more effective monitoring of the progress on specified parameters, based on the strengthening of the data-indicators match on the three key dimensions identified in the analytical framework.

Addressing this mismatch could be guided by Braa et al's (2007) proposed strategy of "Flexible Standards" for HIS in developing countries based on complexity science (Holland 1995; Holland 1998). This approach involves defining a hierarchy of data standards for different levels of the health administration, with the lowest level (the community) requiring the most disaggregated level of detail and the highest (the national) most aggregated. Each level further has the freedom to add locally relevant data and indicators as long as they don't delete those that are required for the level above. Each level then has their own "essential dataset" that has a clear match with the indicators required to be generated at each level. To apply this principle, Tajikistan will need to define the MDGs (and other nationally required indicators) as requirements for the highest level (and with it the corresponding data sets). The level below (say viloyat) then must necessarily collect the data required for the generation of the national core indicators, plus they can add those indicators that their level requires and with it the required data elements. Similarly, the hierarchy principle applies for the levels below. However, creating this order as complexity science guides us (Dooley 1997) is an emergent rather than a predetermined process in which outcomes are often largely unpredictable. To engage with this process, Braa et al (2007) argues to identify the agents who can be seen as semi-autonomous units that seek to maximize some measure of goodness, or fitness, by evolving over time. An example of an attractor could be the norm of an "essential data set" that reflects an effective compatibility on the dimensions of

completeness, fittingness and actionability with respect to the data-indicator linkage. Creating and spreading this attractor is a politically fraught process, and requires ongoing political negotiations with the different stakeholders who may "own" different components of the HIS. Tajikistan needs to set up such a process of political negotiations but guided by the principle of the flexible standards to try and strengthen the data-indicator linkage and with it the monitoring and evaluation mechanisms towards reaching the MDG goals.

7. REFERENCES

Braa at al 2004. Networks of Action: Sustainable Health Information Systems Across Developing Countries, MIS Quarterly Vol. 28, No 3, pp. 337-362/september 2004

Braa at al 2007. *Developing Health Information Systems in Developing Countries: The Flexible Standards Strategy*, MIS Quarterly Vol. 31 Special Issue /August 2007

Dooley, K. (1997): "A Complex Adaptive Systems Model of Organization Change," Nonlinear Dynamics, Psychology, & Life Science, Vol. 1, No. 1, p. 69-97.

Holland, John Henry (1995). "*Hidden Order: How Adaptation Builds Complexity*." Reading, MA: Helix Books.

Holland, John Henry (1998). " *Emergence: From Chaos to Order*." Addison-Wesley, Redwood City, CA, ISBN 0-201-14943-5.

MDG (Millennium Development Goals) Needs Assessment Team Tajikistan. 2004. *MDG Needs Assessment Interim Report.* Tajikistan.

MoH (Ministry of Health) RT. 2002. *National Concept of Healthcare Reform of the Republic of Tajikistan.* Dushanbe, 2002.

MoH (Ministry of Health) RT. 2004. *Strategic Program on counteraction of HIV/AIDS epidemic within the system of the Ministry of Health of the Republic of Tajikistan for period 2004-2010*. Dushanbe.

MoH (Ministry of Health) RT. 2003. *Program on Combating Tuberculosis in the Republic of Tajikistan, (DOTS) for 2003-2010.* Dushanbe.

MoH (Ministry of Health) RT. 2005. Recommendation of Working Groups of the Ministry of Health of RT. *Primary Healthcare System, Immunization, Formation of healthy Living, Malaria, HIV/AIDS, Tuberculosis, Helminthes.*

United Nations (2007), *Human Development Report 2007/2008*, United Nations Development programme 1 UN Plaza, New York, New York, 10017, USA, ISBN 978-0-230-54704-9.

United Nations (2003). *Indicators for Monitoring the Millennium Development Goals* ST/ESA/STAT/SER.F/95, United Nations Publication, Sales No. E.03.XVII. 18, ISBN 92-1-161467-8, United Nations 2003

United Nations (2001). *Indicators of Sustainable Development: Guidelines and Methodologies*. Sales No. E.01.II.A.6. Available from http://www.un.org/esa/sustdev/natlinfo/indicators/isd.htm .

United Nations (2003). *Millennium Indicators Database*. Statistics Division Internet site http://millenniumindicators.un.org.

WHO Regional Office for Europe, 2000, *Health Care Systems in Transition – Tajikistan 2000*, European Observatory on Health Care Systems, Copenhagen

WHO *2008. World health statistics 2008.* WHO Library Cataloguing-in-Publication Data, ISBN 978 92 4 156359 8 (NLM classification: WA 900.1)

APPENDIX II

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PRACTICAL APPROACHES TO DESIGNING STANDARDS: THE CASE OF A DISTRICT HOSPITAL INFORMATION SYSTEM IN NORTHERN INDIA

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Abstract: This paper explores the issue of designing standards within the setting of a district hospital system in the context of a Northern State in India. The aim is to develop a practical approach to the design and implementation of standards during the course of the evolution of a hospital management information system (HospMIS) first in one hospital, and later to be scaled to a total of 20 such hospitals in the state. A three level framework of health information standards comprising of information needs, software and interoperability as been evolved through the HISP (Health Information Systems Programme) initiative is drawn upon to approach this issue of standards. While this framework has indeed been a very useful lens to understand standards, we have also contributed to its extension by additionally focusing on issues relating to the process of development, implementation and scaling of standards.

Key words: HospIS, Standards, OpenMRS, Scaling

PRACTICAL APPROACHES TO DESIGNING STANDARDS: THE CASE OF A DISTRICT HOSPITAL INFORMATION SYSTEM IN NORTHERN INDIA

1. INTRODUCTION

While Hospital Information Systems (HospIS) based on Electronic Medical Records (EMRs) are indeed a popular phenomenon in the West (Coiera 2003, Øvretveit et al., 2007), and also to some extent in private hospitals in the developing world (Chae et al. 1994, Rotich 2003, Seedberg et al., 2009), they have found limited use in district hospitals within the public health system of the developing world. The reasons for this are both institutional and technological. Public health systems by and large have focused on primary health care, and correspondingly technology development efforts have been on the "HMIS" (Health Management Information Systems) for aggregate facility based statistics. District hospitals, which are predominantly curative in focus, have been largely ignored in computerization efforts to date. Arguably, patient based EMR (Electronic Medical Record) systems are more complex (at least technically) than HMIS, and since success in the HMIS domain has been also rather limited across the developing world, some may argue district hospitals are not ready for EMRs. Stories of experiences of implementation of EMR systems both from "infrastructure rich" contexts of the West (for example, McDonald 1997, Conn 2007) and from the developing world (Shaw 2003, Fraser et al. 2005, Sheraz 2010) have been far from encouraging, and have till date provided a strong deterrent to new developments, magnified greatly by their prohibitive costs.

There are strong arguments for strengthening HospIS of district hospitals in the developing world. Firstly, district hospitals typically consume significant proportion of district health budgets, and also provide a large chunk of primary health services related to antenatal, delivery and immunization. Ignoring district hospital data makes the district database significantly incomplete. Further, information about the working of the district hospital can provide useful insights into the effectiveness of referral linkages with the primary health facilities in the district. Data on communicable and non-communicable diseases required for national reporting to a majority extent are provided by district hospitals. Given this need for stronger and more integrated HospIS, a point of debate that is pertinent is not whether such systems are relevant but rather what kind of systems are appropriate? Should the focus be only on the aggregate statistics coming out from the hospital, or a "semi-EMR" which records patient based episodic details without attempting longitudinal tracking, or a relatively full blooded EMR but still not as may be seen in the West, say with electronic imaging?

Increasingly, as seen during the course of our work on health information systems implementation in India, there is an increasing demand from state health departments for EMR systems in their district hospitals. There is naturally a lack of clarity on what constitutes an EMR system; the hospital administrators don't fully comprehend the possibilities as vendors continue to sell them dreams of fully integrated paper less hospitals where patients in remote rural areas are scheduled for appointments on SMS and X rays and scans are part of the electronic archive!! Without going into a discussion on why these dreams are utopian, the important point in the context of this paper which focuses on the issue of ***standards*** is to understand what constitutes relevant standards in a HospIS, and what are practical approaches to their effective design and implementation. Standards are increasingly being identified as being fundamental to the effectiveness health information systems (Braa et al. 2007), in the context of both primary health (Hanseth et al. 2006) and also hospitals (Shaw

2009). However, given the relative novelty of HospIS in district hospital information systems in the developing world, not much has been written about the nature of standards, and even less so about how these are developed and implemented. Our experience of nearly 15 years of engagement with health information systems in the developing world under the HISP (Health Information Systems Programme) initiative (Braa et al. 2007), leads us to argue standards developed and implemented top down and which seek to be universal are doomed for failure. Instead, the HISP philosophy has been towards the realization of "flexible standards" (ibid) through engagement on the ground, representing "the third way" between universal standards on one side and complete relativity on the other (ibid).

While these ideas and concepts have been developed primarily through our engagement in the primary health care sector over the last decade, there are strong reasons to argue they will also find relevance in the district hospital system. The aim of the paper is thus to understand the nature of standards and approaches to their practical implementation in the context of a HospIS in district hospitals. Our empirical site primarily is a district hospital in Northern India, which we anonymously refer to as DDH. The broader empirical mission has involved the design and development of 10 modules (registration, billing, laboratory, radiology, pharmacy, inventory, out patient department (OPD), in patient department (IPD), blood bank and finance) which need to be deployed as an integrated HospIS first in DDH and then scaled to 19 other hospitals within the district system in the state.

The rest of the paper is organized as follows. In the next section, we provide a brief overview of the research context and methods used, followed by a theoretical section on standards – how can they be conceptualized within the domain of health information systems. Following which, we discuss the empirical case including the processes of requirements gathering and its interaction with design and development with a focus on standards. In the analysis section which follows, we use the framework discussed in section 2 to outline the nature of standards with corresponding examples emanating from the empirical work. In the discussion section, we discuss more broadly the issue of standards for district hospitals in developing countries and the challenge in making them scaleable.

2. RESEARCH SETTING

The research is based in a state in Northern India which has developed a memorandum of understanding (MoU) with HISP India for the design, development, implementation and support of integrated HospIS, first in one hospital in the state capital to be subsequently scaled to the other 19 district hospitals in the state within a two year framework. There were various rounds of discussion between the state and HISP about what should constitute the core modules of the HospIS which were ultimately narrowed down to the 10 modules listed earlier representing a subset of 20 modules which the state had scoped earlier based on a vendor initiated requirement analysis. Further, a broad schedule was agreed upon for the implementation of the modules, featuring first the registration and billing modules (which were important for DDH because of the public interface) and then followed by other modules. It was agreed that OPD, being a complex module, would be taken up later.

The study is based on action research principles of collaborative action (of the HISP team with the state), where there is mutual engagement in defining problems, participation in identifying solutions, and processes of interventions. There have been continuous and iterative cycles of action, review and revisions based on mutual inputs. Outputs from this process have resulted in insights useful for practice and also to help generate new knowledge, in this case related to standards in the context of HospIS for district hospitals in developing countries. (Jacucci et al., 2006, Tierneya 2010, Øvretveit et al., 2007).

The HISP technical team was comprised of 10 people with a 11th serving as the project coordinator. Roughly half the team was responsible for implementation issues including gathering requirements, documentation and communication with the development team, participating in design discussions, and testing and training the hospital staff once the modules were in place. Developers comprised the other half of the team, with the responsibility of finalizing design, carrying out development and trouble shooting. As can be expected, there were challenges in defining these work boundaries and responsibilities which were constantly subject to negotiation and redefinition depending on personalities, availability, and the complexity of the task. In addition to the onsite team, there was support sought from global HISP team especially on issues relating to technicalities of OpenMRS (the chosen development platform), issues of server management, and more general questions on EPR (Electronic Patient Record) design such as related to security.

The process broadly involved of initially creating a two person team for each module (one each from development and implementation) with the implementer having the primary responsibility for requirements and the developer for development of that module. There were various challenges experienced in operationalizing this process, including knowledge gaps that existed between the team members, and often the developers privileging technical knowledge over the health or implementation systems. Trying to plug these gaps required a healthy atmosphere of mutual learning and trust, which was often not forthcoming leading to frequent crisis situations and fire fighting action. These created attritions in the team, but over time a reasonably steady state has been achieved with a core group of dedicated team members in place having a reasonable understanding of both the technology and the hospital systems.

As we write this paper, the first (and in some cases second versions) of 6 of the 10 modules have been deployed in the hospital, which were officially inaugurated by the Health Minister of the state. The plan is to have the completed integrated system in place for a March 31st inauguration by the State. While there are many stories to tell about the various processes, our focus in this paper is on the issue of standards.

3. THEORETICAL PERSPECTIVE: STANDARDS FOR HIS IN DEVELOPING COUNTRIES

This issue of standards requires a conceptual understanding, and in the current empirical case they manifest at different levels. At the first level, it is within a module of what should be the data collected, their formats and frequency. At the next level is between the modules, as there must be standards which enable different modules (for example billing and laboratory) to speak to each other. This involves the challenge of understanding requirements, a problem magnified by the fact that the hospital staff is unable to articulate them clearly (and for the implementation team to understand), making it complex to both develop appropriate design, and then finding the appropriate software solution. At the next level, the aim is for this application developed in the context of one hospital to be scaled up to all the other district hospitals in the state, and further have it generic enough that other states may also find it useful for their hospitals. At the next and more global level, since this development is being carried out in the framework of the global HISP network, there is also the need to consider how the application can have larger global implications. Standards provide the important glue to understand these different levels of scaling.

3.1 A Framework to understand standards

The topic of standards and interoperability is not new in IT, but in case of healthcare (especially in developing countries) it is still in a rather nascent stage and a subject of various debates. Beale (2004) differentiates health IT from ITs in other domains in the way they treat persons: "*It is often asked: what is the difference between health IT and IT in other domains? One well-known answer is "the patient". Systems in other domains such as banking and airline reservation have "customers" or "travelers" but these are grossly simplified abstract versions of a person. "Patients" in clinical systems are anything but: their biological and social complexity is manifested directly in clinical information, posing a far greater challenge than in other domains. ...*" (p. 301). For example airline reservation system may have a number of clearly defined procedures, like booking, purchasing or cancellation, each consisting of predefined formats and number of data elements. Indeed, in an EMR, the patient may undergo different routes of healthcare services depending on the illness and procedures for that particular treatment. Moreover data collected for one process may vary from the other; patient with positive X-ray results will have different prescriptions than with negative X-ray, negative result may even lead to other X-ray tests and so on. In one word there is a need to uniformly address these complex interactions in patient – care relations. Over time, various standards have emerged in the health domain to address representations, storage and transfer of patient records, namely HL7 v3 (2003), ISO18308 (2004), ASTM Committee E31.19 (2004), CEN 13606 (2004), HL7 Clinical Document Architecture (CDA) (2005), ICD1…10 (1900 to 2005) . Without going into the details of these (see www.openclinical.org for more details), it can be broadly stated that most of these standards have come into being largely in the context of Western hospitals, and making them relevant to the context of developing countries requires a lot of adaptation work, or the creation of new standards. In the last few months, the WHO has announced a standard called SDMX.HD (www.sdmx-hd.org) that is specific to the developing country context, providing guidelines on data transfer from patient systems to aggregated facility systems. But this touches upon only partially (related to interoperability) the issue of standards from our perspective.

A general framework to understand the different levels of standards which has emerged out of the HISP engagement with health systems over the last 15 years is depicted in Table 1 below.

Three Levels of the Health Information Architecture	
Level 1: Information needs, users and usage	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 organizational. The defining layer of the architecture!
Level 1 uses services from the level below (level 2)	
Level 2: Software applications and information systems	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	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.

Table 1: Three levels of the Health Information Architecture

This table can also be conceptualized as in Figure 1 below, with a focus on interoperability issues.

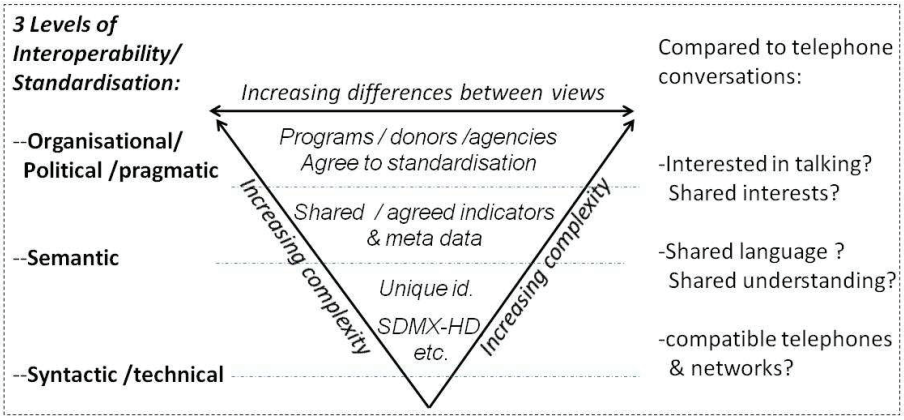


Figure 1: Three levels of standardization of increasing differences and complexities

- **Syntactic / technical level:** Data transfer and interoperability. For example, the SDMX-HD standard is a syntactic description of how to write the data for export in a file so that it can be

understood by the system importing the file – thus compatible with both the sender and receiver. In a manual system, paper based registers and data reporting formats will be similar. Also here the data to be registered or reported are syntactically described so that it can be understood both by the sender and receiver. The practical difficulties in changing paper based reporting forms make up an important driving factor in the fragmentation of HIS and problems facing data standardization. While SDMX-HD is software based, and therefore changeable, paper formats are hardware based, not changeable!

