UNIVERSITY OF OSLO
Department of Informatics

Evaluating a health information system in India: A measurement Model of Technology and Acceptance

Master Thesis

Jeton Mehmeti

May 2010

DEDICATION

To my lovely Parents

ABSTRACT

Some healthcare information systems do succeed but the majority are likely to fail in some way.

As healthcare costs continue to spiral upward, healthcare institutions are under enormous pressure to create cost efficient systems without risking quality of care. Healthcare IT applications provide considerable promises for achieving this multifaceted goal through managing information, reducing costs, and facilitating total quality management and continuous quality improvement programs. However, the desired outcome cannot be achieved if these applications are not being used.

In order to better predict, explain, and increase the usage of IT, it is of vital importance to understand the antecedents of end users' IT adoption decisions. This research focuses on the user acceptance of District Health Information System 2 used in Kerala, India. It evaluates health staff acceptance of DHIS2 to explain, forecast and improve usage pattern. It applies the theoretical framework of technology acceptance model (TAM) and Partial Least Square (PLS) model for estimation of parameters.

TAM predicts whether users will ultimately use software applications based upon causal relationships among belief and attitudinal constructs that influence usage behavior.

Overall, the findings show that TAM applied in the context of this research attest positively towards acceptance of health staff using DHIS-2.

ACKONLEDGMENT

First of all, I would like to thank the HISP India team for making my field work in Kerala an exciting and memorable experience.

I also thank Sundeep Sahay and Jens Kaasbøll for guiding me and supporting me throughout this thesis.

In addition, I thank Jyotsna Sahay and Louisa Williamson for good collaboration on the analysis and useful discussions.

Last but not least, I would like to thank my uncle Tefik Mehmeti and his family for moral support, accommodation and hospitality in Oslo.

Contents

List of Figures

List of Tables

1 Introduction

New information systems have a powerful potential to improve the functional of a health care organizations (Neumann et al., 1996; Raghupathi, 1997). However, that potential is only realized if health care information systems can be successfully developed and implemented. Moreover, after all, that system needs to be used by the end users as for one to call it a success.

Information systems pervade modern organizations, however, they cannot improve performance if they are not used (e.g., Davis et al., 1989).

It has been widely acknowledged that user acceptance of information technology systems is an important factor in determining its success. Although organizations make primary IT procurement decisions, the true value of an IT cannot appear until the end-users incorporate it into their work processes.

In order to predict, foresee, explain and increase user acceptance of a new information system technology one should take appropriate steps towards this. Steps to include in this regard is to taking into consideration a variety of factors, such as system design features (e.g. technical design characters), industry or workplace norms (e.g. professional autonomy), and individual differences (e.g. cognitive styles).

A number of research theories exist to predicting the user acceptance and all of these come from the field of social psychology. Notably, three theories have gained popularity and have been applied to variety of IT systems to study the user acceptance. These theories are: Theory of Reasoned Action (TRA, 1967), Theory of Planned Behavior (TPB, 1988), and Technology Acceptance Model (TAM, 1989). While there are other related developed theories, the above three are most widely used and have received a tremendous attention in the IS stream.

This thesis takes a closer look at user acceptance of a health information system application, namely District Health Information System 2 (hereinafter, DHIS2); a comprehensive HMIS solution based on data warehousing principles and a modular structure which can easily be customized to the needs of different health systems - nations, states, districts, and facilities.

1.1 Research problem

This thesis examines and evaluates the user acceptance of DHIS which is being implemented in Kerala under the patronage of Health Information System (HISP) – a health management information system that offers free open source software founded on the principals of evolutionary system development, action research and participatory design.

1.2 Research Question

The research question that this thesis addresses is:

What are the key attributes that affect user acceptance of the District Health Information Systems – version 2?

1.3 Hypothesis

In the context of this study, the hypotheses are:

H1: The degree of ease of use associated with the use of DHIS2 as perceived by a health worker has a positive effect on the degree to which a health worker believes that DHIS-2 will help him or her to attain gains in work performance (perceived usefulness).

H2: The degree to which a health worker believes that DHIS-2 will help him or her to attain gains in work performance (perceived usefulness) has a positive effect on his/her attitude towards DHIS-2.

H3: The degree of ease of use associated with the use of DHIS-2 as perceived by a health worker has a positive effect on his/her attitude towards DHIS2.

H4: The degree to which a health worker believes that DHIS-2 will help him or her to attain gains in work performance (perceived usefulness) has a positive effect on his/her intention to use DHIS2.

H5: The attitude of a health worker towards DHIS-2 has a positive effect on his/her intention to use DHIS2.

H6: Behavioral intention will have a significant positive effect on actual system use.

1.4 Research settings and methods

The thesis is based on the fieldwork held in the state of Kerala, India through November 2008 till late February 2009. The empirical data collection of this thesis is based on qualitative and quantitative research methods. This study applies the theoretical framework of Technological Acceptance Model (TAM), introduced by Davis (1989) to study the user acceptance of the DHIS-2 in Kerala. Questionnaires were used to find the results of user acceptance and a participatory action research was deployed to study the friendliness and effectiveness of the DHIS2 that has an indirect effect towards user acceptance. The latter was studied through interviews, observations and document reviews.

1.5 Structure of the Thesis

Besides the 1st chapter of Introduction which gives a brief summary of the thesis, the 2nd chapter reviews the theory incorporated within this thesis with relevant concepts as Information Systems, Health Information Systems, Technology Acceptance Model, Partial Least Square and others. The following chapter 3 takes into the consideration the research setting. Chapter 4 gives projects a background of Health Information System Program (HISP). Next a description on the research methodology and data collection is given in chapter 5.

Chapter 6 focuses on a brief history and background of District Health Information System (DHIS).

Next, chapter 7 gives an overview of the case study from Kerala, India where health system and health itself is projected.

Analysis and discussion is reflected in chapter 8 through use of Partial Least Square (PLS) algorithm in accordance with research proposed Technology Acceptance Model (TAM).

Finally, conclusion and summary is given in chapter 9.

2 Theory

This chapter builds a theoretical and conceptual framework that will be used to discuss and analyze the situation in different perspectives. The theoretical and conceptual framework is based on literature in the domain of HIS development and forms the basis of analysis and discussion of the study conducted.

2.1 Information Technology (IT) and Information Systems (IS)

The terms IT and IS have been used by various researchers over the years. Heeks (1998) defines IT and IS as “Information technology (IT) is computing and telecommunications technologies that provide automatic means of handling information. IT is therefore taken here to represent equipment: both the tangible hardware and the intangible software. Information systems (IS) are systems of human and technical components that accept, store, process, output, and transmit information. Information systems may be based on any combination of human endeavours, paper based methods and IT” (Heeks 1998, p.5). This points out that IS are just not computer systems, but represent also a larger network of people, practices, and organizations.

Computer-based information systems are often taken to be technical systems and behavioral and organizational issues are relegated to a secondary role or are not considered at all (Walsham et al. 1998). Information technology (IT) on its own does not do anything useful. In

order to do anything, it must become part of an information system (Heeks, 1998), even though IT offers a remarkable potential for improving the efficiency and effectiveness of organization (Mackenzi 1999, Winner 1999). In order to address this complexity, Walsham (2001) argues that the ISs are a part of social context that need to be understood with respect to relationships and dynamics within the organization and the infrastructure supporting them.

2.2 Health Menagement Information Systems

There is no doubt that adequate, reliable and timely health information is crucial for effective planning, management and evaluation of health services and this in turn helps to improve the health care delivery. However, most developing countries are not able to meet the demand for information. Health service statistics are often outdated or incomplete, information is collected out of habit and for the sake of collecting rather than for systemic decision-making (Sauerborn and Lippeveld 2000, Equity 2000).

Information systems are increasingly important for measuring and improving quality and coverage of health services (Campbell 1997; Lippeveld et al. 2000).

When discussing health information technologies within the context of information systems, usually the discussion is about the use of computers in health information systems. Wilson and Smith (1991 cited Wilson 2000) suggest that, “the creative use of microcomputer technology is one of the most promising means of improving the quality, timeliness, clarity, presentation, and use of relevant information for primary health care” (Wilson, 2000, p.199).

However, Wilson (2000) gives a note that, “it is important to ensure that computerization of health information systems does not dominate the health information system reform improvement process” (Wilson 2000, p.199). This is because the majority of health information users in developing countries have no access to computer technology, thus the development and improvement of manual systems for collection, analysis, and use of data should be the primary focus.

As cited in NHSRC a guide from WHO to developing an HMIS is keen to the following terms:

System: “A collection of aligned components designed work together to achieve a common objective.”

Information System: “A system that provides information support to the decision-making process at each level of an organization.”

Health Information System: “A system that integrates processes of data collection, processing, reporting, and use of the information necessary for improving health service delivery effectiveness and develop efficiencies in the reporting systems.”

Health Management Information System: “An information system that is especially designed to assist in the management and planning of all health programs.”

2.3 Building block concepts of HMIS

According to NHSRC, the building block concept of HMIS is namely, data, information and knowledge.

Data: “is raw material in the form of numbers, characters, images or other outputs that gives information after being analyzed. Data is this raw material without context.”

Information: “A meaningful collection of data organized with reference to a context.”

Knowledge: “when information is analyzed, communicated and acted upon, it becomes knowledge.”

DATA ----→ INFORMATION ----→ KNOWLEDGE

This can be illustrated by giving an infant’s vaccination example of an X health sub centre in Kerala. Put this in one piece, the first thing needed is *Data* of the number or percentage of vaccines given for a certain period of time which is gathered by filling up a corresponding form which consists of many vaccine related indicators such as BCG, TT1, TT2 and so forth. As this particular form is transferred to a higher institutional level, say for instance, Y, *information* comes into handy. As the institution Y receives other data relating to infant vaccination from sub centers other than X, it has the availability of information by, for example, comparing the percentage of vaccine coverage between many sub centers. At this stage, information is useless if it is not converted into knowledge. How can this information be converted into knowledge? By following the herein example, the procedure of transferring data from a lower level institution to a higher level institution follows the same. Thus, institution Y transfers aggregated data to a higher institution, name it Z. The institution Z translates all the information gathered into knowledge by, for example, analyzing

data through different forms of visualization (e.g, tables, graphs, charts) and as a result of analysis, action is taken upon.

2.4 Health Systems management functions

> *"Health systems consist of all the people and actions whose primary purpose is to improve health. They may be integrated and centrally directed, but often they are not. After centuries as small-scale, largely private or charitable, mostly ineffectual entities, they have grown explosively in this century as knowledge has been gained and applied. They have contributed enormously to better health, but their contribution could be greater still, especially for the poor. Failure to achieve that potential is due more to systemic failings than to technical limitations. It is therefore urgent to assess current performance and to judge how health systems can reach their potential" (WHO 2000).*

"The objective of health systems management is to coordinate and provide planning and management support to the service delivery levels." (Lippeveld and Sauerborn). According to Lippeveld (undated) some of the functions that are generally accepted are:

- Intersectoral coordination
- Strategic planning and programming
- Budgeting and financial resource allocation
- Organization of the system, including referral mechanisms
- Personnel development including continuing education
- Resource management, including finance, personnel, and information
- Distribution and management of equipment, supplies and drugs
- Disease surveillance
- Protection of the environment
- Supervision of the health services

Whereas, Table 1-1 lists management functions proposed by WHO (1988, cited at Lippeveld and Sauerborn) at central, regional, and district levels in a decentralized health services system.

Table 1-1: Health system management functions in a decentralized health service system

The central level (ministry of health) is responsible for:
Health policy formulation, including policy on intersectoral activities
Production of national health plans and regional and local planning guidelines
Advisory role on allocation of resources, particularly capital funds
Source of high level technical advice for specific programmes
Control over purchasing pharmaceuticals and distribution of supplies
Training and regulation of health personnel development
Regulation of private profit and nonprofit health organizations
Control of national health organizations and research institutes
Liaison with international health organizations and aid agencies
Regions and/or provinces are responsible for:
Regional health planning and programme monitoring
Coordination of all regional health activities
Employment and control of part or all of the health personnel
Budgeting and auditing of health expenditure
Approval and financing of large-scale capital projects
Managerial and technical supervision of district health teams and district
Heads of specific health programmes
District are given the following main functions:

Organizing and running the district hospital services
Managing all other government health facilities
Implementing all community based health programmes
Managing and controlling local health budgets
Coordinating and supervising all government, nongovernment and private health services within the district
Promoting active links with local government departments
Promoting active links with local government, nongovernment and private health services within the district
Promoting active links with local government departments
Promoting community participation in local health services planning
Preparing an annual health plan
Raising additional local funds
In-service training of health workers
Supervising and controlling all community health workers in the district
Collecting and compiling routine health information and forwarding it to regions and ministries of health.

Source: WHO (1988, cited at Lippeveld and Sauerborn)

Lippeveld and Sauerborn argue that health management functions differ from level to level and from country to country. For example, in a country where the majority of health services are private most of the listed functions are performed by private institutions whereas the government has only a regulatory role by setting policies and legislation. On the other hand, in a country with predominantly public health sector, the functions are organized from a top down strategy as in the Table 1-1.

2.5 Theory of Reasoned Action and Technology Acceptance Model

This section reviews the theoretical background of *intention models* that have been widely used to study factors governing IT acceptance, with particular focus on the technology acceptance model (TAM)—a prevalent technology adoption theory in the area of information system research.

"The theory of reasoned action (TRA) and theory of planned behavior (TPB) are widely studied theories of social psychology that address the determinants of consciously intended *behavior (B)*. Both theories are intention models which posit that the fundamental determinant of a person's consciously intended behaviors is behavioral *intention (BI)"* (K. Zheng et al. 2007).

According to TRA, behavioral intention is an additive combination of *attitude (A)* toward performing the behavior and *subjective norm (SN)* (Ajzen and Fishbein, 1980). " 'Attitude' refers to individual's positive or negative feelings about performing the focal behavior in question, which is determined by his or her salient beliefs *(bi)* about consequences of performing the behavior multiplied by the evaluation of these consequences *(ei)*. 'Subjective norm' captures a person' s perception that most people who are important to him or her think the person should or should not perform the target behavior. The perception is determined by a multiplicative function of his or her normative beliefs *(nbi),* i.e., whether perceived expectations of specific referent individuals or groups, and his or her motivation to comply with these expectations *(mci)*." (K. Zheng et al. 2007). Mathematical expressions for these three constructs follow as:

$$BI = A + SN$$

$$A = \sum b_i e_i$$

$$SN = \sum nb_i mc_i|$$

TRA is unable to fully present situations in which intervening environmental conditions are in place so comes the development of an extension of TRA called the theory of planned behavior (TPB). TPB adds a third determinant of behavior intention, perceived behavioral control (PBC), to the TRA framework (Ajzen, 1991). Perceived behavioral control indicates a person's perception concerning how difficult the behaviors are and how successfully the individual can, or cannot, perform the activity. PBC is said to have a direct impact on behavior; it also influences the target behavior indirectly via behavioral intention. "PBC is determined by the total set of accessible control beliefs *(ci)*, i.e., beliefs about the presence of factors that may facilitate or impede performance of the behavior, weighted by the perceived power *(pi)* of the control factor:"

$$BI = A + SN + PBC$$

$$PBC = \sum c_i p_i$$

Figure 2-1 illustrates the constructs and their relations as posited by the theories of reasoned action and planned behavior. These two theories have been extensively tested in empirical studies spanning a wide variety of subject areas, such as dishonest actions (Beck and Ajzen, 1991), driving violations (Parker et al. 1992), condom use (Albarracin et al. 2001, physician activities (Gatch and K. D, 1990), smoking cessation (Clarke and Aish, 2002), and substance use

(Morrison et al. 1998). Meta analyses have shown that their predictive powers are substantially supported (Armitage and M. Conner, 2001).

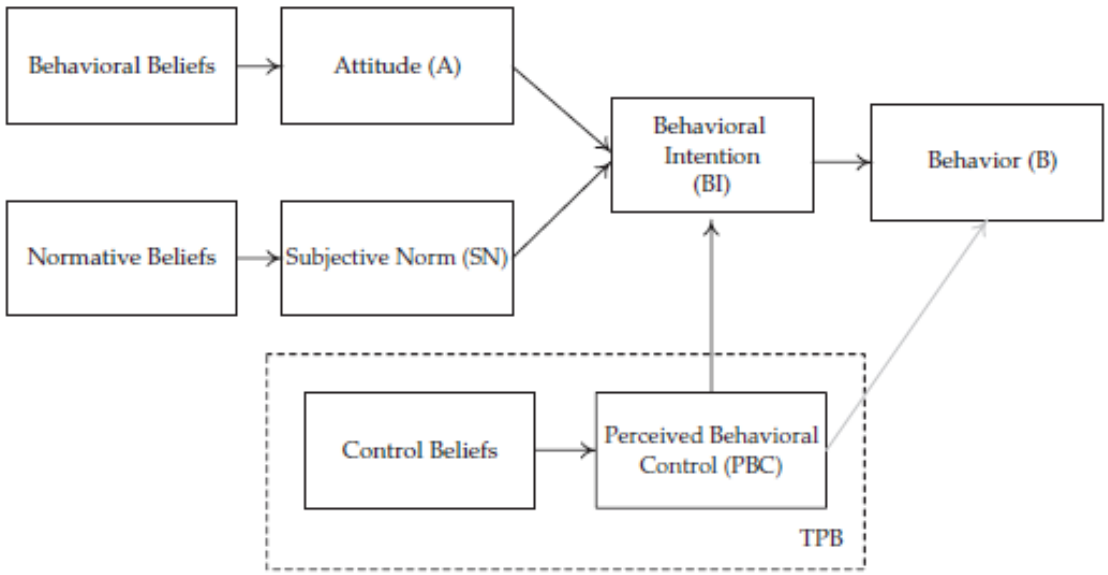


Figure 2-1: Theory of Reasoned Action and Theory of Planned Behavior

2.6 Technology Acceptance Model (TAM)

The most well-known IT acceptance theory in IS is the technology acceptance model (TAM). TAM is an adaptation of TRA that is specifically designed to study user acceptance of computer systems. The goal of TAM is to "provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behavior across a broad range of end user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified" (Davis et al. 1989, page 985).

The theoretical foundation of TRA is the assumption that behavioral intention influences actual behavior. Davis (1986) used this insight to

propose that IT acceptance behavior, actual *system use (U)*, is determined by a person's *behavioral intention* to use *(BI)*; this intention, in turn, is determined by the person's *attitudes* towards using *(A)* and his or her *perceived usefulness (PU)* of the IT. In TAM, "attitudes towards use are formed from two beliefs: *perceived usefulness (PU)* of the IT and its *perceived ease of use (PEoU).* All external variables, such as system design characteristics, user characteristics, task characteristics, nature of the development or implementation process, political influences, organization structure and so on, are expected to influence acceptance behavior indirectly by affecting beliefs, attitudes, and intentions". (Davis, 1986). Thus the mathematical expression is as follow:

$$BI = A + PU$$

$$A = PU + PEoU$$

$$PU = PEoU + External\ Variables$$

PU and PEoU are two fundamental determinants of TAM. Perceived usefulness (PU) is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" , whereas perceived ease of use (PEoU) refers to "the degree to which a person believes that using a particular system would be free of effort" Davis (1986). Figure 2-2 depicts these basic constructs and their relations.

