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**FINAL REPORT**

This is an assessment of public health IT systems in India. While it was not possible to study every system existing, we have picked up a representative set. It is an attempt to learn from the past, look forward and leap ahead. The findings and recommendations will feed into the 12th Plan and the ICT sub-group of the Healthcare SIC.

# Study of Public Health IT Systems in India

## Background Study for ICT subgroup of Sector Innovation Council in Health.

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# Content



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# EXECUTIVE SUMMARY

This is an assessment of the public health IT systems in India. While it was not possible to study every system existing, we have picked up a representative set that was diverse enough to extract critical findings that need urgent attention. It is an attempt to learn from the past, look forward and leap ahead. The findings and recommendations will feed into the 12th Plan and the ICT sub-group of the Healthcare SIC.

The report attempts to bring out common findings, best practices and learnings. For individual public health IT system specific discussions, please refer to the individual system sections of this report.

## A) Findings - Learnings

In the absence of any national guidelines for ICT in public health, various national programs and States have taken the lead in building their own IT systems. However most of them have not achieved their own objectives. One key reason has been a failure to properly anticipate and manage appropriately, the extent of change management across areas of people, process and technology. Another key missing area has been the lack of focus on sharing of data through interoperability standards. Almost all the public health programs encountered the same/similar issues and there is a lot of commonality in learnings across the various systems studied.

**PEOPLE:** Almost all the IT systems suffered from Capacity building and change management issues due to mismatch between the human resource capacity (in numbers, skills and appropriate cultural intelligence) and system useage / data entry load in terms of facility-wise reporting and patient-based reporting.

Private sector participation has been an issue everywhere. There is no motivation or incentive for the private sector to share their data. The true picture for - disease prevalence and response to interventions - doesn't emerge without looking at public and private data together.

**PROCESS:** Paper based processes were implemented, as is and without change, in the electronic system without being aware of the potential differences, pitfalls and benefits of electronic systems such as the ability of of such systems to carry out intensive data analytics and improve performance and efficiency at every facility. Process errors in earlier information flows were thus significantly accentuated in the IT system, with systems often taking the blame for these process errors

There has been too much focus on data entry with little or no culture of use of information for planning, analysis, design and performance management. Information has become an end in itself. In the absence of any guidelines for useage of such information and value to end users, every system owner and project have designed and executed his/her own architecture and implementation protocol leading to data silos and chaos in the public health technology ecosystem.

Duplication of systems and processes has created confusion in the minds of the users. Lack of clear direction has led many States to stop using these IT systems.

**TECHNOLOGY:** The requirements of most of these systems are never frozen and are constantly changing. This has technical repercussions, as well as adoption, maintenance and continued usage issues.

Most of the public health IT systems studied were built as applications for a single purpose rather than flexible products, capable of evolving over time. They lack a product life cycle management approach. The Procurement process too is insensitive to product life cycle and technology obsolescence.

The result is an extremely narrow self-limiting paradigm of static, one-time application development for data entry alone. Applications have a poor and heavy form design. They lack local data analysis capability and the reports too are not user friendly. A large number of ad hoc reports are required and the online analytical processing power has not been given to the users.

The big picture doesn't emerge because all the public health IT systems have been developed in silos and they lack integration standards like HL7 and XML.

Hardware and Network issues have contributed to low adoption. The hardware has often become obsolete and has not been upgraded. The Directorates and States have not paid attention to the hardware and network requirements. These have almost always came as afterthoughts or as learnings from errors and problem and corrections attempted in hindsight and with short term emergency problems to solve.

### B) Situation Analysis – Working group documents and background papers

All working group papers have discussed their information technology requirements and advanced suggestions for how IT architecture should be developed with respect to the health sector. The High Level Expert group also has a sub-section dedicated to this theme.

There are significant points of convergence between the different recommendations. However there are areas of divergence and varying concerns underlying different points. One vision that emerges across papers – which could be an overarching goal or ambition, is a National eHealth Architecture [NeHA], based on universal registration and biometrics, which is dynamic and constantly updated health record of every citizen-family. It begins with universal vital (demographic and identifiers) registration, which is portable and accessible to service providers and to the families themselves. Based on this foundation a network links all service providers, public and private laboratories and also generates the aggregate figures needed at different levels for policy making and management. It also generates the alerts needed for disease surveillance. Data fidelity is assured by triangulation with data from periodic surveys and community based monitoring.

We need to confess that we have been actively trying to solve these needs for at least 15 years, and despite considerable expenditure, these past efforts have not yielded desired results. We couldn't achieve the dream because of ineffective change management in terms

of people, process and technology adoption. Currently procurement is insensitive to software and hardware product lifecycle and technology obsolescence. Procurement and Support process have to change to cater to the specific requirements of a public health IT paradigm.

## C) Global eHealth Architectures

A recent editorial in Lancet, (Issue no 9791, pg 542, Aug 13, 2011) described the fate of a similar project planned in the UK in 2002 that aimed at creating a fully integrated centralised electronic care records system to improve services and patient care. The budget for the undertaking was a substantial 11.4 billion pounds. Nine years on, the Department of Health has spent 6.4 billion pounds on the project so far, but failed to meet its initial deadline and has had to abandon the central goal of the project because it is unable to deliver a universal system .

The centralised model of the UK has failed. Decentralised models adopted by countries like Canada, Australia and Singapore are more successful. They have learnt from the failures of the UK NHS (National Health Service) and improved upon it. India has a unique opportunity to learn from all these global efforts in avoiding mistakes made and developing a unique and innovative e-health model.

Canada Health Infoway [CHI], the Healthcare-IT Czar of Canada has published a National eHealth Architecture [Blue-Print] and attached relevant funding with it. The blueprint is a centrally defined reference architecture that serves as a guideline to various regional eHealth projects. Projects are funded if they comply to the blue-print. Likewise the Regional Health Authorities [RHA] have published their own flavours of the blue-print and allocated additional funds for eHealth projects that comply with the blue-print.

This democratic change management is a successful paradigm where the States/ Regions are free to develop their own systems for local planning, monitoring and evaluation. However the IT systems developed by the States, Regions and Disease programs will be funded from the centrally allocated funds only if they conform to the eHealth Architecture [Blue-Print] published by CHI and RHAs.

## D) Recommendations

Innovation is a culture not a strategy. A culture of innovation has to be nurtured in a highly democratic way. Organizations not designed 'ground up' for innovation will not be creative because innovation is disruptive by nature.

Traditionally Indians have used their ingenuity to find the '*Jugaad*' that works around the paucity of resources and funds. Somehow we have lost it along the journey towards modernization and this *Jugaad* paradigm didn't permeate into our modern education system and work ethic. In many ways our current paradigms don't promote innovation. We need to build a democratic culture which nurtures and nourishes innovation. Democratic change is slower but more effective as compared to a centralised command and control model.

The Centre should establish a National eHealth Authority [NeHA] to define the overall Healthcare-IT architecture [blue-print] and allow each State, District and National program to build their own IT systems that conform to the guidelines given in the blueprint. Attach the funds to this National eHealth Architecture and make it mandatory for National and State disease programs to comply with the blue-print architecture for getting the funding. The States will have the space and freedom to innovate and adopt systems that are best suited to their individual styles of functioning and local / regional culture, without compromising the integrity of the overall programme. The maturity of adoption at the States and Districts level will develop over time, but till then NeHA should play a strict regulatory role that shouldn't allow too much of divergence from the blue-print irrespective of funding from the central pool.

This Healthcare-IT architecture blue-print should be like a town planner's blue-print laying down the standards for the buildings, open spaces, parks, roads, water inlets and sewer outlets etc. – such that all colonies are free to do their own development as long as they comply to the overall guidelines given in the blue-print and are thus able to be integrated seamlessly into the town.

The Healthcare-IT architecture blue-print should have standards for Technology, Process and People.

1. **Technology** – The blue print should address standards for Identifiers, vocabulary, diagnosis/ procedure/services code sets, data storage, data privacy and security, data integration, data retrieval, data analysis, information usage, hardware and network.
2. **Process** – The process of implementation is just as important as the technology itself. The blue-print should broadly specify who is allowed to do what, when, where and why.
3. **People** – Capacity building is required for implementing the technology. The blue print needs to specify the human resource capacity building in terms of quantity and quality of Healthcare-IT trained staff. This should include academia, academia-industry alliances and vocational training programs.

Procurement of the software, hardware and network is just as important as conformance to the architecture itself. Need to strengthen and standardize procurement for public health IT, which would ensure that learning from both our past as well as public health IT experiences of other countries, are fully incorporated into future plans. Currently procurement is insensitive to software lifecycle and technology obsolescence. There is little traceability of software life cycle documentation. Either the sponsoring Directorates didn't ask for the documentation from the vendor or the vendor didn't maintain the documents.

The history of Healthcare-IT systems reveals that a slow democratic transition from paper based processes to electronic processes improves adoption and paves the way for innovation. Resistance to change is a problem that needs to be addressed step-by-step over time. Sudden change makes the frog jump out of the hot water.

# Public Health IT Study Findings

India has various public health IT systems existing in silos. Most of the public health IT investments at national and state levels have gone into reproductive and child health [RCH] due to the high IMR and MMR in the country. We have 2 RCH systems at the national level – MCTS and Web Portal, whereas DHIS is reporting facility-based RCH data from district level in many states. MCTS is patient-based reporting whereas Web Portal is designed for facility-based consolidated reporting. On the other hand there are IT systems developed by national disease programs such as malaria [NAMMIS], AIDS [NACO] and disease surveillance [IDSP]. Some states like Gujarat [eMamta] is reporting patient-based RCH data whereas TN [HMIS] is reporting area-wise consolidated RCH data. To overcome the data silos, both Gujarat and TN states have conceptualised the integration of various public health IT systems within their own states.

This is an assessment of public health IT systems in India. While it was not possible to study every system existing, we have picked up a representative set. It is an attempt to learn from the past, look forward and leap ahead. The findings and recommendations will feed into the 12th Plan and the ICT sub-group of the Healthcare SIC.

The following findings are based on the assessment of functional efficacy and continued operational need for the public health IT systems. Almost all the public health programs encountered the same/similar issues and there is a lot of commonality in the learnings across the various systems studied. We present these common findings, best practices and learnings without direct reference to any specific IT system unless necessary. For each IT system specific discussions please refer to the individual system sections of this report.

## A. LEARNINGS

Various national programs and States have taken the lead for building their own IT systems. However most of them have not achieved their own objectives. The key reasons are as follows:

### a. PEOPLE LEARNINGS

I. **Capacity building and change management:** Current capacity building efforts across all Public Health Information Systems are grossly inadequate. Capacity building is limited to - One time trainings at local level with ad hoc refresher trainings on need basis. There is no published schedule of regular and sustained trainings. Only class room trainings are considered as a common medium across all programs; no other interactive training methods are used for consistent support to the users to solve their day-to-day issues. Systems also lack quality training guidelines and protocols for data collection, reporting, verification and error management. In most of the programs, process protocols have not been developed and in some have not even been thought of. Dedicated teams for post training support and follow-up have not been created.

   History of Healthcare-IT systems clearly indicates that one can't achieve adoption by forcing the workers to do anything. The only successful model to improve adoption is

a democratic way which is inclusive and not the autocratic way. There needs to be greater and sustained focus on capacity building and change management in terms of people, process and technology. Put in place sustained training, hand holding and help desk support. Constant interventions are required to change the human behaviour. The resistance to change is a problem that needs to be removed step-by-step over time. Sudden change makes the *frog jump out of the hot water*.

- **Facility wise reporting -** Almost all the systems are built for facility-wise reporting, with a few exceptions. Although the Public health decision making is based on consolidated numbers, the trend towards granular data is probably driven by concerns of data inaccuracy in consolidated numbers. If the District data entry operator entering consolidated District data has to open and enter only 1 screen; then for facility-wise data entry of the same data, the District data entry operator has to open multiple facility-wise screens, thereby increasing the time taken for data entry. Facility-wise data entry increased the data entry load from consolidated data of 634 districts to more than a Lac SC data. The human resource at the District was not increased to match the increased data entry load; therefore leading to fatigue and lower adoption. Data entry point kept at higher levels increases the case load because all facilities under it send their data to the data entry centres. Lower facilities should be provided with computers, to enter their data locally.
- **Patient based reporting –** We found some RCH systems designed for patient based reporting. Patient based reporting is the right thing to do but it is a huge cultural change from the traditional paper based system that works on aggregated data. The human resource was designed for paper based system where the data from SC, PHC, and Block was aggregated at the District level and all aggregated reporting to the state and centre was done by the District. Whereas, these public health IT systems were designed for patient based reporting. The district level human resources got over stretched when fortnightly patient based reporting thru the IT system was applied to the existing process. Along with working on the aggregated data the resources at District level were assigned with an additional task of entering the patient based data received from SC, PHC and Block. Their primary focus shifted from doing the district level tasks to just entering the data.

II. **Private sector participation –** The public health IT systems are unable to complete the big picture without the private sector participation especially for disease surveillance; Whereas there is no incentive or motivation for the private sector to participate in the public health IT systems.

### b. PROCESS LEARNINGS

**I.** **Process transformation -** In the paper based system, the lower facilities were supposed to send the data upstream in the hierarchy. The lower facilities didn't have rights or the wherewithal to analyse the paper data. The higher levels would analyse the data and the lower facilities would be informed only on need to know basis. The same process was implemented in the electronic system also without thinking that now the computer could give data analytics capability and empower every facility. Process errors in information flow get accentuated in the IT system.

II. **Data entry focus –** The public health IT systems have too much focus on data entry rather than data analysis for decision making. No culture of use of information for planning – information becomes an end in itself.

III. **Lack of Standards –** There is total lack of standards in public health IT systems - Technology architecture, Data standards, Disease and procedure codes and Interoperability standards**.** In absence of any guidelines, every system has done their own thing leading to data silos and chaos in the public health ecosystem.

IV. **Duplication of systems –** In the RCH space, duplication of the systems and processes has created confusion in the minds of the users. Lack of clear direction has led many States to stop using the IT system. The valuable data has therefore become a casualty. This is a death knell for change management from paper based system to the electronic system. If the confusion prevails for too long the users will become weary of the situation and dump electronic systems all together.

The field users have to enter data for different diseases into different systems. This is too much of work load due to multiplicity of systems. Rather it would have been valuable to have a single product which allows reporting and data analysis for various disease programs.

### c. TECHNOLOGY LEARNINGS

I. **Poor System Design -** Most of the Public Health IT systems are poorly designed and haven't achieved desired objectives. One of the reasons that come out of the study is lack of technical skills for requirement analysis among program managers of the system. As the desired skills are not available program managers excessively depend on vendor for requirement gathering and system design which may not be in accord with the objective of computerisation.

II. **System in flux –** The requirements of the systems are never frozen and are constantly changing**.** Therefore it becomes difficult to trace the objective after some time. It becomes almost impossible to do a good functional design and technical design and then deliver as per the design. It is very disturbing for the end user when confronted with partly developed and changing functionality and unhandled error messages. This becomes a huge adoption issue.

III. **Inflexibility –** Most of the public health IT systems are built as an application for a single purpose rather than a flexible product capable of evolving over time. These can't be adapted for any other disease program. With the exception of one product, all the public health IT systems don't provide flexibility for defining data elements, forms, reports etc. This system has the ability to be implemented for any public health program. The user can do primary level of customisation such as defining own data elements and indicators. A skilled user (developer) can do further customisation of designing data entry Forms and defining report formats.

IV. **Product life cycle and procurement -** There is no evidence of product life cycle management, configuration management and release management. No evidence of

version control for each release. The systems have turned into applications that are constantly in flux.

Procurement is insensitive to software lifecycle and technology obsolescence. The software development lifecycle documents were not traceable in most of the public health IT systems - requirements document, functional and technical design documents, test plans and test reports. Most of the systems didn't have any documentation or rather the documentation was limited to user manuals. Either the sponsoring Directorate didn't ask for the documentation from the vendor or the vendor didn't maintain the documents. In either case - Technically this is a dangerous situation because it renders the system unviable for the long-term use. A detailed technical evaluation was out of the scope of this study; however it is recommended to technically audit all the IT systems as per SDLC, PLM, ITIL, PMBOK, ISO and CMMI standards.