- **Semantic level:** Meaning and shared understanding. This is the level of standards for data and indicators, data and indicator dictionaries and meta-data on e.g. procedures for calculating indicators, health facility lists with related data and categories, ICD10, the international classification of diseases.
- **Pragmatic – organizational, political level:** This is the level with decision making power when it comes to deciding on 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-organizational level, in terms of procedures, mandates, responsibilities and job-descriptions needed in order to effectuate the other standards.

3.2 Approaches to building standards and their acceptance in use

It has been studied (Shaw 2003) that implementing HospMIS in developing country is a challenging task mostly due to socio technical complexity in healthcare domain including relating to how standards are created and adopted. "Standards emerge and gain acceptance through work on the ground", not by imposition from the top (Timmermans and Berg, 2000). Drawing from the case of adopting of new medical protocols they illustrate how standards emerge and gain "*universality*" through local practices. "*Work practices are made more "efficient," professional practices are supposed to become more "scientific," and technical practices should obey "universal" standards. The disorder of current practices, according to such discourses, should be replaced by scientifically established, rational, and universal modes of working and understanding*" (p 31, ibid). Shaw (2005) demonstrates how an "*essential data set*" strategy in a remote district leads to formation and evolution of standard, and influences other organization hierarchies to benefit from it. Braa at al., (2007) proposes a "*flexible standards strategy*", where standards evolve in the course of practice and adapt to the environment. A similar approach is used in OpenMRS Concept Cooperative (OCC), an online repository created for the OpenMRS concepts' dictionary. OCC tends to provide a global vocabulary of well formed concepts from different implementations of OpenMRS worldwide (Martin 2006, Mamlin 2007).

The issue of standards have also been discussed in detail within the domain of design science. For example, Owen (1997) describes the design research process as "*Knowledge is generated and accumulated through action. Doing something and judging the results is the general model . . . the process is shown as a cycle in which knowledge is used to create works, and works are evaluated to build knowledge*". Similarly, our approach to standards see them as products of iterative actions of refining artefacts to match the ground level needs. Standards represent "*knowledge*" encapsulated in ongoing design and implementation cycles, which over time are stabilized and accepted by concerned parties, for example in our case of interoperable modules of OpenMRS. So, knowledge gained in one module, could be used by other module, or there would be common patterns of knowledge gained, which could form standards that could be circulated from one setting to another. The figure 2 below represents such a practical approach to the development and implementation of standards.

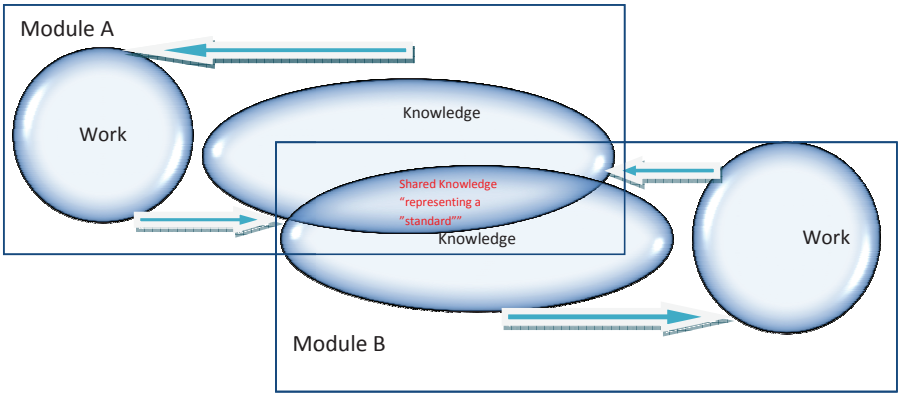


Figure 2. Illustration of shared knowledge representing a "standard" (adopted from Vaishnavi and Kuechler 2004/5)

In summary, our approach to develop and implement standards involves:

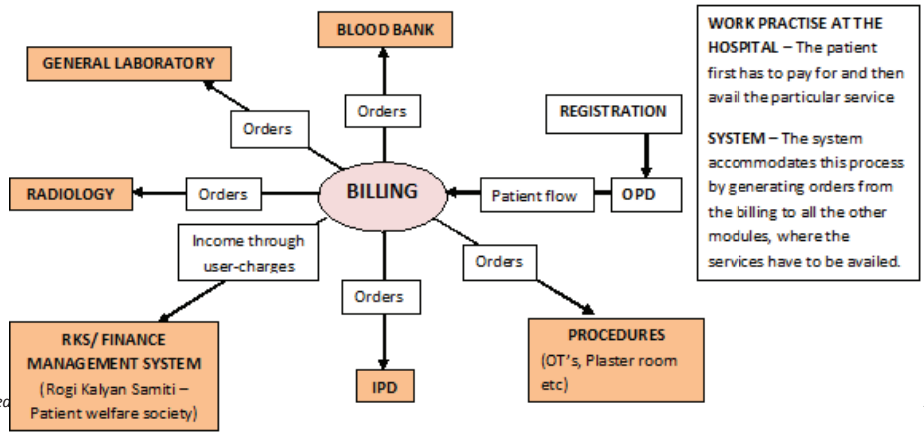
a. Enabling standards to evolve bottom up, based on practice, while adhering to global and national definitions and guidelines.
b. Standards follow a hierarchy where the lowest level requires the most detailed standards and subsequent levels above more abstracted.
c. The aim is to develop standards that are flexible and allows inputs from practices to be incorporated over time and use.

4. CASE STUDY

We use the three level architecture framework to provide some examples from the case that can help to understand the nature of standards.

4.1 Level 1: User and information needs

Each of the10 modules identified in the scope of work were subject to a requirement analysis with the view to understand the information needs from the user perspective. The idea then is the module



functionalities could be identified and communicated for development. The functionalities would need to cover at least two levels of information needs. The first is at the level of operational transactions, for example what information should be captured while carrying out a registration transaction for a patient. The second level is of the analysis reports that need to be generated for the management. This would include both the transaction reports (for example, category wise break up of patients registered in a day) and the indicator reports (say comparing registered patients with hospital capacity in relation to beds, human resources, and financial outlays). Standards at this level then require defining what data needs to be collected, periodicities, formats, and the formulation of various reports and indicators. We illustrate this with an example from the requirement study carried out for the billing module.

The billing module is one of the key and central modules as it represents the operational core at DDH. We began the requirement analysis by first studying the existing system of billing, including the underlying process and how it is inter-related to other processes such as registration and investigations. We observed and analyzed the flow of patients to and from the billing counter and identified all the possible permutation-combination of processes in the hospital, where the billing process/counter played a role. This was followed by days of observation of the process of billing to gauge the load of patients, per-patient time for billing and the average waiting time per patient in the billing queue. A list of all the services, along with the unit prices was collected from the hospital. Informal interactions were held with the billing staff and other hospital officials, regarding how they work, the problems that they face with the existing system and what are the changes that they would want to see in the system and the overall processes (see figure 3 above).

The empirical analysis conducted then allowed us to make a first draft of the "requirements document" describing the basic functionalities expected from the module. This draft was then discussed internally with the team, revisions made, and then subsequently with the panel of officials at the hospitals – they were explained the existing working process and the proposed system, what were the value additions and benefits they would get from the new system; and were asked for their feedback on the mock ups presented. The draft was also presented to and discussed with the billing staff, the actual users of the system for their feedback. Based on the feedback received from both level of users – administrative and operational - the requirement document was then revised and finally written in the form of use-cases which explained in detail the required functionalities and features from the module and provided the basis for the system development. In the box below we provide example of two use cases.

Use Case 1: Generation of a bill of services for each patient

Description

Billing Clerk should be able to generate a bill/ cash memo with the final amount to be paid by the patient/person which has details of service against which payment is made, name of person/id number and date

Work Flow

1 The patient should come to the billing counter with the name of the services to be availed on the OPD/ IPD/ discharge slip/ tender document/ambulance slip
2 The system should display 12 main categories (with sub-categories under each) under which billing can be done
3 The system should display the correct match for the patient record, in case of patient
4 The Billing clerk should the select the respective match
5 The Billing clerk should have the option of adding a new bill or only viewing the previous bills
6 The Billing clerk should not be able to cancel or void any bill
7 To add a new bill, the Billing clerk should select the "add new" option
8 The Billing clerk should tag all the services to be billed
9 The system should display the names of all the services, amount of money to be paid for each service as well as the total amount to be paid by the patient and date

Use Case 2: Generating a work order for investigations

Description

Billing Clerk should be able to generate work order for all the investigations conducted in the hospital (under general lab, radiology, radiography, blood bank lab, ICTC lab, DOTs lab, IDSP lab). As soon as a service has been billed for, the respective laboratories, conducting the tests receive an alert that a test has been ordered for, for a given id number.

Work Flow

10 The billing clerk should select the services that have to be billed

11 After all the services that have to be billed have been selected and the appropriate quantity of each service filled in, the system should generate the bill

12 As the system generates the bill, it should also send a request to the respective laboratory regarding the test to be conducted, for patient with id. No., the quantity of the test to be conducted and date of order of the service. (This should be displayed as an order, on the screen of the respective laboratory, to be accepted by the lab technician)

13 In case any investigation is non-functional in one of the labs (due to any reason), the lab technician should disable the particular test. The billing clerk should be able to view the enabled or disabled status of each test and bill/generate work order only if the test status is functional

Box 1 – Example of use-cases prepared for the billing module

As we started to work on the other modules, an important part of analysis and discussion was on the role of this billing module in the overall system. As the box 1 above describes, operationally, the billing serves at the central core. There was hence the dilemma of whether the module should serve only the purpose of collecting the user charges, but also be a point of generation of orders, to be sent out to other modules. Being a module serving only one major functionality (of collecting user-charges, as opposed to the OPD/IPD modules that serve multiple functions), it was thus decided that the billing module would also act as a point of generation of orders for various services to be conducted, such as laboratory investigation. It thus became essential, that all the services provided by the hospital, be populated as a part of the billing module. Hence, we needed to create a 'hierarchy of

services' for billing, where all the services provided by the hospital, charged or free, were incorporated in the design of the module. The various services were grouped under different categories, based on the functionality of the service and the physical location of provision of the service. 12 broad categories were identified, as described in the box below.

1. General Laboratories	**2. Physiotherapy Department**
3. Cardiology	**4. Dental Department**
5. X-Ray	**6. National Programs** i. DOTS center ii. ICTC iii. IDSP Laboratory
7. Radiology i. Ultrasound ii. Doppler iii. Special investigations	**8. Blood Bank**
9. Hospital Charges i. Refraction room ii. Minor operation iii. Major operation iv. Delivery charges v. Special ward vi. Minor procedure in plaster room	**10. Ambulance**
11. Medical Examination i. Medical examination (G) ii. Medical examination (NG) iii. Medical examination for fitness iv. Medical examination for driving license v. Re-medical exam for gazetted vi. Other medical examinations vii. Re-medical exam State Govt iii/iv empl	**12. Tenders**

Box 2 – 12 Categories of billing

Taking the example of the general laboratory in the hierarchy, the general laboratory was divided into 5 sub-categories: Hematology, Biochemistry, Serology, Cytology and Urine examination. Under each of these categories is listed, the individual tests. This categorization was done based on the work-flow of the laboratory. Each of the categories of the tests are conducted together, at one physical location within the laboratory and by one lab technician. Hence these tests were grouped together in the hierarchy and the same categorization carried forward in the laboratory module (the work-lists for the lab technicians and test results for each of these categories are entered together). The categorization of the general laboratory is illustrated below:

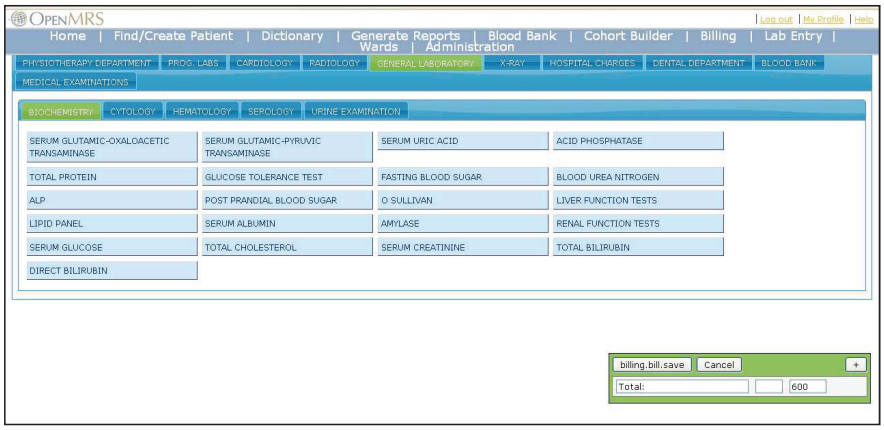


Figure 3 – Hierarchy for general laboratory

Similarly, categorisation of hierarchy of X-Rays is illustrated below :

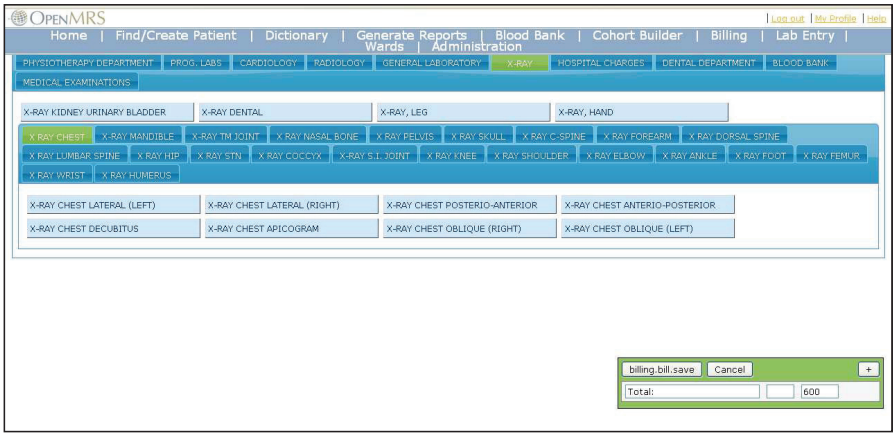


Figure 4 – Figure for X-ray hierarchy

Billing module was also required to fill into the reporting needs of the hospital, especially accounting. We categorized the reports into three categories – transaction reports, management reports and indicator reports. Transaction reports included the core one – daily cash report (giving details of cash collected under each of the 12 categories). Management reports from billing, included – for example, Investigation wise report – giving details of money collections under each investigation type. Indicator reports from billing included – BPL (Below Poverty Line) services support – this give details of amount spent by the hospital on treatment of poor/BPL patients.

4.2 Level 2: Software application

After careful analysis of existing open source software hospital applications in developing country settings, and also exploring the possibility of building an in-house application from scratch, we came to the conclusion to build HospIS on basis of existing electronic medical record (EMR) system -

OpenMRS. This decision was based on characteristics of OpenMRS – a free and open source software (FOSS) for EMR, which is collaborative effort between teams at Regenstrief Institute in Indianapolis and Partners in Health (PIH), an NGO in Boston, USA. The ongoing collaboration has contributed to the development of patient record based applications for HIV/AIDS and TB projects in developing country contexts such as Western Kenya, Peru and Haiti (Mamlyn et al., 2006). The vision of OpenMRS as stated in 2004 was: "*...to provide the foundation and "building blocks" from which fledgling implementations can begin constructing health information systems to meet specific needs. Admittedly, as a fledgling effort, we're just another stovepipe; but we hope that by using freely available tools, employing modular design techniques, and sharing our work, we can seed something bigger*." (ibid). (pp. 529)

This collaboration itself provided the basis for the development of a new standard, and scaling it bottom up to "*something bigger,*" quite similar to the approach of the HISP network. This idea was put into the foundation of OpenMRS design and development: *flexibility and generatively*– the notion of a "concept" and their data model; *extendibility* – modular design and development; *scalability* – ability to increase in size and number of users, installation locations; *gateways* – service APIs; and deployment and interfacing with *existing standards* – HL7, ICD10, LING, SNOMED and nowadays SDMX-HD support as a module. Its scalability was evident in the fact that though OpenMRS had been built originally for HIV/AIDS and TB (Seebergt et al., 2009), it had been applied to different domains in more than 25 developing countries (Tierneya et al., 2010). This large user base was supported by teams of collaborating IT and medical doctors, the use of active knowledge repositories through mailing lists, web sites, workshops, and publications. In short, there existed a vibrant and well supported user community around the application. Taking into account these technical and institutional characteristics of OpenMRS and their focus on developing country contexts, this was the platform chosen. In choosing this, we acknowledge that this platform was a clinic based system suitable for a district hospital where patients visit a clinic, but not so for the primary health care system which is based on outreach services.

Very briefly, OpenMRS is mainly organized as entities for recording encounters of patients with the hospital, which leads to observations, each of which is linked to a concept, represented as an answer or in the form of another question, which was answered at a later stage. A foundational feature here is the concept entity with its *hierarchical, referential and multi format* data structure. There are two other important entities to note: order and drug order, detailed also as concepts.

Using this core, we started the process of developing/customizing the 10 modules which were to provide the building blocks for the HospIS. While some of these modules (such as billing and finance) were external to the OpenMRS core, they still could use the core functionalities (such as using concepts to store services, lab tests and drug orders to notify other modules, etc.) and feed other modules with relevant information to help construct bottom up the overall hospital information infrastructure. Given the challenge and aims of scaling, we tried to use the existing standards and developed new ones to match our emerging needs.

As was noted earlier, the first two modules developed were registration and billing. Registration was an addition to an existing patient registration functionality provided by OpenMRS, while the billing module developed was completely new to OpenMRS. Also, the hospital had previous systems for both these modules and staff was quite familiar with its use. The initial version of the billing module had its own tables for services and pricing and corresponding concepts were linked to billing services. In version two, the need for creating a hierarchy of services was demanded by hospital. This

eventually led to using concepts as services. First, the concepts already had a hierarchical structure which allowed us to generate hierarchy of various forms. Secondly, now we could uniformly use concepts all over the system via the OpenMRS core APIs, eliminating redundancies. We then linked prices to concepts and corresponding service concepts were created based on the services available in the existing hospitals system, but now in a tree like hierarchy. Creating this hierarchy represented the creating of a standard.