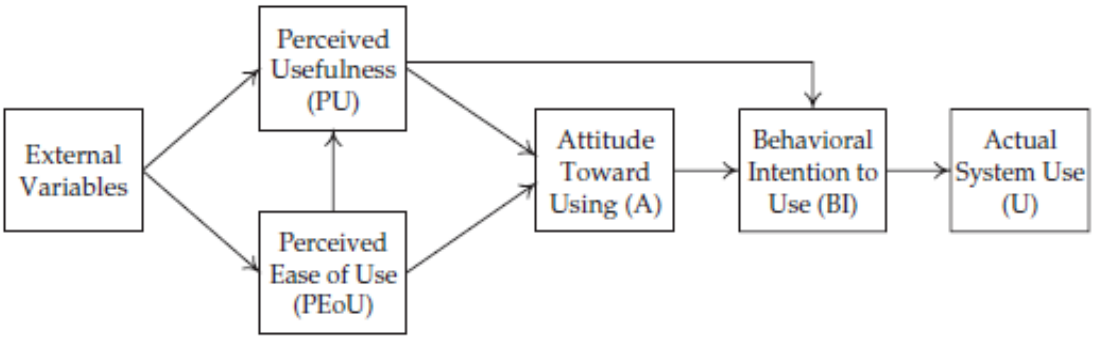


Figure 2-2: Original Technology Acceptance Model

2.7 Partial Least Square (PLS)

PLS is a structured equation modeling method that analyzes how the items load on their constructs simultaneously with estimating all the paths in the model, and is widely used in MIS research (Gefen & Straub, 2005). PLS estimates all paths, loadings, and Average Variance Extracted (AVE) of principal constructs and construct reliability. Convergent and discriminant validity are shown when each item loads much higher on its assigned factor than on any other factor and when the square root of the AVE of each construct is much larger than the correlation of that construct with all other constructs.

2.7.1 PLS Path Modeling

PLS path models are formally defined by two sets of linear equations: the inner model and the outer model. The inner model specifies the relationships between unobserved or latent variables, whereas the outer model specifies the relationships between a latent variable and its observed or manifest variables.

2.7.2 PLS Path Modeling Algorithm

The PLS algorithm is essentially a sequence of regressions in terms of weight vectors.

The basic PLS algorithm, as suggested by Lohmoller (1989), includes the following three stages:

Stage 1: Iterative estimation of latent variable scores, consisting of a four-step iterative procedure that is repeated until convergence is obtained:

(1) Outer approximation of the latent variable scores,

(2) Estimation of the inner weights,

(3) Inner approximation of the latent variable scores, and

(4) Estimation of the outer weights.

Stage 2: Estimation of outer weights/loading and path coefficients.

Stage 3: Estimation of location parameters.

The four steps at Stage 1 are repeated until the change in outer weights between two iterations drops below a predefined limit. The algorithm terminates after step 1, delivering latent variable scores for all latent variables. Loadings and inner regression coefficients are then calculated in a straightforward way. In order to determine the path coefficients, for each endogenous latent variable a (multiple) linear regression is conducted.

2.7.3 Assessing PLS path models

Chin (1998) has put forward a catalog of criteria to assess partial model structures. A systematic application of these criteria is a two-

step process, encompassing (1) the assessment of the outer model and (2) the assessment of the inner model.

At the beginning of the two step process, model assessment focuses on the measurement models. A systematic evaluation of PLS estimates reveals the measurement reliability and validity according to certain criteria that are associated with formative and reflective outer model. This study applies reflective measurement model, thus explained in the following section.

2.7.4 Reflective measurement model

Reflective measurement models should be assessed with regard to their reliability and validity. Usually, the first criterion which is checked is internal consistency reliability. The traditional criterion for internal consistency is Cronbach's ALFA (Cronbach, 1951), which provides an estimate for the reliability based on the indicator intercorrelations. While Cronbach's ALFA assumes that all indicators are equally reliable, PLS prioritizes indicators according to their reliability, resulting in a more reliable composite.

Cronbach's ALFA tends to provide a severe underestimation of the internal consistency reliability of latent variables in PLS path models, it is more appropriate to apply a different measure, the composite reliability (Werts, Linn, & Joreskog, 1974). The composite reliability takes into account that indicators have different loadings, and can be interpreted in the same way as Cronbach's ALFA. An internal consistency reliability value above 0.7 in early stages of research and values above 0.8 or 0.9 in more advanced stages of research are regarded as satisfactory (Nunnally & Bernstein, 1994), whereas a value below 0.6 indicates a lack of reliability.

For the assessment of validity, two validity subtypes are usually examined: the convergent validity and the discriminant validity. Convergent validity signifies that a set of indicators represents one and the same underlying construct, which can be demonstrated through their unidimensionality. Fornell and Larcker (1981) suggest using the average variance extracted (AVE) as a criterion of convergent validity. An AVE value of at least 0.5 indicates sufficient convergent validity, meaning that a latent variable is able to explain more than half of the variance of its indicators on average (Gotz, Liehr-Gobbers, & Krafft, 2009).

Discriminant validity is a rather complementary concept: two conceptually different concepts should exhibit sufficient difference (i.e.the joint set of indicators is expected not to be unidimensional). In PLS path modeling, two measures of discriminant validity has been put forward: The Fornell–Larcker criterion and the cross- loadings. The Fornell–Larcker criterion (Fornell & Larcker, 1981) postulates that a latent variable shares more variance with its assigned indicators than with any other latent variable. In statistical terms, the AVE of each latent variable should be greater than the latent variable's highest squared correlation with any other latent variable. The second criterion of discriminant validity is usually a bit more liberal: The loading of each indicator is expected to be greater than all of its cross-loadings (Chin, 1998; Gotz et al., 2009).

In summary, a reliable and valid reflective measurement of latent variables should meet all the criteria as listed in Table 2-1. If this is not the case, the researcher may want to exclude single indicators from a specific measurement model and eventually revise the path model.

Table 2-1: Assesing Reflective Measurement Models. Source (Jorg Henseler et al.)

Criterion	Description
Composite reliability (ρ_c)	$\rho_c = (\sum \lambda_i)^2/[(\sum \lambda_i)^2 + \sum Var(\varepsilon_i)]$, where λ_i is the outer (component) loading to an indicator, and $Var(\varepsilon_i) = 1 - \lambda_i^2$ in case of standardized indicators. The composite reliability is a measure of internal consistency and must not be lower than 0.6.
Indicator reliability	Absolute standardized outer (component) loadings should be higher than 0.7.
Average variance extracted (AVE)	$AVE = (\sum \lambda_i^2)/[\sum \lambda_i^2 + \sum Var(\varepsilon_i)]$, where λ_i is the component loading to an indicator and $Var(\varepsilon_i) = 1 - \lambda_i^2$ in case of standardized indicators. The average variance extracted should be higher than 0.5.
Fornell–Larcker criterion	In order to ensure discriminant validity, the AVE of each latent variable should be higher than the squared correlations with all other latent variables. Thereby, each latent variable shares more variance with its own block of indicators than with another latent variable representing a different block of indicators.
Cross-loadings	Cross-loadings offer another check for discriminant validity. If an indicator has a higher correlation with another latent variable than with its respective latent variable, the appropriateness of the model should be reconsidered.

3 Research Setting

3.1 Country profile: India

India lies in the southern part of Asia and covers an area of over 3 million square kilometers which makes it the 7th largest country in the world with a population of over 1 billion ranked in 2nd place after China. Geographically, it is bounded by the Indian Ocean in the south, the Arabian Sea in the west, and the Bay of Bengal on the east. In total, India is surrounded by 7,517 km of coastline. On the other hand, it is bordered by Pakistan to the west, China, Nepal, Bhutan to the north and Bangladesh and Burma to the East.

Figure 3-1: Map of India

3.2 Government and Administrative Divisions

India is the largest democracy in the world which has incorporated the constitution of Great Britain since its independence in 1947. Its constitution defines India as 'sovereign', 'socialist', 'secular', and 'democratic' republic which has a parliament operating under 'Westminster-style' parliamentary system. Its power is divided into three braches namely, executive, judiciary, and parliament.

India consists of 28 states and 7 union territories. All states apply the Westminster model of governance.

3.3 Economy

With its fast pace growing economy, India is the 12th place largest economy in the world (Tritsch, 2001). But on the other hand, its poverty is at high stake ranking it in the 139th place in the world in terms of nominal GDP per capita (Tritsch, 2001). It is worth to mention that it has the 2nd largest labor force in the world consisting of three sectors namely agriculture, industry, and service. The majority of agricultural products are rice, wheat, oilseed, cotton, tea, sugarcane, potatoes. Major industries include textile, chemicals, steel, software and so forth.

3.4 Demographics

India as a geographical country is considered to be consistent of one of the most diverse culture, linguistics, and genetics. It is home to over 800 million Hindus. Other major religion groups include Muslims, Christians and minors include Buddhists, Janis, Jews.

3.5 Healthcare in India

India has started a health care reform in 1952 after the independence from the British in 1947 and in 1983, with the Alma Ata declaration (WHO 1979). India started the health care delivery system through Primary Health Centers (PHC) as contrary to medical care, a health care system used before 1983.

The Indian health system is divided into five organizational levels:

1. Level: State
2. Level: District
3. Level: Division
4. Level: Mandal
5. Level: PHC (Primary Health Centre)

The main structure of the health system is much the same in all Indian states. A description is given which tackles the Indian health system information flow.

Detailed data is collected at the two lowest levels, PHC and Sub-centre. Subcentre level is below level 5 (PHC) and placed under administration of the PHCs. The data is collected and reported to the next level in the hierarchy. This way each level has the aggregated data of all the levels below their own level.

The Department of Health is situated at the state level and is directed by the commissioner which is in political charge for the whole state. The commissioner is under the administration of the Government of India. Reports generated at district level are received by the department of health for further reporting to the Government of India. Decision making, concerning the overall health service of a state, is

done at the state level based on districts reports and decisions and resolutions imposed by the Government of India.

At district level the District Medical & Health Officer (DMHO) collects data reports from PHC level. The DMHO is the head of the health service provided at the district level, and in the DHMO mandate is the power to make decisions inflicting PHCs and sub-centers. Reports gathered from sub levels is re-reported and sent to the state level.

The district level is further divided in two divisions. Division is a "support level" for the district. In many cases the division level is just an organizational level in the hierarchy without any employees. Employees working for the DHMO to fulfill the DHMOs tasks will typically work in the division level. The extra level between PHC and district is thought to make it easier for the DHMO to support and help PHC staff. The division level helps the DHMO to gather PHC data and to get a stronger dialogue between the PHC and district level. At the PHC level the Medical Officer is the head chief. The Upper Division Clerk (UDC) collects the data from sub-centre levels for consolidation. The reports generated from the consolidation are used locally and some are sent to the DMHO office at district level. The Medical officer has to a certain extent in the mandate to set focus on health issues and deploy campaigns directed to improve the health situation in the PHC area.

The sub-centre is the root level where Multi Purpose Health Assistants (MPHA) is providing most of the medical/health services to the public. The MPHA makes records of all the services provided to the public (such as ante natal care, etc) and report this data one to two times a

month to the PHCs. In some sub-centers a head nurse is coordinating their operations, but usually the MPHAs work mostly on a solitary basis.

The reporting mechanism, during the paper based HMIS period, was done through filling up reports through various forms corresponding to organizational units. For example, Form 6 which belongs to the lowest hierarchical organization level, with over thousands of data elements is to be filled up every month. Form 6 is then to be sent to PHC. In the PHC, data from all its sub centers is aggregated in a unique Form 7. Afterwards, Form 7 is sent to Block CHC, or CHC doing the same procedure consolidating data from its child organization units that fall under that particular CHC. Afterwards, Form 8 is filled up by the hospitals which, on contrary to CHC-s and PHC-s, have their own data gathered at the hospital facility without any consolidation process that may come from a lower organization unit. Form 8 is as well sent to the district level which does the final procedure of consolidation by filling up Form 9 and sending to the state. All this said is intended to be done by DHIS-2 which runs the same logic but makes the process much easier, effective and efficient by not having to send reports physically from one organization unit to another but rather online in a very organized and computerized way.

4 HISP

The Information System Program (HISP) was started after the fall of apartheid in South Africa in 1994. Initially HISP was based at two Cape Town Universities, and was receiving funding from the Norwegian Agency for Development Cooperation (NORAD) during a two to three year pilot project. HISP's role was to take part in the reconstruction and development program launched by the ANC to reconstruct the health service in South Africa (Sæbø and Titlestad, undated). The reconstruction was done by developing a district based health information system including software, standardization of health data, and general approaches for reconstruction of health services.

The open source District Health Information System (DHIS) application was developed in 1997 and is still being further developed. When the pilot phase turned out to be a success, the strategies, processes, and software developed in the pilot areas was adopted by the Department of Health in 1999 as national standard.

HISP Vision is

> "To support the development of an excellent and sustainable health information system that enables all health workers to use their own information to improve coverage and quality of health care within our communities"

(HISP South Africa, undated).

4.1 HISP INDIA

HISP in India was initiated in Andhra Pradesh (AP) state in the year 2000. Andhra Pradesh and its public healthcare are organized into 23 districts with around 1350 primary health centers (PHCs). These PHCs act as information hubs where different data are collected from various sub centers and aggregated and transmitted to the higher levels. In Andhra Pradesh (AP) the PHCs are now provided with computer facilities, even without adequate infrastructure and staff has the capacity to use them. DHIS has been installed in all the district offices and in a few PHCs in Chittoor district where HISP was piloted.

The piloting part of the project was conducted in the primary health centers in Kuppam division (approximately 300 000 citizens). 70-75 staffs were trained on using computers, DHIS software, analyze data, and generate reports which were automated during the process of implementation based on feedbacks from the health staff and officials. After the initial pilot face, the project expanded to include one more division, and to cover 50% of the PHCs in Chitoor district.

Health department signed a memorandum of understanding (MOU) to support the health information activities in all the districts (23) of the state.

The MOU project would cover the following components:

- Design, development and implementation of Infant Mortality and

  Maternal Mortality Monitoring systems in all district offices.
- Creation of district database for health information systems for all districts

  in the state.

• Stabilization of the Family Health Information Management Systems in Nalgonda district.

• Integrating Geographic Information Systems with the routine health data

being collected every month.

• Web enabling of existing health information systems.

• Large scale training and education expenses of health staff at different

levels.

• Integrating the health information systems with the broader state e

governance efforts of the state.

Along with the development of HISP in Andhra Pradesh the HISP India team has started up a new project in the state of Kerela.

4.2 National Rural Health Mission (NRHM)

The head ministry of health of India has started a mission throughout the country with a special focus on 18 states, including eight empowered action group (EAG) states, the North-Eastern states, Jammu & Kashmir and Himachal Pradesh. The mission is called the 'National Rural Health Mission' (henceforth NRHM) approved on April 12, 2005.

The mission of NRMH is to improve the availability of and access to quality health care by people, especially for those residing in rural areas, the poor, women and children.

Many of the NRHM goals include but not limited to:

- Reduction in Infant Mortality Rate (IMR) and Maternal Mortality Ratio (MMR).

- Universal access to public health services such as Women's health, child health, water, sanitation & hygiene, immunization, and Nutrition.
- Prevention and control of communicable and non-communicable diseases, including locally endemic diseases.
- Access to integrated comprehensive primary healthcare.
- Population stabilization, gender and demographic balance.
- Revitalize local health traditions and mainstream AYUSH.
- Promotion of healthy life styles.

While these above goals are not very implementable in the daily work of health managers, they tend to be recognizable as measurable goals that can be aimed for, and broad strategies and plans developed to achieve them.

The strategies are a statement of how this will be achieved, also in very general terms. According to NRHM the strategies of NRHM are:

- Train and enhance capacity of Panchayati Raj Institutions (PRIs) to own, control and manage public health services.
- Promote access to improved healthcare at household level through the female health activist (ASHA).
- Health Plan for each village through Village Health Committee of the Panchayat.
- Strengthening sub-centre through an untied fund to enable local planning and action and more Multi Purpose Workers (MPWs).
- Strengthening existing PHCs and CHCs, and provision of 30-50 bedded CHC per lakh population for improved curative care to a

normative standard (Indian Public Health Standards defining personnel, equipment and management standards).

- Preparation and Implementation of an inter-sectoral District Health Plan prepared by the District Health Mission, including drinking water, sanitation & hygiene and nutrition.
- Integrating vertical Health and Family Welfare programmes at National, State, Block, and District levels.
- Technical Support to National, State and District Health Missions, for Public Health Management.
- Strengthening capacities for data collection, assessment and review for evidence based planning, monitoring and supervision.
- Formulation of transparent policies for deployment and career development of Human Resources for health.
- Developing capacities for preventive health care at all levels for promoting healthy life styles, reduction in consumption of tobacco and alcohol etc.
- Promoting non-profit sector particularly in underserved areas.

NRHM has also publicized its outcomes of the national level and community level as well. The following results are as of today and some of them present a future target:

OUTCOMES

National Level:

- Infant Mortality Rate reduced to 30/1000 live births.
- Maternal Mortality Ratio reduced to 100/100,000.
- Total Fertility Rate reduced to 2.1.

- Malaria mortality reduction rate –50% up to 2010, additional 10% by 2012.
- Kala Azar mortality reduction rate: 100% by 2010 and sustaining elimination until 2012.
- Filaria/Microfilaria reduction rate: 70% by 2010, 80% by 2012 and elimination by 2015.
- Dengue mortality reduction rate: 50% by 2010 and sustaining at that level until 2012.
- Japanese Encephalitis mortality reduction rate: 50% by 2010 and sustaining at that level until 2012.
- Cataract Operation: increasing to 46 lakhs per year until 2012.
- Leprosy prevalence rate: reduce from 1.8/10,000 in 2005 to less than 1/10,000.
- Tuberculosis DOTS services: Maintain 85% cure rate through entire Mission period.
- Upgrading Community Health Centers to Indian Public Health Standards.
- Increase utilization of First Referral Units from less than 20% to 75%.
- Engaging 250,000 female Accredited Social Health Activists (ASHAs) in 10 States.

Community Level:

- Availability of trained community level worker at village level, with a drug kit for generic ailments.
- Availability of generic drugs for common ailments at Sub-centre and hospital level.
- Good hospital care through assured availability of doctors, drugs and quality services at PHC/CHC level.

- Improved access to Universal Immunization through induction of Auto Disabled Syringes, alternate vaccine delivery and improved mobilization services under the programme.
- Improved facilities for institutional delivery through provision of referral, transport, escort and improved hospital care subsidized under the Janani Suraksha Yojana (JSY) for the Below Poverty Line families.
- Availability of assured healthcare at reduced financial risk through pilots of Community Health Insurance under the Mission.
- Provision of household toilets.
- Improved Outreach services through mobile medical unit at district level.

5 Research Methodology

This chapter presents the methods used for data collection and analysis. This study is not only meant to study the degree of user participation of the HMIS software, DHIS-2, but also the existing and ongoing implementation of DHIS-2 in Kerala. Therefore, action research methodology was used for one part of the study. The initial study commenced in the form of a case study research approach where qualitative methods were incorporated. The second part of the study approached the quantitative methodology in order to find out the user acceptance towards DHIS-2. The first section of the chapter presents an introduction to the chapter followed by the research design in the second section. Third and final section present the research approach and methods used respectively.

5.1 Introduction

The research was based on qualitative and quantitative methods for collection of data of my research. The choice between qualitative or quantitative or a combination of both should be based on what you want to study (Silverman 2000).