V. **Limited options for data entry** - Currently almost all systems are grappling with poor data entry status. However systems provide manual data entry interface and no other interfaces are enabled such as Excel, Imports, Mobile, and IVR etc. Users also don't have the flexibility to switch to aggregated data entry when patient based details are not available. Most of the systems also don't have the flexibility to change hierarchy of data entry when disaggregate facility data is not available.

VI. **Poor and Heavy Form Design –** Very little attention has been paid to user friendliness and forms design for slow speed networks. Forms are heavy and take a long time in loading on slow connections. The forms have multiple drop-down and options that need to be loaded from the server. In some systems lot of horizontal scroll forces the use of mouse and thus slows down the work.

A good gauge of simplicity is often the number of panels that must be displayed and the number of mouse clicks or keystrokes that are required to accomplish a particular task. All of these should be minimized. The fewer things users have to see and do in order to get their work done, the happier and more effective they will be. This is especially important on slow speed connection to the server.

In a good design, all the forms should be of approximately same length and similar data element types and should take approximately the same amount of time to fill. It's a bad design to have forms of different lengths. A long form should be split into 2 if it needs a lot of scrolling.

Long and heavy forms are slow to load on a slow speed network connection. It is frustrating for the user to keep waiting for a long and heavy form to load.

VII. **Local Data Analysis –** Just as in the paper based system, the analytics was not provided at every level. Only the higher levels [Centre, State & in some cases District] had the analysis capability and the facilities in the lower hierarchy were at best given some fixed report formats. The lower facilities would be informed only on need to know basis. Therefore there was no motivation in the lower hierarchy to enter data in electronic systems. Planning at district level is not established. Data

analysis is not geared to meeting needs of the Decentralised user – what's in it for them.

Most of the systems are currently working as a reporting tool rather than program management information systems. Part of the problem is due to the excessive burden of unnecessary data elements and lack of program monitoring indicators in the system. Indicators and reports which are available, merely focus on data entry and reporting completeness rather than supporting program management.

VIII. **User Friendly Reports -** Wherever the functionality to generate reports is provided, Report generation is not user friendly. Many reports can't be seen online; to view they have to be downloaded on the local disk. User can't slice, dice, drill down or drill-up. Some systems use SAS in the back-end for data analysis. Although SAS is a very powerful analytics engine; but these systems don't come across as using the power of SAS in the back-end.

IX. **Ad hoc reports and OLAP -** The systems have fixed predefined report formats. The flexibility to produce your own reports is lacking in the system. Lots of ad hoc reports are required which couldn't be thought of at the time of software system design. The support team spends a lot of time producing these ad hoc reports. Rather an online analytical processing [OLAP] functionality would have gone a long way to enable the users to produce their own reports.

X. **Data Privacy & Security -** Most of the Public Health IT systems don't follow common data security norms and have not been built with a purpose to ensure confidentiality, security & privacy of public health data. It is easy to identify a community from aggregate numbers; whereas a patient can be identified from Patient based reporting systems. Therefore data security & privacy need to be maintained in aggregate number reporting systems as well as patient based system. Whenever Data Security Bill becomes a law, protecting health data will become mandatory in India. Therefore it is prudent to design public health IT systems to ensure data security and privacy.

XI. **Integration -** The need for integration between the public health IT systems was felt and discussed but was not implemented due to technical and administrative structural rigidities. All the public health IT systems have been developed in silos and they lack integration standards like HL7 and XML. Also the master data is not tuned for integration. Each IT system has a different way of looking at the master data.

The public health data makes more sense when integrated across different programs. There is a need to facilitate exchanging of health information across systems such that the big picture can emerge e.g. Malnutrition data of a block in one system and the deaths and incidence of acute respiratory infection from another system.

XII. **Hardware and Network issues –** The Directorates provided the funds to the States for the hardware and network. However the States lacked knowledge of hardware and needed support for procurement and maintenance of computers.

Hardware got obsolete, and wasn't upgraded by the States due to lack of knowledge at the time of writing the IT maintenance contract.

Neither the Directorates nor the States paid any attention to the Network connectivity. Slow speed IT Network to the Block, PHC and Village level was cited as a reason for lower adoption and usage of the system.

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## B. BEST PRACTICES

### a. PEOPLE BEST PRACTICES

I. **Dedicated Human Resource –** Dedicated human resource is always a problem and one program data entry operator is used for various other program data reporting. However, in one system, Directorate had provided with a dedicated 3 persons team for data collection, reporting and verification, which is a good practice and should be followed for other programs.

II. **Help Desk –** Two systems provided a centralized call centre (help desk) to help implementation and solve user queries quickly. This has developed a bond between users and system and helped in early adoption.

### b. PROCESS BEST PRACTICES

I. **Dedicated IT cell –** Two programs were provided with a dedicated IT cell within their office for setting up the procurement process, project management, monitoring and control.

II. **Data back-up policy -** Most of the systems had back-up policy defined by the agency where application is hosted. However one system had three step data back-up policy and was also followed by the hosting agency. Defining data back-up plans becomes easy if they are part of the contract.

III. **Data Archiving -** Most of the systems are struggling with the adoptions issues and have not thought of data archiving as a tool to reduce data load on the system. However two systems in the study had developed data archive features in the system through which system load can be reduced. This is a good practice.

### c. TECHNOLOGY BEST PRACTICES

I. **System Flexibility -** System's flexibility plays an important role in its adoption and it's a good practice to have flexible system. As seen during study, those systems are easily adopted and had good ownership where users had the flexibility to define their own program specific parameters (data elements, indicators, forms, reports) and protocols (reporting hierarchy) whereas systems which were rigid in their design had low adoption.

Most of the systems are built as application to cater one program reporting needs and for each program separate application is required. However one system has been developed as a product which had the flexibility to adapt to any program and emerged as a best practice in the study. It is always a good practice to develop systems in Public Health as products rather than application which can be enriched based on implementation experiences.

II. **UID –** In two patient based tracking systems, we found a unique ID for Patients, Providers and facilities. The system is capable of taking Voter ID, Ration card ID, PAN# etc. and auto generate a system ID to identify the patient. The patient ID is also triangulated from the family register. There is a place for the ADHAAR also when it arrives. Using the ID, Area wise reporting covers all the patients in that area irrespective of the services being rendered in the local public health facility or elsewhere. Although it's a best practice but should be implemented based on the readiness of the State; the readiness depends on education levels, local culture, supporting data etc.

III. **Work plan –** We found three systems that generate workplans for the ANM/ ASHA. This enables and empowers the ANM/ASHA for doing her daily/weekly/monthly job. Obviously there is a better chance the patient also gets better care. However IT system can't monitor if the ANM/ASHA is doing her job or just using the workplan as a template to submit the report.

IV. **Clinical Protocols –** Atleast one patient based tracking program has clinical protocols built into the data entry forms. The form acts as a template that reminds the ANM/ASHA about the services that need to be rendered. Although it's a best practice but should be implemented based on the readiness of the State; the readiness depends on education levels, network and hardware infrastructure etc.

V. **Error management protocols -** Most of the systems had poor error management protocols and errors are frequently thrown to users during routine activity with no guidelines to users about what to do next. However one system had very good inbuilt error handling system with defined protocols for what to do next when the error strikes, which is a good practice.

VI. **System Security –** System security is not considered as a key issue in design of most of the system and two systems in the study were using encryptions for system security which is a good practice to protect system from attacks, frauds using Audit trails, Roll back & encryption. However limited audit trail is available in most of the system but no one had Roll back facility as a function.

VII. **Documentations related to software design & development -** As the program needs changes over time each system will be required to go through a stage of updation, customization and change. System documents related to requirements analysis, design (functional design & technical design), and implementation plays an important role in further customization. Some system had detailed documents related

to the functional & technical design but no system had any documentation related to the requirement analysis, test plan and test cases.

VIII. **Hardware & Network Procurement -** Hardware plays a key role in long term uninterrupted use of system. Most of the systems were struggling with hardware and network support. However in one System, State has procured and provided hardware with 5 years of warranty at each data entry point. State also had developed dedicated State Wide Area Network with a good speed of 4 MBPS for the users in addition to the liberty to get broadband internet connections to ensure uninterrupted data reporting.

In 1-2 instances we noted a best practice - Centralised procurement with 3 years maintenance contract was done by the Directorate and supplied the hardware to the States. The Directorate also negotiated with ISRO and BSNL for the network and got broadband established for the States. Wireless data cards were issued/sponsored wherever fixed line network couldn't reach. After the expiry of the contract the States were free to look for local maintenance and support. We could see better adoption for the IT system with this approach.

# Recommendations

Innovation is a culture not a strategy. A culture of innovation has to be nurtured in a highly democratic way. Organizations not designed 'ground up' for innovation will not be creative because innovation is disruptive by nature.

Traditionally Indians have used their ingenuity to find the '*Jugaad*' that works around the paucity of resources and funds. Somehow we have lost it along the journey towards modernization and this *Jugaad* paradigm didn't permeate into our modern education system and work ethic. In many ways our current paradigms don't promote innovation. We need to build a democratic culture which nurtures and nourishes innovation. Democratic change is slower but more effective as compared to a centralised command and control model.

The Centre should establish a National eHealth Authority [NeHA] to define the overall Healthcare-IT architecture [blue-print] and allow each State, District and National program to build their own IT systems that conform to the guidelines given in the blueprint. Attach the funds to this National eHealth Architecture and make it mandatory for National and State disease programs to comply with the blue-print architecture for getting the funding. The States will have the space and freedom to innovate and adopt systems that are best suited to their individual styles of functioning and local / regional culture, without compromising the integrity of the overall programme. The maturity of adoption at the States and Districts level will develop over time, but till then NeHA should play a strict regulatory role that shouldn't allow too much of divergence from the blue-print irrespective of funding from the central pool.

This Healthcare-IT architecture blue-print should be like a town planner's blue-print laying down the standards for the buildings, open spaces, parks, roads, water inlets and sewer outlets etc. – such that all colonies are free to do their own development as long as they comply to the overall guidelines given in the blue-print and are thus able to be integrated seamlessly into the town.

The Healthcare-IT architecture blue-print should have standards for Technology, Process and People.

a. **Technology** – India should learn from the decentralised eHealth architectures of other commonwealth countries like Canada, Australia and Singapore. However avoid the mistake of centralised eHealth model developed by NHS UK. Ultimately all Public Health IT systems have to converge to a Health Information Exchange. The blue print should address standards for Identifiers, vocabulary, diagnosis/ procedure/services code sets, data storage, data privacy and security, data integration, data retrieval, data analysis and information usage.

I. *National eHealth Authority [NeHA]* needs to have the mandate to design, publish, execute and regulate the National eHealth Architecture [Blue-Print] as per standards for vocabulary, data, input/output, storage, integration, hardware and network**.** Attach the funds to this National eHealth Architecture and make it mandatory for National and

State disease programs to comply with the blue-print architecture for getting the funding.

II. The *blue-print* should have local, regional and state health information exchanges [HIE] that feed the national health information network [NHIN]. A centralised health information exchange [HIE] has to emerge for every state that will be used for exchanging health information. The HIE should have a data warehouse to analyse the consolidated public health data. We should adopt a federated structure where the data is pulled on-demand; whereas we should stay away from central data repository model because it becomes unwieldy and too expensive over time. The HIE pulls up only that data that is required for consolidated data analysis or health record portability. The patient registry will have entries for the diseases being tracked and will also cater to population migrations where the portability of patient-based health record is important.

III. *Minimum Data Sets and Standards* – The blue-print should define the minimum data sets in terms of Indicators that should be captured for each reportable disease. The vocabulary should be standardised as per *SNOMED standards*. The diseases should be coded as per *ICD 9 and ICD 10 standards* and procedures/services should be coded as per *CPT standards*. The standard vocabulary and code sets make sure that everyone speaks the same language. This also goes a long way in public health resource planning and epidemiological research – incidence, prevalence and surveillance.

IV. *Flexible Data Input* - The Public Health IT system should be designed to be flexible so that it allows inputs in consolidated [District-wise or facility-wise] as well as granular [patient-based] models. Based on readiness, allow the States to decide mode of data entry – consolidated, facility-wise or patient-based; as long as the published architecture and standards for vocabulary, data, input/output, storage, integration, hardware and network are followed. Patient-based tracking should not become a pre-requisite for any public health IT system. In the absence of patient-based EMR, the public health IT system should be able to work on consolidated numbers alone.

a. Basic – The SC/PHC/CHC/DH should do the data entry on paper and the District enters the consolidated numbers into the public health IT system. In this case the patient registry will not have any data from such States/Districts.

b. Regular - The patient-based tracking should be done by the EMR at the point-of-care and consolidated numbers should be fed by the EMR into the public health IT system through a standards based integration. As per the current efficiency and training levels in the country, the regular patient-based data entry directly into the IT system is possible if the hospital/clinic is seeing less than 10 patients per hour on an average. The patient registry will have entries for the diseases being tracked and will also cater to population migrations where the portability of patient-based health record is important. This registry based model is suitable for Cancer and some chronic diseases, whereas acute illness like common cold will not reach the registries unless we are tracking epidemic flues.

c. Advanced - The patient-based tracking should be done by the EMR at the point-of-care and consolidated numbers should be fed by the EMR into the public health IT system through a standards based integration. The patient and disease registries will be populated with top 20 diseases for public health resource planning, surveillance, and early warning. To implement this advanced data entry model across the board will

require a lot of maturity in terms of people and process. Whereas in reality this will not be sequential, some States/Districts will move ahead and adopt the advanced data entry and others will be still doing regular or basic level data entry.

V. *Flexible Data Output* – The blue-print should specify data analytics framework so that it can become flexible and capable of catering to local, District, State and National analysis and reporting requirements. This includes:

1. National Data Warehouse **–** Blue-print should define a National level data warehouse in the NHIN to analyse the consolidated data and produce indicator based reports from source systems.
2. Local Data Analytics **-** Blue-print should define a local data mart in every State HIE. The blue-print should provide online analytical processing [OLAP] for the users at all levels to generate their own reports needed to take local action. The users should be able to save the report format and define the frequency at which the reports should be populated with data and sent to them. This will significantly enhance acceptability, usability and adoption.

VI. *Storage* – The systems should have online and offline modes to ensure the continuity of work even though connectivity maybe lost due to any reason. The local offline database should remain in sync with the online database.

VII. *Integration* – All public health IT systems should be designed for integration based on known standards such as *HL7, DICOM, XML* etc. Point-to-point integration is a short term approach. Ultimately all Public Health IT systems have to converge to a Health Information Exchange.

VIII. *Single System* – Field workers at District/CHC/PHC shouldn't be burdened to report on multiple systems. Multiple Disease specific applications are neither economical nor a good software design. Rather the Public Health IT product should follow the standard architecture [blue-print] and have a flexible design such that it can be applied to any disease and region specific reporting. The system should have flexibility to define its own data elements, forms, workflow, reporting frequency and report formats. That way it is easy to integrate the different implementations of the same architecture and aggregate the data at any level for analysis. Also it takes off the load from the field staff, as they have to report in one system. This will go a long way in improving the adoption of Health IT systems.

IX. *Multi modal connectivity*- The data can be transmitted over multiple networks including fixed line broadband, wireless, mobile etc. The systems should work on LAN/WAN via a fibre optic cable to every facility as well as provide connectivity to the field worker through broadband on GSM and CDMA based mobile platforms. Mobile is a viable option with the bandwidth increasing on the mobile platforms. Interactive voice response [IVR] over a phone is another way to get data input from the field workers. The redundancy is by design to ensure connectivity to the system always.

X. The field workers should be trained and enabled with low cost mobile platforms to enter patient-based and facility-based data directly from the field. This will avoid overloading of the district resources; and also improve the accuracy of the data. This change obviously requires a big change management and should be done step by step.