During iterative cycles of development and testing, the billing module started to undergo major changes, conceptually, and with it the data structure and functionality. Now billing had to initiate and trigger service delivery requests such as notifying the laboratory, radiology and blood bank modules once the patient was charged accordingly. Billing thus became central to the HospMIS, and we are currently debating how it should become a part of the hospital core. We also expect further changes to the module as the OPD and IPD modules become functional. This represents the emergence of standards through practice.

4.3 Level 3: Interoperability

The interoperability issue manifests at different levels, the first being sharing of data across modules. An example of the interaction between the billing and radiology modules is described. While creating for the billing module the concepts, which were either made new or selected from the pool of existing ones (populated in the standard OpenMRS database), was done through series of discussions with hospital doctors. There were mismatches in initial presentation of the module and existing hospital practices, for example in setting hospital services for the radiology department. According to the current DDH operations, radiology services patients were charged based on size and quantity of films used. Mainly there were 3 types of film sizes to charge patients for irrespective of the type of radiology and its complexity. But according to the design of the billing module, which had to follow concept standards, this was not acceptable. First the billing module had to trigger an order notifying radiology department for a x-ray to be taken and hence the service couldn't be named "X-ray film 18x12", and required more details to enable the radiologist to know which x-ray type to perform. Secondly, the billing clerk had no knowledge on what film size and quantity to assign to the case. This is known only by the radiologist who selects film size based on x-ray type and age and body size of patient. After bringing the issue to the attention of the hospital management, a meeting was organized, where this issue was discussed. Next day the hospital came up with new list of x-ray grouped into types, and views as subtypes. In total there were 74 x-ray types presented. Our baseline concept database didn't have concepts matching this list, and required new concepts to be prepared. Creating this flexibility for the radiologist raised side effects for the billing module. It was hard and time consuming for the billing clerk to find and select the appropriate x-ray from the 74 types. This led to another round of meeting and discussions between the HISP team and hospital staff where it was agreed to organize concepts in sets and redesign the graphical user interface to follow the same hierarchy to make selection of x-rays easy for billing clerk. This example represents how the creation of a standard involved various negotiations and agreements between the different interest groups.

At another level, interoperability involves the sharing of patient level data with the (aggregated) facility level database. For example, valuable data collected through the everyday operation of hospital such as related to patient details (age, gender), OPDs visited, diagnosis, tests conducted, date and time of events need to be aggregated and summarized for being useful for managerial decision making. For example, the Health Secretary wanted a report on how many patients were registered from 8 pm to 8 am to examine whether the hospital provided efficient services during night time.

Further, aggregated data also could need to be ported to other systems requiring both portability and interoperability. In OpenMRS, each concept could be mapped to ICD10 standard codes, which while providing semantic uniformity to enable data exchange, it still requires data to be made portable in relation to metadata standards and well defined structure and syntax. SDMX-HD is a standard released by WHO that seeks to enable this. SDMX-HD defines the structure of aggregated data as well as validation rules for ensuring the completeness of the data.

5. DISCUSSION

We take the example of billing provided in this paper to describe the making of a standard in the context of HospIS:

5.1 The name of the standard - Billable services in a district hospital

In context of DDH over 155 services were being billed. The challenge was to create a 'standard' that defines all these services in categories based on a hierarchy, which should be in sync with hospital processes. E.g. for: the process of centralized billing agreed with hospital and now all billable services are channelized through billing.

5.2 Process of development

155 billable services in DDH were categorized into 12 categories, forming the 'hierarchy of services'. Based on 'billing type', these 12 categories were further classified into four types – patient services, ambulance services, billing for tenders and a miscellaneous category of services. Taking the example of X-ray hierarchy - hospital does 72 types of X-rays; these were divided into 26 types based on body parts and further divided into views. (Figure 4 depicts this– X-ray hierarchy)

The billing system is also catering to other kinds of billing services such as billing of tenders (floated by hospital for purchase of various items), which is capturing data such as the name and address of the company applying for tender, something the hospital did not have earlier. Similarly other billing is for rent (being collected for leasing out space), student internship fees (being collected from nursing or pharmacy interns); these items are now being billed and details being maintained under the miscellaneous category of billing.

Creation of the 'hierarchy of services' thus helped to create a standard frame-work, for all the billable services of the hospital. This when scaled to the other 19 hospitals in the state, would potentially serve as a standard (or base), which could be customized to the specific requirements of the particular hospital.

5.3 Process of implementation

This billing framework was implemented through the hospital's horizontal, vertical and locational processes, using tools in the OpenMRS framework such as 'concepts', 'encounters' and 'orders'. Each of the billable services in the hierarchy has been defined as a concept, using the OpenMRS dictionary. Concepts as defined in the OpenMRS framework are individual points of data collected from each patient. Thus, through these concepts, data about the tests being conducted by each of the patients is being gathered. Each of these services/concepts is in-turn associated to an 'order'. As each service is billed, an 'order', is generated/triggered, to be sent to the respective department (module). Different 'order types', have been defined based on the location and functionality of the service. For example – for billing of all tests being conducted in the general laboratory of the hospital, the order type is 'General Lab order', similarly there are 'blood bank orders'. These processes, being conducted

at different locations and serving different purposes, are also linked through 'encounters'. An encounter represents a single interaction of the patient with hospital. Different 'encounter types' based on different locations have been defined such as a 'billing encounter' or a 'lab encounter.' Based on the nature of the encounters, different security roles were developed and applied to the use of information through an authorization process.

Implementation of the 'hierarchy of services' also led us to understand the various processes and practices that would need to be standardized at DDH. For example, X-rays, that were previously being charged based on the size of X-ray films being used, was now changed to a standard price per film, for all X-rays. Services such as tenders, rent, student fees, have now been standardized, with a specific process in place and details of each of these transactions being captured.

CONCLUSIONS

The example of billable services presented above has been developed through the case study where elements of its design, development, and implementation have been identified in the process of the making of the standard. As we see standards to be developed and reified in practice, through use, it may be still premature to conclude of how successful or effective this standard will be – on this, time will tell. Overall, the process described has helped to identify the framework within which the various standards across all the modules can be identified. The three level architecture consisting of levels of information, software, and interoperability will be drawn upon to sketch out the various standards.

While making this standard work in one setting through use in DDH is of course the primary challenge, at the next level we need to see how this standard (and others) can be scaled to the other 19 hospitals in the state. Our approach would be to take the identified standards as the reference list as we go to the other hospitals and then study the existing systems there within this background, and see what is it that is additional or not. Through this process of analysis, the aim would be to develop a set of "core standards" that the state could define as a state benchmark. This would imply that all the hospitals in the state would need to adhere to this core standard, while having the flexibility to add something to cater to local requirements. They would however, not have the freedom to remove anything from the core list. This is essence divides the process of the making and the scaling of standards as envisaged by us for DDH in particular, and to the state more generally.

In summary, our understandings of standards from the domain of primary health care systems have provided us with a firm foundation to approach the complex issue of standards in the district hospital setting. As these standards are not being imposed from the top, but have evolved through practice based on a strongly participative approach, we expect there is a higher potential of it being accepted as something useful and useable. The future challenge would be to take these standards into the other hospitals, where undoubtedly local practices and traditions will challenge these standards, which may be then seen as "imposed from the top." Continuing this participatoryy approach while allowing for local flexibility within a defined framework will be our proposed approach.

References

1. Braa Jorn, Monteiro Eric, and Sahay Sundeep (2004), *Networks of Action: Sustainable Health Information System Across Developing Countries*, MIS Quarterly Vol. 28 No. 3, pp. 337-362/September 2004

2. Braa Jorn, Ole Hanseth, Woinshet Muhammed, Vincent Shaw (2007). *Developing Health Information Systems in Developing Countries: The Flexible Standards Strategy*. MIS Quarterly Vol. 31 Special Issue/August 2007
3. Beale T. *The Health Record – why is it so hard?* IMIA Yearbook of Medical Informatics (2005): Ubiquitous Health Care Systems. Haux R, Kulikowski C, editors. Stuttgart: Schattauer; 2004. p. 301-304. Available from http://www.deepthought.com.au/. Last accessed on 12 May 2010.
4. Conn, J. (2007). *Failure, de-installation of EHRs abound: Study. Modern Healthcare*. Available at http://www.modernhealthcare.com/article/20071030/FREE/310300002#. Last accessed 10 August 2010.
5. Coiera E. The Guide to Health Informatics (2nd Edition) (2003). Arnold, London,. *The electronic medical record*, p111-123
6. Douglas G (2003). *The Lilongwe Central Hospital Patient Management Information System: a success in computer based order entry where one might least expect*. Proceedings of the AMIA Annual Fall Symposium 2003;833
7. Hamish SF Fraser, Paul Biondich, Deshen Moodley, Sharon Choi, Burke W Mamlin, Peter Szolovits (2005). *Implementing electronic medical record systems in developing countries.* Informatics in Primary Care 2005;13:83–95
8. John Øvretveit, Tim Scott, Thomas G. Rundall,Stephen M. Shortell, Mats Brommels (2007). *Improving quality through effective implementation of information technology in healthcare*. International Journal of Quality Health Care 19 (5): 259-266. doi:10.1093/intqhc/mzm031.
9. Rotich JK, Hannan TJ, and Smith FE (2003). *Installing and implementing a computer-based patient record system in sub-Saharan Africa: the Mosoriot Medical Record System*. Journal of the American Medical Informatics Association 2003;10:295–303
10. Jacucci, E., Shaw, V., & Braa, J. (2006). *Standardization of Health Information Systems in South Africa: The Challenge of Local Sustainability*. *Information Technology for Development, 12*(3), 225-239.
11. Mamlin, Burke W., Paul G. Biondich, Ben A. Wolfe, Hamish Fraser, Darius Jazayeri, Christian Allen, Justin Miranda, and William M. Tierney (2006). *Cooking Up An Open Source EMR For Developing Countries: OpenMRS – A Recipe For Successful Collaboration*. AMIA 2006 Symposium Proceedings, pp. 529-533Martin C. Were, Burke W. Mamlin, William M. Tierney, Ben Wolfe and Paul G. Biondich (2007). *Concept Dictionary Creation and Maintenance Under Resource Constraints: Lessons from the AMPATH Medical Record System.* AMIA 2007 Symposium Proceedings, pp. 791-795
12. McDonald CJ (1997). *The barriers to electronic medical record systems and how to overcome them.* Journal of the American Medical Informatics Assoc. 1997 May-Jun;4(3):213-21
13. Owen, C. (1997). "Design Research: Building the Knowledge Base." Journal of the Japanese Society for the Science of Design 5(2): 36-45
14. Rotich JK, Hannan TJ, Smith FE, Bii J, Odero WW (2003), et al. *Installing and implementing a computer-based patient record system in sub-saharan Africa: the Mosoriot Medical Record System*. Journal of the American Medical Informatics Assoc. 2003; 10:295-303
15. Seebregts CJ, Mamlin BW, Biondich PG, Fraser HS, Wolfe BA, Jazayeri D, Allen C, Miranda J, Baker E, Musinguzi N, Kayiwa D, Fourie C, Lesh N, Kanter A, Yiannoutsos CT, Bailey C (2009); *The OpenMRS Implementers Network*. International Journal of Medical Informatics 2009; 78:711-720
16. Shaw, V (2003). *The Development of an Information System for District Hospitals*. In S. Krishna & S. Madon (Eds.), The Digital Challenge: Information Technology in the Development Context: Ashgate, 2003
17. Shaw, V. (2005). Health information system reform in South Africa: developing an essential data set. Bulletin of the World Health Organisation, 2005(83), 632 – 639
18. Shaw, V. (2009) *Series of dissertations submitted to the Faculty of Mathematics and Natural Sciences, University of Oslo, No. 905,* ISSN 1501-7710Sheraz F. Noormohammad, Burke W. Mamlin, Paul G. Biondich, Brian McKown, Sylvester N. Kimaiyod, Martin C. Were (2010). *Changing course to make clinical decision support work in an HIV clinic in Kenya.* International Journal of Medical Informatics 79 (2010) 204–210
19. Stefan Timmermans and Marc Berg (2000). *Orders and Their Others: On the Constitution of Universalities in Medical Work*, Volume 8, Number 1, 2000
20. Timmermans, S. and Berg, M. (2003), *The Gold Standard: The Challenge of Evidence-basedMedicine and Standardization in Health Care*, Philadelphia, PA: Temple University Press. Womack, J.P. (1990), *The Machine that Changed the World*, New York: Rawson Associates.

21. Vaishnavi, V. and Kuechler, W. (2004/5). "Design Research in Information Systems" January 20, 2004, last updated August 16, 2009. URL: http://desrist.org/design-research-in-information-systems
22. William M. Tierney, Marion Achieng, Elaine Baker, April Bell, Paul Biondich, Paul Braitstein, Daniel Kayiwa, Sylvester Kimaiyo, Burke Mamlin, Brian McKown, Nicholas Musinguzi, Winstone Nyandiko, Joseph Rotich, John Sidle, Abraham Siika, Martin Were, Ben Wolfe, Kara Wools- Kaloustian, Ada Yeung, Constantin Yiannoutsos, and the Tanzania-Uganda OpenMRS Consortium (2010). *Experience Implementing Electronic Health Records in Three East African Countries.* MEDINFO 2010 IOS Press, 2010 © 2010 IMIA and SAHIA. doi:10.3233/978-1-60750-588-4-371
23. Y.M. Chae, S.I. Kim, S.H. Choi, I.S. Kim (1994). *Implementing Health Information System: Measuring Success in Korea's Health Centers*, International Journal of Health Planning and Management, 1994; 9, pp. 341-348

APPENDIX III

Latifov, Murodillo Abdusamadovich and Sundeep Sahay (2012). Data Warehouse Approach to Strengthen Actionability of HIS: Experiences from Tajikistan.

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DATA WAREHOUSE APPROACH TO STRENGTHEN ACTIONABILITY OF HEALTH INFORMATION SYSTEMS: EXPERIENCES FROM TAJIKISTAN

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ABSTRACT

Health Information Systems (HIS) in developing countries are notorious for not supporting action – implying the use of information for supporting health management. While authors have identified many reasons for this, we focus on the actionability of the HIS reflected through the data-indicator linkage. The better this link, the stronger will be the actionability of the HIS, which we evaluate through the three item criterion based on completeness, fittingness and actionability. This framework is used to analyze the actionability of the Tajikistan HIS. Furthermore, this paper argues for the value of a data warehouse approach in strengthening the data-indicator linkage. However, the data warehouse is far from being a mere technical artefact, but is something socio-technical; in order to understand it, we draw upon theories of institutions. A key contribution of the paper is in understanding competing institutional logics, and how this requires a sensitive management of the installed base.

1. INTRODUCTION

Public health management in developing countries is data intensive, implying that the routine health information systems (HIS) typically collect large amounts of data on a regular basis. The Indian public health system till 2008 was collecting about 3,000 data elements on a monthly basis (Sahay & Lewis, 2009). With nearly 200,000 facilities in the country reporting this data, potentially 600,000,000 data values were being compiled in the national database on a monthly basis. Similarly, in Tajikistan, approximately 30,000 data elements were being reported on an annual basis (Sahay et al., 2009). With about 70 districts sending consolidated reports, potentially 2,100,000 data elements can be estimated to be reported into the national database annually. At first glance, Tajikistan is collecting much less data than India, but on comparing number of data elements respectively in each country, a reverse picture emerges, with ten times more data being collected by individual health units.

These examples from India and Tajikistan illustrate two common characteristics of HIS across most developing countries, including those from Central Asia (Ahmedov et al., 2007; Ibraimova et al., 2011; Khodjamurodov and Rechel, 2010; Kylzhanov and Rechel, 2007). One, excessive data is collected; and, two, the data that is collected is not adequately utilized. Based on a detailed assessment of the Indian situation, Sahay et al. (2010) report that this data is not utilized for decision making, for reasons which are both technical-institutional in nature. Institutional reasons include the dominance of centralized information flows which favors data for statistical reporting rather than local action. This malaise is particularly evident in countries influenced by the Soviet legacy which promoted prospective 5 year plans, with the central ministry in Moscow deciding on funds allocation to national level ministries, and further sub-national levels (McKee et al., 2002). Further, HIS are fragmented, largely because of donor influences that favor vertical programmes which impede utilization of information for action (Braa & Sahay, 2012). Technical reasons usually relate to the use of rigid and proprietary software, which makes it difficult to respond to changes required in the system, such as creating new indicators, linking them with data elements, and redefining the

periodicity of reports.

This paper has two key foci. The first is to "examine the actionability of the HIS in Tajikistan" implying how capable the HIS is of supporting action taking to strengthen health service delivery. We use the concept of "indicator" as a reflection of actionability of the HIS, and examine how effectively does the HIS support the definition, processing, analysis and use of indicators. The second focus of this paper is to examine issues of design of the HIS using a data warehouse approach, which we argue can potentially improve the actionability of the HIS (ibid). This design involves, we argue, a socio-technical approach, for which we draw upon institutional theory to provide guidelines.