A qualitative method tries to catch the picture of social phenomena including background about persons and situations using collection methods such as interviews, observations, and analysis o documents and pictures (Thagaard 1988). Qualitative methods improve the design

by providing data that can give insights into how findings work and how findings can be translated to practice.

In many scholars view, the best research design is a mixed method design that integrates qualitative and quantitative research. Quantitative method is a research method that relies less on interviews, observations, small numbers of questionnaires, focus groups, subjective reports and case studies but is much more focused on the collection and analysis of numerical data and statistics. By combining the two methods, we can obtain a much richer understanding. In other words, using a rigorous design the quantitative methods tell us what works, while the qualitative methods can tell us how it works.

The first part of the study falls under the framework of an action research paradigm, where a participatory action research methodology was adopted.

5.2 Research design and approach

This research focuses on two different ways of gathering data and therefore two different but interrelated targets are aimed to study. The first tries to find out the user acceptance of DHIS-22 in the scope of two studied districts: Trivandrum and Wayanad districts of the state of Kerala. Within this first study, two levels of stakeholders (health care workers) are studied and are taken into consideration as far as ‘user acceptance’, in the context of DHIS2, is concerned. The two levels of stakeholders consist of: 1) health workers working in a higher hierarchical health organization units, mainly in districts and hospitals, which are presupposed to be coming from a higher educational

background, to include but not limited to doctors, health statisticians and so forth, and 2) health workers working in lower hierarchical health institutions, CHC-s, PHC-s, sub centers to name a few. This study applies the theoretical framework of Technological Acceptance Model (TAM), introduced by Davis (1989) to study the user acceptance of the DHIS-2 in Kerala. Questionnaires were used to find the results of user acceptance.

The second research target aimed to study the user friendliness and effectiveness, in general, of the DHIS-2 which I believe there is a close correlation with user acceptance. I argue that the more friendly and effective DHIS-2 is found to be among stakeholders, the higher the user acceptance of software should be. For this purpose, action research proves to be a very good approach. Baskerville (1999) describes action research to be “grounded in practical action, aimed at solving an immediate problem situation while carefully informing theory” (Baskerville 1999:3).

Therefore, within this second part of the research, I deployed a special form of action research, participatory action research. In participatory action research responsibilities are shared between the researcher and the participants, that is, instead of leaving the responsibilities to the researcher only, those who ‘own’ the problem are also involved in selecting problems and searching for solutions (Elden and Chisholm 1993).

In this case, health workers are the owners of the problem to be studied. Their participation as the main source of information gave me insights on what needs to be changed in the software to make the software even more friendly and effective towards its main tasks. Based on suggestions and discussion with health workers I responded

accordingly with the appropriate change or modification in the context of user friendliness.

The data, as mentioned, is collected in two districts, that of Trivandrum and Wayanad. Questionnaires were handed out during the training sessions which were held for the purpose of capacity building (health workers) towards operation of the software DHIS-2. Trainings took place in special computer labs rented by NRHM. Interviews and observation took place during the training session periods as well. In addition, the conducted interviews took place also during health facility site visits. Visits took place in 2 Community Health Centers (CHC), 1 hospital, and few sub centers.

As far as the second part of the research is concerned, I followed the five phase cyclical approach described in Baskerville (1999).

The empirical work was carried out between November 2008 and late February 2009 in the state of Kerala, India.

5.3 Research methods

As introduced in the first section of this chapter, this research is divided in two parts aiming for two different targets but at the same time very inter-related. The first part applies the theoretical framework of technology acceptance model, which in order to find out the degree of user acceptance towards a specific technology, one would need to figure it out by employing the use of questionnaires. Thus, in my case, questionnaires were used as part of the quantitative research methodology.

As for the second part of my research which aims to find out the user friendliness of the DHIS-2 and its effectiveness, an action research framework was employed. Different tools and methods can be used depending on the study context. I picked qualitative research methods

for understanding the complexity of the system and the situation of the health care towards HMIS. By this approach, I would be able to understand 'how' the system works and 'why' it works the way it works (Anderson and Aydin, 1994). I aimed to explore the nuts and bolts of DHIS-2. Especially I focused on my addressed research problem to try to find a way to increase the user acceptance. This can be achieved by trying to find out GUI details, reports and graphs that could be changed for the purpose of becoming 'user friendly'. Within this context, qualitative methods can better explore the case. In qualitative research, the researcher usually tends to "stress the socially constructed nature of reality, the intimate relationship between researcher and what is studied, and the situational constraints that shape enquiry" (Denzin and Lincoln 1994:4). The methods used are believed to "provide a 'deeper' understanding of social phenomena than would be obtained from purely quantitative data" (Silverman 2001:32).

Three main methods were used for the data collection process as regards the second part of the research, and those are categorized in the qualitative research: interviews, participant observation, and document analysis.

5.4 Interviews

A number of informal and semi-structured interviews were conducted along with my research fellow Dibya. Interviews took place in health care facility site visits, PHC, hospital, and DMO. Also, informal interviews took place during DHIS-2 training session in Trivandrum as well as Wayanad district. My intention was to understand what was there to be changed in the software so it would affect the user acceptance. Initially, after the diagnosis of DHIS2 phase, suggestions

of DHIS-2 modification were offered to health workers during the interviews and feedback was taken seriously into consideration. In addition, suggestions from the users were taken as well into consideration and were further analyzed. Proposed modifications were small details of DHIS-2 GUI, reports and presentation formats which maybe cannot be catch by the naked eye unless focused on deep analysis. But I believe 'small details make differences'.

5.5 Observations

During my study, both planned and unplanned observation took place. Majority of observations took place during the training sessions. Silverman (2000) argues that extended observation is a better method to really understand what people or a group of people do naturally in their work environment. Thus, my intention was to understand how health workers find their way out of DHIS-2 while they were training the use of it. In fact, in the context of second part of my study, I believe, one of the most effective techniques of data collection methods was observations. The unplanned observations provided a better understanding of the real situation, since the observed staff was not in focus that they were being observed, compared to the planned observations.

5.6 Document review

Available documents of DHIS and HMIS in India were collected through various resources. Documents are very important in a qualitative study. Atkinson and Coffey (2000) argue, "If we wish to understand how organizations work and how people work in them, then we cannot afford to ignore their various activities as readers and writers.

Moreover if we wish to understand how the organizations function, then we also need to take account of the role of recording, filling, archiving and retrieving information" (Atkinson and Coffey 2000:46). Important resources include HISP website, DHIS2 website, Ministry of Health care of Kerala and so forth.

5.7 Questionnaires

The system's implementation included the training of users from various component hospitals and their respective departments and other health institutions meant to use the software. During the training session, the users were expected to learn new skills and then practice these skills in hands-on exercises. One important expectation from training was that the users would return to their jobs with new skills and their resulting use of the system would result in immediate improvements in their effectiveness and productivity. Data were collected from the questionnaires completed by the users participating in the training sessions. Over the duration of little less than three months, 5 training sessions were conducted in which 120 potential users of DHIS-2 participated. During each training session, the survey questionnaires were handed to the trainees who were expected to complete the questionnaire at the end of the training session. These surveys were returned before the trainees left the classroom. Overall, of 120 questionnaires that were handed out during these training sessions, 107 usable questionnaires were received that were used for data analyses, thus giving a response rate of over 89%. The survey questions are shown in the Appendix 1. 23 Questions of ten-point Likert scales were used with the anchors "1 = strongly disagree" and "10 = strongly agree". The first 6 questions were intended to measure the 'Perceived easy of use' of software. Another 6 questions were

intended to measure the ‘Perceived Usefulness’. The next 4 questions measured ‘Attitude towards Use’. Yet, another 4 questions measured ‘Behavioral Intention” and the final 3 questions measured the ‘Actual Use’.

5.8 Data Analysis

Data analysis, for the first part of the study which aims to measure the degree of user acceptance and for which a quantitative research approach was applied, was conducted with Partial Least Square (PLS) (Chin, 1998; Chin, Marcolin, & Newsted, 2003), using smartPLS 2.0 (beta) software (Ringle, Winde, & Will, 2005).

Whereas in the second part of the study where qualitative approach was employed, I usually took field notes to document the interviews, observations and the content of the documents I analyzed. At the end of each day, I re-organized my field notes comparing the data I obtained from the three methods. This also contributed to the plan for the next day’s fieldwork, where I could learn about what was missing regarding my questions. This continuous collection and analysis of data is common in qualitative methods. Agar (1980) explains the process to be inductive and cyclic. Usually you learn something by collecting some data, analyze the data to make sense out of it and then you go back and see if the interpretation makes sense in light of new experience, thereby collecting more data.

6 DISTRICT HEALTH INFORMATION SOFTWARE-2

The history and background introduction of District Health Information Software – version 2 is given in this chapter. In addition, a brief technical overview is given as well.

6.1 Introduction

District Health Information Software –version 2 (DHIS2) is a comprehensive HMIS solution based on data warehousing principles and a modular structure which can easily be customized to the needs of different health systems - nations, states, districts, and facilities.
It is Free and Open Source Software (FOSS) designed and developed under a global action research and developed under HISP initiative. It is originated from the Department of Informatics, University of Oslo, Norway. Whereas the first version of DHIS, 1.3/1.4 was developed and kept being continuously upgraded on an ongoing bases in its root base in South Africa 1997.

6.2 DHIS 1.3/1.4

DHIS version 1.3 and 1.4 is based on Microsoft technology with a database and a user interface created in Microsoft Access., it is distributed free since 1998 and is currently the national standard being used all over South Africa, be it in national level or lower health facility

hierarchical levels. Moreover, DHIS 1.4 besides South Africa is being used in many other countries such as Ethiopia, Nigeria, Botswana, Tanzania, Zambia, and, various other countries. WHO emphasizes that decentralization of the health system is essential in order to facilitate decision-making to the site where the information is generated (WHO 1994). To meet these decentralization efforts, DHIS have been introduced. The DHIS aims at enabling facility and district level health care providers to use locally generated information to improve coverage and quality of health services (Heywood and Rohde 2002). Another input, the intention of DHIS is to collect few data elements, and by analyzing and interpreting them, health workers and managers can often understand how to focus their efforts to prevent and control illness (Heywood and Rohde 2002).

Bra and Hedberg (2002) cited in Joshi (2009), emphasize the following objectives of DHIS 1:

- "Shift of control of information systems from central towards local levels, i.e. towards more equal control between central and local levels.
- Local flexibility and user orientation – it should be easy to adapt the software to local conditions
- Support for health sector reform towards decentralization and the development of health districts, i.e. integrating the vertical flows at district level.
- Empowerment of local management, health workers and communities.
- Horizontal flow of information and knowledge, based on the principle of free access to all anonymous, aggregated health data/information."

6.3 DHIS2

Beyond the desire of DHIS 1 being free and open source, the application is not to its full extent 'free'. It is so because it is developed on proprietary software such as Visual Basic (VB) and runs in a Microsoft environment dependant. Such tools include MS Office and Excel. In order to break this barrier, DHIS1 gradually evolved to another version, DHIS2 being free. "Free" refers to the freedoms rather than in the monetary sense of the word. The latter, same as the first, serves as a data collection, recording and compilation tool, and all data (be it in numbers or text form) can be entered into it. Data entry can be done in lists of data elements or in customized user defined forms based on the paper forms. "DHIS is based on a modular approach of design. A module can be seen as an independent component of application that is capable of both processing inputs as well as outputs, that is used to communicate with other modules. The modules are flexible enough to allow changes in one module without having any effect on other modules." (DHIS User Manual).

To better understand DHIS2, a comparison between DHIS1 and DHIS2 is necessary to be embedded in order to assess its capability of functions it offers:

- DHIS1 is not web-enabled and the technologies used for its development makes this approach literally impossible.
- DHIS1 is a standalone desktop application that would only run on Windows operating system, using Access as its database, whereas DHIS2 is cross platform independent.
- DHIS1 experiences low performances with MS Access database whereas the later version uses more advanced database.

The above critics are the main features that distinguish both versions. In addition, DHIS 2 provides a more thorough comprehensive HMIS solution for reporting and analysis needs of health facilities at any level and its main objectives are as follows:

- Provide a comprehensive HMIS solution based on data warehousing principles and a modular structure which can easily be customized to the needs of different health systems - nations, states, districts, and facilities.
- Provide data entry facilities which can either be in the form of standard (scroll down) lists (of data elements), or can be customized to replicate paper forms – to make easy the process of data entry.
- Provide different kinds of tools for data validation and improvement of data quality.
- Provide different tools for reporting – both for automated routine reports and analysis reports, and in addition provide the user with functionality and flexibility to make their user defined reports
- A dashboard for monitoring and evaluation of health programs that can allow for the generation and analysis of different indicators, and also carry out data quality analysis.
- Systems management functions to carry out various operations to manage hierarchy of organization units, addition/ deletion/modification of data elements etc.
- Functionality to design and modify indicators.
- Functionalities of export-import, so that data entered on an offline version can be exported to the district or higher level

systems. Export import can also be made in relation to other applications such as Excel and Epi Info.

- Integration with other software systems – such as RIMS.
- Integration with Geographic Information Systems (GIS).
- User management module for passwords, security, and defining authorization.
- Further modules can be developed (such as for human resources management) and integrated as per user needs (DHIS User Manual).

6.4 DHIS 2 Technical Overview

DHIS 2 is developed in Java and is based on three layer architecture: presentation layer, service layer, and store layer. Figure 6-1 presents the architecture and figure 6-2 presents the project structure.

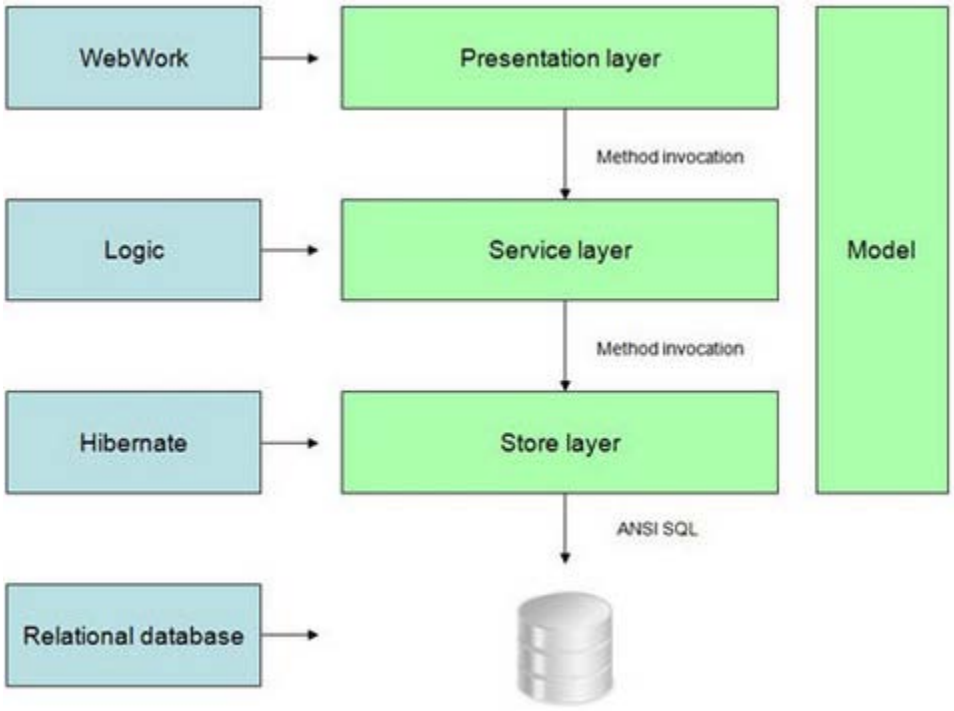


Figure 6-1: DHIS 2 Architecture

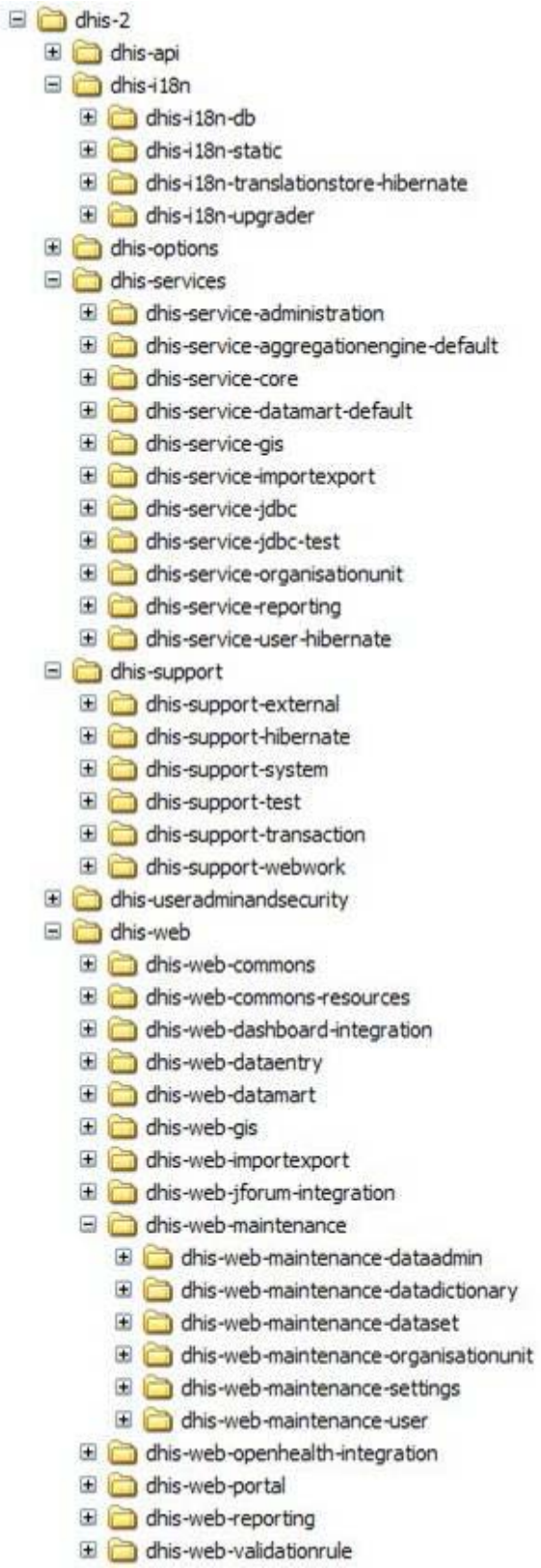


Figure 6-2: Project structure

7 Case Study

7.1 The State of Kerala

Tucked away in the south west corner of India, Kerala is a narrow strip of land between the Arabian Sea and the Western Ghats. It is lined by coconut trees and sinfully beautiful beaches, the coconut palms shade nearly the entire State from the tropical sun.

The state has an area of 38,863 km2 with 31,841,374 people. In addition, Kerala consists of 14 districts, 63 taluks, 21 revenue divisions, 152 rural blocks, 999 panchayats, and 1452 villages and it is bordered by Karnataka to the north, Tamil Nadu to the south and the east and the Arabian Sea towards the west. Thiruvananthapuram is the capital of Kerala with Kochi and Kozhikode as other major cities.

Kerala has the highest Human Development Index in India. The state has a literacy rate of 91 percent, the highest in India.

Figure 7-1: Map of Kerala

7.2 Government

Kerala consists of three branches of government and is governed via a parliamentary system of representative democracy; universal suffrage is granted to state residents.