XI. *Registries* - The heart of the HIE is a registry based model that has disease, facility and patient registries upto the district and state level. The registry will have metadata that

points to the details in the source systems. The indicators derived from the state disease registries should be rolled up to the central disease registry for reporting. However drill down should be available to get granular data on demand.

XII. *Unique Identifiers* - Patient, healthcare staff and health facility needs to be uniquely identified. System should generate a unique ID based on other IDs such as - Adhaar [UIDAI], Voter ID, Ration card ID, PAN# that can be used as a patient identifier for the patient registry.

XIII. Push *Disease Specific care plans and protocols* – The Architecture should mandate that disease specific care plans and protocols are provided as guidelines in consolidated data reporting systems. In the patient-based reporting systems, the disease specific care plans and protocols should be built into the form design, so that the field staff doesn't forget a step or a service.

XIV. Push *Disease Specific Alerts and Reminders* – Based on data analysis in the background the system should be able to provide disease specific alerts to the field staff. The reminders are in terms of any service delayed or missed out from the work plans. The alerts and reminders can be sent on the mobile phones via SMS or flashes on the web portal whenever the person logs in.

XV. *Social Networking* – The Architecture should encourage a platform for lateral interaction between facilities, districts, states etc. So that common issues can be sorted out amongst each other. Also it enables the collective knowledge to grow faster than silos created by hierarchical command and control.

XVI. *GIS* – The architecture should encourage the plotting of disease, facility, staff and patient data on geographical maps e.g. google maps. The disease incidence, prevalence and surveillance can be mapped on the geographical information system for easier viewing and faster decision making for interventions.

XVII. *Data privacy and security* – The blue-print should ensure that the HIE/NHIN has unique identifiers and registries to provide access rights to all the stakeholders. Only the person, who needs to see, gets to see the data or use it. Likewise detailed audit trails are also required to make sure all transactions are recorded for auditing and roll-back. Further all data communication needs to be encrypted to ensure data security.

b. **Process -** The process of implementation is just as important as the technology itself. The blue-print should broadly specify who is allowed to do what, when, where and why. Paper based process thinking has to give way to the electronic system based processes and protocols. Again this requires a massive change management.

c. **People -** Capacity building is required for implementing the technology. The blue print needs to specify the human resource capacity building in terms of quantity and quality of Healthcare-IT trained staff. This should include academia, academia-industry alliances and vocational training programs. Skills of the staff have to be upgraded to achieve the change in culture. Requires a massive change management. The existing staff has to be trained in a Healthcare-IT paradigm. Sustained training, help desk, message boards, discussion forums, user group support is required for improved adoption. Also new breed of Healthcare Business Analysts have to emerge that will have knowledge of healthcare, management and IT. These Analysts have to work with

the program managers to define the requirements of the public health IT systems. An ICT cell has to be created in the Dept of Health at every State, District, Block and Municipality that will work with the National eHealth Authority [NeHA].

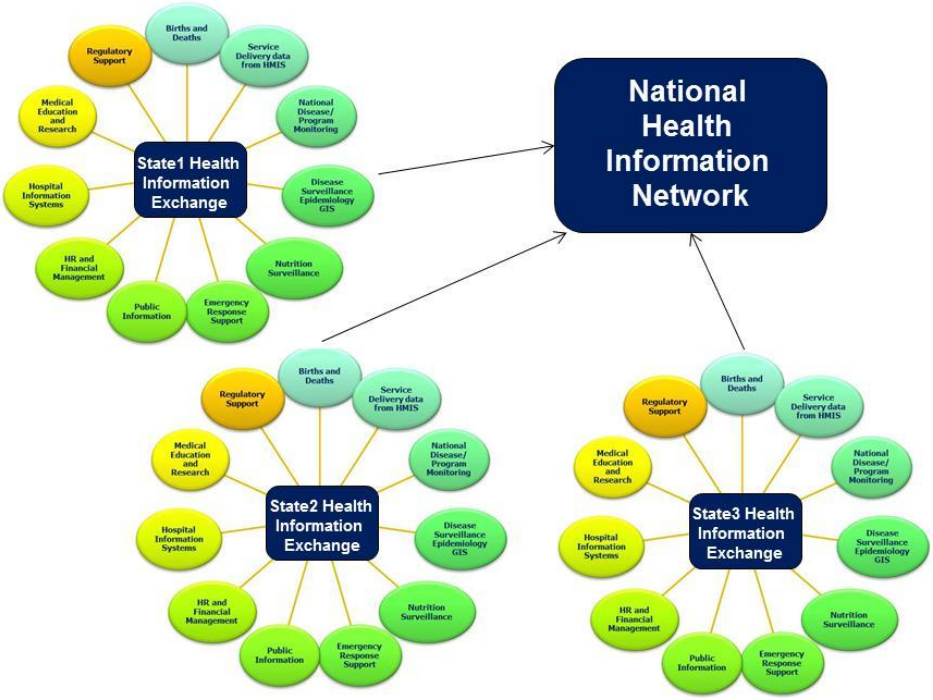
**Procurement -** Strengthen, standardize globally accepted public health procedures for software procurement for healthcare, which would ensure that learning from both our past as well as public health IT experiences of other countries, are fully incorporated into future plans. The procurement should ensure that the project management follows *PMBOK standards* or equivalent*.* The software product life cycle and related documentation should be as per *SEI-CMMI standards* or equivalent*.* Currently procurement is insensitive to software lifecycle and technology obsolescence. There is little traceability of software life cycle documentation. Either the sponsoring Directorates didn't ask for the documentation from the vendor or the vendor didn't maintain the documents. From a technical perspective this is a dangerous situation and needs to be prevented at all cost.

Some States and National programs will take the lead while others will trail. The efforts for establishing the National eHealth Authority [NeHA] have to start early for the blue-print to become available and the implementation to start. Meanwhile the culture of electronic data has to be established by enhancing the adoption of existing systems. The options are:

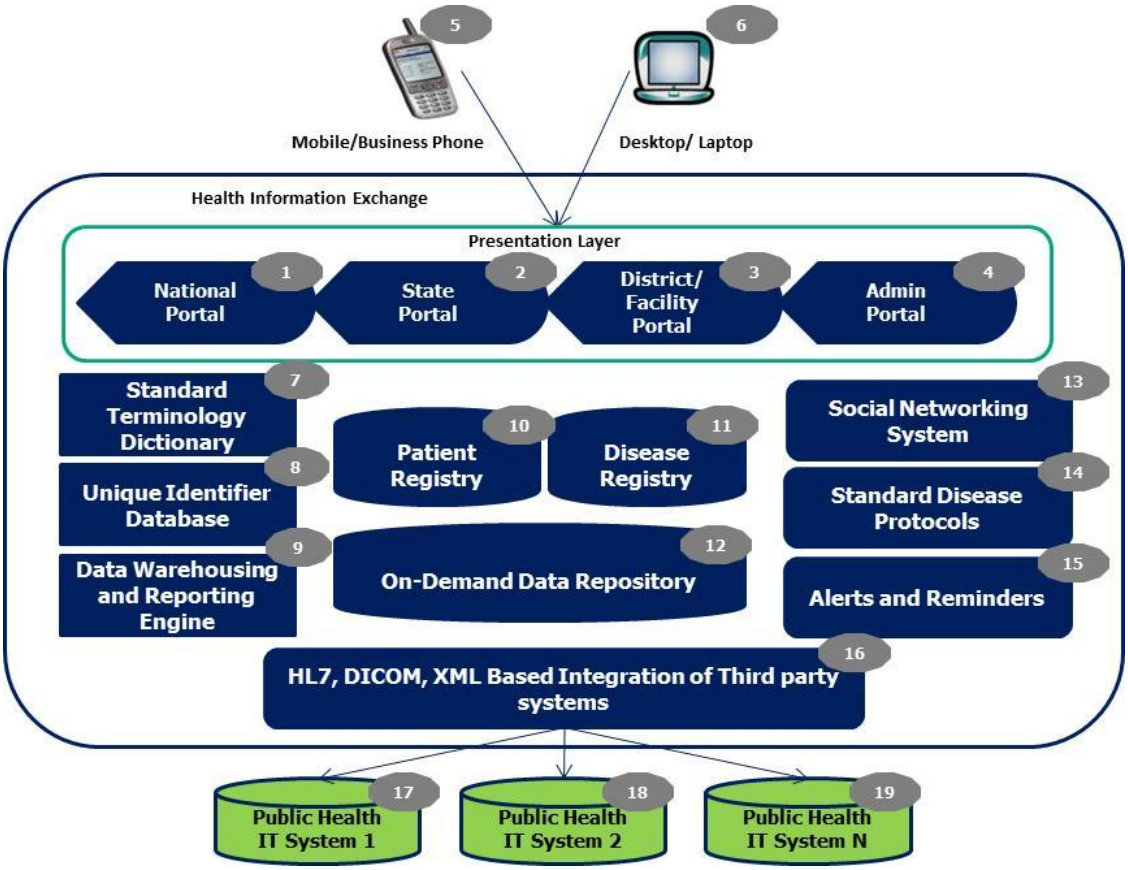
a. Current system - Retain and re-implement current system
b. Current system Plus - Enhance current system wherever used, and put in new system with integration between the two systems
c. New system - Completely replace system with new system with internationally accepted standards of public health software procurement.

The history of Healthcare-IT systems reveals that a slow democratic transition from paper based processes to electronic processes improves adoption and paves the way for innovation. The resistance to change is a problem that needs to be removed step-by-step over time. Sudden change makes *the frog jump out of the hot water*.


**Conceptual Architecture depicting the State Health Information Exchange [HIE] where all the different public health IT systems, patient based reporting systems and other related systems get integrated.**




**Conceptual Architecture of the National Health Information Network [NHIN] that is essentially an HIE too at the National level. HIE should be built at every State level and then aggregated into the NHIN at the National level.**



Conceptual Architecture of the components inside the Health Information Exchange [HIE]. The NHIN is also an HIE at the national level; it aggregates the data from various state level HIEs on demand**.**

1 – National portal for national level public health agencies to look at the data in the NHIN/HIE. The portal is a presentation layer that may have multiple repositories behind it.

2- State portal for state level public health agencies to look at the data in the NHIN/HIE. The portal is a presentation layer that may have multiple repositories behind it.

3- District/Facility portal for District/Facility level public health agencies to look at the data in the NHIN/HIE. The portal is a presentation layer that may have multiple repositories behind it.

4- Admin portal to provide access rights to all the stakeholders. Only the person who needs to see, gets to see it or use it. Data privacy, security and monitoring of the system will be done by system administrator usually provided by a trusted IT vendor

5- All stake holders can access the system through the advanced mobile platforms like Blackberry or Palmtops and they can receive SMS on basic mobile phones

6- All stake holders can access the system on laptops or desktops through the LAN/WAN/Internet network

7- System has a standard terminology dictionary such as SNOMED to make sure that everyone uses a standard set of keywords e.g. congestive cardiac failure, congestive heart failure, myocardial infarction are understood as synonyms by the data warehouse and analytic engine. Similarly the diagnosis, procedures/services are coded by standard codes such as ICD and CPT respectively.

8- Unique identifier is assigned by the HIE to every person in the registry based on the data in the registry - demographics and secondary identifiers such as voter ID, ration card #, PAN# etc. UID/AADHAR can also be used in place of this system generated UID. Till UID/AADHAR becomes available, Enterprise Master Person Index [EMPI] technology can be used for system generated UID. The UID is important for uniquely identifying the patient while pulling the relevant data from the source systems on-demand and also ensuring the data privacy and data security. The UID will be populated only when patient-based data is collected. The UID is not populated in basic data entry where only consolidated numbers are entered into the public health system.

9- Data warehousing and reporting engine is used for data analysis such as slicing and dicing. It's a tool used for picking up only the relevant pieces of data from a bigger data set. It is used when the user demands any analysis/report through the portal.

10- Patient registry is a unique list of all the patients in the system. If a patient shifts from one location to another, the new location checks the registry before making a new record. UID database works with the registry to make sure there are no duplicates. The UID is important for uniquely identifying the patient while pulling the relevant data from the source systems on-demand and also ensuring the data privacy and data security. The UID will be

populated only when patient-based data is collected. The UID and registry is not populated in basic data entry model where only consolidated numbers are entered into the public health system.

11- Disease Registry is a classification of patients based on top 20 diseases prevalent in the State. This is used as target groups for disease management programs. In advanced level this can also be used for mobile based alerts and reminders.

12- On demand Data Repository is populated on-demand with data pulled from different sources such as patient-based tracking systems, facility-based tracking, area-wise tracking systems etc. Only the data required for data analysis or data exchange is pulled-in from the source systems. There is no need to load everything from the source systems and overload the HIE. Similarly the NHIN - Only the data required for data analysis or data exchange is pulled-in from the HIEs. There is no need to load everything from the HIEs and overload the NHIN.

13- Social networking system- This component links the HIE with social networking websites promoting horizontal networking through the internet e.g. Facebook, Twitter, LinkedIn etc.

14- This component provides standard disease protocols and customized care plans as a guide to the field staff. At advanced level it can be incorporated into the workplans.

15- Alerts and reminders work with the disease registry to select the target groups and send customised alerts and reminders based on standard protocols.

16- Standards based integration- Messaging standard such as HL7, DICOM and XML are used for connecting multiple public health IT systems.

17, 18, 19 – Various public health IT systems

# Learning from Global eHealth Networks

## Canada Health Infoway - Executive Summary

Canada Health Infoway a federally-funded, independent, not-for-profit organization, has been created to foster and accelerate the development and adoption of electronic health record (EHR) systems with compatible standards and communications technologies. Infoway works with the country's ten provinces and three territories to implement private, secure EHR systems, enabling best practices and successful projects in one region to be shared or replicated in other regions for sharing critical healthcare information. Infoway and all levels of government in Canada have committed to provide the residents of Canada and their health care providers timely, appropriate and secure access to the right information when and where they enter into the health care system.

Infoway, together with its 14 jurisdictional partners, developed Vision 2015, an information and communications technology roadmap for health care in Canada.
It represents the initiatives that jurisdictions want to achieve as a country and consists of 5 key priorities:

- Complete the work underway in Electronic Health Records, Telehealth and Public Health Surveillance,
- Implement Electronic Medical Record (EMR) systems in physician offices and Provider Order Entry systems in hospitals,
- Deploy Wait Time Management Systems,
- Implement Consumer Health Solutions to support self-care, and
- Integrate Chronic Disease Management systems, starting with Diabetes.

Infoway received its most recent funding allocation of $500 million as part of the Federal Government's Economic Action Plan. Infoway has dedicated the bulk of this funding to ensuring that Canadian physicians adopt and use electronic health care information systems in their office settings.

Canada Health Infoway [CHI], the Healthcare-IT Czar of Canada has published a National eHealth Architecture [Blue-Print] and attached relevant funding with it. Blue print is a reference architecture that serves as guidelines for the eHealth projects. The projects get funded if they comply with the blue-print. Likewise the Regional Health Authorities [RHA] have published their own flavours of the blue-print and allocated additional funds for eHealth projects that comply with the blue-print.

The technology Blueprint is a guide for the development of electronic health records. The EHR Blueprint is reference architecture useful to information technology professionals, in governments, health regions and hospitals planning to implement electronic health record solutions. It is also valuable to technology vendors who want to align their products and services with Canada's vision for the interoperable electronic health record. This architecture is like a town planner's blue-print laying down the standards for the buildings, open spaces, parks, roads, water inlets and sewer outlets etc. – such that all colonies are free to do their own development as long as they comply to the overall guidelines given in the blue-print and get integrated seamlessly into the town

The plan to bring a fully functioning electronic health record network to all Canadians calls for three core components: Storage, Point of Care Systems and Connection. The Storage is built around six Registries - Client Registry, Provider Registry, Diagnostic Imaging , Laboratory Information repositories, Drug Information repositories, Other information

repositories - such as clinical and immunization reports. The "point of care systems" component of the Blueprint makes sure that all health care facilities in Canada have consistent systems in place to send, retrieve and manage critical health information. Currently, based on the current systems in place, some facilities can adopt health records right away, while others need to be upgraded, or need new electronic systems to be built. The connection component provides the plumbing to allow all types of health information to move between all points of care in the community, within the province and eventually across the country.