A socio-technical perspective recognizes data, its utilization and software designed to support data processing is a product of institutional processes and practices. The business logic in public health management are typically embedded in a variety of complex issues relating to disease burdens, disease determinants, institutional practices, geographical and temporal trends and various other factors. Typically, these analytical dimensions are formulated and labeled as "indicators" which can then be used to compare performance across different catchment areas, facilities, periods and the like. Indicators are generated from "data elements" such as "number of children given BCG vaccination in a particular period in a facility." Taken in this "raw form", this data is of little use to the immunization programme health manager for the district or state who needs to know "what percentage of children born in the catchment area of the particular facility have been given BCG vaccination". This implies the creation of an "indicator" from the raw data which will divide the data element (number of children given BCG vaccination) with a denominator (expected births in the area for the period) and multiply it by a factor (in this case it is a percentage). The strength of the of the HIS tools is the functionality it provides to define, modify, and generate useful and relevant indicators, and then to be able to present them in easy to use manner (for example, graphs, tables, charts, maps, etc.) for the typically non-computer savvy health manager (in the developing country context). This capability to work with indicators is fundamentally dependent on the user having a coherent understanding of the business logic which helps to convert raw data (without context) into information (putting data into relevant context) that can be acted upon (knowledge).

Different types of data are required in the setting up of relevant indicators for health management. For example, services data (such as number of BCG vaccinations given) need to be combined with resources details (such as number of field nurses available) to get efficiency calculations. Population data (including civil registration events of births and deaths) are further important data sources providing the denominator values for the generation of various indicators. The database which is thus being used to store these different data must be able to accommodate data from multiple sources, and also, typically work with the different formats they are available in. This in essence is the approach advocated by the Health Metrics Network (HMN) since 2005 for the development and use of data warehouse or data repository as a basis for a national HIS.

In this paper, the focus is on the socio-technical approach adopted in the design and development of a data warehouse for the national HIS in Tajikistan. Problems of fragmentation, excessive data, minimal indicators, poor quality has been reported to be significant in Tajikistan (Khojamurodov & Retchel, 2010; Mirzoev et al., 2007; Sahay & Latifov, 2009), and a data warehouse approach carries the potential of trying to address these challenges and provide a basis for a evidence based decision making. This paper reports on our attempts to do so, specifically focusing on the following research questions:

1. What are the socio-technical approaches relevant to the design and development of a data warehouse to support the national HIS in Tajikistan?
2. How can the data warehouse based HIS help to develop an action-led HIS for Tajikistan?

The rest of the paper is organized as follows. In the next section, we discuss literature relevant to the analysis of our case. After starting from a more practical discussion on issues relating to "data use", with a focus on the data-indicator linkage, we discuss how concepts from institutional theory can help understanding how to strengthen this linkage, especially through a data warehouse approach. Following this we discuss the methods and then describe the case study. This is followed by an analysis of the case, and then discussions and conclusions.

2. THEORETICAL PERSPECTIVE

The theoretical perspective is developed in two main steps. The first discusses the linkage between data and indicators, and how this needs to be strengthened. In the second, we discuss how institutional theory concepts can help and inform towards a socio-technical approach to the design and development of a data warehouse.

2.1 The Data-Indicator Linkage: The Weak Link in HIS in Developing Countries

In the health sector of developing countries, many technical, institutional and contextual conditions impede the processes of data collection, its transformation into information and further its use as practical knowledge. For example, gathering data in multi-level organizations comprising of different sub units and spread across geographical locations is a challenge, as each unit may have specific needs for information, and have its set of primary data collection and storage procedures. The diversity of data formats and data elements can potentially contribute adversely to data quality implying "garbage in and garbage out". Data quality, namely of it being erroneous, overloaded and irrelevant, have been identified as a major contributors to the lack of optimal effectiveness of HIS (AHIMA, 1998a, 1998b).

Poor quality data adversely affects decisions, and even may lead to inappropriate decisions. "Defining data quality and realizing the need for information that is free of defects and that possesses the right qualities for the task at hand remains a difficult issue. This is particularly so in the healthcare sector where the need for effective decision making is high" (Kerr et al., 2007, p.1017). In the context of public health management, problems with data of irrelevance, erroneous, overload are significant, but there are many other problems that relate to the particularities of the sector. For example, a common problem is that the health sector often has different estimates of catchment area population depending on who is the collecting agency. In such a case, indicator calculations become flawed, and suspect to be acted upon. Another particularity of the sector is there are targets given to field health workers on what they should achieve for services being delivered. As a result, data often tends to get manipulated to show performance is along the lines of the set targets.

In the context of health systems generally, and public health in particular, indicators are a specific tool for programme management, including for the analysis and diagnosis of problems and also for taking corrective action. Indicators are abstracted knowledge from broader information sets and composed for comparison on different relevant factors, or sometimes single units of information to support decision making processes or for measuring levels of achievements. For example, the indicator of full immunization coverage is broadly a measure of the effectiveness of the immunization programme indicating what percentage of

live births taking place in a particular catchment area have got all their vaccination shots (BCG, TT, DPT etc) in a pre-specified time period (less than 12 months). The national level for example can take the immunization coverage of a district and compare it with other districts and also over time as a measure of performance and use this analysis to take decisions like which district needs what kind of vaccine stocks and when. These figures have to be also reported by the national level to international agencies like GAVI and WHO that monitor a nation's progress with respect to the MDGs. Similar analysis can be conducted at the district and sub-district levels, where the immunization coverage indicator may also be supplemented with some other specific monitoring indicators such as BCG-TT drop out rate which reflects what percentage of the children who took their BCG shot did not take their TT shot. Such detailed monitoring indicators like drop out rates are required to better manage service delivery while immunization coverage is used more as an "impact" indicator to study how the overall programme is doing with implications for health policy. Service delivery indicators are useful for the district managers while impact indicators are relevant for national level monitoring and evaluation.

The above examples illustrate two points. Firstly, with different levels of the health administration (from sub district to district, province, national and international), the types of indicators used vary, and also to the kind of use they are put to. Secondly, each indicator has a specific numerator and denominator. In the first example, the numerator used in "total number of children fully immunized" while in the second the numerator is "total number of children who received TT shots MINUS Total number of children who received BCG shots". Similarly, the denominators also vary with the first example using "total number of live births" and the latter "total number of children given BCG shots." In both cases the factor used in %. Given this, it is imperative that the numerator value is being provided by the HIS, implying that the data element "total number of children fully immunized" is included in the forms being filled every month by the health workers, and the data being filled against this data element is of good quality. If that is the case, we can say one dimension of the indicator-data match, let us call it "completeness," is adequate.

Another dimension of this match can be identified when we take the health systems perspective whereby we look at all the health programmes say that a particular district has to administer. Suppose, there are ten such programs and each of them have 2 indicators, then at least 20 numerators and 20 denominator values would need to be provided by the HIS. And if we further assume that each numerator and each denominator is made up of two data elements, the HIS should periodically provide data on (20 numerators+20 denominators) X 2 data elements = 80 data elements on a timely basis to the health programme managers. If the HIS is providing data on exactly these 80 elements, then it can be seen to be a precise and actionable HIS. However, if it provides data on say 200 data elements (including the above 80) then the HIS can be described as being "redundant". And if some or all these 80 data elements are not included (in the 200) in the HIS, it can be described as both a "redundant and inefficient" system. Let us call this dimension of the indicator-data match as "fittingness".

While the dimensions of completeness and fittingness give us a sense of the data supply ends, another key facet concerns how the indicators are understood and used by the health programme managers for supporting their everyday action. Let us call this dimension "actionability" of the indicator-data match. While the generation of indicators can be seen as a necessary condition for their use, they are not sufficient. To provide it with the property of sufficiency, the indicators should be easy to understand, well presented, and the decision makers should have the capacity and the will to understand and use the indicators. This may be the hardest aspect of the indicator-data match, as building it requires large and sustained

investment in building capacity of the users on the use of information. This involves a cultural shift from using data just for the generation of tables of aggregate numbers for upward reporting to satisfy bureaucratic needs to using indicators for local action (Sahay et al., 2009, Braa et al., 2004).

The three identified criteria of completeness, fittingness, and actionability, taken together provide us with the basis of an analytical framework to examine the indicator-data match. Further, these three criteria are interconnected, because for example if fittingness is poor, so will be its actionability because if the indicator cannot be generated in the first place, it cannot be used and be actionable. When the data-indicator linkage is analyzed with respect to HIS in developing countries, it can be emphatically argued that this linkage is weak (Sahay et al., 2010). Typically, we find that even though lots of data is collected, it does not cover many data elements required for key indicators. The HIS is not complete. Fittingness is normally poor, as HIS are not integrated, and one database does not house data from the different health programmes, thus not allowing for cross-programme indicators. Actionability is almost universally poor (Bankowitz, 2010; Young, 2011), as it has been repeatedly brought to attention that the data being collected is not effectively and adequately used.

Strengthening this linkage is thus a crucial step in supporting the national HIS in a country. We have argued that a data warehouse approach is a preferred approach to strengthen this linkage. However, recognizing this as a socio-technical challenge, we draw upon some guiding concepts from institutional theory to guide this perspective.

2.2 Strengthening Data-Indicator Linkage with Data Warehouse: Some Institutional Guidelines

A data warehouse, as briefly introduced earlier, represents a data repository that can accommodate data from different sources, transform them into a common representation, and help the user to view various presentation tools (such as charting, graphing and mapping) to visualize the processed data more effectively, in order to take more informed decisions for strengthening health management. This is much more than a mere technical exercise of designing a database, but in fact is a socio-technical exercise, where institutional actors have to agree to share data in a common source, bring them in one place, and accept the visibility to their data that is created through the data presentation tools.

Concepts drawn from institutional theory are thus useful to our analysis. As per North (1990), while teams playing a football match can be visualized as organizations, institutions represent the rules which govern the game. Institutions thus represent "multifaceted, durable social structures, made up of symbolic elements, social activities, and material resources" (Scott 2001, p.49). A data warehouse, visualized in institutional terms, can be seen to represent a material resource (of a database, business intelligence tools, etc.), which have symbolic elements (of presenting an integrated framework for HIS for example), and whose use is governed by various social activities such as around data collection, its processing to indicators, and its analysis and use for decision making. Within such a perspective, materiality is not an incidental or intermittent aspect of organizational life; it is integral to it." (Orlikowski, 2007, p.1436) with "material resources" and "material practices" represent intertwining of material and cultural dimensions (Friedland & Alford, 1991).

However, for the data warehouse to take on an institutional character, it must become a "durable social structure" where it becomes an integral part of the HIS working in the organization. Durability will come through the creation of both formal and informal institutions that are based on norms, symbols, myths, belief systems, and informal arrangements that influence organization culture (Scott, 2001). Noir and Walsham (2007,

p.314) similarly argue that often institutions "reflect the myths of their institutional environments instead of the demands of their work activities". Basically, this is an argument that technologies such as data warehouses have institutional myths associated with them, such as of promoting integration and efficiency.

Agreeing with this view of technology as having both material and symbolic implications, we argue that the design, development and implementation of a data warehouse must pay attention to both these dimensions. When introduced, organizations need to constantly respond to the surrounding environment adjusting to the change, be it political, technological or economic. Technology introduction represents a process of change, often involving competing institutional logics: what the technology entails new and what pre-exists. Institutional logics (Alford & Friedland, 1985) describe the contradictory practices and beliefs inherent in the institutions, including the "socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules by which individuals produce and reproduce their material subsistence, organize time and space, and provide meaning to their social reality." (Thornton and Ocasio, 2008, p.101). This implies that individual agency and cognition is linked with socially constructed institutional practices and rule structures. "By categorizing societal influences as an inter-institutional system, previously tractable issues such as embedded agency and institutional change can be better addressed" (Thornton and Ocasio, 2008, p.122).

This notion of institutional logic has in recent years been drawn upon by IS researchers. Hayes and Rajao (2011) drawing on the historical data of Amazon deforestation in Brazil demonstrated how a number of Geographical Information Systems (GIS) applications were developed and deployed around alternate institutional logics. They elaborate on three dominant institutional logics: sovereignty, economic and environmental sustainability; which at different time periods shaped different conception and use of the GIS applications. They demonstrated how institutional change occurs through political negotiations, economic benefits and sanctions imposed by internal and external actors leading to the emergence of new institutional logics and weakening of others. They showed how coexistence of multiple institutional logics over time shaped different conception and use of GIS application with dominant institutional logic playing the key role.

Sahay and colleagues (2010) used institutional logic as a lens to study the introduction of new computer based HIS in Tajikistan. They say "that theories of institutional logics provided us with the language to analyze and communicate these findings" (Sahay et al. 2010, p.23). They analyzed the tensions in two logics: decentralized decision-making (being proposed by the new system) to centrally managed system (which was pre-existing), to create a case for institutional change. They argue that social, political, and functional pressures contribute to the deinstitutionalisation of some logics and erosion and disappearance of others. Further, analysing the post installation process of the National Aeronautics and Space Administration (NASA's) enterprise information system, Berente and Yoo (2012) characterize NASA as a plural organization (Kraatz & Block 2008, Dunn & Jones 2010) reflecting diverse institutional logics, some consistent and some contradictory to each other. They point that different individual actors may draw on institutional logics (e.g. scientific professionalism) that contradict with logic of enterprise IS (e.g. managerial rationalism) and try to loosely couple elements of their practices from the practices implied by the enterprise system, thus satisfying the demands associated with both institutional fields. Further, they demonstrated how through the use of institutional logics, researchers can identify fundamental institutional contradictions that explain regularities in the situated responses to enterprise system implementations (Berente & Yoo, 2012).

In summary, the focus of our theoretical analysis is to firstly have an analytical focus relating to the use of information – which we have defined in terms of the data-indicator linkage. Further, we argue for the relevance of a data warehouse to help address this challenge. The design, development and implementation of this data warehouse is conceptualized in terms of institutional theory, specifically as a combination of material and symbolic aspects that need to take on a durable social structure. Further, both formal and informal institutions are crucial in the institutionalization of something like a data warehouse in an organization. Such an introduction would always involve the interplay of different institutional logics, which sometimes may contradict or support each other.

After having described the theoretical perspective, we move to the empirical components that are presented in 2 parts. The first is the description of methods, and second the case study.

3. RESEARCH METHODS

The research methods adopted aimed at firstly gaining an understanding of the broader situation of the HIS in Tajikistan, with a focus on the indicator data linkage, and secondly to work towards a data warehouse based HIS design to try strengthen this linkage.

The research has been carried out by the two authors of this paper, who have been involved at different stages of the HIS reform process in the country. One of the authors is a Tajik national, an IT expert, who has been hands on involved in the design and development of the data warehouse. The other author, a non-Tajik, has played the role of the information systems expert, involved in processes of situation analysis and strategy development. The research takes place within the broad framework of the Health Information Systems Programme (HISP), following an action research approach. Within this framework, the authors have carried out concrete activities of situation analysis, data warehouse design, and planning for implementation. During these activities, the authors have worked closely with the Ministry, international donors and other actors involved with the HIS reform process.

Broadly, the research has taken place since 2008 to current time, involving three broad phases:

1. Situation analysis (2008-2009)
2. Designing for the data warehouse approach (2009-2011)
3. Implementing the data warehouse (2012 onwards)

In this paper, we broadly discuss results from the first two phases.

3.1 Setting

The empirical setting for this research is Tajikistan, a country located in Central Asia with a territory of 143,100 square kilometers, population of 6.7 million (UN, 2007) that shows an annual growth rate of 3.0%. Nearly half the population is below the age of 25 years. The Republic of Tajikistan is governed by the President and an elected Parliament, and is administratively divided into the capital – Dushanbe city, four regions (called “viloyat”), which in turn are divided into sixty seven districts (called “nohiya”), that have further smaller municipal areas called “jamoat”. After independence from the Soviet Union in 1991, Tajikistan faced a grueling civil war in which up to 50,000 people were killed and over one-tenth of the population fled the country. This unrest ended in 1997 with a United Nations-brokered peace agreement. The abrupt breakdown of the centrally managed Soviet system and the consequences of the civil war contributed to a poor economy, damage of the public

utility systems of water supply and heating, which magnified the spread of various communicable diseases. A WHO report (2008) indicated a decrease in life expectancy owing to poor nutrition, polluted water, and increased incidence of malaria, tuberculosis, typhoid, cholera, and cardiovascular diseases.

Despite the independence from Soviet Union, it can be said the health system has continued thus far with few structural changes, and still comprising of the Ministry of Health and its regional and district offices. There are specialized hospitals at the national level for more complex care, hospitals at regional and district levels, with health centers and health stations at the municipality level. Some ministries and government agencies have their own specific hospitals. Even with respect to the HIS, we see the legacy of the Soviet system to be still dominant with a high focus on the collection of statistics and their centralized compilation and reporting as an annual statistical exercise at the national level. While the Soviet legacy lives on in terms of this focus on statistics, the supporting systems of expertise required for statistical analysis is much more limited than what existed pre-1991.

With regards to the situation analysis, the empirical setting was defined by an existing initiative of the Asian Development Bank (ADB) that was supporting the Tajikistan Ministry of Health through the creation of an institutional structure called Health Sector Reform Project (HSRP). The HSRP became the focal point through which technical assistance was being channeled to the Ministry on various areas, including HIS which is the focus of this paper. One of the authors of the paper was invited in 2008 by the ADB to support this process of HIS reform which had started some years before.

3.2 Data Collection

The initial phase of the situation analysis was through the study of various reports and secondary data which helped to develop a historical understanding of the HIS in Tajikistan. The various previous efforts, such as studies by consultants or project reports of HSRP were studied in depth to get a sense of the status of the existing efforts. The national HIS consultant at HSRP was a crucial link in this process to help provide continuity to the events and narrate the past and help to focus on the current needs. Numerous discussions, formal and informal, between the authors and this consultant helped to gain a sense of coherence to the various pieces of the story. For example, she described how a Pakistani consulting group had been hired by HSRP to develop the strategic conceptual framework for the national HIS reform. The mandate now was to take this framework as the point of departure, and try to move towards actually developing and implementing a computer based HIS.

After conducting this overview, personal interviews were conducted with various programme level managers at the national level, plus staff at the Medical Statistics division who were responsible for the operation of the national HIS. The programme managers included immunization, maternal health, HIV/AIDS, tropical diseases, epidemiology and TB. In total, about 15 interviews were conducted, each lasting about 90 to 120 minutes, and involving a translator. Each interview was conducted in Russian, and the translator first translated the questions posed, and then the answers.