The Governor of Kerala is the constitutional head of state, appointed by the President of India. The executive authority is headed by the Chief Minister of Kerala, who is the 'de facto' head of state and is vested with extensive executive powers; the Legislative Assembly's majority party leader is appointed to this position by the Governor. The Council of Ministers, which answers to the Legislative Assembly, has its members appointed by the Governor on advice of the Chief Minister.

7.3 Demographics

The majority of Kerala's population is of Malayali ethnicity and minorities consisting of Jewish and Arab culture and ancestry. The predominant religion is Hinduism followed by Islam and Christianity. According to 2001 Census of India figures, 56 percent of Kerala residents are Hindus, 24 percent are Muslims, 19 percent are Christians and the remaining one percent follows other religions.

7.4 ICT in Kerala

Despite the lack of computer literacy in late 1990's, fruitful initiatives have been considered as regards the promotion of ICT. One mayor step is taken towards education of e-literacy and computer training. Akshaya, an innovative project implemented in the State of Kerala aimed at bridging the digital divide, addresses the issues of ICT access, basic skill sets and availability of relevant content. Quality ICT

dissemination and service delivery facilities ('Akshaya Centres') are set up within a maximum of 2 kilometers for any household. The prime objective of Akshaya is to provide ICT accessibility and services to the reach of the common man and, thus, to bridge the gap between the "*Information Rich and the Information Poor*" – Akshaya project was conceived in such a way as to achieve this objective by developing ICT access points (e-centres) primarily and also addressing issues in the three main areas of:

- Skill sets: giving e-literacy training to at least one member in the 640,000 families of the State.
- Content Development: content relevant to local people in Malayalam in web and digital media to be created.
- Services Delivery: e-learning, e-business, e-payment, e-governance etc to be carried out. The hope that Akshaya will act as an instrument for the State's overall development is being fulfilled. By bringing ICT to all segments of people it acts as a vehicle for improved quality of life, accessibility to information, transparency in governance and overall socio-economic growth.

After the pilot stage implemented in Malappuram district the following results are achieved:

- At least one person in every family in Malappuram district has been made e-literate, making it the first fully e-literate district in the country.
- 351 functional e-kendras in Malappuram providing computer education, e-pay, e-krishi and socially relevant content to the Public
- Creation of around 500 direct and 2500 indirect employment opportunities.

- Rural Internet Banking and Financial Services have been made available to the entire population of a district.

Moreover, Kerala is also known for initiatives towards the notion of open source software. Various open sources have been taken by National Informatics Center (NIC) Kerala for effective online applications. These solutions have been implemented in various application areas such as:

- E-collectorate
- Online Counselling for engineering/medical/legal/MCA
- Lok Ayukta
- Treasury
- Dairy development board
- PIB news
- KV schools
- Secretariate Knowledge Management system Solutions to be showcased have been developed using LAMP and JAVA technologies.

7.5 ICT in health sector

Taking into the consideration the ICT within the context of health, I visited several health facilities during my fieldwork. It is essential to note that it has been observed that there is a lack of computers in low level health units such as sub centers. In three visited sub centers within the Trivandrum district, no computers were present. During the visit, I was told that NRHM is supposed to bring the computers in sub centers so they can run DHIS-2. These sub centers were still using paper based monthly reports to report to their respective PHC. It

seems NRHM started the distribution of computers from top level organization units. During another visit at the Vizhinjam CHC, Kerala district, there was one computer only, and that is used only for printing blank CHC reports generated by DHIS. The reason they print a blank report is because they don't have access to internet. Thus, they have to print the report, fill in the data elements and finally physically send the report to the District. This is a pity, because in order to use DHIS-2 to a degree of 'full use' one needs to have the computer connected to internet. Also, the computer used at the facility was very old and had low quality performance, making it difficult to run DHIS-2. Yet another visit at the Vellanad CHC, Trivandrum district, resulted to be not in the desired level. Here, I noticed few discrepancies as well. The printer was out of use since it was out of order implying non-use of DHIS-2. The other issue is that DHIS health users had forgotten their DHIS password. As a result they had not used the system for the last two months. Luckily, I was there to inject a password into their system through the backend door.

7.7 Training sessions

During the fieldwork in Kerala I was involved in training sessions organized by HISP and NRHM. Altogether I attended 4 training sessions. Three of them are 'three days training' and one is 'five day training'. The latter is reserved for the State level and District level health workers whereas the former is reserved for Block level health workers. The purpose of the training sessions is for the sake of understanding major HMIS approaches, concepts and components. Moreover, it adds on an understanding of HMIS in the context of NRHM, that is reporting systems, datasets, indicators, data elements

and last but not least it strives to build an understanding of use in DHIS-2. Appendix 2 shows the detailed training agenda.

Trainings were organized by HISP and supported by NRHM at computer lab facilities rented by NRHM. I was involved in trainings at two districts, namely Trivandrum and Wayanad.

Figure 7-2: Fieldwork training session

7.8 Health care in Kerala

The Indian state of Kerala has been internationally praised for its health achievements despite its economic backwardness. The United Nations Children's Fund (UNICEF) and the World Health Organization designated Kerala the world's first "baby-friendly state" because of its effective promotion of breast-feeding over formulas. Along the modern health facilities are equally reputed facilities for Homoeopathy and Ayurveda. The last being an ancient Hindu system (medicine based on herbs, oils and other natural ingredients) meaning

"science of life/health" and is called upon the belief that the body, spirit and mind are one.

Health status is generally measured in terms of mortality indicators like Death rate, Infant mortality rate and expectation of life at birth among others. Mortality indicators show that health status of Kerala is far advanced and higher than the all India average and is even comparable with developed countries. This progress of health status is achieved through widespread growth of the three systems of medicine in public, private, co-operative sectors combined with people's health awareness. The basic health indicators of Kerala and India are given in Table below. Though Kerala has attained better health care indicators, the people are now facing the problem of high morbidity both from communicable and non- communicable diseases.

Table 7-1: Basic health indicators – Kerala and India 2008

Basic health indicators – kerala and india 2008

Sl.No.	Health Indicators	Kerala	India
1	Birth rate ('000 population)	14.7	23.1
2	Death rate (,,)	6.8	7.4
3	Infant mortality rate (,,)	13	55
4	Child mortality rate (,,)	3	17
5	Maternal mortality rate (per lakh live birth)	110	301
6	Total fertility rate (children per woman)	1.7	2.9
7	Couple protection rate	47.22 (2007)	46.6 (2005)
8	Life at birth Male	71.3	62.3
	Female	76.3	63.9
	Total	73.8	63.1

Source: Directorate of Health Services

Kerala has the highest number of health care institutions as per the 1997 census. About 26% of total health care institutions in India are

located in Kerala. Table 7-2 gives a view of the number of health care institutions and beds.

Table 7-2: District wise details of health care institution

District	No of Health Care Institutions	Number of beds
Alappuzha	343	8835
Ernakulam	546	15819
Idukki	194	4096
Kannur	392	5149
Kasaragod	209	2107
Kollam	704	7530
Kottayam	440	9323
Kozhikode	342	9034
Malappuram	327	5030
Palakkad	316	4925
Pathanamthitta	310	5096
Thiruvananthapuram	411	12910
Thrissur	434	12991
Wayanad	127	2307
Total	**5095**	**105152**

Despite its economic backwardness, Kerala is often referred to as an example for other Indian states to follow. These achievements are said to be based on the good performance of its health sector as well as its

non-health sector. However, the sluggish economy in the past decade has caused fiscal problems thus Kerala's health care system is facing new challenges. Increasingly, the public sector is unable to meet the demands for health care and therefore comes the response of increasingly private sector launches. This trend is not something to welcome as the private sector raises household health care expenditures, making health a luxury purchased by 'ability to pay.' Many public facilities remain underutilized. According to the Journal of the National Institute of Public Health there is a lack of regulations over the private sector does not guarantee the quality of care and any medical graduates are enticed to work at the private sector, where no systematic training exists. The journal emphasizes three major suggestions that may overcome these challenges. First, Kerala must invest in the public sector to revitalize the system. To achieve this, tax revenue must be increased. Second, Kerala must streamline the system through decentralization. Kerala launched a radical decentralization policy in 1996, by which the health care system would be responsive to the local people. Third, Kerala must take a step to revamp the health care system in a way that the public and private sectors effectively cooperate and complement each other to meet the needs of the people. (National Institute of Public Health, undated).

8 ANALYSIS AND DISCUSSION

This chapter includes an analysis of the projected results from SmartPLS according to TAM proposed model, which uses algorithms from PLS to access the reliability of DHIS-2. Moreover, it focuses on the analysis of DHIS-2 against the 'information cycle phases'.

8.1 PLS Analysis

As far as analysis of questionnaires built according to TAM proposed model is concerned, Partial Least Squares and structural equation modeling (SEM) tool (Smart-PLS 2.0 M3) is applied. SEM permits a simultaneous assessment of the structural component (path model) and measurement component (factor model) in the one model.

The measurement model consists of relationships among the conceptual factors of interests and the measures underlying each construct.

The data indicates that the measures are robust in terms of their internal consistency reliability as indexed by the composite reliability (Table 8-1). The composite reliabilities of the different measures ranged from 0.89 to 0.90 which exceed the recommended threshold value of 0.70 (Nunally 1978).

Table 8-1: Composite Reliability

	Composite Reliability
ATT	0.898436
BI	0.929891
PEOU	0.960426
PU	0.898335
USE	0.907876

Table 8-2: AVE

	AVE
ATT	0.691119
BI	0.768669
PEOU	0.801983
PU	0.596401
USE	0.767080

Table 8-2 shows the AVE values which range from 0.6 to 0.7, all values are higher than the cutoff of 0.50 for AVE recommended by Fornell and Larcker (1981).

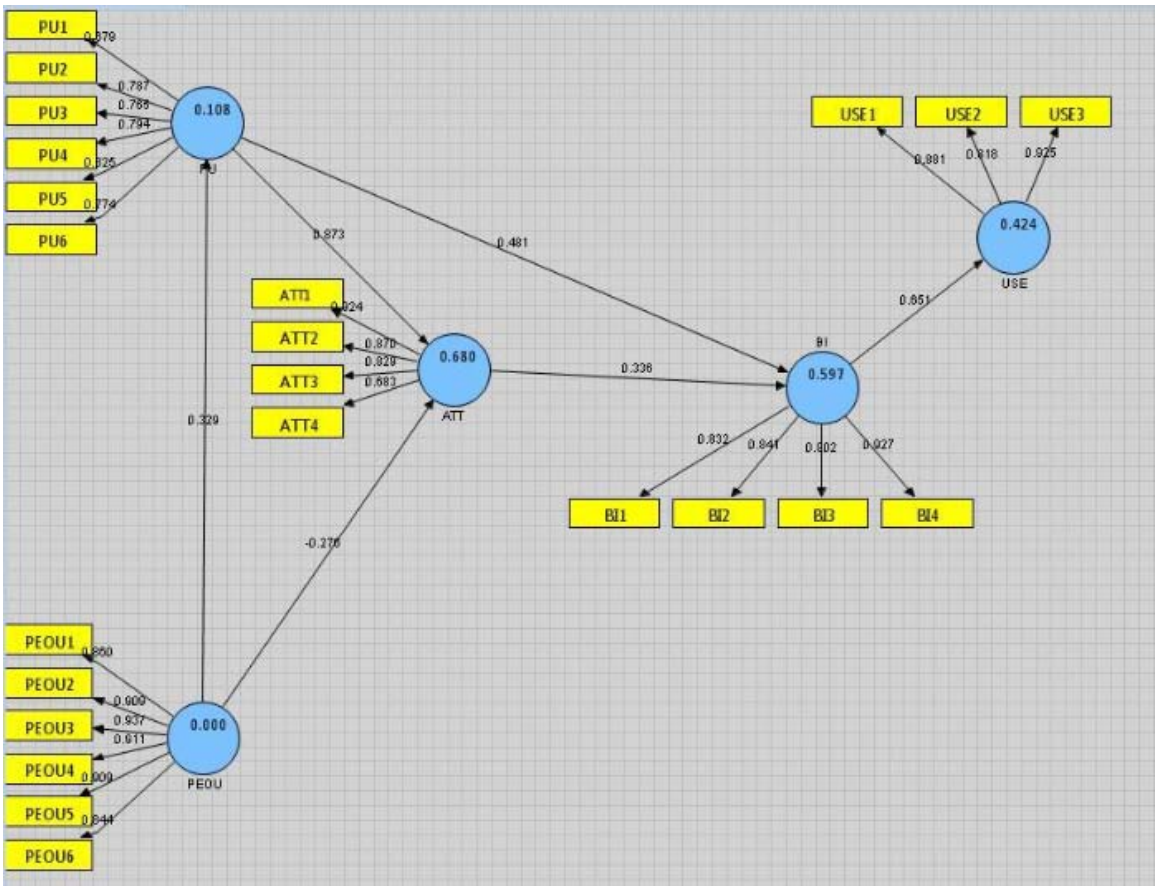


Figure 8-1: The structural model

Looking at the structural model in Figure 8-1, perceived usefulness has a greater effect on intention (directly and indirectly) than perceived ease of use. Moreover, perceived usefulness and perceived ease of use appear to be important determinants of health workers attitudes towards DHIS2 and together seem to explain a significant portion (68%) of the variance of attitude. Likewise, attitude and perceived usefulness explain 59% of health workers intention to use DHIS2. However, perceived usefulness has a stronger direct positive effect on health workers intention than attitude. Health workers intention is a significant determinant of actual use of DHIS2.

Table 8-2: Overview

	AVE	Composite Reliability	R Square	Cronbachs Alpha	Communality	Redundancy
ATT	0.691119	0.898436	0.679800	0.850007	0.691118	-0.051784
BI	0.768669	0.929891	0.597418	0.898944	0.768669	0.281652
PEOU	0.801983	0.960426		0.951916	0.801982	
PU	0.596401	0.898335	0.108427	0.863724	0.596401	0.064157
USE	0.767080	0.907876	0.424350	0.847037	0.767080	0.321013

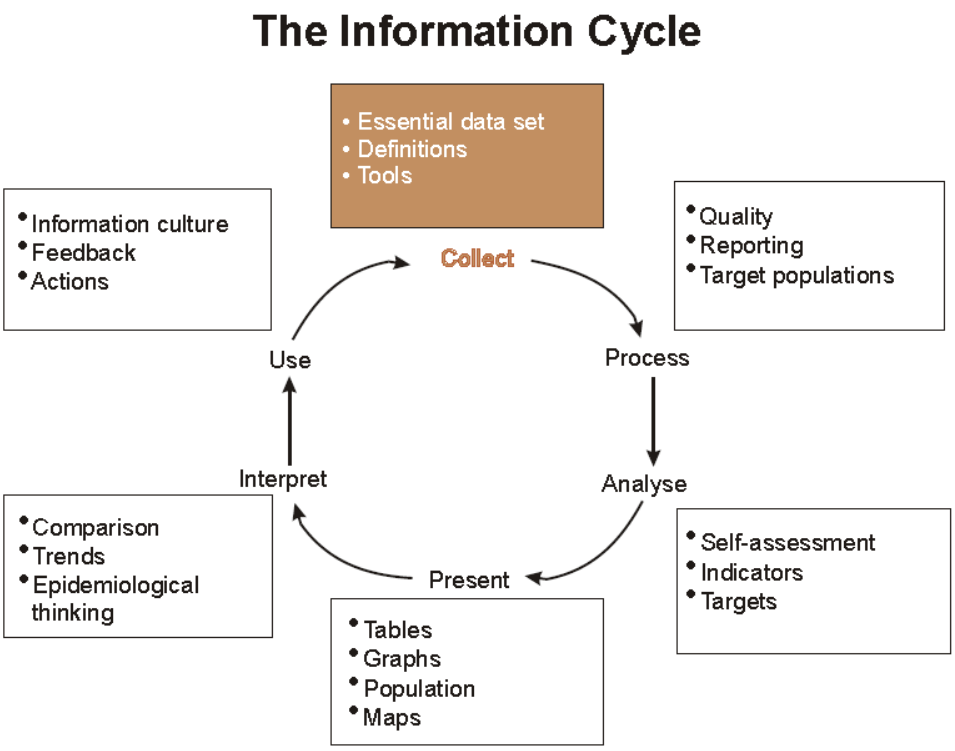
8.2 Overview of DHIS-2 with respect to Information Cycle

According to Information For Action (undated), a recent study carried out by National Health Systems Resource Centre (NHSRC) across various states in India has revealed the following lacunae in the existing HMIS

- Very high number of data elements is collected by the field health staff at the cost of the time devoted to outreach services. E.g. ANMs report somewhere between 500 to 1500 data elements monthly.
- High % of blank or zero values in the monthly reports being sent, sometimes even to the extent of 55-65% of the total data reported on. Systematic patterns of zeros or blanks raises questions of whether those data elements are required, or whether the corresponding services are being provided, or whether the facility does not have the capacity to provide the service. Such a situation raises the need for an analysis of what data is being collected and why, and also the quality of the reports.

- Duplications and gaps represent systemic ambiguities in the HMIS. For example, the same immunization service data is recorded in both the UIP (Universal Immunization Program) and the routine data collection – Form 6. While on one hand, there are these duplications, on the other hand, there are gaps in important service data being collected, for example on laboratory care and HIV/AIDS care.
- Indicator to data mismatch in the existing HMIS data is being collected without being put to use in the calculation of indicators.
- Lack of uniformity and standards in naming conventions leads to problems in recording, reporting and analysis of data.

Taking into consideration these gaps, DHIS-2 is an intention to be the solution for these issues underlined above. It highly reduces the chances of poor data quality consolidation, making health managers precise and efficient in analyzing important activities to include but not limited to: Obtaining an overview of the health status of a community, district or state; monitoring and evaluating the extent and quality of health services delivered; controlling epidemics and out breaks; better management of infrastructure and staff.



Information is central to the planning process, and the importance of the conversion of data into information and knowledge. In this section, the focal point is to go through all steps of the 'information cycle', by explaining them and using them through real HMIS software. This way, a practical understanding is built through going into every phase of the cycle having DHIS-2 as the facilitator of real world information cycle. First, let's see the primary component of the information cycle: Data.

In order to understand data collection, it is of significant importance one understands essential terms data: data element, data group, dataset, essential dataset.

Data element: Concerns the raw data that is collected for a particular activity or service: for example, the number of infants given BCG vaccines in a month is a data element.

Data group: Will comprise of all such data elements that relate to a particular service (say child health).

Dataset: Data set consists of all data groups within a health program, such as related to Reproductive Child Health Program. So, a RCH dataset will consist for example, of data groups related to child health, maternal health and family planning.

As regards the *collection* of data using DHIS-2, a screenshots has been taken to show the entry of data from different organizational levels.