Infoway will cost a total of $10 billion to implement, $1.5 billion per year to operate and will generate approximately $6 billion in annual benefits. The benefits would come from specified improvements in access, quality and productivity to the Canadian health care system.

To focus the agenda, Infoway drew a line stating that "by 2010, 50 per cent of Canadians will have their electronic health record available to their authorized health care providers". This call to action has been achieved, with 49 per cent of electronic health records available to authorized providers as of December 2010.

In 2009, the investments in diagnostic imaging had shown cost reductions of almost $1 billion a year.
In 2010, an early evaluation of Infoway funded drug information systems showed that they generated $436 million worth of annual benefits; resulting from increased productivity of doctors and pharmacists, increased patient compliance with medications, increased patient safety and reduced preventable adverse drug events. These are only the initial benefits.

This democratic change management has been a successful paradigm where the States/ Regions are free to develop their own systems for local planning, monitoring and evaluation. However the IT systems developed by the States, Regions and Disease programs got funded from the allocated funds if they conformed to the eHealth Architecture [Blue-Print] published by CHI and RHAs.

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## NEHTA Australia - Executive Summary

The National E-Health Transition Authority (NEHTA) is a company established by the Australian State and Territory governments in 2005 to develop better ways of electronically collecting and securely exchanging health information. As the lead organization supporting the national vision for e-health in Australia, NEHTA has focused on establishing a national e-health infrastructure. The government of Australia is committed to providing personally controlled electronic health records for all Australians. Australians will be able to check their medical history online boosting patient safety, improving healthcare delivery, and cutting waste and duplication. A national e-health records system was identified as a national priority by the National Health and Hospitals Reform Commission and the draft National Primary Health Care Strategy. One of the most important aspects of e-health is its role in rural and remote medicine. It will enable healthcare providers to rapidly access help and assistance from better-equipped medical centers.

The Commonwealth Government approved the development of the personally controlled electronic health record (PCEHR) system in 2010, and allocated funding to deliver this by July 2012. NEHTA has been contracted as a managing agent on behalf of the Department of Health and Ageing (DOHA) in relation to contracts and agreements for: National Infrastructure Partner/s; National Change and Adoption Partner; Benefits Evaluation Partner; and eHealth Sites.

As part of the 2010/11 federal budget, the Government announced a $466.7 million investment over two years for a national Personally Controlled Electronic Health Record (PCEHR) system for all Australians who choose to register online, from 2012-13. From July 2012, all Australians who choose to, can register for a PCEHR. As the PCEHR system matures, Australians who use a PCEHR will be able to see their important health information in one consolidated view. They will be able to share this information with trusted healthcare practitioners, who in turn will be able to access their patient's PCEHR to support the delivery of high quality healthcare regardless of where and when it is needed.

The passage of Healthcare Identifiers Act 2010 by the Federal Parliament signified a turning point for both NEHTA and the Australian health system. The Act and its supporting Regulations enabled the governments of Australia to launch the new Healthcare Identifiers (HI) Service on 1 July 2010. The use of national healthcare identifiers ensures clinicians to associate health information with the right patient more accurately, securely and consistently than was previously possible and it will reduce the likelihood of any confusion over patient information. Approximately 23 million individual healthcare identifiers have been created by the contracted service operator Medicare Australia for people with a Medicare Card or a Department of Veterans' Affairs Card. The HI Service also expects to allocate 500,000 healthcare provider identifiers through the newly created Australian Health Practitioner Regulation Agency (AHPRA) process and 200,000 to other healthcare providers outside of the national registration process.

The Clinical Knowledge Manager (CKM) is the collaborative environment which NEHTA is trailing to engage the Australian healthcare community – clinicians, jurisdictions, vendors, professional bodies and informed key stakeholders in the development of computable clinical concept definitions to be used in the development of e-Health clinical technical solutions, known as archetypes. The NEHTA archetypes, known as Detailed Clinical Models (DCMs) are intended to provide the content building blocks (information and terminology) for technical

specifications for e-health solutions. There has been extensive work in Australia on the development of health informatics standards by Standards Australia's IT-014 Health Informatics community. This range of existing Australian Standards includes a number of standards that support integration of eHealth systems, many of which are based on international standards.

SNOMED CT-AU is a standard clinical language, which NEHTA administers and makes available for use by practitioners across Australia on behalf of the International Health Terminology Standards Development Organisation. Australian Medicines Terminology (AMT) includes standard naming conventions and terminology to accurately describe medications in medication management software systems. NEHTA regularly releases Australian Medicines Terminology on a monthly basis to include new items from the Australian Register of Therapeutic Goods and items.

The privacy of patients is protected by legislation banning unauthorized access to patient information. The system will contain protocols and controls designed to ensure access is limited to those requiring it and will be subject to random audits to ensure compliance. Individuals and their authorized representatives will be able to access demographic information held by Medicare Australia as part of the HI Service and an audit log of which organizations have obtained their identifier.

Supply chain reform was one of NEHTA's first initiatives designed to provide the critical standards and infrastructure required to support connectivity and interoperability of electronic health information systems across Australia. There was also recognition that inefficient data management in the healthcare supply chain may impact patient safety and result in increased costs. NEHTA is now working with the Australian health sector to adopt the following solutions:

- The National Product Catalogue (NPC).
- A common approach to e-Procurement.
- Business Intelligence (BI) tools.
- GS1Locatenet for Healthcare.

In the past year, NEHTA has made very good progress on specifications for the most commonly exchanged health information, namely, eDischarge, ePrescriptions, eReferral, ePathology. Clinicians from different disciplines are playing the vital role of providing clinical input to NEHTA's work programme and engaging with the Australian clinical community to make sure that the systems built are first class and enhance the way that health professionals work.

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## NHS- UK - Executive Summary

The National Programme for IT in the NHS (the Programme) is an £11.4 billion programme of investment. Launched in 2002, its stated aim was to reform the way that the NHS in England uses information, and hence to improve services and the quality of patient care. The Department has spent £2 billion on the development and delivery of national systems, including a broadband network and a system to electronically share X-rays. A further £1.7 billion has been spent on the maintenance of national systems by local NHS organizations and on central Programme management by the Department. The core of the Programme was NHS Care Records Service, which will make relevant parts of a patient's clinical record available to whoever needs it to care for the patient. The Programme also includes many other elements, including X-rays accessible by computer, E-Prescription, and electronic booking of first outpatient appointments. It also intends to benefit NHS staff and help make the NHS more efficient, for example by reducing the time spent repeatedly taking patients' medical histories and demographic details. The main aim is to improve services rather than to reduce costs. The Department awarded five 10-year contracts totaling some £5 billion to four suppliers for the delivery of local care records systems: Accenture in the East and in the North East; BT in London; Computer Sciences Corporation (CSC) in the North West, and West Midlands; and Fujitsu in the South.

In the past, procurement and development of Information Technology (IT) within the NHS has been haphazard, with individual NHS organizations procuring and maintaining their own IT systems, leading to thousands of different IT systems and configurations being in used in the NHS. These are provided by hundreds of different suppliers, with differing levels of functionality in use across the country. The large numbers of different and incompatible systems have meant that the NHS's IT systems infrastructure has been built up to create silos of information, which, with few exceptions, are not shared. As a result, the information required for safe and efficient care may be absent.

To obviate the historical problems, the Department decided to pursue a dual policy of procuring large systems centrally; implementing them through Local Service Providers in conjunction with NHS Trusts, having left all local IT resources in place; and providing support for systems as they are implemented locally. The Department also considered that central procurement was the only way to deliver an integrated national system, to counter difficulties such as integrating large numbers of system components. The purchase and use of fewer types of systems was intended to reduce costs through aggregation, improve effectiveness through the employment of robust suppliers and systems and make it quicker and cheaper to introduce subsequent amendments and upgrades. In addition, it aimed to promote standardization, make it easier for staff to move between NHS employers without requiring re-training, enable easier transfer of data, contribute to the achievement of patient centric care, and overcome financial and operational inefficiencies in procurement.

The NHS is the only public sector organization to have universally adopted the electronic Government Interoperability Framework (e-GIF) standard Level 3 to verify the identity of users for secure registration and authentication. The elements of the program delivered in April 2006 are:

- The Quality Management and Analysis System (QMAS) to support the new contract for General Practitioners from April 2004 were delivered on time.

- The first 14,130 connections (compared to a target for March 2006 of 12,000) of the 18,000 eventually planned for the new NHS secure communications network, the New National Network (N3).
- Initial milestones for new systems to deliver Ministerial targets for the Electronic Prescribing Service, and deployments of X-ray and other diagnostic images systems (Picture Archiving and Communications Systems – PACS), with PACS systems installed at 30 Trusts out of the planned final total of 130.
- The Choose and Book system available at all relevant locations and being used for 12 per cent of bookings. A total of 261,983 Choose and Book bookings had been made.
- The Electronic Prescribing Service available at around 15 per cent of GP surgeries and pharmacies and used to issue a total of 726,843 prescriptions.
- A total of 9,600 initial deployments of software of various types, the registration of 208,990 staff for issue with Smartcards for secure access and 45,000 NHS staff accessing the NHS Care Record Spine every day.

In September 2009, the Department announced that it was changing its approach to a more locally-led system allowing NHS organizations to introduce smaller, more manageable change in line with their local business requirements and capacity. The Department no longer intends to replace systems wholesale, and will instead in some instances build on 'trusts'. In December 2009, the Department revised its approach to implementing care records systems and each acute trust is now allowed to build on their existing system where this is possible and take the elements of the system they most require. Due to changes in the contracts, however, which enable trusts in London and the South to configure systems as they require, the Department cannot easily compare the level of functionality available across the NHS with that set out in the Programme's original specification. To support interoperability of the systems the Department has developed a set of standards which systems will be required to meet. With fewer systems being provided through the Programme and more use being made of a variety of existing systems, there is an increased risk of not achieving adequate compatibility across the NHS to effectively support joined up healthcare. The Department estimates that achieving interoperability will cost at least £220 million.

Central to achieving the Programme's aim of improving services and the quality of patient care, was the successful delivery of an electronic patient record for each NHS patient. Although some care records systems are in place, progress against plans has fallen far below expectations and the Department has not delivered care records systems across the NHS, or anywhere near completeness of functionality that will enable it to achieve the original aspirations of the Programme. The Department has also significantly reduced the scope of the Programme without a proportionate reduction in costs. The Department considers, however, that the money spent to date has not been wasted and will potentially deliver value for money. This is based on the fact that more than half of the Trusts in England have received systems under the programme and no supplier is paid for a system until that system has been verified by the Trust to have been deployed successfully. The Department believes that the flexibility provided by the future delivery model for the programme will deliver functionality that best fits the needs of the clinical and managerial community. The future architecture of the programme allows many sources of information to be connected together as opposed to assuming that all relevant information will be stored in a single system.

A recent editorial in Lancet, (Issue no 9791, pg 542, Aug 13, 2011) described the fate of a similar project planned in the UK in 2002 that aimed at creating a fully integrated centralised electronic care records system to improve services and patient care. The budget for the

undertaking was a substantial 11.4 billion pounds. Nine years on, the Department of Health has spent 6.4 billion pounds on the project so far, but failed to meet its initial deadline and has had to abandon the central goal of the project because it is unable to deliver a universal system . Centralised model of UK has failed. UK is now shifting towards more decentralised models like Canada, Australia and Singapore.

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# Public Health IT System Studies

# Reproductive Child Health IT Systems

## I. National HMIS Web Portal

Web Portal has been developed for HMIS data reporting under NRHM. Web Portal development was sponsored by MoHFW and technical development was done by iBuilt technologies in 2008.

**A. Problem Statement-** MoHFW was getting paper data from the states with inconsistency in frequency and format and a time lag of 2-3 months. Also the paper system wasn't tuned towards district level data analysis for local action.

**B. Objectives of developing the system-**To build an effective decision support system to monitor and evaluate the impact of NRHM and provide key inputs for health related policy formulation and interventions.

This broad objective can be divided into these sub objectives.

1. Real time data reporting- Which will strengthen the monitoring and will enable policy makers to make better decisions for public health delivery.
2. Data to Information continuum- The portal will help converting the data locally into useful information, management indicators, trends etc which could be displayed graphically in the reports.
3. Improving data availability and quality - The new system envisages enhancing the information flow at various levels and providing useful and timely inputs for program development, monitoring and midcourse interventions in the policies.
4. Feedback – System will be able to provide feedback to lower facilities.
5. Central hub of all data- Portal will slowly initiate facility-wise data entry and will have all health related data into one platform.
6. Advance analysis & integration- The portal will be generating unique intelligence reports using the advanced SAS data warehouse platform and explore and establish new linkages and advanced analysis for policy initiatives.

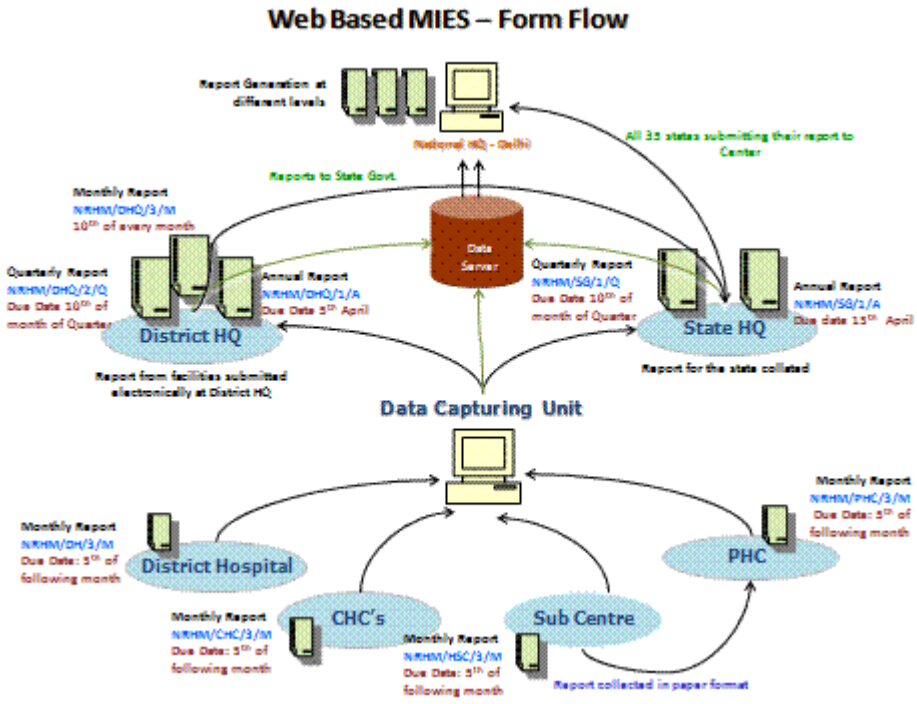
**C. Brief overview of system**

NHRM has undertaken reforms for HMIS which includes rationalisation of data elements, designing of data sets for data reporting from each facility and defining of information flow. Three sets of reporting forms [data sets] have been developed - sub centre form, PHC form and CHC/ Hospital form. Each facility has a mandate to report their monthly data in these

forms. These reporting forms cover mostly data related to Reproductive Child Health services (RCH) with some additional data elements related to deaths and stock details for program management. Earlier the facilities were asked to report their data in hard copy to Block where first level of manual consolidation would be done. Blocks were asked to report their consolidated data to District in hard copy, where second level of manual consolidation would be done. The consolidated District data was to be uploaded in NRHM Web Portal.

Now the Blocks have been asked to do data entry for individual facilities and the Blocks have become point of data entry to enter data of all facilities under it.