Also, contributing to the situation analysis was a detailed study of the existing data recording and reporting formats. There were nearly 37 data reporting formats each of them containing multiple sub formats. For example, one of their reporting formats had more than 50 sub formats running to more than 100 pages. The bulk and redundancies of the formats and data were a potent reflection of the existing data-indicator mismatch.

Similarly, reports of the HSRP efforts, such as around the rationalization of the indicators which involved a reduction from 1300 to 833 indicators provided concrete

information on which indicators were identified to be relevant to the national ministry. Some of the other reports referred to were: "Health for all - 2005" national strategy (1997), National Programme of Health Care Reform (1998), AIDS Prevention (1993), and the Law on Health Protection of the Population (1997).

3.3 Data Analysis

Data analysis was carried out through a combination of qualitative and quantitative methods. Qualitatively, first the various interviews were written out in English and studied to identify themes. Interpretations were converted into presentations. At least three sets of presentations were made by one of the authors of this paper to audiences at the HSRP, the national Ministry of Health, and at a national workshop. The comments received during these presentations and the ensuing discussions helped in the fine tuning of the situation analysis. A final report of more than 150 pages submitted to the HSRP and ADB elaborated in detail on the overall analysis.

In terms of quantitative analysis, we obtained a copy of the legacy database through HSRP which included the data being entered in the HMIS from 2001 onwards for all the districts in .dbf format. This database was analyzed firstly for identifying duplicate data elements (same data being recorded in different forms) and also redundant data elements (for example, data elements that recorded "Totals" of a particular category and also the various "Totals" of the different sub-categories. To identify the data-indicator (mis)match, we took the government mandated 833 indicators and their respective formulas (numerator and denominator) as the starting point. Then working backwards, we tried to identify whether the numerator and denominator required for the calculation of the indicator were included in the database or not. Following from this, we could also identify which of the data elements that were currently included in the database were actually being utilized for the calculation of an indicator. Interestingly, this led to an estimation of a figure of nearly 80% of "un-utilized" data elements, reflecting the gross data-indicator mismatch. Further, we found a high percentage of data being left as blank or filled as zero (null values are blank or no value in the cell, but zero values could also mean 0 as a value). The table below gives an example of the high percentage of such blank/zero values (for randomly selected forms from 2005/6 reports).

Table 1. MedStat Database Zero/Null Values

Form Number	Table Name	Number of Entries Analyzed	Number of Zero/Missing Values	% of Zero/Missing Values
1	Infectious diseases	76,370	66,153	86.62
	Parasitic diseases	8,576	6,913	80.61
	Hospital acquired diseases	11,286	11,127	98.59
5	Reproductive health facility activities	1,360	148	10.88
	Contraceptive resources	3,060	1,483	48.48
	Contraceptive health	3,672	1,426	38.83
	Contraceptive assistance	3,264	627	19.21
7	Temporary disability and work injury	91,403	82,645	90.42

8	Active tuberculosis diseases	22,848	16,158	70.72
9	Sexually transmitted diseases, fungal skin diseases and itch	26,928	23,352	86.72
10	Psychological disorder (alcoholism, drug addiction)	16,214	13,243	81.68
10D	Employees with scientific degree working in organizations, enterprises.	7,548	6,702	88.79
11	Mental disorder and behavior connected with usage of psycho active substances	15,488	14,303	92.35
12	Diseases registered in treatment facility of catchment area	692,736	542,084	78.25
12D	Diarrhea diseases registered in treatment facility of catchment area (0-14 year)	17,226	13,306	77.24
12O	Acute respiratory diseases registered in treatment facility of catchment area (0-14 year)	11,154	6,741	60.44
13	Abortion report	11,232	8,920	79.42
Total		**1,020,365**	**815,331**	**79.91**

As the above table indicates, the percentage of missing/zero values is approximately 80% with Form 7 and 11 even indicating an average of greater than 90%. This extraordinary high percentage raises the question of whether this data is required and if they are used for any indicator calculation and identification of action points.

4. CASE STUDY

We describe the case study in two parts. In the first, we describe the existing HIS, focusing on the poor linkage between data-indicator, violating the basic principles of a data warehouse and integrated HIS. In the second, we describe our efforts towards the design and development of a data warehouse based HIS.

4.1 Existing HIS: Fragmented, Data Anomalies, and Poor Data-Indicator Linkage

Data anomalies were rampant, with extreme fragmentation of information flows, including multiple parallel and uncoordinated flows inherent with redundancies and duplications. For example, under the TB programme some provinces (viloyats) entered data into a software application called EpiInfo (a popular software being used by the medical community) and sent it to the national level TB centre. Since the data format in which the national Medical Statistics division wanted was incompatible with EpiInfo, the national TB center manually copied the data from EpiInfo into a paper format and transmitted it manually where it was entered into the MedStat programme (the national HIS software). Further, there was no hierarchy of information recognized, and all the data collected at the lower levels flowed to the Republican (national) level with limited abstraction and analysis. The focus on upward reporting with no business intelligence being generated from it lent itself to almost no

feedback to strengthen action and to increase the motivation of staff who only saw their task to collect and transmit upwards huge amounts of data.

A key theme identified was of the existing HIS being primarily data driven and not action led, implying its primary focus on reporting for meeting the needs of the bureaucracy rather than on the analysis and use of information for action. The focus of the HIS was on the collection of statistics, which at the end of the year was used for the annual compilation of a comprehensive health statistics book. While there were approximately more than 30,000 data elements being collected through the information system, very few indicators were generated. While through the reform process undertaken by HSRP, a total of 833 indicators were identified, these had still as yet not been operationalized into the HIS. Despite this wealth of data available, little to no analytical knowledge was being derived from it.

The formats for reporting were poorly designed, containing numerous tables, sub-forms and sometimes even a thousand data elements. In the same form, no distinction was made between annual and monthly data, or between the data required for diseases and those on infrastructure and staff. Such data was hard to be used for formulating actions for correction. Same data was reported in different forms, for example Form 30 and 32 had identical data elements regarding maternal health and child mortality. In the Box below, the case of Form 18 is presented as an example, especially to reflect how the motivation for forms was around people and the manner in which they were embedded in existing routines.

Case of Form 18

Form 18 – "Report of sanitary and epidemiology services of the Republic of Tajikistan" was one of the lengthiest forms, with 40 tables and 3,796 data elements and the printed version coming to 40 pages of A4 size paper. It was a mix of administrative, personnel and epidemiology service data. For example, Table 1 had list of number of staff available by professions and their source of funding, while Table 6 had data on "Air Pollution", Table 7 on "Soil Condition", and Table 10 on "Hygienic and Sanitation Condition of Food products". This form represented a kind of summary of epidemiology and sanitary service's performance on annual basis, rather than routinely collected health data.

Form 18 was subject of our discussion with epidemiologists from Sanitation and Epidemiology Service department of the MoH, aiming at reduction and splitting of this form into smaller sets of data. Due to its high volume and possibly irrelevance of content to HIS, this form was not included into MedStat database, but was prepared manually. The Epidemiologist argued that all the information in the form was relevant and important to know:

"*The form was used from the Soviet period and has all relevant data with regards to epidemiology service and sanitation. It is important to have such summarized information on performed routine laboratory analysis, sanitation control of public offices and living areas of population*".

While the data would have value for administration, it seemed less useful for monitoring and evaluation of events and early warning. An epidemiologist said:

"*This is correct, but we have such data for our use in the district offices, but we report*

summary of findings in this form. Now, as you see most of the report fields [table cells] are empty because we do not have chemical reagents and sufficient fundings for such tests. Later, when time comes we will continue as before. From this standpoint we do not want to reduce the form. Only parts, where no such entities existed or no more exist, for example "Enterprises of the aviation industry and civil aviation" could be removed".

Form 18 and similar forms are more of a final report rather aggregated data to be reported upwards. It was hard to convince the Epidemiologists to alter any aspect of the Form 18, even though it could be shown to them the data is not currently used.

The existing software in use at the national level (called MedStat) had been developed in-house using Microsoft Visual FoxPro deploying .dbf tables for data storage. The MedStat database was poorly designed and was an electronic reflection of the paper based system, with all its existing inefficiencies. The example of "Total" provided above, although originally designed to support the logic of a manual system, was also mirrored in the software. The software had no functionalities for indicator calculations and other visual analysis tools such as graphs and charts. In summary, the software was outdated, poorly supported, and grossly inadequate for the generation of indicators, and their linking to specific organizational units.

For the analysis of the database to understand the data-indicator linkage, we first studied the list of indicators mandated by the Ministry. There were 833 indicators grouped into 6 main categories: demography, healthcare resources, environment, healthcare services, MDG and life style. In general we found that the data available from the existing 37 report forms could be used to calculate approximately 40% of these indicators. For example, the indicator "Obstetric aid rate with the participation of specially trained health workers," required data from different sources: Forms 30 (Report on treatment of prophylactic activity of facility), 32 (Report on medical aid to pregnant, parturient and puerperal women) and 16 (Report on collective farm medical centers). Form 30 contained from both facility and service data, while 32 contained data elements related to maternal and child health. There were duplications of data leaving the situation ambiguous of what data should be used for which indicator calculation: one of the forms or a combination of many. Table 2 below demonstrates the percentage of data coverage of indicator needs, to summarize the indicator data mis(match).

Table 2. Indicator Data Match by Indicator Groups

Indicator group	Number of indicators i a group	% of data availability from existing data elements
Demography	353	30
MDG	12	25
Lifestyle	28	20
Environment	89	5
Health conditions	224	90
HC Resources	128	70
Average		40

Many indicators in the list were based on surveys (and not routine data) or were the responsibility of other State Agencies, mainly from the State Statistical Agency (SSA) which had the official mandate to compile and release the official indicators, along with the population census, surveys and other socio-economic data. All state organizations, ministries, private sector organizations report to SSA. The Ministry of Health reports its data to the SSA through its statistical department and receives the calculated indicators.

4.2 Towards a Data Warehouse based HIS

We now discuss two of our interventions in trying to bring in improvements: first, concerns the redesign of the manual HIS; and second, the design of the DHIS2 (District Health Information Software – Version 2) as the data warehouse.

4.2.1 Redesign of the Manual HIS – Working with the Installed Base

In the effort to redesign the manual HIS in 2008, we were confronted with a paradoxical situation – the agenda was to reform, but the instructions were that nothing can be changed – "not even the logo on the form". So, reform had to be carried out within the framework of the existing installed base.

The paper based system, as described earlier, was a product of the Soviet legacy and subscribed to a paper based logic of reporting. For example, a data element would have three columns representing categories (such as age groups), and a fourth column showing a total even though that could have been generated by the computer and did not need to be entered manually. While it had been identified in various consultant reports that the number of data elements was excessive, and many were irrelevant, not useful for the generation of indicators, still there were no permissions forthcoming on changing the formats. We were told, any change has to be taken by the SSA under the President's office, and that legally no change could be made for 5 years – the time for the next review. The computer system (MedStat), which succeeded the paper based system, was a replica of it, with the only difference being that it was in an electronic tabular format. MedStat mirrored the existing redundancies, such as the subtotals and totals still being stored in physical database.

With respect to the data-indicator linkage, we can say that on a minimum average, the number of data elements used in an indicator calculation is 2. So, for the currently defined 834 indicators, we need a total of about 1668 data elements. Further, if we assume that each data element has on an average 8 categories (taken on the higher side), we require a total of 13,344 data element units, which represents 42.3% of the current Tajikistan HIS size (31,544). This implies that 57.7% of the existing data elements have no value for indicator calculations, and are hence redundant. This level of redundancy reflects a very poor fit between data and indicators. Further, in many cases, the data collected is not relevant with respect to the indicators being generated. For example, the MDG6 indicator calculation (UN, 2001) requires data on women in the age category of 15-24 years, whereas the Tajikistan HIS provides 15-19 years data.

Further, no indicators were currently generated from the existing MedStat system. However, from this system, some data elements were extracted and about 5 indicators were generated and uploaded into another system (WHO DPS – Data Presentation System). These indicators were not being made available to programme managers to support their everyday monitoring and evaluation purposes. These 5 indicators used less than 50 out of the 31,544 data elements (less than 1%) reflecting the high degree of non-use of data for action. Two, all the data which is collected by the lower levels are fed to the national level with no degree of abstraction and aggregation in the form of indicators.

Given that there was no permission to change the forms or data elements, our strategy was very much to mimic the paper based system, and to take the existing forms as they were into the DHIS2. The idea was once the forms were there, we would try to import in all the available legacy data, and be able to show the abnormalities in the data to the decision makers, as a catalyst to argue for change. For example, we found that in data from some sample years and forms, there were nearly 80-90% of blank values. It would not have been able to identify such abnormalities if the data was all on paper and could not be included in a electronic database.

In summary, the data reporting forms were organized in a way that did not support local monitoring and action. A majority of the institutionalized practices, products of the Soviet bureaucratic context still persisted. Though they have eroded significantly and for the most part lost their initial value in relation to the new socio-technical realities. "Gigantic forms" which still continued, were largely left "blank" making the HIS overloaded and inefficient. Bringing in change would necessarily involve dealing with the competing institutional logics at play, and find ways of reconciling them.

In the next section, we describe more of "moving the installed base" from an existing paper based system, to something which was computer supported, so as to not alienate the users and act within the political affordance available.

4.2.2 The Data Warehouse Based on DHIS2[1]

One key element of our intervention through the HSRP was the piloting of DHIS2 in some selected districts. DHIS2 is an open source tool for collection, validation, analysis, and presentation of aggregate statistical data, tailored (but not limited) to integrated health information management activities. DHIS2 is a generic tool rather than a pre-configured database application, with an open meta-data model (figure 1) and a flexible user interface that allows the user to design the contents of a specific information system through the user interface without the need for programming intervention. This allows to build customized set of data elements and indicators into the system. Modularity is another flexible feature of DHIS2 which allows the adding of new functionality by developing new modules in addition to existing core modules.

In terms of customizing DHIS2 to the Tajikistan context, first, the organization unit structure of the MoH and its sub-units were created and added to the system. Since we were not given permission to make any design changes to the paper forms, as it required prior approval from the SSA, the data entry forms were designed for each data set in accordance and resemblance of the 37 paper based forms. While forms were organized in a structured and standardized metadata, they could still be visualized exactly as their paper based version. This is actually an outstanding feature of DHIS2, which helps end user to gradually shift from paper to a computer based reporting with minimum disruptions (Sahay et al., 2010). DHIS2 was installed in pilot districts with the same set of data elements. Through training programmes conducted in the pilot sites by a technical agency, the users were trained to enter data into the different data sets on a monthly basis, and data from these local pilot sites were combined via the import/export feature to be transmitted to the central DHIS2 database.

[1] DHIS2 has been successfully implemented as a Health Information System in many developing countries in Africa and Asia and has also been adopted by the WHO as a part of their Public Health Information Toolkit being offered by them as a part of their technical assistance package on HMIS to partner countries.

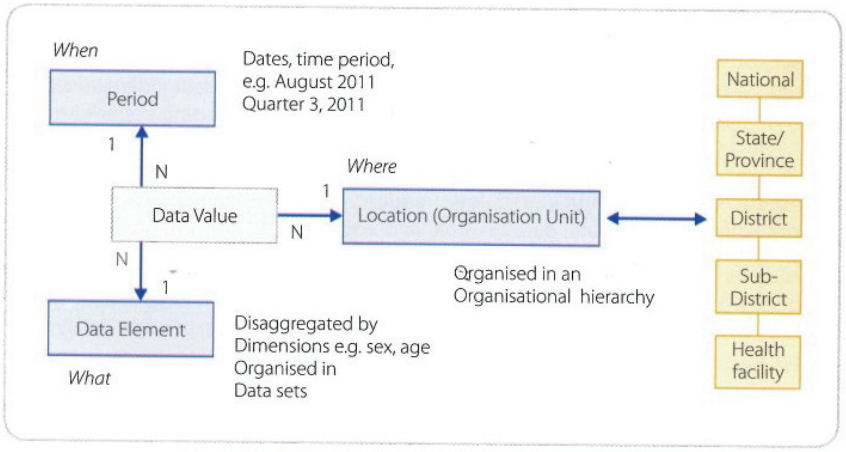


Figure 1. DHIS2 Generic Data Model (Source: Braa & Sahay, 2012)

Once the data was in the database, the focus shifted in training to build capacity in the staff in the district hospitals to be able to analyze their data locally and take corrective actions, without waiting for instructions to come from the higher levels. Such instructions typically never came or if they did it was a year or more late thus making it irrelevant for local action. Over time, the central database was populated with all the data from health units at the lower levels of the pilot sites and transmitted to the national level. Outputs from the pilot were seen to be path breaking and the Ministry was satisfied with the DHIS2 functionality and performance as a form of a data warehouse. In March 2010, a new project with support from European Commission was launched to implement DHIS2 nationally, a process planned to start early 2013.