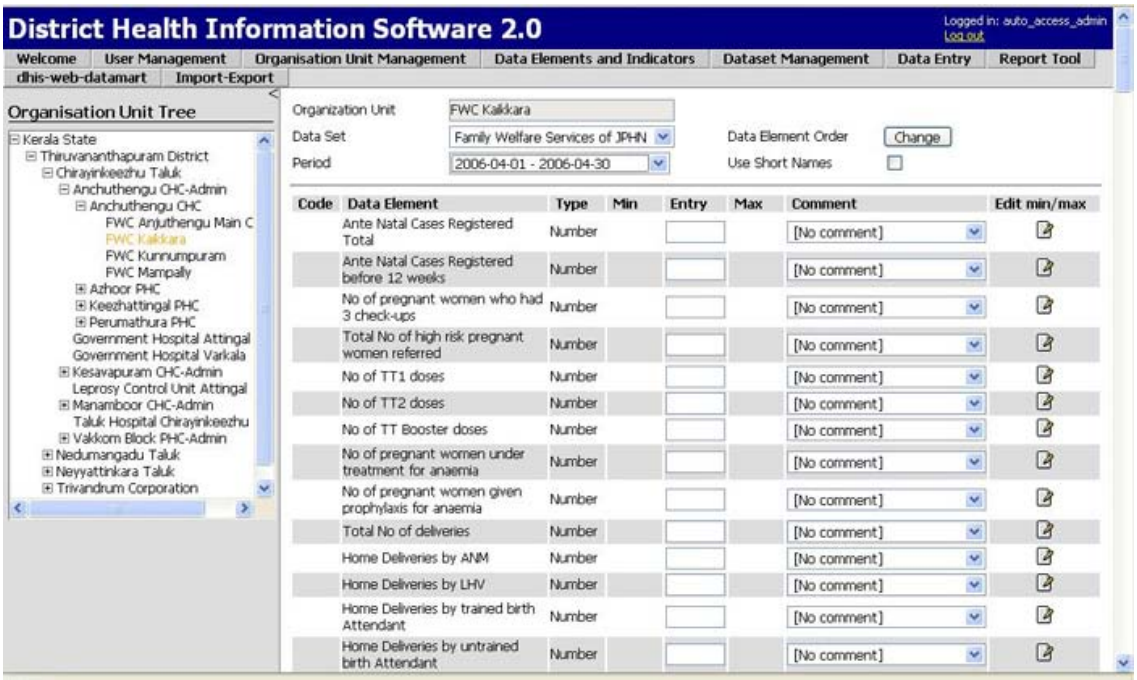


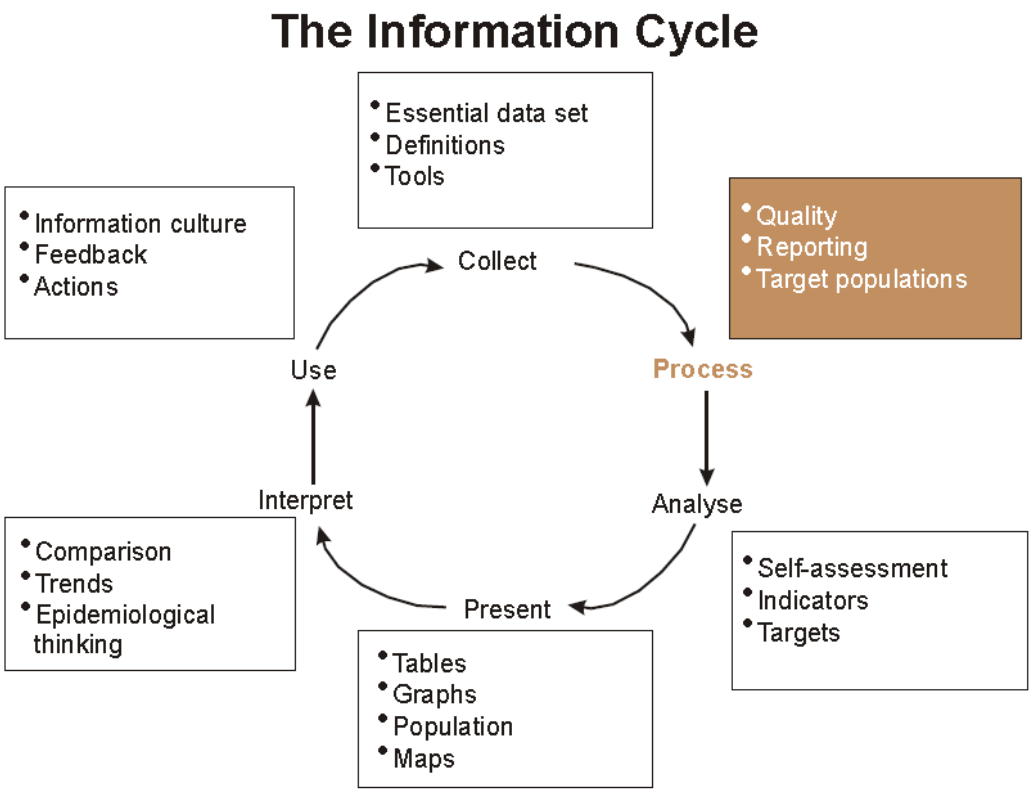
Figure 8-2: Data entry - collection phase

Health staff, in general, finds it easy to enter data for their corresponding level of data entry. A JPHN, from Wayanad district finds the data entry table very user friendly.

> *"It is very easy to enter data in DHIS2, because it is clean and straightforward especially I like the minimum and maximum value to make the data element more correct" (Junior Public Health Nurse, Wayanad).*

Another staff member from Trivandrum district finds data entry quite efficient.

> *"Now it's easy to put data in forms because we use computer instead of pencil. Before we use paper to register and we had thousands of data elements to fill. Now we have only so little to type in computer. I like it very much" (Healh Inspector, Trivandrum).*



"Data quality defines quality of HMIS" (Information for Action).

The process of data collection is useless if it is left in the first phase of the information cycle. As mentioned, data is the basis for information but its quality and accuracy is of outmost importance. In order to have an efficient and qualitative HMIS, its collected data must be checked for accuracy so top health managers know what correct action must be considered to be taken. "Data quality or accuracy can be defined as the gap between the actual (the reality which seeks to be measured) and the measured (what is actually measured)" (Information for Action). Therefore, the smaller the gap the greater would be the accuracy.

In order to reach high data accuracy in the context of a paper based health information system, a considerable time and effort is needed to be allocated. This in effect compromises the primary task - that of providing health service delivery. Thus, health staff needs to find the correct balance and sometimes need the 'trade-off' mechanism between data accuracy and health delivery service and vice versa.

On contrary, the DHIS-2 provides the health staff the capability of checking for data quality or accuracy by employing validation rules in the system beforehand. Such validation rules can be, for instance, 'total number of full immunization must be equal to total number of Measles given' or 'the number of deliveries must be equal to or less than the sum of live births and still births'. Figure 8-3 shows a DHIS-2 screenshot defining the validation rules.

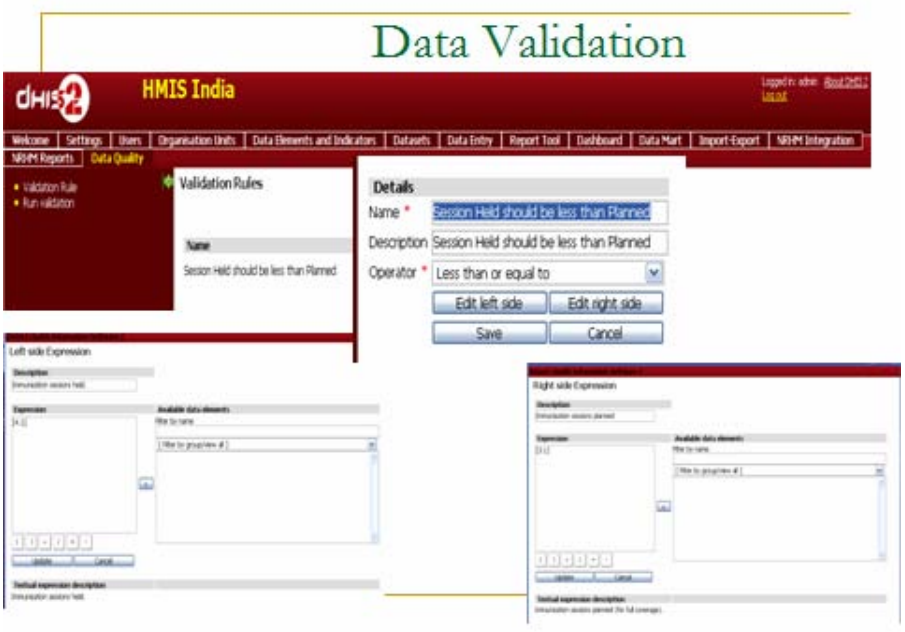


Figure 8-3: Defining data validation rules

Other data quality measures are taken into consideration in DHIS-2. The software has the capability of computerized quality checks for minimum or maximum values. The purpose of having the minimum/maximum mechanism is to ensure specific data element fall within the range of expected value. Figure 8-4 shows the data quality by min/max value checks in DHIS2.

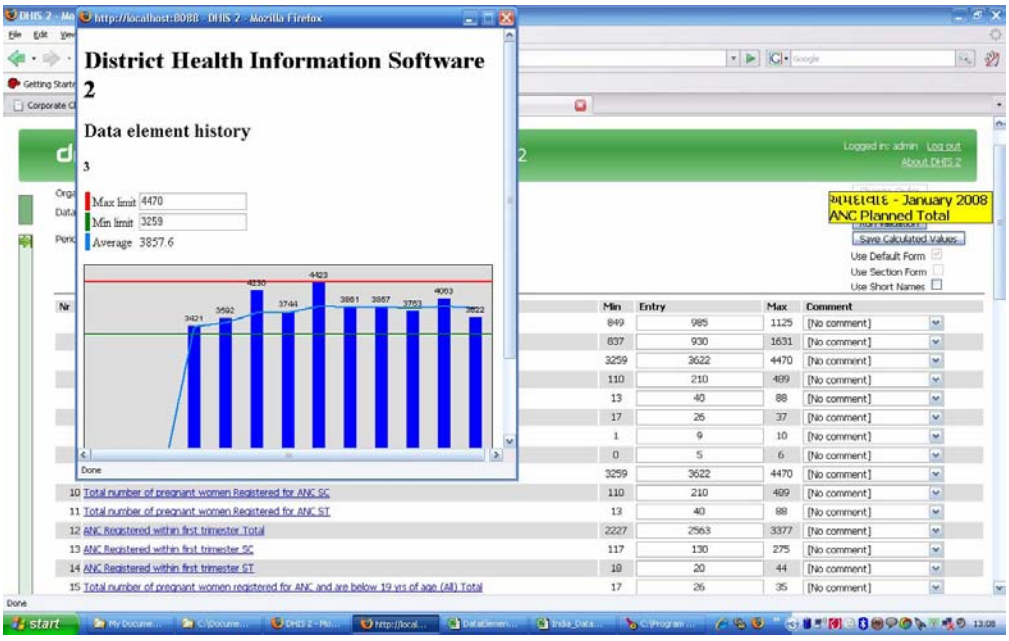


Figure 8-4: min/max value

DHIS-2 also facilitates the capability of commenting in the box of a specific data element, in case that particular data falls out of the range of expected value.

Moreover, data quality checks can be can visually be done by comparing particular data elements between organizational levels. For example, three data elements namely ANC registered Total, ANC registered ST, and ANC registered SC can be visually compared

between as many as desired organizational levels. This approach is called SDA approach. It is developed by HISP India and it stands for Symptom, Diagnosis, and Action. It is integrated in DHIS-2 by examining the data, look for abnormalities and finally drill down to organizational levels to find root source of the abnormality. Three step analysis composes the SDA approach:

Symptom – identification of problems:

- Eyeballing raw data by person with public health knowledge and experience to detect abnormalities.
- Formalizing validation rules in the software.
- Min-max ranges for each data element.
- Data triangulation from multiple sources (Intra Health & Paper Form 9).

Diagnosis of problems to identify causes:

- Further interrogation of data to identify source of problem (data entry mistake or logical errors etc).
- Drilling down by facilities/periods/categories.

Action taking to address causes (not symptoms):

- Systemic approach.
- Policy implications.
- Establishing protocols for action.

Screenshots of DHIS2 has been taking giving examples of SDA approach.

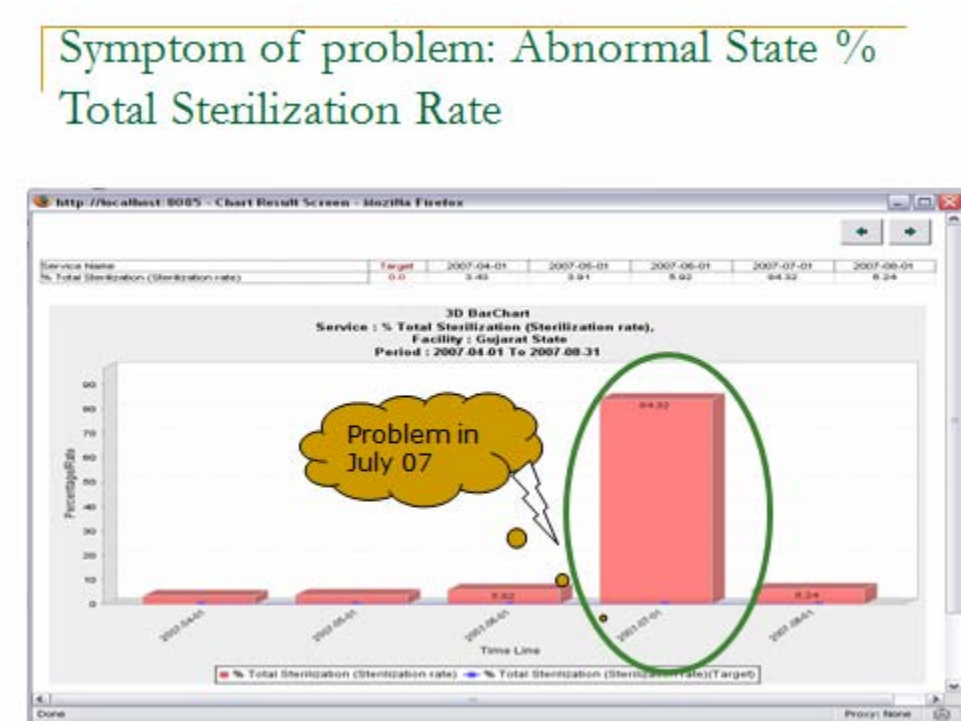


Figure 8-5: Identifying symptoms

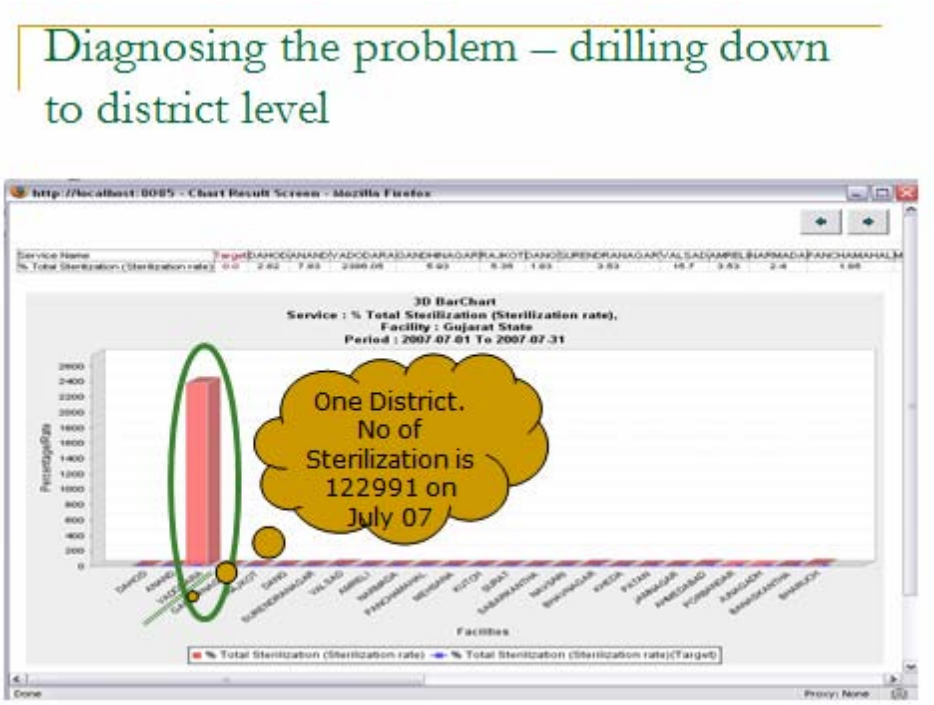


Figure 8-6: Conducting diagnosis

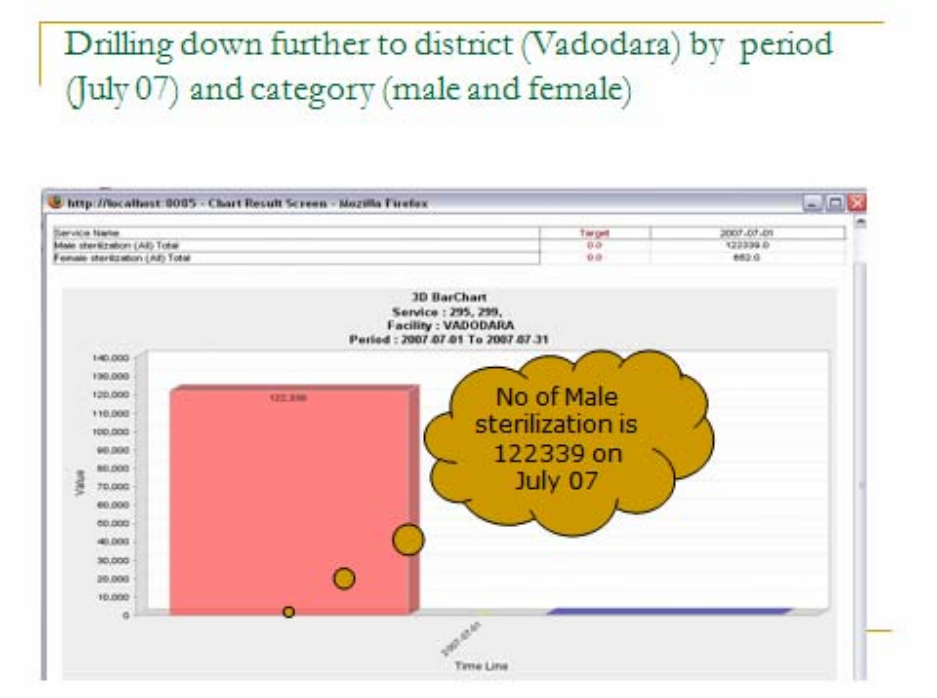


Figure 8-7: Conducting further diagnosis

Data processing

The data that have been going through the first phase of entry to the quality checks and accuracy in the second phase now needs to go for further processing – report generation. This process involves the consolidation of data from various resources to compile it in one comprehensive and representative report. For instance, a block PHC report consists of the data consolidation from all its child nodes consisting of miniPHC-s which further consists of many subcentres.

An example of a CHC report is presented in Figure 8-8.