**Information Flow-**




## D. Gaps & opportunities

### 1. Functional specifications

The detailed study of the system was done based on a pre-defined set of parameters. The details of the findings are given in the table below. Red and Yellow items are the gaps and their corresponding remarks explain the opportunities for improvements.

| S N | Functionality | | | Comments | | |
|---|---|---|---|---|---|---|
| **1.** | | | **User Friendliness** | | | |
| | I | | Simplicity - Average Number of panels, keystrokes and mouse | Y | Gateway of Health indicators – Simple to read and navigate.<br>NRHM publications – Simple to read and | |

| | | | | | | |
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| | | | clicks | | navigate.<br>HMIS data reporting: Difficult to Navigate to the data entry page. Form is not intuitive; needs training for data entry. Multiple panels and key strokes required for the data entry and report generation.<br>Master Report –1 -3 keystrokes and PRC verify report – 26 keystrokes. Average-13 keystrokes per page. | |
| | II | | Time to fill one form with average number of data elements<br>* 0-15 minutes<br>* 15-30 Minutes<br>*30- 60 minutes<br>* More than 60 minutes | Y | To fill one form manually, it takes approximately 15-30 minutes. As there are multiple screens in one form (sub centre- 7, PHC -11, CHC/Hospital- 14 screens), it takes long time for completing data entry and user has to submit the form to save the data of each section.<br>In case of data entry by excel, upload is easier, simpler and takes less time to complete the form. | |
| | III | | Field Defaults | G | Field defaults are present at required location, however due to continuous upgrade in the application all drop down categories do not have in built field defaults. | |
| | IV | | Mandatory Fields Indication | G | Mandatory fields are highlighted with the asterisk (*) sign and date entry is standardized with notification of dd/mm/yyyy. | |
| | IV | | Use of Tabs | G | Use of tabs is noted. | |
| | V | | Field Tab Order | G | Tab order works sequentially as required by the user. | |
| | VI | | Colour Definition | Y | There is no colour coding or colour differentiation/segregation. There are no separate themes for display of screens. Only HMIS training screens have different colour coding to distinguish it from routine HMIS screen. | |
| | VII | | Section Segregation | Y | Sections are segregated into ANC, Pregnancy outcome or PNC and also levels of reporting, but not with colour or font display. Sections are also well segregated in report sections.<br>However section segregation is not present in final output report. This is very essential as output report is not | |

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| | | | | | readable in current format. Headings are not mentioned (for eg. in Data element - Number of JSY incentive paid to -Mother, ANM, ASHA, main data element is not present but subset-Mother, ANM, ASHA is present, which is confusing)<br>In some sections like- "Verified Data" & "Previous Month Data" in data entry screen nothing can be entered which is confusing for user. | |
| | VIII | | Scrolling | R | Vertical as well as horizontal scrolling is present. Horizontal scrolling should not be present in a well designed application. | |
| **2.** | | | Data Entry & associated functionality | | | |
| | I | | Data entry by reference | R | Data entry by reference is not present and is not a big issue but it is a good practice to have data entry based on reference.<br>Line listing data entry is free form and can be avoided in good design. It was not available during District consolidated data entry. Once the facility-wise data entry function is enabled all facilities are required to enter death data in line listing form. No consolidated figures for death can be entered in facility-wise data reporting. Line list data is aggregated based on causes of death. | |
| | II | | Data entry by value | G | Data entry by value is present. | |
| | III | | Data entry - Manually | Y | Manual data entry for all levels i.e. SC, PHC, CHC and DH is available. It takes long time to fill the form because user has to submit or save the data individually for each section. | |
| | IV | | Data entry- by excel import | Y | Excel upload data entry functionality is available. Excel should be in predefined format as designed by the MoHFW. | |
| | V | | At every level does it allow data entry of figures consolidated from facilities below it? | Y | Only the District is allowed to do consolidated data entry for levels below it.<br>No functionality for Block to upload consolidated data of all facilities below it. Similarly PHC cannot upload consolidated data of all SCs below it. | |
| | VI | | At every level does it allow data entry of individual facilities below it? | Y | System allows Block to enter data of all individual facilities. District allows data entry for stock details at District HQ level. District hospital and any other hospital data entry is being done by the Block under which it comes. | |

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| **3.** | | | Data Quality check functionality | | | |
| | I | | Data validation | | | |
| | | a | During data entry – front end validation | R | Validation cannot be done by the rules written in the front-end. Such function does not exist. | |
| | | | During data entry- validation done from back-end | Y | During data entry, limited validation rules exist only for the parent and child value. Line listing data entry does not have any validation rules, e.g. a 23 year old person's death can be reported with low birth weight as cause of death.<br><br>Validation rules cannot be defined by user. Backend programming is required. | |
| | | b | After data entry | G | Data validation of the entire form is done on submission. All the data entry errors are pin-pointed to the user with detailed comments. At the end pop up screen also shows the number of zeros or blanks that need attention during data entry. | |
| | | d | Validation Rules for Imports | Y | Predefined excel sheet does not have any in-built validation rules. However Excel sheet accepts numeric values only, no other characters are permitted. Also if the user tries to upload blank report, application rejects the request. | |
| | | e | Auto Validation for Excel Based Imports | R | There are no auto validation rules in case of excel sheet import. | |
| | II | | Identify duplication | R | There is no function to identify duplicates. | |
| | III | | Assess completeness | | | |
| | | a | Of all Reporting Units | G | Data status for data elements and number of facilities reported can be generated. | |
| | | b | Timeliness | R | User cannot assess whether report has been submitted within stipulated time period or not. Although each facility has to upload data on predefined dates but application does not have any functionality to identify timeliness of data entry. | |
| | | c | Differentiate between zero & non-zero | G | Report can be generated to show percentage of zeros filled and percentage of blanks left in a particular report. | |
| | IV | | Data Confirmation | G | This functionality is available by clicking the "forwarding" button. This means that once user has forwarded the data it cannot be modified by anyone else. | |
| | V | | Data Modification | G | Changes can be made any number of times in data entry screen until data is | |

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| | | | | | forwarded to the next level. Data can be reset by the next higher level on request. | |
| **4.** | | | Data load on system | | | |
| | I | | Form data element | | | |
| | | a | Indicator to data element ratio | G | 1:3.2 ( 76:248) | |
| | | b | Number of forms to be filled from each facility | G | Only one form to be filled from each facility on monthly basis. | |
| | | c | Form design | Y | As one form is bifurcated into various parts (SC-7, PHC-11, CHC-14) thus it take long time to complete the form in case of slow connection. | |
| | II | | Data archiving | G | Data archiving functionality is available in Web Portal. Data for 2008-09 & 2009-10 has been archived already. | |
| | | a | within the database | G | This function is available with the developers. | |
| | | b | in a separate database | G | This function is available with developers. | |
| | III | | Case load per data entry unit | R | Due to network speed/connectivity issues the ideal data entry unit is Block. On an average 120-130 facility report is to be entered per Block on monthly basis. The facility based data entry at District/Block level lays heavy pressure on the District/Block level human resource. | |
| | IV | | System response time | G | 2-3 seconds response time in login or opening any screen. It takes 2.1 minutes to generate a monthly report at the speed of 2.2971Mbps. | |
| **5.** | | | Unique identifier | | | |
| | I | | For each Patient | N | This function is not available in Web Portal. However Line listing data entry for individual case is done in the system without using any identification number. | |
| | II | | Provider/ Staff | N | Individual provider identification is not required in aggregation based application | |
| | IV | | Facility | G | Unique identifier of each facility is present at back end only. | |
| | V | | Encounter | N | Encounter based identifier also doesn't exist | |
| **6.** | | | Report generation | | | |
| | I | | By Design | | | |
| | | a | Static – predefined | G | Web portal has number of useful reports like facility wise, period wise, element wise etc. All predefined reports can be | |

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| | | | | | generated with all types of combinations. Below Block parent-child relationship hierarchy is not defined for CHC, PHC (e.g. no way to identify which SC is under which PHC and which PHC is under which CHC). Below Block all SCs are grouped at one level; similarly PHC & CHC are also grouped. In this arrangement group reports can be generated e.g. SC group, PHC group, CHC group but parent-child hierarchy report (e.g. PHC with all its SCs) can't be generated as the hierarchy is not available. | |
| | | b | Dynamic – can be configured by user | R | Users can not design their own report. It can be done only by developers. | |
| | | c | Report generation by programming/ SQL Queries | G | This functionality is available at back end. | |
| | | d | Online Analytical Processing (OLAP) for user | Y | Very limited features of OLAP functionality are present i.e. consolidation; but feature such as drill down; slicing and dicing and pivot are not possible. | |
| | | i | Consolidation | Y | Consolidated report can be generated at District and at Block level but below Block no consolidation is possible. | |
| | | ii | Drill down | R | Hierarchical drill down is possible till Block level. Below Block – PHC, CHC and SC all are at same level. | |
| | | iii | Slicing-dicing | R | Slicing and dicing functionality is not available | |
| | II | | By use | | | |
| | | a | Number based aggregated only | G | Aggregation is possible up-to the Block level. Below Block no aggregation functionality is present | |
| | | b | Analyzed (indicator based) | G | Indicators are inbuilt but need some enhancement (on basis of specificity, sensitivity, validity reliability and feasibility). User can visualize only one indicator at a time, multiple indicators cannot be compared with each other and there is no indicator-based static report existing in the application. | |
| | III | | User can generate aggregated report for his level and level below. | Y | Block and District can generate aggregate report of their level below. | |
| | IV | | User can generate disaggregated report for his level and level below. | Y | Only District & Block can generate disaggregate report for level below. | |

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| | V | | Data Mart | G | Data Mart is available. | |
| | VI | | Dashboard for decision makers | R | Dashboard module does not exist but available types of reports are useful enough to view data as per user's choice. There is no such functionality where user can save the set of essential or desired parameters. | |
| | | a | Showing values only | | | |
| | | i | Numbers and tables | G | Reports show values in number and tables. | |
| | | ii | Indicators | G | Indicators exist and grouped on the basis of type of services (e.g. ANC, Delivery, and Immunisation). | |
| | | b | Graphical – Charts | G | Graphs can be generated for individual data element or indicator. User cannot use more than one data element or indicator to generate the graph. | |
| | VII | | GIS-Map based data analysis | R | No such functionality is available | |
| **7.** | | | System Flexibility (to define your own) | | | |
| | I | | Data fields | R | User cannot define their own data fields | |
| | II | | Indicators | R | User cannot define their own indicators | |
| | III | | Forms | R | User cannot define their own forms | |
| | IV | | Formats | R | User cannot define their own formats | |
| | V | | Reports | R | User cannot define their own reports | |
| | VI | | Dashboard | R | User cannot define their own dashboard | |
| | VII | | Rules Engine – To define Clinical Protocol and Disease Management based Rules | R | User cannot define their own rule engine | |
| | VIII | | Workflow Engine – To define user defined public healthcare program specific workflow | R | User cannot define their workflow. (User has to follow the predefined hierarchy). Below Block there is no hierarchy. All facilities are directly located within the Block. | |
| **8.** | | | Standards | | | |
| | I | | Data Definitions – | | | |
| | | a | Vocabulary Standards | | | |
| | | i | For local - | G | Vocabulary used as per standard MIES NRHM formats | |
| | | ii | For global – eg SNOMED, | R | This functionality is not available. | |
| | | b | Size | R | This functionality is not available. | |
| | | c | Type | Y | Design document is not available. | |

| | | | | | | |
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| | II | | Disease & Diagnosis code sets – Local codes, ICD 9, ICD 10 | R | This functionality is not available. | |
| | III | | Procedure & Service Code sets – eg Local codes, CPT, CAP | R | This functionality is not available. | |
| | IV | | Interoperability standards for integration – eg HL7, DICOM | R | This functionality is not available. Only excel based interoperability is possible | |
| **9.** | | | Data Privacy | | | |
| | I | | Role-based access | Y | Role-based access functionality is available but username and passwords are given to individual facility for data reporting and report generation. Access privilege is not linked with individual position. | |
| | II | | Data locking | G | Data locking functionality is not specifically available, but after forwarding data gets locked automatically. Locked data can be reset (converted into changeable mode) by the state officials only. | |
| | III | | Password Protection | G | Password protection is weak because - password does not expire, can be pasted from other documents and system will not disable after any number of unsuccessful login. Password changing functionality is present after login in. | |
| | IV | | Field Based Access Rights | R | Field based access rights are not available. | |
| **10** | | | Data Security | | | |
| | I | | Audit trails | G | At the backend this function is available. Any minute changes in portal data can be tracked from log files. | |
| | II | | Roll-back facility | R | Roll- back is not available currently but if required can be developed. | |
| | III | | Data back-up including tiered backup | Y | Three step back-up functionality-<br>1. By NIC in their server,<br>2. By development agency in their server and<br>3. Time to time back-up in External Hard Disk Drive is taken and is stored separately. | |
| | IV | | Encryption - PKI usage | R | This function is not available. | |
| | V | | Digital Signature Certificate Usage | R | This function is not available. | |
| **11** | | | System Functions | | | |
| | I | | Search | G | Search option is available in data entry for data viewing/editing. | |

| | | | | | | |
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| | II | | Feedback | G | Feedback is present | |
| | III | | Help | G | Help is present in form of operations manual | |
| | V | | System flexible to adapt to any Disease Program? | R | System is not flexible to adapt to any disease programme | |
| | VI | | Disease Specific Educational Content | R | No educational content other than help file is available. | |
| | VII | | Error handling | R | Error handling measures are weak. System neither shows any specific message regarding error and nor any corrective action in case any error is encountered | |
| | VIII | | Deployment | Y | Application has only online deployment functionality. Offline excel import is possible | |
| | | a | Online | G | Online application is available | |
| | | b | Offline | Y | Offline excel import functionality is available | |
| **12** | | | Other | | | |
| | I | | Mobile user interface | R | No mobile user interface | |
| | II | | Capacity building/Change Management Methodology after initial implementation | Y | Formal capacity building in a structured way was not undertaken due to administrative and structural rigidities | |
| | | a | Skill Building | Y | Training of state officials were conducted by national team. Then it was state's responsibility to conduct training for the lower levels. In few states training was conducted as planned; but no evidence of it being done in all states. | |
| | | i | One time training | G | Initially one time training was given for the use of Web Portal. | |
| | | ii | Ongoing handholding and support | Y | Ongoing training is provided in states for the use of Web Portal. In NHSRC supported states, HMIS person has been provided for handholding and support on Web Portal. | |
| | | b | Infrastructure | Y | This was the responsibility of state for which funds were provided from the centre. No evidence of how the states managed it. | |
| | | c | Human Resource | Y | This was the responsibility of state for which funds were provided from the centre. | |
| | | d | Protocol for HMIS related process | Y | Some protocols are in place and are still being updated. | |

| | | | | | | |
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| | III | | Capacity building/Change management budget available as part of initial budgeting | Y | Capacity building budget was allocated from the centre. | |
| | IV | | Capacity building/Change management process signed off during implementation | G | Initial training on the use of Web Portal was provided by development agency, as MoHFW has a five year contract with agency. The agency provides refresher training to MoHFW HMIS team which further acts as master trainers. | |
| | V | | Software support through multi-year maintenance contract | G | Support is provided by Vyam technologies initially for five years. | |
| | VI | | Hardware support through multi-year maintenance contract | G | Server is managed by NIC and end user hardware is state's responsibility. | |
| | VII | | Source code available? | G | Available ( either with Vyam technologies or MoHFW) | |
| | VIII | | Open source Technology? – Proprietary v/s Open Source | G | Proprietary | |
| | IX | | Obsolete technology? | G | No, Technology used is- .Net, Visual Basic, Sequel Server. | |
| | X | | Software upgrades being done? | G | Yes, timely software upgrades are provided as per Ad-hoc requirement. | |
| | | a | Software Configuration Management | Y | Software product versions are being managed by Vyam technologies. There is no release management cycle. Constant updates are going on as per ad-hoc requirement. | |
| | | b | Software Product Life Cycle Management | Y | Web portal application is built as a single monolithic Application for a single purpose. It cannot be used for multiple programmes There is no release management cycle. Constant updates are going on as per ad-hoc requirement. | |
| | XI | | Hardware upgrades being done? | R | Server capacity is increased time to time as per the requirement but computer hardware upgrade is done by state. | |
| | XII | | Infrastructure for scalability – e.g. SAN, Data Centre, Web Farm | G | Server is managed by NIC and end user hardware is state's responsibility. | |
| | XIII | | Capex or Opex financing model? | G | Capex. | |