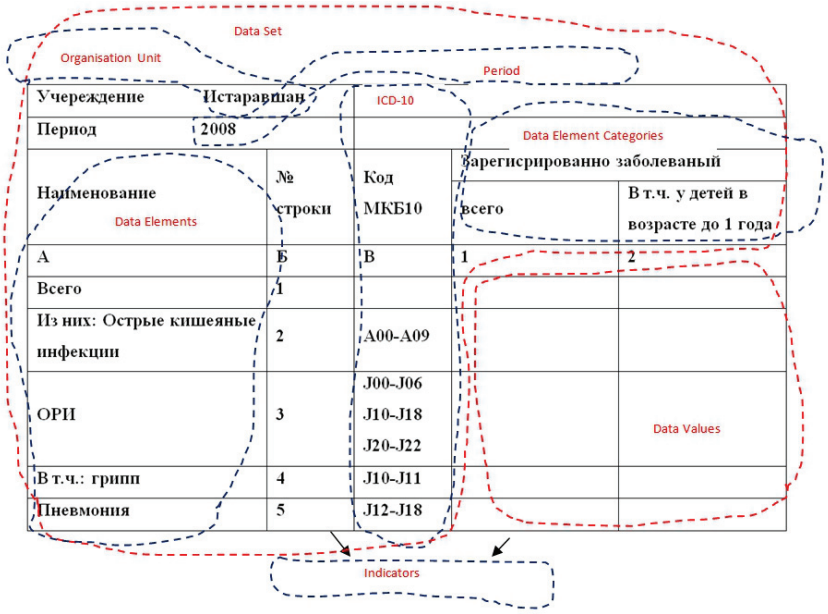
After presenting case study, we move to the discussion section to examine institutional and infrastructural influences in HMIS implementation followed by analysis of indicator-data match, using the three dimensional framework of completeness, fittingness, and actionability.

5. DISCUSSION

It has been argued earlier that there are two major competing institutional logics in the HIS of Tajikistan: a centrally managed system which exists and of decentralized decision-making being proposed through the reform process (Sahay et al., 2010). The centrally managed system logic was largely institutionalized during Soviet period, materialized into paper based HIS and later was computerized with minor changes. As an inscription of Soviet legacy of centralized management and planning, the paper based system reflected many contradictions with the latest organizational and institutional developments in healthcare of Tajikistan. In other words, despite its contradictory nature, the paper based system was the "installed base" resisting changes aimed towards decentralized decision-making and the everyday practices emerging of health professionals in the result of socio-economic pressures, such as payment for performance.

Being constrained by such resistance, our strategy was towards developing a process of standardization using a meta-data dictionary standardization as an intermediary step towards building a HIS that would support "data for action", and the institutional logic of decentralized decision-making. Reporting forms were codified (see figure 2 for an example)

and documented into meta-data dictionary, which were then loaded into the DHIS2 data warehouse. Each table in existing paper based forms were added to meta-data dictionary, comprising of data elements, data element categories, indicators and linked them together along with other properties relevant to these data elements and indicators. The user interface for data capture also was designed in a manner to provide the same look and feel as the existing paper forms. With this approach, we tried to firstly minimize the collision of competing institutional logics, while adding analytical and reporting features with the data warehouse to allow users have ability to see the data. The drawback of this approach is it continues, and also reinforces the existing redundancies that were inherent in the paper based system.



Учереждение	Истаравшан			
Период	2008			
Наименование	№ строки	Код МКБ10	Зарегисрированно заболеваный	
			всего	В т.ч. у детей в возрасте до 1 года
А	Б	В	1	2
Всего	1			
Из них: Острые кишеяные инфекции	2	A00-A09		
ОРИ	3	J00-J06 J10-J18 J20-J22		
В т.ч.: грипп	4	J10-J11		
Пневмония	5	J12-J18		

Figure 2. An Example Demonstrating Metadata Definition for Table 4 of Child Morbidity of Form 41 – "Kindergarten Report", Paper Based Form.

Implementing IT-enabled projects is not simply about installing new hardware and software, but requires a significant change in the working practices of clinicians and administrators (Currie & Guah, 2007). Practicing with the data warehouse system being gradually introduced could potentially allow users attain more analytical skills, which would help to focus them on data that they need, while recognizing the redundancies of other data. In this way, the HIS can become more embedded in formal and informal institutional arrangements, becoming a more durable social structure.

The DHIS2 based data warehouse approach, we argue can strengthen the actionability of the HIS. For example, the analytical features of the DHIS2 can help to identify duplicate data elements and thus improve the fittingness of the system. By being able to define the indicators required, the completeness of the HIS could be strengthened. The Business Intelligence tools provided by the DHIS2, such as GIS, dashboard etc could allow the non-expert user to be able to generate their locally required indicators, and present it in ways which could potentially aid their analysis and interpretation.

6. CONCLUSIONS

Based on the normative aim of strengthening the actionability of the HIS in terms of the data-indicator linkage, we have analyzed the existing HIS in Tajikistan using a framework of three interdependent dimensions in order to discover overlaps, duplications and ambiguities that adversely influence data quality and its use as indicators. The analysis shows that the existing data elements being generated by the HIS were marginally useful or relevant and actionable with respect to the operationalization and use of indicators. Next, we have tried to develop an approach of the development of a data warehouse application, based on a socio-technical approach inspired by the concepts from institutional theory. This reflects the recognition that bringing change is about addressing the contradictory implications arising from competing institutional logics, and steering it towards the direction of desired change.

Institutional changes do not occur overnight, they are rather result of longer socio-political negotiations among various stakeholders of HIS, who are seeking benefits from it. Placing existing paper based forms into standardized meta-data definitions, we created an intermediary that complied with both the conflicting institutional logics, that is having the existing system's look and feel and the volume of data to be reported (centrally managed logic), while the data is however stored in the standardized definition on the background. This allowed users to analyse data at different organizational levels (logic of "data for action"). Interplay of system users with competing logics, which comes from their organizational principles and external forces, will gradually guide them to build the culture of evidence based decision making.

What we have demonstrated through our case description and analysis is that analytical data warehousing tools have a vast potential for public health management in developing countries for critical activities such as the monitoring of national indicators or MDGs which are of national and global importance. However, this potential has remained to a large extent unutilized. We have argued that there are two key paths to improve this situation. One, is the redesign of the manual systems with a key aim of improving the data-indicator linkage with respect to dimensions of fittingness, completeness and actionability. Two, is through the more effective use of analytical tools provided by the data warehouse, which are flexible and easy to customize by users and have strong capabilities of data analysis and presentation.

Abbreviations:
BCG - Bacille Calmette-Guerin vaccine
TT - Tetanus Toxoid vaccine
TB - Tuberculosis
DPS - Data Presentation System
GAVI - The Global Alliance for Vaccines and Immunization
MDG - Millennium Development Goals
HIS - Health Information System
HMIS - Health Management Information System
HIV/AIDS - Human immunodeficiency virus/Acquired immune deficiency syndrome
MoH - Ministry of Health
SSA - State Statistical Agency
HSRP - Health System Reform Project
WHO - World Health Organization
UN - United Nations
ADB - Asian Development Bank
AHIMA - American Health Information Management Association

References

AHIMA (American Health Information Management Association) (1998a) Improving the Quality of Healthcare Data. (Resolution from the 1997 House of Delegates) *Journal of AHIMA* 69, 1..

AHIMA (American Health Information Management Association) (1998b) Practice Brief: Data Quality Management Model. http://library.ahima.org/xpedio/groups/public/documents/ahima/bok1_000066.hcsp?dDocName=bok1_000066.

Ahmedov, M., Azimov, R., Alimova, V., Rechel, B. (2007) *Uzbekistan: Health System Review*. *Health Systems in Transition*, 9, 3, 1-210.

Alford, R.R. and Friedland, R. (1985) *Powers of Theory, Capitalism, the State, and Democracy*. Cambridge University Press.

Bankowitz, R. (2010) Turning Data into Actionable Information and Improved Outcomes. *Healthcare Financial Management*. 64, 9, 134-136.

Berente, N. and Yoo, Y. (2012) Institutional Contradictions and Loose Coupling: Postimplementation of NASA's Enterprise Information System, *Information Systems Research*, 27, 2, 376-396..

Braa, J and Sahay, S.. (2012) *Integrated Health Information Architecture. Power to the Users*. Matrix Publishers.

Braa, J., Monteiro, E. & Sahay, S. (2004) Networks of Action: Sustainable Health Information Systems across Developing Countries, *MIS Quarterly*, 28, 3, 337-362.

Currie, W.L. and Guah, M.W. (2007) Conflicting Institutional Logics: A National Programme for IT in the Organisational Field of Healthcare. *Journal of Information Technology*, 22, 235-247.

Dunn, M. B. and Jones, C. (2010). Institutional Logics and Institutional Pluralism: The Contestation of Care and Science Logics in Medical Education 1967–2005. Administrative Science Quarterly, 55, 114-149.

Friedland, R. and Alford, R.R. (1991) Bringing Society Back in: *Symbols, Practices, and Institutional Contradictions: The New Institutionalism in Organizational Analysis* (Powell, W.W. and DiMaggio, P.J. (Eds)), Chicago: University of Chicago Press, 232–266.

Hayes, N. and Rajão, R. (2011) Competing Institutional Logics and Sustainable Development: The Case of Geographic Information Systems in Brazil's Amazon region, *Information Technology for Development*, 17, 1, 4-23.

Ibraimova, A., Akkazieva, B., Ibraimov, A., Manzhieva, E. and Rechel, B. (2011) Kyrgyzstan: Health System Review, *Health Systems in Transition* 13, 3, 1-152.

Kerr, K., Norris, T. and Stockdale, R. (2007) Data Quality Information and Decision Making: A Healthcare Case Study. *18th Australasian Conference on Information Systems Data Quality in Healthcare*, 5-7 Dec 2007, Toowoomba, 1017-1026.

Khodjamurodov, G.. and Rechel, B. (2010) Tajikistan: Health System Review. *Health Systems in Transition*, 12, 2, 1-154.

Kraatz, M.S. and Block, E.S. (2008) Organizational Implications of Institutional Pluralism, in: Sahlin-Andersson, K., Greenwood, R., Oliver, C. and Suddaby, R. (Eds). *Handbook of Organizational Institutionalism*. Sage Publications, London, 243–275.

Kulzhanov, M. and Rechel, B. (2007) Kazakhstan: Health System Review, *Health Systems in Transition*, 9, 7, 1-158.

McKee, M., Healy, J. and Falkingham, J. (2002) *Health Care in Central Asia*. Open University Press, Buckingham.

Mirzoev, T.N., Green, A.T. and Newell, J.N. (2007) Progress towards Health Reform in Tajikistan. *Journal of Health Organization and Management* 21, 6, 495-505.

Noir, C. and Walsham, G.. (2007) The Great Legitimizer: ICT as Myth and Ceremony in the Indian Healthcare Sector, *IT & People* 20, 4, 313-333.

North, D.C. (1990) *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, New York.

Orlikowski, W.J. (2007) Sociomaterial Practices: Exploring Technology at Work, *Organization Studies*, 28, 1435-1448.

Sahay, S. and Latifov, M.A. (2009) The Data to Indicator (Mis)Match: Experiences from Trying to Strengthen this Link in the Health Information System in Tajikistan. Proceedings of the 10th International Conference on Social Implications of Computers in Developing Countries, Dubai, May.

Sahay, S. and Lewis, J. (2009) Challenges and Approaches in Moving from Data to Information to Knowledge: Case Study from the Gujarat State Health System in India. Proceedings of the 10th International Conference on Social Implications of Computers in Developing Countries, Dubai.

Sahay, S., Sæbø, J.I., Mekonnen, S.M. and Gizaw, A.A. (2009) Interplay of Institutional Logics and Implications for Deinstitutionalization: Case Study of HMIS Implementation in Tajikistan. Proceedings of the 10th International Conference on Social Implications of Computers in Developing Countries, Dubai.

Sahay, S., Sæbø, J.I., Mekonnen, S.M. and Gizaw, A.A. (2010) Interplay of Institutional Logics and Implications for Deinstitutionalization: Case Study of HMIS Implementation in Tajikistan. *Information Technologies & International Development*. 6, 3, 19-32.

Scott, W.R. (2001) Institutions and Organizations. Sage Publications, Thousand Oaks.

Thornton, P.H. and Ocasio, W. (2008) Institutional Logics, in: Greenwood, R., Oliver, C., Suddaby, R. and Sahlin-Andersen, K. (Eds), The SAGE Handbook of Organizational Institutionalism.

United Nations (2001) Indicators of Sustainable Development: Guidelines and Methodologies. http://www.un.org/esa/sustdev/natlinfo/indicators/isd.htm

WHO (2008) World Health Statistics, WHO Library.

Young, J.W. (2011) Health and Actionable Advice. IDC Health Insights #HI229293. www.anvitahealth.com/pdf/IDC_Health_Insights_Brief.pdf

APPENDIX IV

Murodillo Abdusamadovich Latifov and Sundeep Sahay (2013). Challenges in Moving to ”Health Information for Action”: an Infrastructural Perspective from a Case Study in Tajikistan

Information Technology for Development, in print

APPENDIX V

Latifov, Murodillo Abdusamadovich (2013). Global standards and Local Applications: Case of Implementing ICD-10 Standard in HMIS of Tajikistan.

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Global standards and Local Applications: Case of Implementing ICD-10 Standard in HMIS Tajikistan

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Abstract. This paper contributes to the ongoing debate on the interplay of global and local standardization processes and how can these be effectively managed. Based on the longitudinal case study of the Health Management Information System (HMIS) implementation in Tajikistan, the paper analyses how the adoption and usage of global standards of International Classification of Diseases (ICD) contributes to the improved quality of health data for clinical and statistical purposes and the related implications it has for the health service delivery. The analysis focus onto negotiation processes among various stakeholders of HMIS in interplay between the global standards and local implementation of these standards through the lens of proposed conceptual framework of 'global and local interplay of HMIS standards'. Three distinct approaches developed by stakeholders in redesign of HMIS standards were identified, each having advantages and limitations. Further varying level of ICD use in these approaches is discussed along with future prospects from gradual use and institutionalization of ICD.

Keywords. ICD; HMIS; Healthcare; Standard; Developing country; Tajikistan.

I. Introduction

Nowadays we live in a world of globalization, where initiatives and concerns are raised globally and measures for implementation are taken locally, often involving transnational and regional collaborations. The recent "2009 swine flu pandemic" (WHO, 2009) is a clear example of a global event involving an outbreak of influenza A(N1H1) followed by attempts of the World Health Organization (WHO) to rapid response to lower the risk of the virus, including through the use of global information systems and guidelines. Nations then seek to adapt these guidelines in their local contexts, for example in India with attempts also to use herbal medicines to combat this virus. This interplay of the global and local dynamics is an interesting phenomenon permeating nearly all domains of our everyday lives, including health information systems (HIS) which is the focus of this paper.

"World-level" data are built around standards and classifications with the promise to uniformly address local conditions of global concerns. One such case in the domain of health is the International Classification of Diseases (ICD), which is administered by the WHO to provide standards for recording diseases. A key function of ICD is to give stability of nomenclature and meaning over different sites and time (Timmermans & Berg, 2003). The history of ICD starts with the 1893 conference in Paris and

subsequent conferences related to eradication of cholera, one of the deadliest pandemics of the 19th century (Lee, 2003). Since cholera spread with travelers, the issue became global, requiring local actions at national level and to obtain global recognition of the state to be classified as cholera free. ICD represented inscriptions of a series of technical, social, political and economic decisions taken at different moments of time (Bowker & Star, 1999), which needed to be locally adapted to different contexts of use. Typically, different perspectives exist on these standards, for example, the cause of death as given on the death certificate by the physician is frequently not the same as that which enters into statistical records (Fagot-Largeault 1989). Classifications, by their very nature and design, constrain the kind of story that the statistics want to tell (Bowker & Star, 1999).

In the context of health information, a key challenge is around managing the interaction between the introduction of global standards and local appropriation (Braa et al., 2007; Jacucci, Shaw & Braa, 2006; Braa & Hedberg, 2002; Shaw, 2002). A key research finding concerns the use of a "flexible standard" strategy to meet the diversity of information needs, representing a defined set of obligatory data sets for all levels (Jacucci, Shaw & Braa, 2006), while simultaneously giving each level the flexibility to add standards for their local use. In contrast to this suggested "bottom-up" approach to implement standards, there are other "top-down" or "hybrid" strategies. "Top-down" approaches typically respond to national needs or to the demands of global agencies (Sahay, 2011), but will necessarily need to interact with local processes and conditions during implementation (Ciborra, 1994). These appropriation processes are shaped through negotiations amongst actors, often representing diverging interests and needs, with implications on the acceptance or not of the standard.

The intent of the paper thus is to contribute to the ongoing debate on the interplay of global and local standardization processes and how can these be effectively managed. The specific object of study is the global ICD standards, and the ongoing attempts to make them as an integral part of the Tajikistan's national HMIS. The ongoing interplay, is not only studied, but also I tried to intervene in during the course of this action research study from 2008 to date. The research questions addressed include:

a. What is the nature of interplay between the global and local dynamics around ICD standards and their introduction in the Tajikistan national HMIS?

b. What are approaches to best manage this interplay, so as to strengthen the national HMIS?

In the next section, I sketch out key concepts that inform my analysis drawing from Institutional Theory and the Information Infrastructure (II) perspective, including the discussions on standards. Then an account of the methodology is provided, following which the case study is presented. The analysis and discussions, and then conclusions follow.

II. Related Research

In this section, a theoretical framework is developed based on three sets of founding concepts from institutional theory, an II perspective, and standards. The underlying perspective is of HIS, including the relevant standards, as a socio-technical process where the social and technical dimensions are seen to be intertwined with each other.

2.1 Institutional Theory, Information Infrastructure Perspective and Standards

The process of IS implementation involves institutionalization (Silva and Backhouse, 2003), and this is greater for large scale and networked systems as they span across different contexts and administrative divisions. Information systems represent a web of technical artefacts, people, and procedures immersed in a particular context (Kling & Scacchi, 1982), influenced by a socio-technical installed base (Hanseth & Monteiro, 1997). Standards provide the socio-technical back-bone to information infrastructures, defining the framework to regulate communicative patterns.. As such, "These standards are neither ready-made nor neutral. They are currently being developed, and they 'inscribe' behaviour in complex and non-transparent ways" (Hanseth & Monteiro, 1997:183).The role of standards becomes increasingly important as systems becomes networked and complex (Fomin, Keil & Lyytinen, 2003) as the need for coordination is heightened.