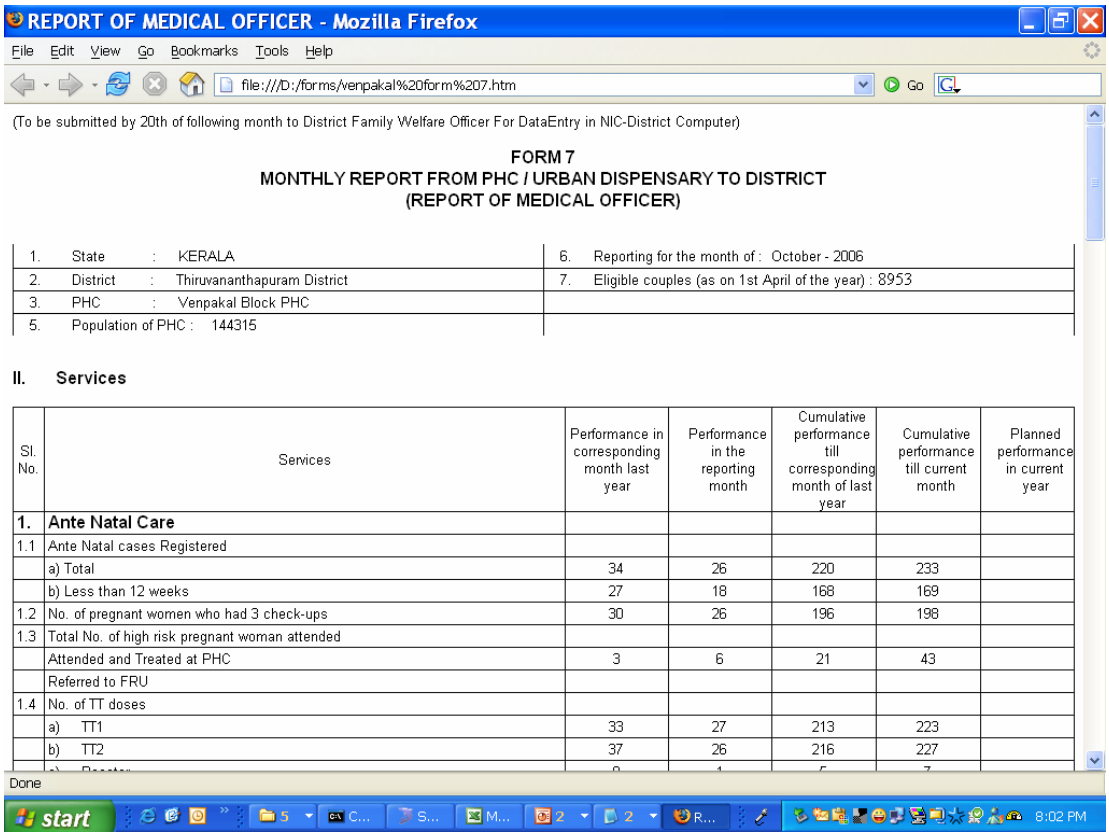
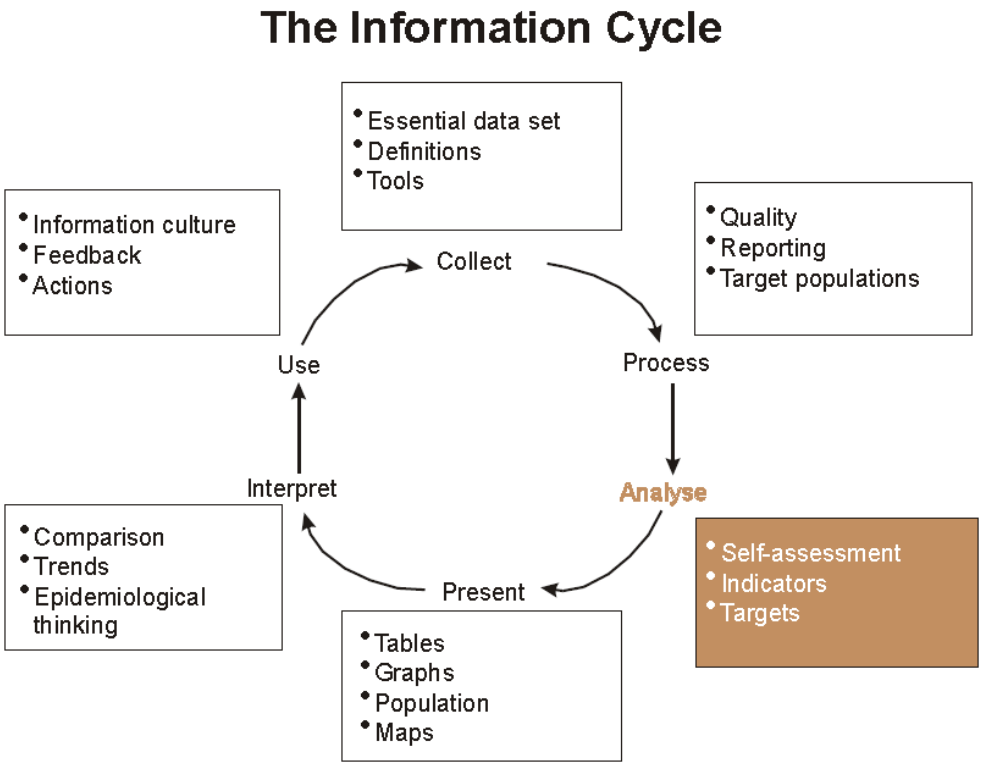


Figure 8-8: CHC report

"Effectiveness of HMIS is enhanced through indicator based analytical comparisons"



Once data has gone through the first and second step of information cycle, that is collection and process, respectively, next data needs to be analyzed. Usually analysis is done in the form of self-assessment, comparing actual activities against plans made and actual targets. Analysis, according to NHSRC-HMIS, must take into consideration four fundamental questions:

- Did everyone who should have received services receive them? (Coverage)
- How good is the service provided? (Quality)
- Did you follow-up clients who needed it? (Continuity)
- Did you identify all clients with potential problems? (Risk)

To come to a point where one would want to make analysis of health data according to the four questions roused above, one needs to understand what indicators are.

Indicators are “variables that help to measure changes, directly or indirectly” (WHO 1981).

Indicators are mathematical expressions that can be in the form of percentages, ratios, and rates that relate data to standardized populations or sub-groups or items. Typical examples of indicators are number of patients served per ANM or per 1000 populations or per type of client. These “indicators” can be compared across any different facility size or population.

Indicators are usually made up of a numerator (top number) that is divided by a denominator as shown below:

Indicator = (Numerator / Denominator) x 100%

Numerators are the things we count: numbers of clients, infants immunized, new cases of TB, number of doctors, etc.

Denominators are the group with which the things we count are compared: total population, all live births in a year, number of adults or numbers of clinics, total miles travelled, and number of beds in the hospital.

“Indicators enables us to compare ‘apples’ with ‘apples’ and not with ‘melons’!”

WHO 2000, classifies four types of indicators:

- Count Indicator: Number of events without denominator (e.g. number of new cases of Acute Flaccid Paralysis)
- Proportion Indicator: Numerator is contained in the denominator (e.g. Proportion of health centers without electricity)
- Rate Indicators: Frequency of the event in a specified time in a given population (e.g. Incidence of new TB cases in a specific time and given population)
- Ratio Indicator: Numerator in not included in the denominator (e.g. Ratio of male TB deaths to female TB deaths)

Figure 8-9 represents applying indicators in DHIS2.

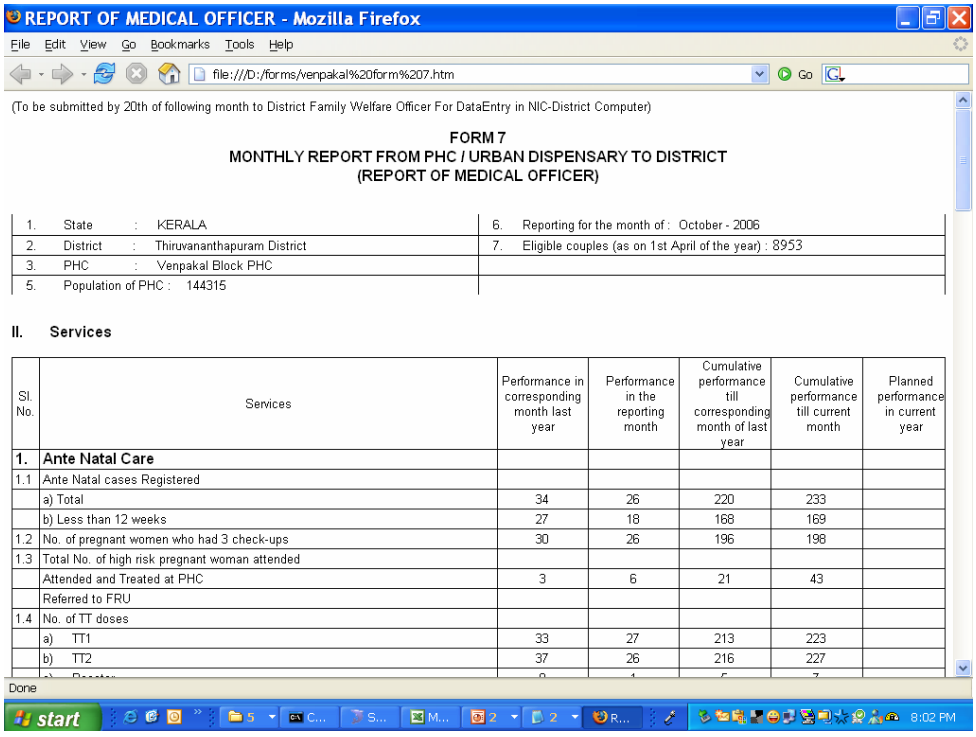
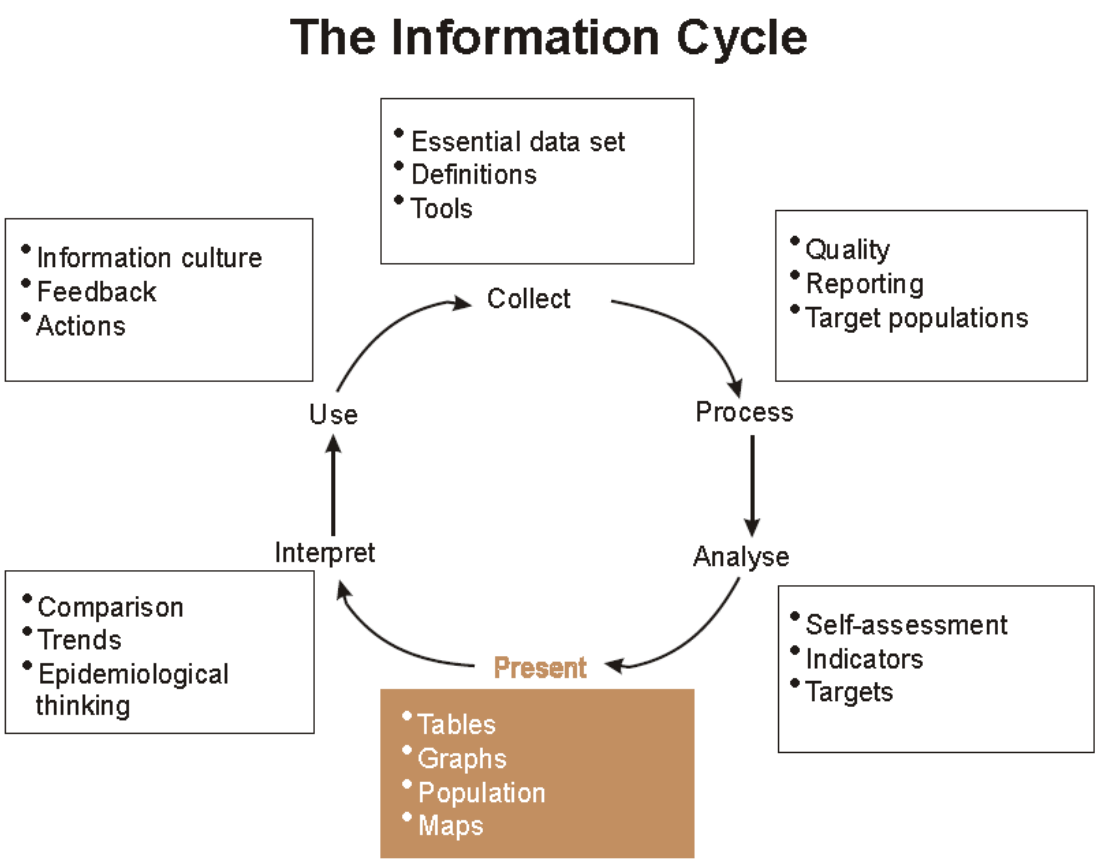


Figure 8-9: Indicators in DHIS2



All the above highlighted information cycle phases are essential to a fruitful HMIS. Analysis of data is useful for top health managers for the sake of duty effectiveness and efficiency. But having a more pragmatic view of what is visually going on with all the consolidated data from the very low levels of organization units up to higher ones makes an HMIS even more efficient – that is presentation of data.

Presentation of data can be presented in various forms such as tables, graphs, maps. A decent HMIS software must possess the availability of presenting data in a variety of forms, and that is exactly what DHIS-2 offers to health staff. As mentioned, indicators are a very important in the health management cycle. But in order to make them very useful health managers need to display them in forms of tables, graphs and maps that can easily be seen and interpreted for further discussions at

all health organization level meetings. Again, DHIS-2 is facilitated with the capability of transferring indicators and data elements into visual forms as discussed in this paragraph.

Figure 8-10 shows data presented in a linear graph.

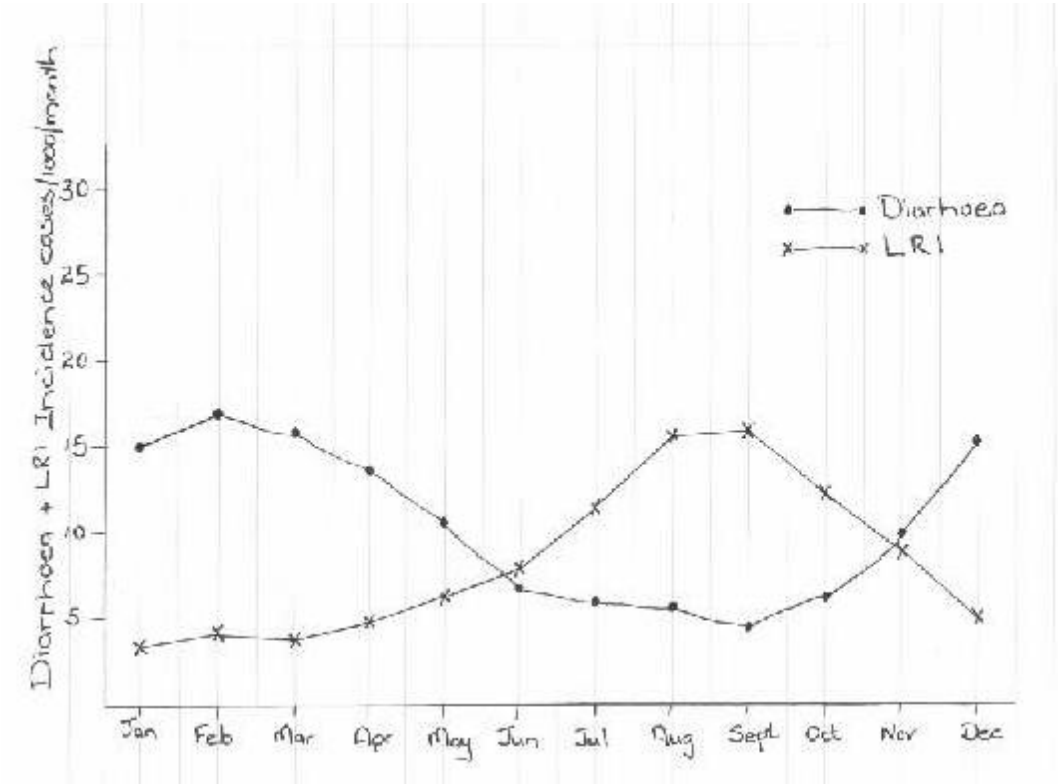


Figure 8-10: Line graphs

Line graphs are used to show patterns or trends of related activities over time and are useful if more than one data item is to be displayed.

Yet another presentation format is important – cumulative graphs. These graphs show progress towards a fixed target in a period of a specific time given. Figure 8-10 presents a cumulative graph.

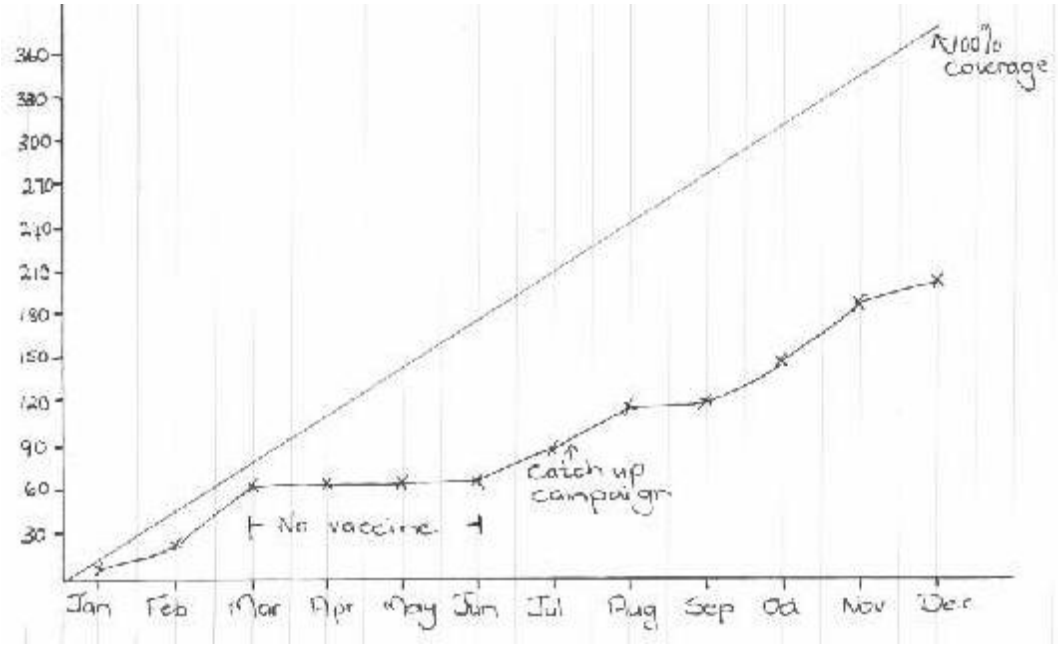


Figure 8-11: Cumulative graph

Finally, last but not least is the pie chart. Figure 8-12 presents a pie chart showing the population percentage. Pie charts are supported by DHIS2 as well.

To conclude, DHIS-2 does a pretty neat job as regards the graphs. But *presentation* as a phase within the information cycle does not constitute of only graphs and tables but maps too. As far as Kerala state is concerned, DHIS-2 is not supported by GIS as of February 2009. GIS can be very fruitfully used for mapping all data on elements and indicators on maps using different levels of boundaries-districts, PHCs etc. An example is shown in Figure 8-13.