**E. Did system achieve its objectives?**

| | Objectives | Remarks |
|---|---|---|
| 1 | Real time data reporting. | Centre now gets near real-time data thru the Web Portal. |
| 2 | Data to Information continuum. | Web Portal does not provide any local analysis of data. There are no management indicators for local monitoring and control. Does not provide any function to identify poor performing facilities and take corrective measures. |

| | | |
|---|---|---|
| 3 | Improving data availability and quality. | Data quality has improved as compared to paper data. Improvement in data quality has also occurred due to the sustainable capacity building efforts by NHSRC in 15-20 states. |
| 4 | Feedback to all reporting units. | Web Portal does not provide any feedback to reporting units. |
| 5 | Central hub of all data. | Some states/Districts/Blocks have started entering facility wise data into the Web portal. The adoption is low. RCH data from many States/Districts/Blocks is on MCTS and DHIS. |
| 6 | Integration with other systems. | The big picture is lost because Web Portal is not integrated with other systems such as MCTS and DHIS. |

**Discussions**-

1. **Source of health information** - Web portal has served well as a source of all health related information. All survey indicators are compiled and available in Web Portal. It also has limited publications related to NRHM.
2. **Poor form design** - Forms are heavy and take a long time in loading on slow connections. The forms have multiple drop-down and options that need to be loaded from the server. Lot of horizontal scroll forces the use of mouse and thus slows down the work.
3. **Local level data analysis** - Web Portal was supposed to empower the Districts for local level analysis and take action. On the contrary the web portal does not provide any local analysis of data. There are no management indicators for local monitoring and control. It does not provide any function to identify poor performing facilities and take corrective measures.
4. **Data analysis and reports** - Report generation is not user friendly. Many reports can't be seen online; to view they have to be downloaded on the local disk. User can't slice, dice, drill down or drill-up. Although SAS is a very powerful analytics engine; but Web portal doesn't come across as using the power of SAS in the back-end.
5. **Hierarchy within Block** – Web portal doesn't reflect the full hierarchy of facilities in the field. All SCs are grouped together without regard to their respective PHC and CHC. Similarly all PHCs & CHCs are also grouped without regard to their respective functional and administrative hierarchy. This hierarchy is not compatible with the workflow. The CHC will never be able to identify good performing PHC & poor performing SC under it.
6. **Mismatch between HR Capacity and reporting needs** - Web Portal was developed on data warehouse approach to report aggregated data under NRHM. All the 634

districts were uploading data during 2010-11. The user base has dwindled after the facility-wise data entry was started. Facility-wise data entry increased the data entry load from consolidated data of 634 districts to more than a lac SC data. The human resource at the District was not matched to take the increased data entry load. Therefore leading to fatigue.

7. **Integration with other system** - Web Portal does not have any integration done with any other reporting system e.g. DHIS, MCTS. It does not support any standards for integration e.g. HL7. However initial attempts are being made to integrate Web portal with NVBDCP thru an Excel upload.

## F. Recommendations

Get the data into the electronic system. We can't leave the data out. Fix the issues and run the existing systems.

1. **Focus on consolidated reporting** – System should allow granular reporting as well as consolidated reporting at different levels. Based on capacity building, let the States decide the granularity level from which they want to report. Therefore it is recommended that system should reflect the real hierarchy of the field and allow consolidated reporting as well as reporting from each level such as states/districts/Blocks/CHCs/PHCs/SCs. Then do a massive change management to push the States that are lagging behind in adopting the reporting in electronic systems.
2. **Look at the big picture** – Make the MCTS, DHIS2 and Web portal work in tandem to complete the big picture. Although each of these systems has a different approach to the same problem of IMR and MMR, but each has certain set of dedicated users. It is very important to get all the data into the electronic system. Can't leave out any of the data from the electronic system. Else the whole concept of going electronic will collapse because partial data is meaningless in the long-run. Also lot of funds and time have been sunk into all the 3 systems. Therefore it is advisable to invest in integrating the 3 systems.
3. **Integration** – A central Data Warehouse is required to which all the 3 systems feed their respective data through HL7 based integration. This is to ensure that the data is not lost. The data warehouse can be used for reporting numbers consolidated from all the 3 systems.

4. **Fix the technical issues** related to requirements, design, product life cycle management, release management etc. Technically stabilise the system so that the long-term viability improves and the data is secure.
5. **Change Management** - It is a huge cultural change from the traditional paper based system that works on aggregated data. History of Healthcare-IT systems clearly indicates that one can't achieve adoption by forcing the workers to do anything. The only successful model to improve adoption is a democratic way which is inclusive and not the autocratic way. Therefore there needs to be greater and sustained focus on capacity building and change management. Constant interventions are required to change the human behaviour. The resistance to change is a problem that needs to be removed step-by-step over time. Sudden change makes the *frog jump out of the hot water*.

**Sources of Data for the report:**

| Sl. | Sources of Data | Remarks |
|---|---|---|
| 1 | Interview of stakeholders | NA |
| 2 | System Requirement Specifications Document | NA |
| 3 | Functional Design Document | NA |
| 4 | Technical Design Document | NA |
| 5 | System Architecture Document | NA |
| 6 | Test Cases and Test Report Document | NA |
| 7 | User Manual | Available |
| 8 | Other | Overview of Web Portal from various reports, research papers etc. |
| 9 | Live System Demo | Available |

**References:**


- Operational Guidelines HMIS Web Portal http://nrhm-mis.nic.in/Downloads.aspx Accessed on 12/11/2011, 10:30 AM.
- HMIS Reports http://nrhm-mis.nic.in/PublicPeriodicReports.aspx Accessed on 12/11/2011 12:00 PM.
- Understanding Health Management Information System, HMIS Managers Manual Volume III NHSRC- MOHFW 2011.

## II. NRHM- Mother and Child Tracking System

Mother and Child Tracking System [MCTS] was sponsored by MoHFW, Govt of India, and developed by NIC between 2010-2011 for tracking pregnancies and pushing standard protocols in order to reduce IMR and MMR.

### A. Problem Statement:

Credible and timely data isn't available for reducing IMR and MMR. By the time the data gets aggregated and analysed, the pregnancy events/complications have already occurred.

### B. Objective of developing the Electronic System:

Objectives of developing MCTS can be divided into main and supporting objectives.

#### 1. Main Objectives:

I. MCTS was developed for reducing the IMR and MMR.

II. Centralised system for tracking each pregnancy - Name based reporting.

III. Pushing standard protocols based work plan to the ANM and ASHA workers so that they don't miss any step in the protocol.

IV. Mother and child gets service in time.

#### 2. Supporting objectives:

I. Analysed data is available for administrative and resource planning purposes

II. Plan and roll-out trainings and skill upgrades as per region based in service levels

### C. Brief overview of system

Pre-MCTS the data was reported manually from the field and compiled at various levels before reaching to the directorate. Some states had their own reporting variations and some states even had their own software (e.g. eMamata from Gujarat). Therefore the Directorate felt the need to computerise the system and rationalise the information collected in different states.

eMamata from Gujarat was taken as a base and technically migrated from .Net 2005 to .Net 2008. In the process, new features were added and the architecture was improved. Extreme agile methodology was followed to develop the system.

Data is collected in standardised forms from the field. The forms are compiled and data is sent to the next level on fortnightly basis. Lowest unit of data collection is sub-centre.

Data for every pregnancy in the villages is collected by ANM and ASHA workers and manually compiled at sub-Centre to make aggregated sub-centre report. Sub-centre report is sent to the PHC and from the PHC it reaches to the District. In the District data entry operator enters the patient based data into computer application.

The system has been designed for patient based reporting such that each pregnancy can be tracked. An 16 digit unique identifier based on census codes is assigned to every mother and the system tracks every service provided thru the pregnancy. MCTS can switch to ADHAAR when it becomes available universally. Additional layer of validation is done thru a call centre that confirms the identity of the mother and takes feedback about the services being rendered. Currently it is reported to have more than 1 Cr records and growing.

System generates monthly work plan for every ANM and a print-out is given to the ANM for follow-up with the patients. Mobile based alerts to ANM as reminders are technically in place. Sending the entire work plan to the ANM thru mobile platforms is technically possible.

Data analysis is available to all the users. Various pre-configured reports are available for the users depending on their level of access. Reports about quality of data entered and the timeliness of the services rendered can be generated from the system. The system can push simple reports to a mobile via SMS e.g. Current number of registrations, % services coverage etc.

## D. Gaps & opportunities

The detailed study of the system was done based on a pre-defined set of parameters. The details of the findings are given in the table below. Red and Yellow items are the gaps and their corresponding remarks explain the opportunities for improvements.

| Serial Number | | Functionality | | Comments |
|---|---|---|---|---|
| **1.** | | **User Friendliness** | | |
| | I | Simplicity - Average Number of panels, keystrokes and mouse clicks | G | Average 7 keystrokes are required to finish any task in application. Application features are very simple and easily understandable. |
| | II | Time to fill one form with average number of data elements<br>* 0-15 minutes<br>* 15-30 Minutes<br>*30- 60 minutes | G | It takes 5-7 minutes to fill one encounter details. |

| | | | | |
|---|---|---|---|---|
| | | * More than 60 minutes | | |
| | II | Field Defaults | G | Field defaults are present wherever required, however due to continuous upgrade in the application all drop down categories do not have in built field defaults. |
| | III | Mandatory Fields Indication | G | Mandatory fields are highlighted with the asterisk (*) sign. |
| | IV | Use of Tabs | G | Use of tab is noted. |
| | V | Field Tab Order | G | Tab order is sequential, no click is required in default sections e.g. ANM Mobile Number (which comes by default). |
| | VI | Color Definition | G | Application works with predefined color themes. |
| | VII | Section Segregation | G | Sections are segregated for encounter-based data entry e.g. ANC, Pregnancy outcome or PNC. However it does not have clear color or font differentiations. |
| | VIII | Scrolling | G | Only vertical scrolling is available where-ever required. |
| **2.** | | Data Entry & associated functionality | | |
| | I | Data entry by reference | Y | No data entry is done by reference. It is not a big issue but it is a good practice to have reference ranges for data entry. |
| | II | Data entry by value | G | Data entry is done by value only. |
| | II | Data entry - Manually | G | Manual data entry functionality is available. |
| | III | Data entry- by excel import | G | Data entry using excel import is available, but is available with separate user ID & password and is accessible to State NIC coordinator only.<br>Excel-based data upload functionality was initially given to upload legacy data but now its use is discouraged because unreadable/corrupted/junk data started getting uploaded thru the Excel. Also it was proving difficult to update the Excel sheet format along with the changes in the application; else the Excel sheet becomes obsolete over time. |
| | IV | At every level does it allow data entry of figures consolidated from facilities below it? | R | MCTS is built for patient-wise data entry. It does not have any functionality to allow consolidated data entry. It is a good practice to allow consolidated data entry in case the granular data entry cannot be done due to administrative and cultural constraints. |
| | V | At every level does it allow data entry of individual facilities below it? | G | Patient-based individual encounter records are entered in MCTS; and this can be done for individual facilities, for all SC under one facility and even for all villages under one SC. |
| **3** | | Data Quality check functionality | | |
| | I | Data validation | | |
| | a | During data entry- front end validation | G | Validation rules are inbuilt in data entry form. This allows users to enter data which is compliant to those rules. |
| | b | During data entry- validation done from back-end | G | Based on one input the next few options are populated from the back-end. |
| | c | After data entry | G | Post data entry validation functionality is not available and is not required due to presence of real time data entry validation. |

| | | | | | |
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| | | | | | MCTS unit has a call center to confirm the details uploaded on application. Calls are being made from the call centre to check the details of data entry and if records are not verifiable, same is reported in MCTS application.<br><br>Also MCTS allows user to generate data verification report with the outcome of verification. |
| | | d | Validation Rules for Imports | Y | Excel based import functionality is available. This Excel sheet has inbuilt validation defined by macros. Before uploading excel sheet in MCTS online application, user has to run validation in excel sheet itself. Violations are marked yellow in the excel sheet. Once these violations are corrected, yellow color of cell is converted into white. Till all violations are corrected excel sheet can't be uploaded in online MCTS application.<br><br>Excel sheet itself has changed twice due to change in the data element list but if the user is trying to enter data through old excel sheet, system will not allow that and excel will not be uploaded. |
| | | e | Auto Validation for Excel Based Imports | Y | There is no auto validation functionality for excel based uploads. Also it is not required because of other validations built into the system. Although this is a gap but it is covered by other validations in the system. |
| | II | | Identify duplication | G | Duplicate patient identification functionality is available in the application. There are two ways to identify duplicates- first by the use of unique identifier and second is by comparison of date of birth in a facility if names are same. If the name and date of birth are same for two patients then new entry should have number attached with name in chronology. E.g. Radha, Radha1, Radha2. |
| | III | | Assess completeness | | |
| | | a | Of all Reporting Units | G | District data completeness in terms of number & percentage of block, facilities not reporting can be assessed.<br>Encounter specific completeness against total registration can also be assessed. E.g. number of mother registered with address, number of mother registered with ANM details etc.<br>Mother fact-sheet in dashboard gives completeness for each data element in each facility. |
| | | b | Timeliness | R | There is no way to know the timeliness of data entry as ANMs are not given any fix date by which they should complete data entry and the application also records only time of last change done in data entry screen. So there is no way of identifying data entry timeliness in the application. |
| | | c | Differentiate between zero & | G | Where-ever text is to be entered and is left blank; application considers it as no entry. |

| | | | | |
|---|---|---|---|---|
| | | non-zero | | |
| | IV | Data Confirmation | R | There is no data confirmation functionality in the application. User only has option of saving the data by clicking on "Save details" button. Other than that there is no functionality to confirm data. |
| | V | Data Modification | G | Data modification can be done anytime with an exception that some of the encounter dates can not be changed during subsequent data entry. E.g. LMP date, First ANC visit date cannot be changed during ANC second or ANC third visit data entry. |
| **4.** | | Data load on system | | |
| | I | Form elements | | |
| | a | Indicator to data element ratio | R | There are no program management specific indicators calculated from the application. Only one indicator "percentage of pregnancy registration" is being calculated for estimating registration completeness. No other program specific indicators are generated from the application. |
| | b | Number of forms to be filled from each facility or the Case load per data entry unit | R | The number of forms to be filled in a patient based system is significantly larger than facility based reporting. In patient based reporting the load of data entry is equal to the patient load under the facility multiplied by the number of forms per patient.<br>In this case the only measure of patient load per Block is birth rate [22.22 births/1000 population] divided by the total number of Blocks [6000 Blocks] multiplied by the number of encounters per case.<br>There are two programs and each program has certain encounters. Each encounter can be considered as one form.<br>Pregnancy tracking- 5 encounter (including registration)<br>Child tracking- 8 encounter (including registration)<br>Obviously the system requires a higher number of human resources to take this data entry load on a slow network connection. |
| | c | Form design | Y | Form is simple and is not lengthy but has many dropdowns. Pages with lot of Dropdowns tend to be slow to load on slow speed networks. |
| | II | Data archiving | | |
| | a | within the database | Y | Data can be archived within the database but by developers only. Administrators/ Super Users should also have limited rights to archive their old data. |
| | b | in a separate database | Y | Data can be archived in a separate database by developers only. However it seems that complete archiving has not been institutionalized yet. |
| | III | Case load per data entry unit | R | The number of forms to be filled in a patient based system is significantly larger than facility based reporting. In patient based reporting the load of data entry is equal to the patient load under the facility multiplied by the number of forms per patient. |
| | IV | System response time | G | Takes average 10 sec per page @1.18 mbps speed. |
| **5.** | | Unique identifier | | |