"Organizations are suspended in a web of values, norms, beliefs, and taken-for-granted assumptions" (Barley & Tolbert, 1997:93) that guide and constrain organization and individual actions (Scott, 2001). Institutions thus represent "multifaceted, durable social structures, made up of symbolic elements, social activities, and material resources" (Scott 2001:49). Information systems represent institutionalized material resources inscribing daily organizational routines, and "represent constraints on the options that individuals and collectives are likely to exercise, albeit constraints that are open to modification over time" (Barley and Tolbert, 1997:94). They take effort and long time to both institutionalize and deinstitutionalize (Oliver, 1992).

Existing systems are an indivisible part of an organization's institutional arrangements, representing the "installed base", which need to be accounted for whilst planning the change. Challenges in change may be magnified in globally distributed systems because of the multiplicity of installed bases in use, requiring different "workarounds" and adaptations (Rolland & Monteiro, 2002) to weaken and erode 'old institutions' and for new ones replace them. This involves a process of deinstitutionalization and reinstitutionalization where new ones are created and gradually embedded in the local context (Oliver, 1992). Changes necessarily take place around the installed base (Hanseth & Monteiro, 1997), and as it becomes increasingly deep rooted and impossible to change, they start to become irreversible (Hanseth & Monteiro, 1998).

Implementing and institutionalizing global standards like ICD into local contexts requires building similarities between global definitions and local contexts (AbouZahr & Boerma, 2005). Often we are biased towards building context sensitivity while dealing with global solutions (Pollock, Williams & D'Adderio, 2007; Rolland & Monteiro, 2002), ignoring the similarities that different contexts may also have. In their study of a maritime classification company, Rolland and Monteiro (2002) describe a 'moving context', where ships of varying dimensions and characteristics travel from one dock to another, when surveys are being performed, magnifying the complexity of the locale context and the work of surveyors. They propose finding a 'pragmatic balance' between the global and local which is based on various political, operational and economic considerations.

Incentives also play an important role in mediating the interplay between the global and local. Incentives can encourage purposeful action of individuals as it creates expectations of some sort of rewards (Armstrong, 2002). Incentives can be positive or negative depending on individual's perception of changes resulting from particular actions within a particular physical and social context (Ostrom, Schroeder, & Wynne, 1993). For example, "pay for performance" is a mechanism being used by healthcare providers for improving quality of care by providing incentives to medical practitioners (Garber, 2005).

Based on the discussions above, I propose a theoretical framework to support the analysis process.

2.2 Theoretical Framework

Based on the discussions above, I propose a theoretical framework to support the analysis process. The proposed theoretical framework is based on three key components:

- Institutional actors;
- The existing installed base in the system; and,
- The interplay between global and local standards.

Many institutional actors are involved in HMIS implementation, playing different roles in the localization of global standards. These actors include global actors like WHO; development partners providing expertise to countries; global open source software vendors; local ministries, their regional and sub-regional offices. These actors provide varying influences on the standardization process. While WHO drives the content of global standards like ICD, national ministries take decisions to adopt them, while district and other sub-national systems implement them. Donor agencies provide funds and expertise to deploy standards, while software vendors seek to enable this process through technical systems.

Installed base consists of existing applications of paper and computer based HMIS, including standards for data collection, their formats, and periodicity of data collection. Installed base, which is spread across geographic locations, is composed of heterogeneous elements, including actors and standards, becoming the arena for negotiations between actors seeking to find a balance in global and local standardization. This process is confronted with constrains and affordances coming from the installed base, the global standards themselves, and the existing local practices.

The process of standardization involves both local and global actors, and their interplay has to engage with the installed base. Incentives become one important instrument to mediate this interplay. Actors constantly seek incentives from the actions they perform in balancing between different constraints, and incentive seeking, be it material or moral. If incentives received are positive and accepted by actors, it may lead to the acceptance and legitimation of a standard (Markus & Gelinas, 2006), while a negative incentive could lead to further negotiations, local workarounds or even the abandoning of a standard. Negotiation is important in managing this interplay, often involving countries to request global actors for technical support. "Negotiation is an interaction in which parties start out with different understandings about something, disagreement, and via the interplay of offer and counter-offer, or at least an exploration

of contending views, try and reach a common understanding, agreement." (Cohen, 2000:317). Negotiation seeks to reach consensus and balance global/local requirements through working solutions.

The relationships between these three elements of actors, installed base and interplay, are guided by formal rules and informal constraints, shaped within particular institutional contexts. These linkages and influences can sometimes be multiple and contradictory in shaping processes of standardization as they simultaneously involve generification (Pollock, Williams & D'Adderio, 2007), and also localization involving the embedding of a standard in a particular setting. Contextualization (Jarulaitis & Monteiro, 2009) is ongoing, representing the process where local actors adopt local implementation into their context. In each of these above processes, actors play specific roles and their interactions are shaped by incentives received from the standards implemented. Further, present actions are guided and restricted by their past experiences and existing routines and artifacts - the installed base.

The schematic below sketches the above described conceptual framework:

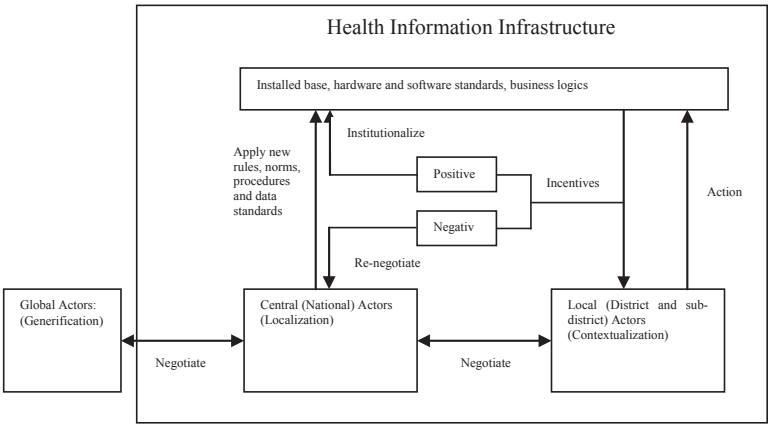

Figure 1. Global and local interplay around HMIS standards

The theoretical framework helps to identify relevant institutional actors at the different levels, and their respective influences on the standardization process. I focus on both the formal and informal mediators to this relationship, including incentives which provide alternative strategies to manage this global/local interplay, and a more effective balance between them.

III. Research Methods and Data Collection

This study is part of larger action research carried out during 2008-2012 in collaboration with Republican Centre for Statistics and Medical Information (RCSMI) of MoH Tajikistan, and the European Union (EU) delegation in Tajikistan. Empirically this research is a longitudinal and qualitative case study based on an interpretive analysis of the HMIS of Tajikistan. The Tajikistan HMIS reform process has been organized over three phases: phase I – assessment of existing systems (2009-10), phase II - planning for implementation (2010-11) and the forthcoming phase III on implementation (2013-15). My involvement started in Phase I which was funded by an Asian Development Bank loan, serving as an entry point for me to carry out an action research intervention together with University of Oslo researchers.

I actively participated in Phases I and II, collaborating with multiple stakeholders. Action research tasks included the customization of the data warehousing application for local needs, assisting the RCSMI with the creation of the national meta-data dictionary of indicators and data elements. In both these tasks, I dealt with issues around the ICD including how they were understood, used and expected to improve the data quality. Through continuous evaluation of the interventions together with MOH colleagues, I sharpened my understanding of the situation and improved the focus of my interventions. Important was to understand how inter-subjectivity was achieved (Baskerville, 1999), by "understanding a phenomena through accessing the meaning that participants assign to them" (Orlikovski & Barudi, 1991:5) and the nature of "hidden" meanings (Walsham, 1995).

Data collection took place at multiple levels, including global partners (such as EU), central ministries and sub-national actors. Data collection methods included interviews, observations, questionnaires, participation in stakeholder meetings, conducting prototyping and secondary documents analysis. Interview respondents included donor organizations (e.g. ADB and EU), development partners, various national government agencies such as the Ministry of Health, the State Statistics Agency (SSA), and Civil Registry Office (CRO). In Tajikistan, SSA official statistics and coordinates data exchange among different parties. CRO processes birth and deaths in collaboration with HMU and SSA. Questionnaires helped to compile data such as related to: number of health facilities; number of computer equipment in use; availability of Internet; and "whether ICD-10 codes were used? And how?"

With respect to the ICD, the following was done:

1. To understand how ICD codes could be included in the data registration forms?
2. To develop software application to include ICD codes based on individual case records, and its integration with the national HMIS.
3. The development of reports depicting the ICD based disease profiles.

I conducted three sets of interviews in Sogd and Khatlon provinces. The first was in Aug'11 lasting for 10 days and covering 10 districts and also the Sogd province centre. The second covered 3 districts and the provincial centre during Nov'11 over 4 days. The third visit to Khatlon province and four of its districts took place in March 2012, with a key focus on the CRO at the district level and the health management units (HMU). A focus of these visits was to understand data exchange between the

health department and CROs, representing two different ministries (health and justice), and their respective uses of ICD in recording the cause of death for which both were signatories.

IV. Case Study

4.1 Setting the Context

The MoH Tajikistan inherited the 70 year legacy of the Soviet system, reflected also in the HMIS. "Gosplan" was the central government organization for planning and distribution of resources nationwide, including for healthcare. In the turbulence of the post 1991 Soviet collapse period, there was the rapid shift from planned to open market economy; the emergence of new states across Soviet borders; new forms of property ownership; and the sharp splintering of formerly existing economic and financial systems which also affected health (Braguinsky & Yavlinski, 2000). Furthermore, Tajikistan suffered from a brutal civil war that lasted from 1991 to 1997, which ruined the national economy and led to a rapid decline of public transport, utilities like electricity and water supply, affecting the well being of the entire population, including their access to health care services.

The case study is presented in two broad parts: The agenda for reform which highlights the existing situation with a focus on ICD; and, the process of managing the interplay in implementing the ICD codes in the national and sub-national systems.

4.2 Reforming HMIS: The National Agenda

A key reform agenda of the government was to strengthen the health system, including the supporting HMIS. Different evaluations of the HMIS by experts concluded that the HMIS had many redundancies including number of the data elements being collected (Sahay et al. 2009; Latifov & Sahay, 2012). This volume (representing nearly 30,000 data elements being collected) made the HMIS both inefficient and largely irrelevant as it continued to collect data on parameters defined during the Soviet period (for example, "number of airplane vibrations heard") which had little meaning in the contemporary context.

Contributing significantly to this volume of data was the MOH requirement to collect disease specific data detailed by ICD codes, covering almost all chapters of ICD-10 code list. For example form 32 - "Report about medical aid to pregnant, parturient and puerperal women" covered almost all categories under "O" (Pregnancy, childbirth and the puerperium) and "P" (Certain conditions originating in the perinatal period) chapters of ICD-10, and also some of "J" (Diseases of the respiratory system) and "L" (Diseases of the skin and subcutaneous tissue) chapters. These codes were also largely duplicated in form "1" – "Report about infectious and parasitic diseases". Duplications arose because these forms collected data from the same source, even though there was no need to record them more than once. Since the reporting forms were thematically designed, they mixed administrative and health related data, making it difficult both in terms of data entry and analysis.

While the reporting forms had an advanced use of ICD-10 codes, the adopted list of ICD-10 codes for use (data collection) was much smaller (2500 in count), not covering all the codes used in forms. For example form "32" had data elements

"Endocrine, nutritional and metabolic diseases" corresponding to the ICD-10 "O" chapter, code "99.2", which is not listed in the handbook (Saifuddinov & Kurbanov, 2010). The list of adopted ICD-10 codes represented only 4% of the total ICD-10 codes, which the doctors felt was not sufficient for clinical use, but useful for statistical purposes only. In order to provide understandable and exact description of the diagnosis, doctors used free text to record diagnosis and lab orders so that staff of the lab and radiology departments understood the instructions they needed to perform, and what ICD-10 codes to assign to the free text diagnosis. The limited use of the ICD 10 codes was seen inadequate for clinical use (Watzlaf et al., 2007).

In 2009, the EU following HMN framework insisted on the inclusion of the CRO as a part of the HMIS because CRO is responsible for recording and reporting of birth and death and these data are used for indicator calculation. This flow of data back and forth needed to be standardized with the use of ICD-10 codes between district HMUs, CROs and SSAs. Three scenarios existed in exchanging data between these organizations and the recording of ICDs. In some districts, a medical doctor placed ICD codes on the report, in others, the medical doctor reported to the CRO, and jointly with the CRO specialist filled the form with ICD codes. In other cases, the report was submitted by the HMU statistician to the CRO and then to the SSA without coding, and only the SSA coder placed ICD codes into the report.

Lack of common standards and formats for data exchange resulted in discrepancies between the CRO and HMU reports, as cases registered in one organization were not communicated to other. For example, if birth took place outside delivery house, the HMU most likely would not record it, but the CRO would record the case if it was reported by the parents. Also there were cases that the CRO would not record due to legislative restrictions if the complete set of legal documents was not present, even if the case was reported by the HMU.

4.3 Managing the interplay in implementing the ICD in HMIS of Tajikistan

From initial stages of the HMIS reform (2007), there existed dilemmas of standardization with respect to the existing HMIS and the proposed new data warehouse solution. In Tajikistan, a "bottom up" approach was not taken as a basis, and instead national health managers redesigned the existing system with national standards for data processing and storage. During the planning phase (II) of the project, two working groups were formed, bringing together national experts from various healthcare fields, including the CRO and SSA. One working group was dedicated to the revision of recording and reporting forms and the other for the indicators. Addressing the gap between the "old" and "new" systems and finding approaches to standardize the national data sets was of high priority, including finding ways of incorporating global standards like ICD. These working groups served as negotiation arenas for experts of different specialities and backgrounds, who helped formulate of three distinct approaches, which are discussed next.

The first approach proposed to standardize data sets by taking the list of national indicators and work out the data elements needed for the calculation of these indicators identified by the National Health Strategy (NHS). While this approach optimized data elements for the national level, it overlooked lower level needs. Some district representatives participating in working said "this approach only serves NHS purposes

and does not address local priorities at district and facility levels". The RCSMI senior official replied: "We used this system for so many years, and it was fulfilling all the information needs of the ministry, why to change it?" A district representative responded: "We know that system was doing well, but so many things have changed in the recent past, which we also want to see in the system. For example, as a district health manager I would like to know prevalence of this or that disease in the district during the winter session to prepare for the next year. This is only possible if we have standardized and electronic record of individual cases".

These discussions led to the second approach in the redesign of HMIS, which compared data elements from the existing system against the actual work load in the districts. Information needs of districts demanded more detailed data than the national level. These details came also with recent reform efforts which involved the introduction of new financing mechanisms and structural reorganization of healthcare management at the district level. The idea was to compare two set of data elements (formally mandated by the national ministry and informal workarounds by medical professionals in the districts) and find out the difference, which could be than classified as redundant and removed from the national standard list. This approach was criticized by senior officials at RCSMI for being locale specific, and not accounting for variations across districts.

The third approach proposed by the expert group was to use ICD-10 standard for data collection at the patient record level. Though this approach did not reduce the number of data elements, it provided a better balance between the first two approaches. It eliminated lengthy data entry forms and also reduced the number of zero values against which data elements were being collected.

Several new reform efforts were introduced which potentially influenced the uptake of ICD codes, and subsequently their import into the HMIS. For example, the Guaranteed Benefit Package (GBP) - a mechanism to provide equitable access to the healthcare services, where government shared the cost of services with patients. The GBP was piloted in selected districts from 2007 onwards, including the "Form66" application which recorded all in-patient cases with ICD-10 codes, and costs of diagnosis and treatments provided. Similarly in another pilot project, a fee-for-service mechanism was introduced in six hospitals (Khojamurodov & Rechel, 2010), in which the performance of the facility was measured by recording disease cases using ICD codes.

EU supported the CRO and RCSMI with provision of computers, printers, servers and networking equipment. In 2013, this equipment is planned to be used for creating a network connecting all district offices of CRO and HMUs with central servers which will host the database and application. This would allow stakeholders to have more advanced and timely information. Also improvements in electricity supply and communication networks built by private and public sectors, were favourably enhancing the HMIS infrastructure, potentially with positive implications for the ICD implementation by providing users the possibility of recording ICDs in the computers at the point of diagnosis.

In the table below, the three approaches to HMIS redesign with implications on ICD use is summarized

Table 1. Summary of HMIS redesign approaches

Approach for the redesign	Pros and cons	Implications on ICD use
Top-down alignment of data sets with NHS indicators	Pros: fully compliant with NHS Cons: Does not account for local needs	No direct use of ICD, emphasis on aggregate and not patient based data
Bottom-up approach, where district priorities are included into national data sets	Pros: better suits local needs Cons: maybe overwhelming for districts given their high workloads	No direct use of ICD even though elements of individual case records are present
Individual record level data capturing using ICD-10 standard	Pros: Individual level records can easily be included into various reports. Cons: Requires advanced infrastructure and computing equipment, trained staff	Based on ICD as classification of diseases in processing and storing of individual records

V. Analysis

As the case study demonstrates, the existing HMIS did not fulfil national and local demands for analytical data. While data was collected on a daily basis on primary forms, districts reported annually, thus it would be more relevant if reported on shorter periods (e.g. quarterly or monthly). The situation could be improved if data was computerized and stored in standardized formats.

Actors at various levels had different expectations from the HMIS. For example, donor organizations tried to minimize gaps between global requirements, such as WHO mandated collection of vital statistics and its reporting to the national level. This required closer linking of the different HMIS stakeholders to help increase the reliability and quality of data for meeting both national and global demands. For example, improved CRO and MoH collaboration would improve quality of demographic data, strengthening thus the quality of the generated national indicators. Data quality would also be improved by minimizing the data collection burden and reducing data sets and reporting forms.