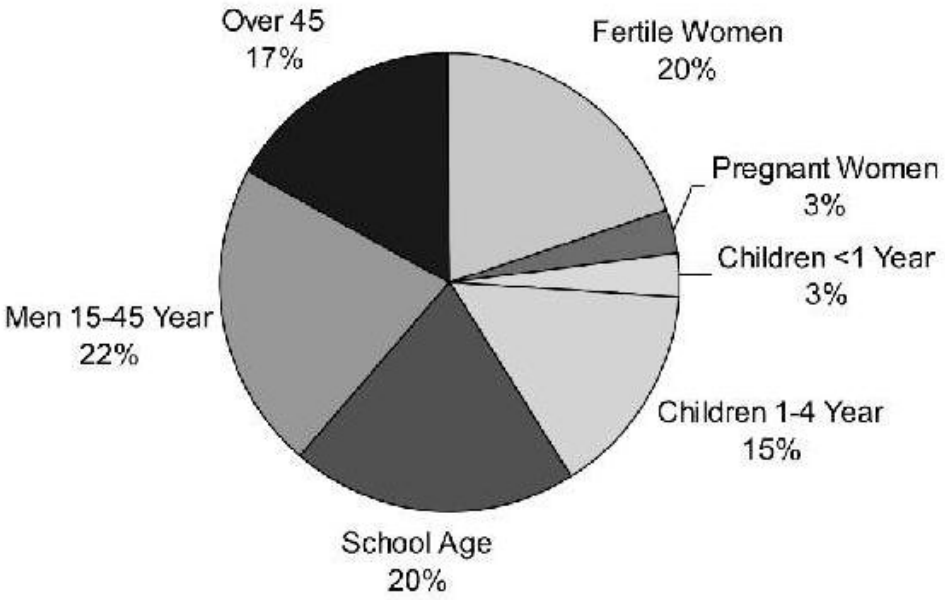


Figure 8-12: Pie chart, population

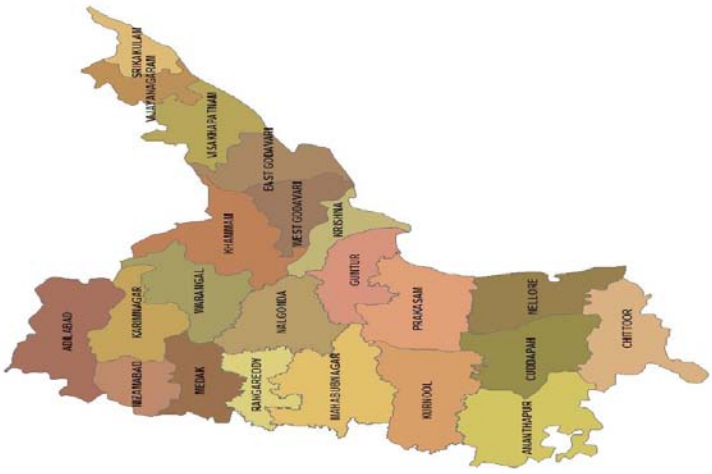
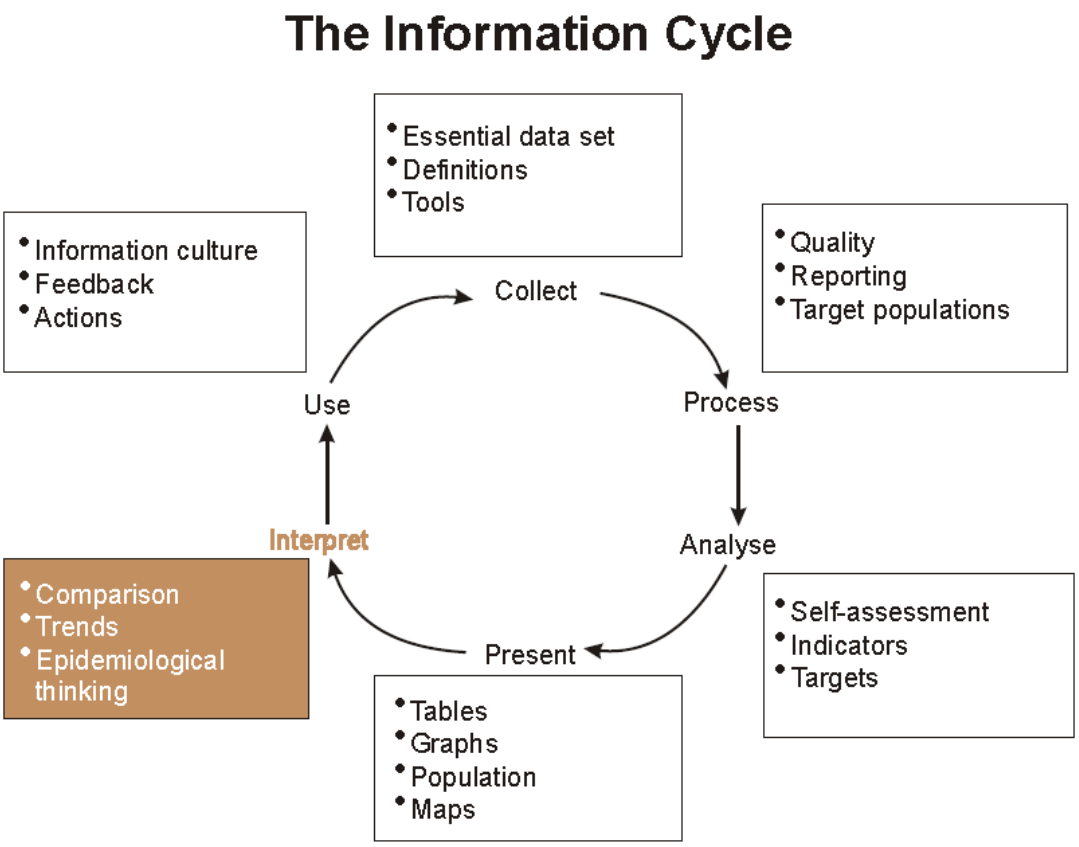


Figure 8-13: Map of Andra Pradesh showing district boundaries with color coded RCH wise performance



The second last phase of information cycle is interpretation. Health managers need to assess their progress against the goals they have set in order to take corrective action. Assessment can be done by a comparison technique; that is comparing data to other horizontal institutions to see how well a health organization unit has done compared to other sister institutions. It's essential to note that humans can realize the value of something only by comparing it to another similar thing. Here, too, when managers compare results of their institution to another similar institution, only then they may be able to take the right decision based on what is projected. This all said can be performed by DHIS-2 by incorporating the techniques of last two previous information cycle phases.

The last information cycle phase is ensuring use of information. In order to achieve this, health managers need to provide feedback to lower level institutions. It is a mechanism and an opportunity for learning and making changes towards improvement. This feature is as well supported by DHIS-2.

9 CONCLUSION and SUMMARY

A focal point in this chapter is a summary of the essence of the discussion in the previous chapters and present the conclusions related to my research question. Finally, based on the experiences from Kerala, analysis and results produced, a suggestion for further strategy is outlined.

This thesis examines and evaluates the user acceptance of DHIS-2 which is being implemented in Kerala under the patronage of Health Information System (HISP) – a health management information system that offers free open source software founded on the principals of evolutionary system development, action research and participatory design.

The thesis consists of nine chapters each one containing relevant information within the range of the research context. Chapter one gives a brief introduction to the study, its research setting, the methodology used for data collection and the main research question followed by hypotheses.

Chapter two focuses on the theory relevant to this study. Main concepts introduced are technology acceptance model and partial least square. The latter is used for the purpose of analysis of conducted questionnaires and the former is used for the purpose of the technology acceptance model introduced by Davis (1989). Both concepts are used to measure or evaluate the user acceptance of DHIS-2.

Next, chapter three gives an overview of the fieldwork research setting, which is India. Moreover, it tackles down the health system in India besides its economy, geography and demographics.

In chapter four, Health Information System Program is the focal point where a history and background is projected.

Chapter five is the research methodology. The data collected for this study is composed of both qualitative and quantitative research methods. Main mechanisms of data gathering are interviews and questionnaires. Data collected from the questionnaires were completed by the health workers participating in the training sessions. Over the duration of little less than three months, 5 training sessions were held in which 120 potential users of DHIS2 participated and completed the survey. Interviews as well took place during the training sessions. Moreover, participatory observation took place as well for the purpose of trying to find out 'how the end users of DHIS-2 operate the application in the context of 'user friendly'. Both interviews and observation aimed one target; that is finding out how user friendly is DHIS-2.

Chapter six introduces the history and background of District Health Information System, DHIS-2 - a comprehensive HMIS solution based on data warehousing principles and a modular structure which can easily be customized to the needs of different health systems - nations, states, districts, and facilities.

The case study from Kerala is given in chapter seven where common knowledge of the state of Kerala is introduced. In addition, health care, ICT and ICT in health care is explained as well.

Analysis and discussion is the focal point in chapter eight. There are two types of analysis approaches made. One is through questionnaires and the other is through interviews, observation and document reviews. Both approaches aim to find out the research question addressed in this thesis. To find out whether DHIS-2 is accepted by end users, partial least square (PLS) approach is used for analysis based on the technology acceptance proposed model in Figure 7-1.

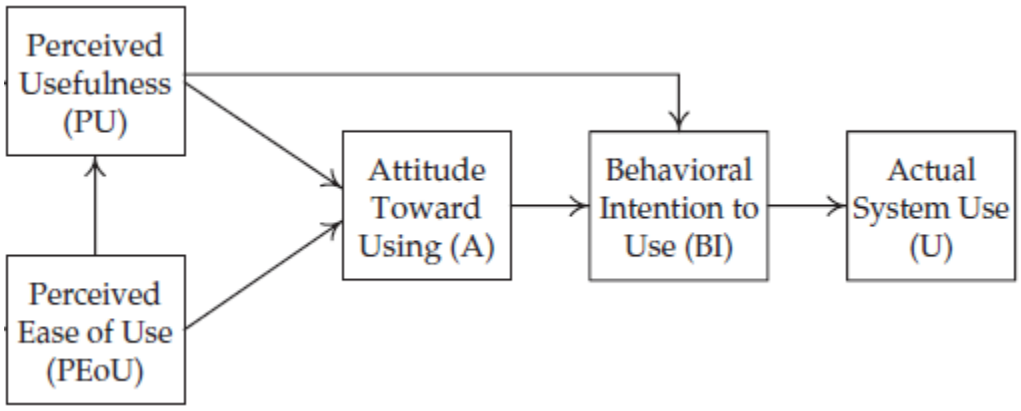


Figure 9-1: Proposed research TAM model

Furthermore, analysis has also derived from interviews, observation and use of DHIS-2 throughout an action research approach as illustrated in figure 7-2.

Figure 9-2: Action research cycle

A thorough analysis of DHIS-2 is projected against the 'information cycle phases' and as a result all phases are fully supported by DHIS-2.

To conclude and to answer my research question "*What are the key attributes that affect user acceptance of the District Health Information Systems – version 2?*", I argue, based on the results projected by SmartPLS software, that perceived usefulness has a greater effect on intention to use (directly and indirectly) than perceived ease of use. Moreover, perceived usefulness and perceived ease of use appear to be important determinants of health workers attitudes towards DHIS-2 and together seem to explain a significant portion (68%) of the variance of attitude.

Furthermore, the six hypotheses addressed attest to be true:

H1: The degree of ease of use associated with the use of DHIS2 as perceived by a health worker has a positive effect on the degree to which a health worker believes that DHIS2 will help him or her to attain gains in work performance (perceived usefulness).

H2: The degree to which a health worker believes that DHIS2 will help him or her to attain gains in work performance (perceived usefulness) has a positive effect on his/her attitude towards DHIS2.

H3: The degree of ease of use associated with the use of DHIS2 as perceived by a health worker has a positive effect on his/her attitude towards DHIS2.

H4: The degree to which a health worker believes that DHIS2 will help him or her to attain gains in work performance (perceived usefulness) has a positive effect on his/her intention to use DHIS2.

H5: The attitude of a health worker towards DHIS2 has a positive effect on his/her intention to use DHIS2.

H6: Behavioral intention will have a significant positive effect on actual system use.

Proposed DHIS-2 Improvement

During my fieldwork stay in Kerala, as stated in previous chapters, I was involved in an action research where improvements of DHIS-2 GUI interface and data presentation was one of the main concerns. The intention of improvement was to ensure the application become 'user friendly' as one of the main contributing factors to DHIS-2 user acceptance. Models and prototypes slightly different from the existing DHIS-2 GUI interface and data presentation module were presented to health workers who in turn happened to find the new model more user friendly. The following figures present a recommended data presentation modification.

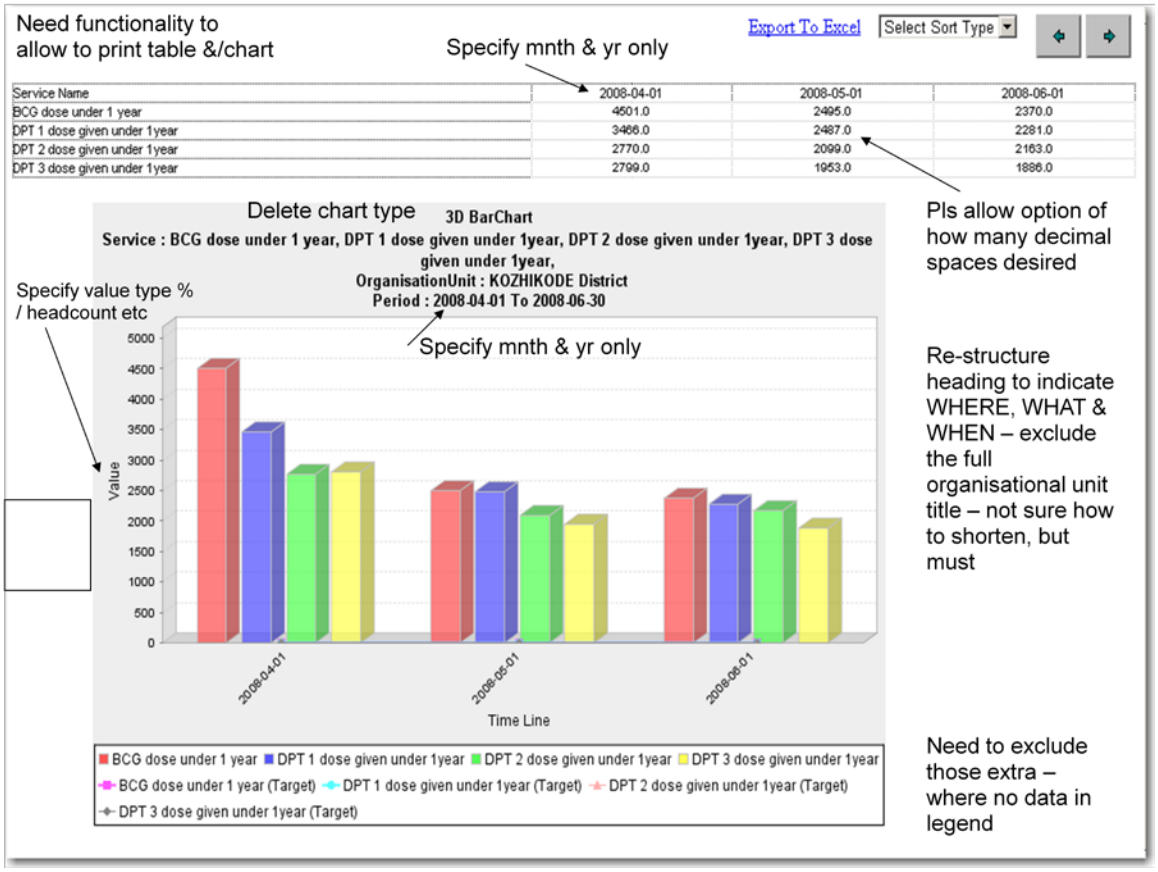
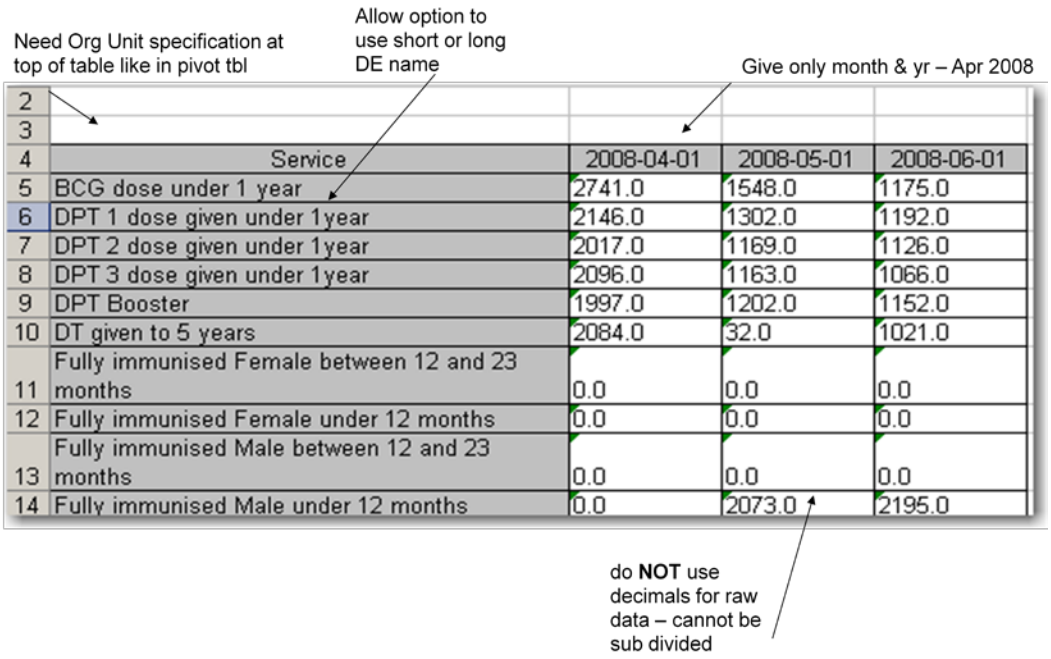


Figure 9-3: Proposed graph modification



	Service	2008-04-01	2008-05-01	2008-06-01
5	BCG dose under 1 year	2741.0	1548.0	1175.0
6	DPT 1 dose given under 1year	2146.0	1302.0	1192.0
7	DPT 2 dose given under 1year	2017.0	1169.0	1126.0
8	DPT 3 dose given under 1year	2096.0	1163.0	1066.0
9	DPT Booster	1997.0	1202.0	1152.0
10	DT given to 5 years	2084.0	32.0	1021.0
11	Fully immunised Female between 12 and 23 months	0.0	0.0	0.0
12	Fully immunised Female under 12 months	0.0	0.0	0.0
13	Fully immunised Male between 12 and 23 months	0.0	0.0	0.0
14	Fully immunised Male under 12 months	0.0	2073.0	2195.0

Figure 9-4: Proposed presentation model

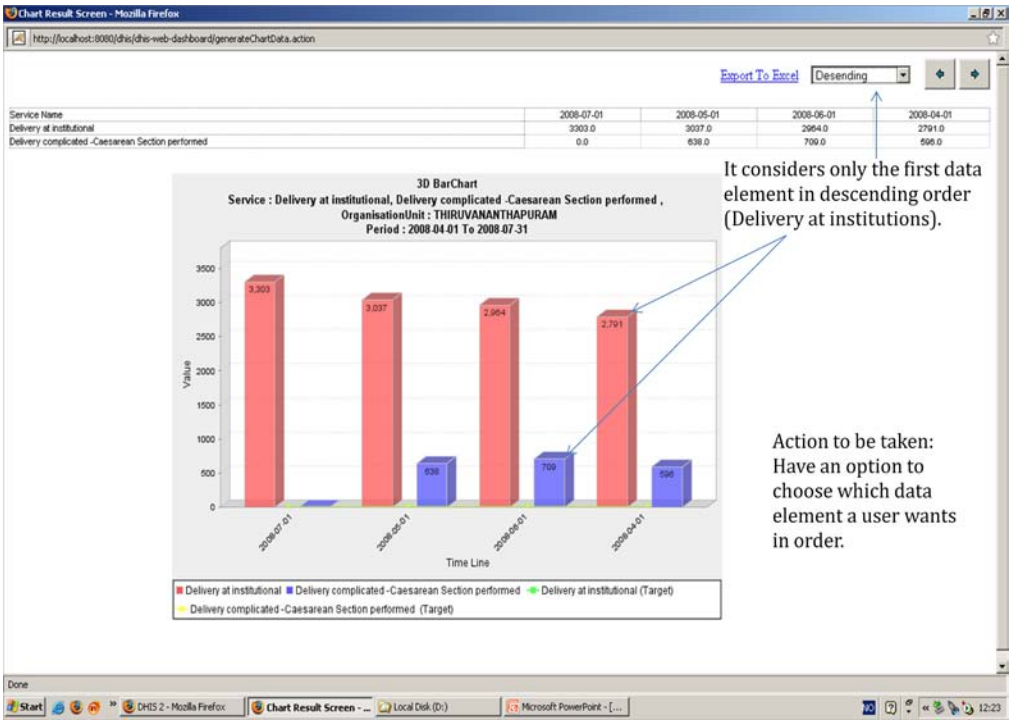


Figure 9-5: Proposed presentation model

Bibliography

- Agarwal, R., & Prasad, J. (1997). The role of innovation characteristics and perceived voluntariness in the acceptance of information technologies. *Decision Sciences, 28*(3), 557-582.