| | | | | |
|---|---|---|---|---|
| | I | Patient | G | Available. This identifier is of 16 digits, first two digits represent state codes, next two digits represent district codes and next three digits are PHC/CHC codes. All these three codes are census codes. Next two digits are sub centre codes to be given serially by Block HQ. Next one digit code is program code- for pregnancy tracking 1 and for child tracking 2 is used. Next two digits are year codes in which last 2 digits for the year is to be used e.g. if year is 2011 then 11 will be used as code. Last four digits are to be given serially to each mother / child starting from 0001. |
| | II | Provider | G | ANM & ASHA are given unique identifier in the state application. This identifier is state specific and is not universal. |
| | III | Facility | G | Each facility is also given a numeric code. |
| | IV | Encounter | Y | No obvious evidence of codes for visits/encounters. |
| **6.** | | Report generation | | |
| | I | By Design | | |
| | a | Static – predefined | G | Predefined reports are available to generate. |
| | b | Dynamic – can be configured by user | R | No functionality available for user to develop his/her own report. |
| | c | Report generation by programming/ SQL Queries | G | This functionality is available. |
| | d | Online Analytical Processing (OLAP) for user | R | Users don't have the flexibility of OLAP including - slice, dice, drill-down, drill-up, roll-up, pivot. |
| | II | By use | | |
| | a | Number based aggregated only | G | This report can be generated. |
| | b | Analyzed (indicator based) | Y | Only data completeness indicator report can be generated and no program specific indicators can be generated. |
| | III | User can generate aggregated report for his level and level below. | Y | PHC/CHC user and States can generate aggregate report for levels below. No other level can generate aggregate report for his level or levels below. |
| | IV | User can generate disaggregated report for his level and level below. | Y | Only PHC/CHC user can generate disaggregate report for levels below him. |
| | V | Data Mart | Y | There is no data mart functionality in MCTS application. However data is consolidated every night and aggregated data is used for all reports the next day. |
| | VI | Dashboard for decision makers | Y | Dashboard module is present but reports are static and mostly relates to data completeness. |
| | a | Showing values only | | |
| | (i) | Numbers and tables | G | Both number & tables are available. |
| | (ii) | Indicators | Y | Only data completeness percentage is present. No program management indicators are used. |

| | | | | |
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| | b | Graphical – Charts | Y | Few charts are used to show data completeness. |
| | VII | GIS-Map based data analysis | R | This functionality is not available. |
| **7.** | | System Flexibility (to define your own) | | |
| | I | Data fields | R | User cannot define their own data fields |
| | II | Indicators | R | User cannot define their own indicators |
| | III | Forms | R | User cannot define their own forms |
| | IV | Formats | R | User cannot define their own formats |
| | V | Reports | R | User cannot define their own reports |
| | VI | Dashboard | R | User cannot define their own dashboard |
| | VII | Rules Engine – To define Clinical Protocol and Disease Management based Rules | R | User cannot define their own rules. |
| | VIII | Workflow Engine – To define user defined public healthcare program specific workflow | R | User cannot define their workflow. (user has to follow the predefined hierarchy) |
| **8.** | | Standards | | |
| | I | Data Definitions – | | |
| | a | Vocabulary Standards | | |
| | (i) | For local - | G | Vocabulary used as per standard MCH tracking format from NRHM |
| | (ii) | For global – eg SNOMED, | R | Not defined in any documentation. |
| | b | Size | R | Not defined in any documentation. |
| | c | Type | R | Not defined in any documentation. |
| | II | Disease & Diagnosis code sets – Local codes, ICD 9, ICD 10 | R | Not defined in any documentation. |
| | III | Procedure & Service Code sets – eg Local codes, CPT, CAP | R | Not defined in any documentation. |
| | IV | Interoperability standards for integration – eg HL7, DICOM, SDMX.HT | R | No interoperability standards are used in MCTS. |
| **9.** | Data Privacy | | | |
| | I | Role-based access | R | Currently not available. Will be released after the system requirements freeze. |
| | II | Data locking | R | Data locking functionality is not available. The administrators don't want to lock the data because it is difficult to assign any fixed timeline for the ANMs to bring |

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| | | | | the paper data in for data entry. |
| | III | Password Protection | Y | Users have been assigned with ID & password and password expires in every 180 days. Password protection is weak. |
| | IV | Field Based Access Rights | R | This functionality is not available. |
| **10.** | Data Security | | | |
| | I | Data Changes/ Error corrections (Audit trails) | Y | System stores Log of only the last change done by any user in data entry screen. It does not specify what changes. |
| | II | Roll-back functionality | R | Roll-back functionality is not available in application. |
| | III | Data back-up including tiered backup | G | Data back-up is taken in the national server automatically. |
| | IV | Encryption - PKI usage | R | Encryption functionality is not available. |
| | V | Digital Signature Certificate Usage | R | Digital signature functionality is not available. |
| **11.** | | System Functions | | |
| | I | Search | G | Search option is available to search individual cases. Records can be searched by using name or by using ID. |
| | II | Feedback | G | Helpdesk option exists for feedback to the developers and designers of system. i.e. email ID for users to contact national level team for any query or any customization request. Also a Call center is developed at national level to verify the records and give feedback to the users of system. |
| | III | Help | Y | FAQs are available but help files for each functionality are not available. |
| | IV | System flexible to adapt to any Disease Program? | Y | Programmatically same design can be used, however it is not flexible for the administrator to apply to another program. |
| | V | Disease Specific Educational Content | R | Disease specific or RCH program specific educational content is not available. |
| | VI | Error handling | R | There is no error handling. There is no list of known bugs. On an average the user encounters at least 1 unhandled error message during each login session. |
| | VII | Deployment | | |
| | a | Online | G | MCTS is currently functioning online and is a central application in which states can enter their data online. Five states have their own system (Gujarat, Karnataka, Rajasthan, Tamil Nadu, and Chhattisgarh) and are sending their data on weekly or daily basis to central MCTS application in 80 desired columns. |
| | b | Offline | Y | Initially MCTS application had offline deployment and Haryana state was doing offline data entry. Later due to frequent changes in the online application, offline became obsolete as changes were not reflected in offline |

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| | | | | version. |
| **12.** | Other | | | |
| | I | Mobile user interface | Y | System can send registration status SMS to the user. The system has capability to send workplans on the mobile of the users, but is being held back due to administrative reasons such as matching the mobile number uniquely to the ANM. |
| | II | Capacity building/Change Management Methodology after initial implementation | Y | Capacity building for use of MCTS is done by MoHFW, where NIC participated in training users for the use of application. This is a centralized program and all cost related to its development, deployment and change management is borne by the central government. |
| | a | Skill Building | G | Skill building is done in most of the states as class room hands-on training. Sometimes state users are asked to come to Delhi for training and some training are done in state on their request. |
| | (i) | One time training | G | Most of the trainings are one time. |
| | (ii) | Ongoing handholding and support | Y | Grossly Inadequate - MCTS refresher training rides with HMIS training, though not always. |
| | b | End user hardware infrastructure | Y | Inadequate and obsolete - This is a responsibility of state, but some funds can be provided from center. States have not procured additional hardware for MCTS data entry because states are short of funds. |
| | c | Human Resource | Y | Similar to above no additional data entry operators provided to take the case load of patient based data entry. |
| | d | Protocol for HMIS related process | R | The need for changing from paper based protocols to IT based protocols has been felt. However IT based protocols has not been defined yet. |
| | III | Capacity building/Change management budget available as part of initial budgeting | G | Capacity building for use of MCTS is done by MoHFW, where NIC participated in training users for the use of application. This is a centralized program and all cost related to its development, deployment and change management is borne by the central government. |
| | IV | Capacity building/Change management process signed off during implementation | Y | Other than one time training and some refresher trainings, we haven't found any evidence of Capacity building/Change management process sign off. |
| | V | Software support through multi-year maintenance contract | Y | Software support is provided by NIC team that is doing the ongoing development of the system. Did not find any evidence of a maintenance contract. Ideally the support team should be different from the development team. |
| | VI | Hardware support through multi-year maintenance contract | Y | Hardware maintenance for computer and internet is done by states whereas centre is responsible for server support. End user hardware maintenance issues have been cited as a reason for lower adoption in the states. |
| | VII | Source code available? | G | NIC has developed the system, so the source code is available with NIC. |

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| | VIII | Open source Technology? – Proprietary v/s Open Source | G | Proprietary – Microsoft .Net has been used for developing the system. There is some license cost of .Net but the system is developed in-house so there is no license cost for the developed system. The IP resides with MoHFW. |
| | IX | Obsolete technology? | G | Latest technology – Microsoft .Net |
| | X | Software upgrades being done? | Y | Yes, system is updated continuously as requirements keep coming from the MoHFW & states. Continuous changes without a product lifecycle management and release management is technically risky for the IT system. The system can be rendered unstable if too many changes are done without keeping detailed documentation and configuration management as per standards e.g. CMMI. |
| | a | Software Configuration Management | R | Haven't noted any evidence of product life cycle management, release management, configuration management and SDLC documentation as per standards e.g. CMMI. |
| | b | Software Product Life Cycle Management | R | Haven't noted any evidence of product life cycle management, release management, configuration management and SDLC documentation as per standards e.g. CMMI. |
| | XI | Hardware upgrades being done? | Y | Hardware maintenance for computer and internet is done by states whereas center is responsible for server support. End user hardware maintenance issues have been cited as a reason for lower adoption in the states. |
| | XII | Infrastructure for scalability – e.g. SAN, Data Centre, Web Farm | G | Scalable hosted in NIC. |
| | XIII | Capex or Opex financing model? | | Capex |

## E. Did the system achieve the objective?

| | Main Objectives: | Remarks |
|---|---|---|
| **1** | MCTS was developed for reducing the IMR and MMR. | No evidence of IMR or MMR reducing yet. The patients who were outside the system are still outside the system. The system is merely converting paper to electronic format. |
| **2** | Centralised system for tracking each pregnancy - Name based reporting. | Although 1 Cr pregnancy cases have been recorded but this is only a fraction of the Birth rate in India! The system suffers from capacity building/change management issues. Achieving wide spread adoption is a distant dream. |
| **3** | Pushing standard protocols based work plan to the ANM and ASHA workers so that they don't miss any step in the protocol. | Work plan is generated for ANM and ASHA. A print out is given to her. However it is turning into an easy reporting tool rather than a tool to |

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| | | improve service levels. |
| **4** | Mother and child gets service in time. | No evidence of improving service levels as yet. |
| | **Supporting objectives:** | |
| **5** | Analysed data is available for administrative and resource planning | Only standard pre-defined reports are available. Flexibility for data analysis from different angles is still lacking. |
| **6** | Plan and roll-out trainings and skill upgrades as per region based in service levels | No significant improvement in skill levels yet. Capacity building suffers due to administrative structural rigidities. |

**Discussion:**

1. **Intuitive Form design –** The design of the UI is user friendly and intuitive. Form design has probably contributed towards a quick adoption and the data reaching 1 Cr records. An intuitive form design requires very little training.
2. **Reporting time delay -** MCTS has reduced time for reporting data from field. Although the delay is inherent in the process because the paper data travels from the field to the district level where it gets consolidated and converted to electronic format. Patient based alerts and consolidated reports are available to all the stakeholders in state and centre soon after the district converts the paper to electronic format.
3. **Patient based reporting -** Patient based reporting is the right thing to do but it is a huge cultural change from the traditional paper based system that works on aggregated data. The history of Healthcare-IT systems reveals that a slow democratic transition from paper based processes to electronic processes improves adoption. The resistance to change is a problem that needs to be removed step-by-step over time. Sudden change makes the *frog jump out of the hot water*. The human resource was designed for paper based system where the data from SC, PHC, and Block was aggregated at the District level and all aggregated reporting to the state and centre was done by the District, whereas, the MCTS IT system was designed for patient based reporting. The district level human resources got over stretched when fortnightly patient based reporting thru the IT system was applied to the existing process. Along with working on the aggregated data the resources at District level were assigned with an additional task of entering the patient based data received from SC, PHC and Block. Their primary focus shifted from doing the district level tasks to just entering the data.

4. **Monolithic design –** The system is following a monolithic design where it is becoming a sort of EMR for the patient based reporting. In some ways the design is a parallel to the centralised model that has failed in NHS UK. Ideally the public health system should be decentralised where the patient based reporting should be left to the EMR and the public health system gets a consolidated view of the granularity in the EMR. In the absence of an EMR, there is an attempt by MCTS to fill the gap all the way down to the patient level. Seems to be too early in the game. The first step should be to get the field staff into the habit of reporting consolidated figures in the electronic system. The EMR can be introduced to capture the patient based details at a later stage – Look at the recommendations section below.
5. **System is in flux -** The requirements of the system were never frozen and are constantly changing. It is very disturbing for the end user when confronted with partly developed/changing functionality and unhandled error messages. This becomes a huge adoption issue with lower education levels of end users. There is no evidence of product life cycle management, configuration management and release management. There is no traceability of any requirements document, design documents, test plans and test reports. No evidence of version control for each release. The system has turned into an application that is constantly in flux. Technically this is a dangerous situation because it renders the system unviable for the long-term use. A detailed technical evaluation was out of the scope of this study; however it is recommended to technically audit MCTS as per SDLC, PLM, ITIL and CMMI standards.
6. **Ad Hoc reports -** The flexibility to produce your own reports is lacking in the system. Lots of ad hoc reports are required which couldn't be thought of at the time of software system design. NIC spends a lot of time producing these ad hoc reports. Rather an online analytical processing [OLAP] functionality would have gone a long way to enable the users to produce their own reports.
7. **Master Data for facilities –** Different states follow different nomenclature and classifications of administrative levels e.g. Block, Taluka, CHC etc. Therefore freezing the master data about different facilities has been a challenge for the system design.
8. **Master Data for providers and staff –** Uniquely identifying each ANM, ASHA worker and mapping her mobile number has been a challenge. Therefore there is difficulty in rolling out the security features such as role-based-access control. Similar problems are encountered for personalised work plans thru mobile platforms.

9. **Network connectivity -** Network connectivity issues to the Block, PHC and Village level was cited as a reason for lower adoption and usage of the system. Although the system is patient based reporting but due to connectivity issues it is being entered by the district rather than the ANM and ASHA. The system is centrally hosted on the NIC servers. The response time depends on the speed of the internet in the field.
10. **Integration with other systems -** The need for integration with the web portal was felt and discussed but was not implemented due to technical and administrative structural rigidities.

## F. Recommendations

Get the data into the electronic system. We can't leave the data out. Fix the issues and run the existing systems.

6. Shift focus to consolidated reporting – System should allow granular reporting as well as consolidated reporting at different levels. Based on capacity building, let the States decide the granularity level from which they want to report. Therefore it is recommended to add functionality in MCTS to allow consolidated reporting for states/districts/blocks/CHCs/PHCs. Then do a massive change management to push the States that are lagging behind in adopting the reporting in electronic systems.
7. Change Management - Patient based reporting is the right thing to do but it is a huge cultural change from the traditional paper based system that works on aggregated data. History of Healthcare-IT systems clearly indicates that one can't achieve adoption by forcing the workers to do anything. The only successful model to improve adoption is a democratic way which is inclusive and not the autocratic way. Therefore there needs to be greater and sustained focus on capacity building and change management. Constant interventions are required to change the human behaviour. The resistance to change is a problem that needs to be removed step-by-step over time. Sudden change makes the *frog jump out of the hot water*.
8. Look at the big picture – Make the MCTS, DHIS2 and Web portal work in tandem to complete the big picture. Although each of these systems has a different approach to the same problem of IMR and MMR, but each has certain set of dedicated users. It is very important to get all the data into the electronic system. Can't leave out any of the data from the electronic system. Else the whole concept of going electronic will collapse because partial data is meaningless in the long-run. Also lot of funds and time have been

sunk into all the 3 systems. Therefore it is advisable to invest in integrating the 3 systems.

9. Integration – A central Data Warehouse is required to which all the 3 systems feed their respective data through HL7 based integration. This is to ensure that the data is not lost. The data warehouse can be used for reporting numbers consolidated from all the 3 systems.
10. Fix the technical issues related to requirements, design, product life cycle management, release management etc. Technically stabilise the system so that the long-term viability improves and the data is secure.