Reduction in data sets were integral to the first two approaches of national HMIS redesign as they focused on what to report and in which format. Indeed, the third approach – based on ICD-10 was to reduce the number of reporting forms, and distinguishing between recording and reporting forms. In the paper system, the reporting and recording forms were treated equally, no longer required in the computerized system. Almost 50% (21 out of 37 annual forms, see table 2) contained ICD-10 codes. In the third approach, all forms containing ICD-10 codes could be reduced, based on the basic principle that reports would be generated by the system once data is captured. Data can be stored as individual records and aggregated as needed to produce reports, thus radically reducing the number of forms to be filled in.

Overall, the three approaches discussed each came with their pros and cons (see table 1), and their supporters and opponents.

Categorization of forms	Sub-categories	Description
Depending on report content	facility-based	There are different forms for hospitals, primary health care units (PHC) units, sanitary and epidemiology departments, ambulance stations, blood transfusion stations, children's hospitals and sanatoriums, forensic medicine units, TB hospitals, health management departments, post-graduate education unit, etc.
	specialty/disease –based	e.g. immunization, tuberculosis, skin and sexually transmitted diseases
	patient group or programme based	Patients with TB, oncological diseases, antenatal care patients, etc.
Periodicity	Annual	37 forms (21 contain ICD-10 codes)
	Quarterly	2 forms
	Monthly	2 forms + one operational data collection form
Reporting level	rural facilities	
	municipal/district level facilities	
	provincial facilities and units	
	republican facilities	

Table 1. Categorization of Reporting Forms in Use in Tajikistan HMIS

VI. Discussions

Consistent with prior research, the case study demonstrates how the existing HMIS, even though inefficient, shows resistance to change (Monteiro, 1998; Bisbal, 1999). This resistance firstly comes in form of individual actors having certain viewpoints and understandings of the nature and purpose of the HMIS, based on their past experience. Secondly, these institutionalized routines and norms are embedded into the existing HMIS itself – an installed base.

From the perspective of proposed theoretical framework, the various discussions raised by the different actors could be seen as part of an ongoing negotiation process where they try to balance or find a common solution for the given problem. Position of actors in reforming the HMIS and setting standards is driven by organizational imperatives and objectives for which they stand. The agreement comes from "incentives" actors receive in performing actions with new standards and procedures. If an incentive received is negative, actors may enter again into negotiations, which can lead to acceptance, rejection or another circle of negotiations relating to the underlying standards or procedures. Acceptance is achieved when actors receive positive incentives and they continue practicing certain routines around the standards. Through continuous practices, these new standards and procedures become institutionalized and inscribed into technological artifacts.

Actors play various roles in global/local standardization process. Global actors, may bring in new knowledge and at the same time learn from particular cases of implementing global standards. Their action falls between generification and

localization. National actors as central players work closely with global partners to localize global standards and negotiate with local actors to contextualize in local contexts. This helps to understand the dynamics in the interplay between global and local standardization processes from the perspectives of different actors.

VII.Conclusions

This paper identified and explored challenges of localization of global standards in HMIS implementation in a developing country context. Three distinct approaches to standardization with respect to ICD codes, were identified: 1). Top-down approach, where national health indicators are taken as final requirements; 2). District level local workarounds are incorporated into the national data sets; and 3). Use of ICD-10 codes to balance the load of top-down and bottom-up approaches. Each approach had its advantages and limitations, stemming from their relationships to the installed base (Hanseth & Monteiro, 1997; 1998). While the first two approaches presented national and district interests respectively, the third was in contrast transitive. It did not reduce data elements, but significantly lessened the load of manual data collection from health statisticians, opening new opportunities towards working with patient level data, contributing to timeliness and data quality.

This paper reinforces research findings that implementing global standards into a local context is complex and challenging task, involving various actors, each coming with their inputs and demands. Together this socio-technical ensemble – the information infrastructure - becomes a carrier of institutional changes applied by global standards and localized into specific contexts through negotiation and incentive seeking of actors.

While the use of ICD-10 in its current state is not feature-rich and advanced, it serves as a "gateway" opening new possibilities for the future adoption of ICD-10 in the developing country context. This requires benefits from the use of ICD-10 to become appealing and deeply rooted into the daily practices of the medical doctors, health and demographics statisticians. In line with new financing mechanisms and methodologies for healthcare delivery, coupled with improvements in the underlying information infrastructure, the ICD-10, I believe will play an important role in managing data exchange, measuring performance and recording the severity of diseases. The use of ICD-10 potentially enforces data accuracy, "if health records do not follow standardized content and predefined templates, they will defeat basic purpose of developing such content" (Mattison, Dolin & Laberge, 2004). However, for ICD to work effectively on the ground, a number of enabling conditions need to be in place including infrastructure, human resources capacity, diagnosis skills, and appropriate workloads.

References

[1] AbouZahr, Carla and Boerma, Ties. (2005). *Health information systems: the foundations of public health*. Bulletin of the World Health Organization, Volume 83, Number 8, August 2005, 561-640.

[2] Armstrong, Michael. (2002). *Employee Reward (People & organizations)*. Chartered Institute of Personnel and Development; 3rd edition.

[3] Barley, S. R. and P. S. Tolbert. (1997). Institutionalization and structuration: Studying the links between institutions and actions. Organization Studies, 18: 93-117.

[4] Baskerville, Richard L. (1999) "Investigating Information Systems with Action Research,"*Communications of the Association for Information Systems*: Vol. 2, Article 19. Available at: http://aisel.aisnet.org/cais/vol2/iss1/19

[5] Bisbal, J., Lawless, D., Wu, B., and Grimson, J (1999). Legacy information systems: Issues and directions. IEEE Software, September/October 1999.

[6] Bowker Geoffrey and Star, Susan Leigh. (1999). *Sorting Things Out*. Cambridge, MA: MIT Press.

[7] Braa, Jorn; Hanseth, Ole; Heywood, Arthur; Mohammed, Woinshet; Shaw, Vincent. (2007). Developing Health Information Systems in Developing Countries: The Flexible Standards Strategy, MIS Quarterly Vol. 31 Special Issue /August 2007.

[8] Braa, J., & Hedberg, C. (2002). The struggle for district-based health information systems in South Africa. The Information Society, 18, 113–127.

[9] Braguinsky, Serguey and Yavlinsky, Grigory. (2000). *Incentives and Institutions: The Transition to a Market Economy in Russia*. 2000, Prinston University Press, ISBN: 9780691009933.

[10] Cohen, Raymond (2000): *Meaning, Interpretation and International Negotiation*, Global Society, 14:3, 317-335.

[11] Ciborra, Claudio. (1994). T. Jelassi (eds), *Strategic information systems - a European perspective*, NY: J. Wiley.

[12] Jarulaitis, Gasparas and Monteiro, Eric. (2009). Cross-contextual use of integrated information systems. ECIS 2009: 2073-2084.

[13] Fomin, V., Keil, T., Lyytinen, K. (2003). *Theorizing about Standardization: Integrating Fragments of Process Theory in Light of Telecommunication Standardization Wars*, Case Western Reserve University, USA. Sprouts: Working Papers on Information Systems, 3(10). ttp://sprouts.aisnet.org/3-10

[14] Fagot-Largeault A. (1989), Les causes de la mort. Histoire naturelle et facteurs de risque, Paris, Vrin.

[15] Garber, Alan M. (2005). Evidence-Based Guidelines as a Foundation for Performance Incentives. Health Affairs, 24, no.1 (2005):174-179.

[16] Hanseth O., Monteiro E. (1998). *Changing irreversible networks*. In Baets, WRJ (Org.) Proceedings of Six European Conference on Information Systems. Aix en provence, 1998.

[17] Hanseth, O. and Monteiro, E. (1997). *Inscribing behaviour in information infrastructure*. Accounting, Management and Information Technologies. 7(4):183 - 211, 1997.

[18] Jacucci, Edoardo; Shaw, Vincent and Braa, Jorn. (2006). *Standardization of Health Information Systems in South Africa: The Challenge of Local Sustainability*. Information Technology for Development, Vol. 12 (3) 225–239.

[19] Khojamurodov, Gaffur & Rechel, Bernd. (2010). Tajikistan Health Review. Health Systems in Transition, Volume 12, no 2.

[20] Kling, Rob and Walt Scacchi. (1982). "The Web of Computing: Computing Technology as Social Organization," Advances in Computers. Vol. 21, Academic Press: New York.

[21] Latifov, Murodillo Abdusamadovich and Sahay, Sundeep (2012). *Data Warehouse Approach to Strengthen Actionability of Health Information Systems: Experiences from Tajikistan*. The Electronic Journal of Information Systems in Developing Countries, Vol 53.

[22] Lee, Kelley (2003) "*Health impacts of globalization: towards global governance*". Palgrave Macmillan. p.131. ISBN 0-333-80254-3.

[23] Markus, M., L., Gelinas, J., U., (2006). *Comparing the Standards Lens with Other Perspectives on IS Innovations: the Case of CPFR*. International Journal of IT Standards and Standardization Research Vol. 4 No. 1.

[24] Mattison, John E.; Dolin, Robert H.; Laberge, Diane. (2004). Managing the Tensions Between National Standardization vs. Regional Localization of Clinical Content and Templates. MEDINFO. pp. 1081-1085.

[25] Monteiro, Eric. (1998). *Living with technology*. *S*candinavian Journal of Information Systems, 10(1&2), 1998:249 - 254.

[26] Oliver, C. (1992). *The antecedents of deinstitutionalization*, Organization Studies (13:5) 1992.

[27] Ostrom, E., Schroeder, L. & Wynne, S. (1993). Institutional Incentives and Sustainable Development: Infrastructure Policies in Perspective. Boulder, CO: Westview Press.

[28] Pollock, Neil; Williams, Robin and D'Adderio, Luciana. (2007). Global Software and its Provenance: Generification Work in the Production of Organizational Software Packages. Social Studies of Science 37/2 (April 2007) 254–280.
[29] Rolland, Knut and Monteiro, Eric. (2002). *Balancing the Local and the Global in Infrastructural Information Systems*. The Information Society, 18:87–100.
[30] Saifuddinov, Safar R and Kurbanov Sh. M. (2010). *Short List of ICD-10 in Tajik Language*. Approved by the decree of MoH Tajikistan under #1-5/2234-2989 from 22.10.2008. Second edition. Dushanbe, 2010, "Farozmand" Publishing.
[31] Sahay S., Sæbø J., Molla S. & Asalefew A. (2009) Interplay of Institutional logics and Implications for Deinstitutionalization: Case Study of HMIS Implementation in Tajikistan. Proceedings of the 10th International Conference on Social Implications of Computers in Developing Countries, IFIP 9.4, Dubai, United Arab Emirates, May 2009. Dubai School of Government.
[32] Sahay, Sundeep. (2011). *Making Health Information Systems Public Health Friendly: Case Study from India,* Master thesis at the University of Westen Cape, South Africa.
[33] Shaw, V. (2002). *The development of an information system for district hospitals*. In S. Krishna & S. Madon (Eds.), Proceedings of the 7th IFIP 9.4 Working Conference, Bangalore, India.
[34] Scott, W. R. (2001). *Institutions and organizations*. (2nd ed). Thousand Oaks, CA: Sage.
[35] Silva, Leiser and Backhouse, James (2003) "The Circuits-of-Power Framework for Studying Power in Institutionalization of Information Systems," *Journal of the Association for Information Systems*: Vol. 4: Iss. 1, Article 14. Available at: http://aisel.aisnet.org/jais/vol4/iss1/14
[36] Timmermans, Stefan and Berg, Marc. (2003). The Gold Standard: The Challenge of Evidence-Based Medicine and Standardization in Health Care. Temple University Press: Philadelphia, PA.
[37] Walsham, G. (1995) "Interpretive case studies in IS research: nature and method." *European Journal of Information Systems*, 4(2): 74-81.
[38] Watzlaf, Valerie J.M.; Garvin, Jennifer Hornung; Moeini, Sohrab; and Firouzan, Patti. (2007). *The Effectiveness of ICD-10-CM in Capturing Public Health Diseases*. Perspectives in Health Information Management 4;6, Summer 2007. pp. 1-31.
[39] WHO. (2009). World Health Organization, http://www.who.int/csr/disease/swineflu/en/ Last consulted 5 October 2011.

APPENDIX VI

IT rapid assessment of Civil Registry Office of Tajikistan, March 2012

ZAGS IT RAPID ASSESSMENT
TAJIKISTAN

Purpose: To determine the readiness for electronic recording of the births and deaths, including their causes at district level.

Target group: The oblast and rayon staff which are in charge for recording vital events following the Ministry of Justice and CR offices regulations, preferably the Chief person responsible for the office.

Target respondent: Knowledgeable person, for example, responsible of the CRO at rayon and oblast levels.

Data collection means: Telephone interview

ZAGS-VITAL EVENTS REPORTING ENTITY	
Q0. Date of inquiry:	___16 ___ / ___ ___ / ___ ___ ___ ___
Q1. Oblast/Province	Badakhshan autonomous province (8) ..... 1 Sugd province (18) ..... 2 Khatlon province (25) ..... v3 Direct ruled districts (13) 4
Q2. Name of district:	_____
Q3. Type of reporting entity:	Population less than 100,000 ..... 1 Population >100,000 and <200,000 ..... 2 Population >200,000 and <300,000 3
Q4. Position of respondent:	Manager ..... 1 Other (specify) 2
Q5. Name of Respondent:	_____
Q6. Telephone number:	_____

ELECTRICITY		E
E1. DOES YOUR OFFICE HAVE MAIN ELECTRICITY	Yes 1	

POWER?	No..... 2	
E2. HAVE YOU AN ALTERNATIVE SOURCE OF ELECTRICITY?	Yes……1 No……..2	1⇨CA
E3. SPECIFY WHICH ALTERNATIVE SOURCE	Solar panel……A Generator……B Other (specify) ……..C	
E4. IN THE PAST 30 DAYS, ON HOW MANY DAYS WAS ELECTRICITY AVAILABLE?	Every day ..... 1 If yes, how many hours _____ Most days (15+ days)..... 2 7 to 15 days..... 3 Less than 7 days 4	 2⇨CA 2⇨CA
E5. ARE THERE CERTAIN MONTHS IN THE YEAR WHEN ELECTRICITY IS NOT AVAILABLE ON 'MOST DAYS' OF THE MONTH? IF YES, WHICH MONTHS?	January .....A February.....B March .....C April .....D May .....E June .....F July..... G August.....H September..... I October ..... J November.....K December..... L	
COMPUTER AVAILABILITY		**CA**
CA1. IS THERE AT LEAST ONE FUNCTIONING COMPUTER IN YOUR OFFICE THAT IS, OR CAN BE, USED FOR ENTERING VITAL EVENTS, E.G. BIRTHS & DEATHS PLUS ITS CAUSES?	Yes ..... 1 No..... 2	 2⇨CL
CA2. IS THAT A DESKTOP OR LAPTOP	Desktop……A Laptop……B	
CA3. IS ANY SPECIFIC SOFTWARE (APPLICATION) FOR CRO INSTALLED ON THIS COMPUTER?	Yes ..... 1 No..... 2 Don't know 3	
CA4. IS ANY OTHER DATA ENTRY APPLICATION INSTALLED, FOR EXAMPLE FOR RECORDING MARRIAGES AND MIGRATORY TRANSFERS OR OTHER APPLICATIONS?	Yes, Marriages .....A Yes, Migration .....B Yes, Commercial software (specify) .....C Yes, International project (specify).....D Yes, Personal initiative (specify) .....E	

	No application ..... X Don't know ..... Y	
COMPUTER LITERACY		**CL**
CL1. How many persons in the office are trained or able to use the computer?	None ..... 1 1-2 ..... 2 3-5 ..... 3 More than 5 4	1⇨IA1
CL2. For reporting 2011 statistics to Agency of Statistics office , were data for births and deaths entered into the computer?	Yes ..... 1 No ..... 2 Don't know 3	
CL3. For reporting 2011 statistics to CRO-ZAGS at Oblast Level, were Data for Births and Deaths entered into the computer?	Yes ..... 1 No ..... 2 Don't know 3	
INTERNET AVAILABILITY		**IA**
IA1. Is there internet connection available on site?	Yes ..... 1 No 2	2⇨End
IA2. In the past 30 days, on how many days was internet connection available?	Every day ..... 1 Most days (15+ days) ..... 2 7 to 15 days ..... 3 Less than 7 days ..... 4 Don't know 5	
IA3. How is internet accessed?	Dial up ..... 1 Cable (dedicated line) ..... 2 WI-FI ..... 3 3G or Mobile phone modem ..... 4 Don't know 5	
IT MAINTENANCE		**IT**
IT1. Do you currently have an active antivirus installed in your Computer?	Yes ..... 1 No ..... 2 Don 't know 3	
IT2. Who provides maintenance for your computer(s)?	No one ..... 1 Myself ..... 2 Staff person on-site ..... 3 Ad hoc (pay IT person as needed) ..... 4 Other (specify) ..... 5 Don't know 6	
OTHER		

SQ1. DO YOU HAVE MEETINGS WITH MOH DISTRICT STAFF ON REVISION AND SUPERVISION OF CAUSES OF DEATH?	Yes, every month……..1 Yes, every 3 months……..2 Yes, some times in a year……...3 No……4	
SQ2. HOW YOUR OFFICE DOES ICD10 CODING OF DEATH CERTIFICATES?	Certificate issued by doctor…..……..1 Certificate issued by CRO to family…….2 Only CRO register…..…….3	
SQ3. THE ICD10 CODE IS WRITTEN IN WHICH FORM?		
OQ1. WHAT DO YOU THINK, HOW TO IMPROVE REPORTING AND DATA ACCESS IN YOUR OFFICE?		

END

INTERVIEW OBSERVATIONS