- Anderson, J. G., and Aydin, C.E., 1994. Theoretical perspectives and methodologies for the evaluation of health care information systems. In: J. G. Anderson, C. E. Aydin, and S. J. Jay, (eds.). *Evaluating health care information systems: methods and applications*. Thousand oaks, CA: Sage, 1 – 29.

- Atkinson, P. and Coffey, A. 1998. Analysing Documentary Realities. In: D. Silverman, (ed.). *Qualitative Research: Theory, method and Practice.* London: Sage, 45 – 62.

- Baskerville, R. L., 1999. Investigating information systems with action research. *Communications of the Association for Information Systems*, 2(19), 1 – 32.

- C. L. Gatch and K. D, *Predicting exercise intentions: the theory of planned behavior*, Research Quarterly For Exercise and Sport, 61 (1990), pp. 100-102

- C. J. Armitage and M. Conner, *Efficacy of the theory of planned behaviour: a meta-analytic review*, Br J Soc Psychol, 40 (2001), pp. 471–499

- Campbell B. 1997. Health management information systems in lower
  income countries: an analysis of system design, implementation and utilization in Ghana and Nepal. Amsterdam: Royal Tropical Institute.

- Cronbach,
  L.J.(1951).Coefficientalphaandtheinternalstructureoftests.
  Psychometrika, 16(3), 297–334.

- Chin, W. W., Marcolin, B. L., & Newsted, P. R. (2003). A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic mail adoption study. *Information Systems Research, 14*(2), 189–217.

- Chin, W.W. (1998).The partial least squares approach to structural equation modeling. In: G. A. Marcoulides (Ed.), Modern Methods for Business Research (pp. 295–358). Mahwah, NJ: Lawrence Erlbaum Associates.

- D. Albarracin, B. T. Johnson, M. Fishbein, and P. A. Muellerleile, *Theories of reasoned action and planned behavior as models of condom use: a meta-analysis*, Psychol Bull, 127 (2001), pp. 142–161

- D. Parker, A. S. R. Manstead, S. G. Stradling, and J. Reason, *Intention to commit driving violations: An application of the theory of planned behavior*, J of Applied Psychology, 77 (1992), pp. 94–101

- D. M. Morrison, M. S. Spencer, and M. R. Gillmore, *Beliefs about substance use among pregnant and parenting adolescents*, J Res Adolesc, 8 (1998), pp. 69–95

- Denzin, N. K. and Lincoln, Y. S., 1994. Introduction: Entering the Field of Qualitative Research. In: N. K. Denzin and Y. S. Lincoln, (eds.). *Handbook of Qualitative Research*. Thousands Oaks, CA and London: Sage, 1 – 17.

- Elden, M. and Chisholm, R. F., 1993. Emerging Varieties of Action Research: Introduction to the Special Issue. *Human Relations*, 46(2), 121 – 142.

- F. D. Davis, R. P. Bagozzi, and P. R. Warshaw, *User acceptance of computer technology: a comparison of two theoretical models*, Management Sci, 35 (1989), pp. 982–1003

- F. D. Davis, *A technology acceptance model for empirically testing new end-user information systems: theory and results*, PhD thesis, Sloan School of Management, Massachusetts Institute of Technology, 1986

- Fornell, C.,&Larcker,D.F.(1981).Structural equation models with unobservable variables and measurement error: Algebra and statistics. Journal of Marketing Research, 18(3), 328–388.

- Gefen, D., & Straub, D. W. (2005). A practical guide to factorial validity using PLS-Graph: Tutorial and annotated example. *Communications of the AIS, 16*(5), 91–109.

- Gotz, O.,Liehr Gobbers, K., & Krafft, M.(2009). Evaluation of structural equation models using the partial least squares (PLS) approach. In: V.EspositoVinzi, W. W. Chin, JORG HENSELER ETAL. 314J. Henseler & H.Wang (Eds), Handbook of partial least squares: Concepts, methods, and applications. Berlin: Springer (inprint).

- Heeks, R., 1998. *Information age reform of the public sector: the potential and problems of IT for India* [online]. Institute for development policy and management, University of Manchester. Available from: http://unpan1.un.org/intradoc [Accessed 19 December 2009].

- Heywood A. and Rohde J. 2002. *Using information for action: A manual for health workers at the facility level*, University of Western Cape, Equity project.

- I. Ajzen and M. Fishbein, *Understanding Attitudes and Predicting Social Behavior*, Prentice-Hall, Englewood Cliffs, NJ, 1980.

- I. Ajzen, *The theory of planned behavior*, Organizational Behavior and Human Decision Processes, 50 (1991), pp. 179–211.

- K. Zheng et al.: *Evaluation of Healthcare IT Applications: The User Acceptance Perspective*,Studies in Computational Intelligence (SCI) *65*, 49–78 (2007).

- K. E. Clarke and A. Aish, *An exploration of health beliefs and attitudes of smokers with vascular disease who participate in or decline a smoking cessation program*, J Vasc Nurs, 20 (2002), pp. 96–105.

- L. Beck and I. Ajzen, *Predicting dishonest actions using the theory of planned behavior*, J of Research and Personality, 25 (1991), pp. 285–301

- Lippeveld T, Sauerborn R, Bodart C (eds). 2000. Design and implementation of health information systems. Geneva: World Health Organization.

- Lippeveld T, Sauebron R. Undated. A framework for designing health Information system

- Lohmoller, J.-B. (1989). Latent variable path modeling with partial least squares. Heidelberg: Physica.

- Nunally, J. (1978). Psychometric, 2nd Edition, New York: McGraw Hill.

- Nunnally, J.C.,&Bernstein,I.H.(1994). Psychometrictheory (3rd ed.). NewYork,NY: McGraw-Hill.

- Ringle, C. M., Wende, S., & Will, A. (2005). *SmartPLS 2.0 (beta)*. http://www.smartpls.de.

- Sauerborn R., and Lippeveled T., 2000. Introduction. *Design and implementation of health information systems*. Edited by Lippeveld T., Sauerborn R. and Bordrat C., Geneva, Switzerland, World Health Organization, 2000.

- Silverman, D. (2000). Doing Qualitative Research: A practical handbook. London, SAGE Publications Ltd.

- Silverman, D., 2001. *Interpreting Qualitative Data: Methods for Analysing Talk, Text and Interaction*, 2nd edition. London: Sage.

- Thagaard, T. (1988). Systematikk og innlevelse: En innforing kvalitativ metode. Bergen. Fagbokfolaget.

- The World health report 2000 : health systems : improving performance.

- Tritsch, M.E. 2001. *Wildlife of India* Harper Collins, London. 192 pages.

- Walsham, G., Symons, V., and Waema, T., 1988. *Information systems as socialsystems: implications for developing countries*. London: Oxford University Press.

- Walsham, G., 1995. The emergence of interpretivism in IS research. *Journal of information systems research*, 6 (4), 376-394.

- Werts, C.E.,Linn,R.L.,&Jo¨ reskog, K.G.(1974).Intra class reliability estimates:Testing structural assumptions. Educational and Psychological Measurement, 34(1), 25–33.

- Wilson, R., 2000. Using computers in health information systems. *In:* T. Lippeveld, R. Sauerborn, and C. Bodart, eds. *Design and implementation of health information system*, Geneva: WHO, 198-212.

- WHO (1979). Report of the international conference held at Alma Ata, USSR, published as Health for All Series, No. 1, Geneva.

Appendix 1

Questionnaire

Perceived Easy of Use **10-very likely; 1-very unlikely**

1. Learning to operate DHIS2 is easy for me. (1 – 10) _____
2. I find DHIS2 flexible to interact with. (1 – 10) _____
3. I find it easy to get DHIS2 to do what I want to do. (1 – 10) _____
4. It is easy for me to become skillful at using DHIS2. (1 – 10) _____
5. I find DHIS2 easy to use. (1 – 10) _____
6. My intention with DHIS2 is clear and understandable. (1 – 10) _____

Perceived Usefulness

7. Using DHIS2 would improve my job performance. (1 – 10) _____
8. Using DHIS2 in my job would enable me to accomplish tasks more clearly. (1-10)_____
9. I would find DHIS2 useful in my job. (1 – 10) _____
10. Using DHIS2 in my job would increase my productivity. (1 – 10) _____
11. Using DHIS2 would enhance my effectiveness on the job. (1 – 10) _____
12. Using DHIS2 would make it easier to do my job. (1 – 10) _____

Attitude Toward Using

All things considered, using DHIS2 in my job is a(n) _____ idea.

13. Wise (10 9 8 7 6 5 4 3 2 1) Foolish
14. Positive (10 9 8 7 6 5 4 3 2 1) Negative
15. Beneficial (10 9 8 7 6 5 4 3 2 1) Harmful
16. Good (10 9 8 7 6 5 4 3 2 1) Bad

Behavioral Intentions

17. I intend to use DHIS2 to increase productivity. (1 – 10) _____

18. I intend to use DHIS2 *frequently* in my job. (1 – 10) _____

19. I intend to use DHIS2 in doing my job. (1 – 10) _____

20. I intend to use DHIS2 for managing/filling reports. (1 – 10) _____

Actual Use

21. How many times do you believe you use DHIS2 during a week?

several times/day *(10 9 8 7 6 5 4 3 2 1)* Not at all

22. How many hours do you believe you use DHIS2 every week?

more than 10hrs *(10 9 8 7 6 5 4 3 2 1)* less than 1 hr

23. How frequently do you believe you use DHIS2?

extremely frequent *(10 9 8 7 6 5 4 3 2 1)* extremely infrequent

Appendix 2

Five Day Training Program

VENUE:

DATE:

OBJECTIVE

1. Building understanding on HMIS–process, approach, major concepts, components, strategies and integration
2. building understanding on HMIS in context of NRHM – reporting system, data-sets, integration of vertical programmes
3. Build understanding on indicators, data elements, integration, web-based monitoring system, GIS and report generation
4. Build understanding on DHIS-2 – free & open source software, benefits, challenges
5. Understand the implementation process along with the detailed capacity building/training programme and time schedule

Participants

State Level: Additional DHS, State Data Officers, State Statistician, State Demographer, State RCH Officer, State Data Manager – IDSP, State Program Manger

District Level: Deputy DMO- IDSP, District Statistician, Block PRO, Hospital Data, Coordinators, CHC Computer assistants

PROGRAMME

FIVE-DAY HMIS ORIENTATION WORKSHOP			
TIME	**TOPIC**	**METHODOLOGY**	**Documents**
DAY I			
Session I: Understanding HMIS & Introduction to DHIS2			
1000-1100 hrs	Planning & information cycle What is HMIS Components of HMIS, Basic Building Blocks of HMIS- Data, Information, Knowledge, Data Sources	Lecture	PowerPoint Presentation "Lecture 1 Planning_InformationCycel.ppt"
1100 – 1200 hrs	Overview of NRHM HMIS NRHM Goals Problems associated with current HMIS Designing HMIS reforms Implementation design	Lecture	PowerPoint Presentation "lecture 2 Overview of NRHM HMIS reforms.ppt"
1200-1330 hrs	Overview of DHIS 2.0 Purpose, use in routine process, Free & open source: Benefit & challenges	Presentation, demonstration and discussion	-----

FIVE-DAY HMIS ORIENTATION WORKSHOP			
TIME	**TOPIC**	**METHODOLOGY**	**Documents**
	Primary modules of DHIS 2 & how it supports information cycle DHIS2 Software Feature: User: Creating new users. Changing Password Organization Unit Adding/Editing Organization unit Hierarchy Operation Creating Organization unit Group Creating Organization unit Group Set	Demo	
1330-1430 hrs	**Lunch**		
Session II: Information Cycle and DHIS			
1430-1600 hrs	Hands-on on above Demo Data	Hands on	---

FIVE-DAY HMIS ORIENTATION WORKSHOP			
TIME	**TOPIC**	**METHODOLOGY**	**Documents**
1600-1615 hrs	**Tea Break**		
1615-1630 hrs	DHIS2 Data Set Editing Data Sets Assigning Data set to Organization unit	Demo	---
1630-End	Hands-on on above Demo	Hands on	---
DAY II - Hands on experience on DHIS2			
1000-1045 hrs	Overview of Information Cycle Data Definition Data Sets Data Collection Tool Introduction to Indicators	Lecture	PowerPoint Presentation "lecture3 Overview on information cycle.ppt"
1100-1200	Datasets details (SC,PHC,CHC Monthly/weekly, Aggregated Data set, District Stocks)	Discussion	MS Word Document "Dataset.doc"
1200-1330	Listing of all the reporting unit at district level Assigning Dataset (Aggregated data or CHC data set) Mapping Form 7 to Aggregated data set Mapping Form 8 to CHC data	Discussion	MS Word Document & Excel Sheet ListofReportingUnits.xls Mapping

FIVE-DAY HMIS ORIENTATION WORKSHOP			
TIME	**TOPIC**	**METHODOLOGY**	**Documents**
	set		Form 7 phc mapped.xls Form 7 phc.xls Form 8 phc mapped.xls Form 8 phc.xls
1330-1430 hrs	**Lunch**		
1430-End	DHIS 2 Data entry module Adding Min/Max & use of Comment Hands-on on Data entry for two months (Sept & Oct 08)	Demo & Hands on	-----
DAY III : Data Analysis using indicators			
1000-1130 hrs	Hands-on on Data entry Completing pending Data entry	Hands on	-----
1130-1230	Data Quality Data quality Checks Min-Max Checks Data Element History Data Validation Data Triangulation SDA Approach	lecture	PowerPoint Presentation "lecture4Data Quality checking.ppt"

FIVE-DAY HMIS ORIENTATION WORKSHOP			
TIME	**TOPIC**	**METHODOLOGY**	**Documents**
1230-1330	DHIS2 Data Quality Feature Running Validation rule from Data Entry module Creating Validation Rule Creating Validation rule group Running Validation rule from Validation module	Demo	----------
1330-1430 hrs	**Lunch**		
1430-1600hrs	Hands-on on above Demo	Hands on	----------
1600-End	Explanation of HMIS tool Kit Indicators Dictionary Data Element Dictionary Use of information Document Basic use of Computer	Discussion	MSWord & PDF Document. HMIS_DataElement_Indicator_Dictionary.doc Informationforaction.pdf UseofComputers.pdf
DAY IV : Dash Board			

FIVE-DAY HMIS ORIENTATION WORKSHOP			
TIME	**TOPIC**	**METHODOLOGY**	**Documents**
1000-1330 hrs	Data Status Regular Analysis • Comparing Indicators across time • Drilling down feature of above Indicators • Explaining ascending , descending order • Explain different types of charts and graphs(Bar , line, Bar&line, Pie chart) • Export to Excel • Comparing data elements across time and drill down feature • Comparing Indicators with orgunit groups • Comparing Individual Orgunits • Compare multiple data elements across time/ across orgunit in tabular form(View summary)	Demo	-------
1330-1430 hrs	**Lunch**		
1430-1600hrs	Hands-on on above demo	Hands on	-------
1600-End	DHIS2 Indicators: Creating Indicators Creating Indicator group Hands on above Demo	Demo & Hands on	--------
DAY V : Practice & institutionalization of Information Culture			

FIVE-DAY HMIS ORIENTATION WORKSHOP			
TIME	**TOPIC**	**METHODOLOGY**	**Documents**
1000-1030 hrs	DHIS2 Reports: Upward Reports Downward Reports	Discussion	Excel Document “Reporting Fromats”
1300-1100 hrs	DHIS2 Repot Generation Upward Reports Feedback Reports	Demo	------
1100-1230	Hands-on on above demo	Hands on	------
1230-1330	Data transmission Export Import Hands-on	Demo & Hands on	-------
1330-1430 hrs			
1430-1530hrs	Orientation of all DHIS modules	Demo (Summary)	-------
1530-1630hrs	Hands-on on user specified problems	Hands on	------
1630-End	Feedback and Suggestions	Discussion	MS word Document “FeedBackForm.doc”

Kerala - Block Level Training Programme on HMIS

Dates: _____ **Start Time:** _____ **End Time:** _____

Venue: _____

Tea time: _____ **Lunch Time:** __ _____

Purpose: The training programme will build your skills in use of the HMIS-DHIS.

Objectives:

6. Building understanding of the HMIS process, approach and streamlining strategies
7. Become familiar with computers
8. Use the HMIS-DHIS for data entry, data quality checks, data analysis and report generation

Training Programme Outline

Session	Topic	Activities
		• Introductions – training process - group rules

DAY 1	Course Overview	• Review course objectives & participant expectations
1	HMIS: an introduction	• Overview of HMIS – what it is • Explain shift from a data led versus information led HMIS • Explore the role of an information system as integral to the effective management of health services • Explain principles of the new HMIS & benefits for users • Explore the link between management & data handling processes (planning & information cycles) • Explore the rationale for implementation of a computer supported HMIS-DHIS • Explain the terms: Data element, Essential Data Set, Data, Indicators
2	Review reporting formats & data flow processes – NRHM-HMIS	• Overview of existing reporting system - NRHM HMIS • Revised MOHFW datasets - State, CHC, PHC, SC (Annual/Monthly), IDSP weekly • Review data collection tools & report formats • Overview of New Reporting System • Upward Reports • Feedback Reports
3	Overview of DHIS 2.0	• Explore main features of DHIS 2.0 • Login, user passwords
Day 2	Reflection	• Reflect on previous days work
4	Familiarisation with computers	• Basics of computers
5	Data entry	• Login, user passwords • How to do data entry (aggregate & line listing)
6	Data entry – features	• How to use features in data entry – min /max ranges, comments field
7	Ensuring data quality	• Data quality checks using DHIS2 • Use of data validation tools
Day 3	Reflection	• Reflect on previous days work
8	Data analysis	• How to use data analysis features of DHIS 2 • Explore the set up and creation of indicators (generation) • Review current indicators included in DHIS • How to use features of the dash board
9	Creating reports & presenting data	• Data Presentation

		• Report generation – saving & printing • How to make a data table • How to make graphs
10	Import & Export of data	• Import & export of data (transmitting)Flows of information in new HMIS • Taking data backups
	Course review - Evaluation	• Identify challenges for the way ahead • Evaluation of the training experience