**Sources of Data for the report:**

| Sl. | Sources of Data | Remarks |
|---|---|---|
| 1 | Interview of stakeholders | 04/Nov/2011 - Had a meeting with the NIC team developing and supporting MCTS @ Nirman Bhavan. |
| 2 | System Requirement Specifications Document | NA |
| 3 | Functional Design Document | NA |
| 4 | Technical Design Document | NA |
| 5 | System Architecture Document | NA |
| 6 | Test Cases and Test Report Document | NA |
| 7 | User Manual | Help available online in the system |
| 8 | Other | NA |
| 9 | Live System Demo | Available |

**References:**


- MCTS Forms Accessed from http://nrhm-mis.nic.in/Downloads.aspx, on 03/11/2011, 12:30 PM.
- Operational Manual for Mother and Child Tracking System v1.2 Accessed from http://nrhm-mis.nic.in/Downloads.aspx, on 03/11/2011, 2:30 PM.
- Instructions for filling up MCTS form http://nrhm-mis.nic.in/Downloads.aspx, on 03/11/2011, 03:30 PM.

## III. District Health Information Software (DHIS)

District Health Information Software (DHIS) is a public health system from The University of Oslo's Society for Health Information Systems Programme [HISP] implemented in India. It was developed to help strengthen Health Management Information Systems [HMIS] under National Rural Health Mission (NRHM). It was believed that DHIS will be able to help NRHM focus on decentralised planning and District health management.

**A. Problem Statement:** Prior to NRHM, health systems were struggling with timeliness and poor quality of data reaching up to the decision makers. Some disease programs did computerisation but resulted in silos of their reporting systems. These fragmented information systems were too focused on their specific program and were of no help to address the challenges of District health management.

**B. Objective of developing the Electronic System:** Objective was "To design and develop a web-based, free and open-source system for data collection, validation, analysis, and presentation of aggregate statistical data. This system should allow distributed data collection and distributed dissemination of data, meeting the requirements of a health management information system." Objectives of developing DHIS can be divided into the following.

**1. Main objectives:**

I. Should enable local level data analysis and use of information.
II. Should improve information culture and evidence based decision making.
III. Local level program managers must be able to identify problems and take corrective actions.

**2. Supporting objectives:**

I. Development of highly flexible system for reporting aggregate facility data.
II. System should be based on open source platforms.
III. System should be able to collect data and provide analysis at each level of hierarchy.
IV. Flexibility for users to customise forms, data elements, indicators and reports.
V. Ability to fit any public health program in any geography.
VI. Ability to be integrated with other reporting systems.
VII. Provide data validation and data quality check.
VIII. Provide dashboards for decision makers.

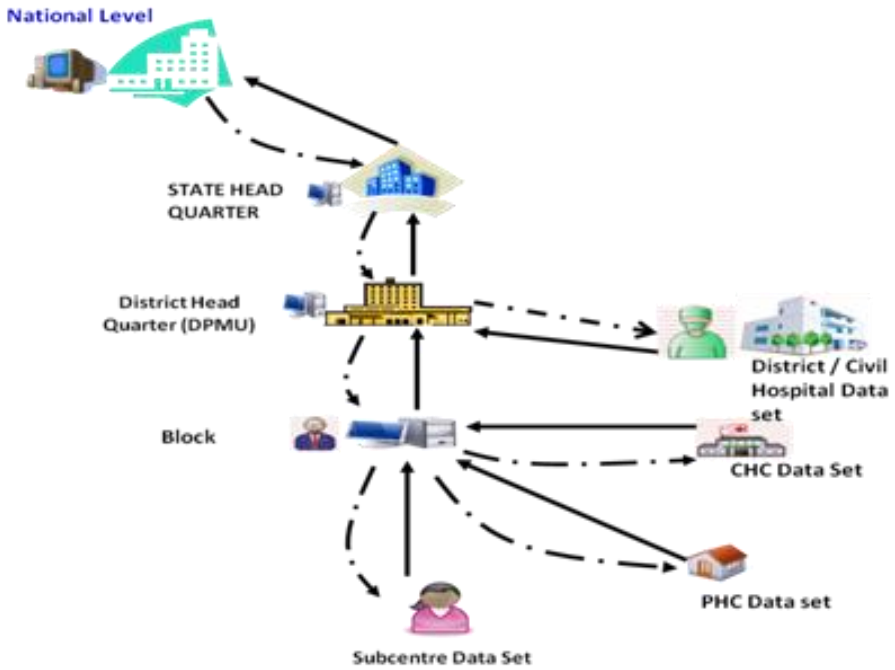
**C. Brief overview of system :** DHIS is a flexible system designed to adapt to any public health program. Here it has been configured for NRHM forms, reporting cycle, analysis and workflow.

NHRM has reformed its HMIS guidelines, which includes rationalization of the data elements, designing of data sets for facility based reporting and defining of information flow. DHIS follows NRHM's new data sets - SC form, PHC form and CHC/ Hospital form. Each facility is mandated to report their monthly data in these forms. These forms are meant to report Reproductive Child Health services (RCH), any related death and inventory details for program management.

**Information Flow-**

On a monthly basis each facility under the Block (SC, PHC, and CHC) sends hard copy reports to the Block. Block enters the data into the DHIS application. District Hospitals are required to report their data directly to District HQ for data entry. After all facilities enter their data, "District Monthly Consolidated Report" can be generated and can be uploaded to the National HMIS Web Portal.

DHIS is highly customisable; therefore point and level of data entry can be decided based on local situations. Some States started with consolidated data entry at District level, and later allowed the Blocks to enter their own data in DHIS; whereas other States started with facility-wise data entry.



## D. Gaps & opportunities

The detailed study of the system was done based on a pre-defined set of parameters. The details of the findings are given in the table below. Red and Yellow items are the gaps and their corresponding remarks explain the opportunities for improvements.

| SN | | Functionality | | Comments |
|---|---|---|---|---|
| **1.** | | **User Friendliness** | | |
| | I | Simplicity - Average Number of panels, keystrokes and mouse clicks. | G | DHIS is a simple application with easy to understand features. Panels, buttons, display don't confuse the user. It is easy to use for first time users as well. Average 10 keystrokes are required to accomplish any task in the application. |
| | II | Time to fill one form with average number of data elements<br>• 0-15 minutes<br>• 15-30 Minutes<br>• 30- 60 minutes<br>• More than 60 minutes | G | Average time for data entry in SC form is- 15 minutes.<br>Average time for data entry in PHC form is 20 minutes.<br>Average time for data entry in CHC form is 25 minutes.<br>Average time for data entry in District Stock form is 30 minutes.<br>Average time to fill any form is **20 minutes**. |
| | II | Field Defaults | G | Field defaults are present wherever required. E.g. reports have field defaults for NRHM reports which is most required by users. |
| | III | Mandatory Fields Indication | G | Mandatory fields are highlighted with the asterisk (*) sign. It is available for defining data elements, indicators, validation rules etc. But all data entry cells are not mandatory and are not marked with asterisk sign. |
| | IV | Use of Tabs | G | Use of tab is noted. |
| | V | Field Tab Order | G | Field tab order was noted. |
| | VI | Color Definition | G | 7 themes are available for users to change display colour of the application. |
| | VII | Section Segregation | Y | Section segregation is not clear, either by colours or font difference. Section segregation helps the user to quickly locate the area of interest and complete the job faster.<br>The functionality is available and user has privilege to change it. |
| | VIII | Scrolling | G | Only vertical scrolling in available where-ever required. |
| **2.** | | **Data Entry & associated functionality** | | |
| | I | Data entry by reference | Y | No data entry is done by reference. It is not a big issue but it is a good practice to have reference ranges for data entry. The line listing is a free form data entry and in a good design that should be avoided. |
| | II | Data entry by value | G | Data entry is done by value only. |
| | II | Data entry - Manually | G | Manual data entry functionality is available. |
| | III | Data entry- by excel import | G | Data entry using excel import is available. Coded excel sheets for each facility (SC, PHC, CHC) are available on HMIS Web Portal to download. After |

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| | | | | data entry these excel sheets can be uploaded in DHIS. |
| | IV | At every level does it allow data entry of figures consolidated from facilities below it? | G | Yes at every level consolidated data entry can be done. |
| | V | At every level does it allow data entry of individual facilities below it? | G | Yes at every level individual facility data can be entered in DHIS application. It has no functionality to enter individual patient data, only line listing of birth & deaths can be entered. |
| **3** | | **Data Quality check functionality** | | |
| | I | Data validation | | |
| | | a | During data entry- front end validation | G | During data entry value for each data element is checked for minimum average value and maximum average value. Violations will be shown to user in pop-up window. This functionality is available to show only data entry errors; however data will be saved in the database. |
| | | b | During data entry-validation done from back-end | G | No validations are used during data entry from back-end. Deliberately all validations are kept in front end itself. Validations from back-end are more expensive on slow speed networks. |
| | | c | After data entry | G | Post data entry validation functionality is available which compares value of one data element with other comparable data element value.<br>This functionality is available for selected data elements only. |
| | | d | Validation Rules for Imports | G | Excel based import functionality is available. Excel sheet has inbuilt validation defined by macros for accepting numbers only.<br>Validation is also available for importing excel sheet; the system will reject the Excel if any mismatch. |
| | | e | Auto Validation for Excel Based Imports | Y | There is no auto correction for Excel imports; violations lead to rejection of import. A good system becomes a mentor for the user when it spots errors in data entry and throws suggestions for correction. |
| | II | Identify duplication | Y | Duplicate identification functionality is not available. This can be covered by the data entry validations to check for duplicate reporting. |
| | III | Assess completeness | | |
| | | a | Of all Reporting Units | G | Data completeness for all reporting units can be assessed using DHIS application. |
| | | b | Timeliness | R | There is no way to know the timeliness of data entry in DHIS. This is an important function to reveal % of late entry and enforce discipline in data entry. |
| | | c | Differentiate between zero & non-zero | G | System has functionality to differentiate zero and non zero values and identify Null reporting. |
| | IV | Data Confirmation | Y | Data confirmation function is available in the product but not available in the implementations in India. |

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| | V | Data Modification | G | User can modify data anytime until it is locked. |
| **4.** | | **Data load on system** | | |
| | I | Form elements | | |
| | a | Indicator to data element ratio | G | 28 indicators per 100 data element. |
| | b | Number of forms to be filled from each facility | G | DHIS provides facility-wise data entry in application. Each facility is required to fill one form on an average on monthly basis. |
| | c | Form design | G | Data entry form is simple and is similar to the hard copy provided to the facilities for data reporting. On an average each form is 3-5 pages long depending on the facility type. |
| | II | Data archiving | | |
| | a | within the database | G | Data can be archived within the database but by developers only.<br><br>Administrators/ Super users should also have privileges to do archiving. Currently DHIS does not provide this function. |
| | b | in a separate database | G | Data can be archived in a separate database by developers only.<br><br>Administrators/ Super users should also have privileges to do archiving. Currently DHIS does not provide this function. |
| | III | Case load per data entry unit | R | States where DHIS application is used, ideal data entry unit is Block. On an average 120-130 facility report is to be entered per Block on monthly basis. The facility based data entry at District/Block level lays heavy pressure on the District/Block level human resource. |
| | IV | System response time | G | It takes 7-10 sec per page @ 0.89 Mbps speed to open any page however it takes 1 to 1:30 minutes to generate a report at same speed. |
| **5.** | | **Unique identifier** | | |
| | I | Patient | G | This functionality is available in Andhra Pradesh DHIS application. Multiple identifiers can be used to identify a patient. In this system, system generated ID is used to identify a patient. |
| | II | Provider | G | This functionality is available in Andhra Pradesh DHIS. |
| | III | Facility | G | Unique ID available on back-end. Though not visible to users. |
| | IV | Encounter | G | Unique ID available on back-end. Though not visible to users. |
| **6.** | | **Report generation** | | |
| | I | By Design | | |
| | a | Static – predefined | G | Predefined reports are available to generate. |
| | b | Dynamic – can be configured by user | G | This functionality is available. User can define their own data elements and generate their report. Another way is to define the report in Excel and |

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| | | | | | mapping it with xml and uploading the format in DHIS. This requires advanced user skills. |
| | | c | Report generation by programming/ SQL Queries | G | Full flexibility is available to programmers. |
| | | d | Online Analytical Processing (OLAP) for user | G | OLAP functions are available in DHIS such as consolidation, drill-down and some slicing-dicing features. |
| | II | | By use | | |
| | | a | Number based aggregated only | G | Number based aggregated report can be generated. |
| | | b | Analyzed (indicator based) | G | Indicator based report can be generated from Data Analyser and from report section. |
| | III | | User can generate aggregated report for his level and level below. | G | This function is available in DHIS. |
| | IV | | User can generate disaggregated report for his level and level below. | G | This function is available in DHIS. |
| | V | | Data Mart | G | Data Mart functionality is available in DHIS. Once data mart is initiated, data till date will be saved separately to generate all reports. This function was developed to reduce data processing load on the application. |
| | VI | | Dashboard for decision makers | G | Dashboard module is present in DHIS where user can select data elements and indicators to generate report. |
| | | a | Showing values only | | |
| | | (i) | Numbers and tables | G | Both number & tables are available. |
| | | (ii) | Indicators | G | DHIS has functionality to choose indicators and generate reports for any level of hierarchy. |
| | | b | Graphical – Charts | G | This function is available in DHIS. |
| | VII | | GIS-Map based data analysis | G | This function is available in DHIS. |
| **7.** | | | **System Flexibility (to define your own)** | | |
| | I | | Data fields | G | User can define their own data fields |
| | II | | Indicators | G | User can define their own indicators |
| | III | | Forms | G | User can define their own forms |
| | IV | | Formats | G | User can define their own formats |
| | V | | Reports | G | User can define their own Reports |
| | VI | | Dashboard | G | User can define his /her own dashboard and the format can be saved for the future use. |
| | VII | | Rules Engine – To define Clinical Protocol and Disease Management based Rules | R | Rule engine for clinical protocol and disease management is not available. |
| | VIII | | Workflow Engine – To define user defined public healthcare program specific workflow | G | There are 7 levels and the flexibility is provided to name the levels and define the work flow at each level. |

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| **8.** | **Standards** | | | |
| | I | Data Definitions – | | |
| | a | Vocabulary Standards | | |
| | (i) | For local - | G | Vocabulary taken from NRHM forms. |
| | (ii) | For global – eg SNOMED, | R | Global vocabulary standards are not available. |
| | b | Size | R | The size is not defined in any document. |
| | c | Type | G | This function is available in DHIS. |
| | II | Disease & Diagnosis code sets – Local codes, ICD 9, ICD 10 | R | There are no Standard disease codes in DHIS. |
| | III | Procedure & Service Code sets – eg Local codes, CPT, CAP | R | There are no procedure codes used in DHIS. |
| | IV | Interoperability standards for integration – eg HL7, DICOM, SDMX.HD | Y | DHIS uses WHO defined open data standards for data transfer called SDMX.HD, DFX, XML, and CSV. However it lacks support for HL7 and DICOM. |
| **9.** | **Data Privacy** | | | |
| | I | Role-based access | G | Role-based access functionality is available for each user. |
| | II | Data locking | G | Data locking functionality is available in DHIS. Data entry cannot be done after data locking. However Data entry can be unlocked with super-user privileges. |
| | III | Password Protection | Y | User has been assigned with password which incorporates special characters but is does not expire. |
| | IV | Field Based Access Rights | G | This functionality is available. |
| **10.** | **Data Security** | | | |
| | I | Data Changes/ Error corrections (Audit trails) | G | System keeps logs in the back-end which can be generated by user. |
| | II | Roll-back facility | R | Does not have roll back function. |
| | III | Data back-up including tiered backup | G | Scheduled Back-up is taken in server automatically and in remote settings. |
| | IV | Encryption - PKI usage | G | This function is available. |
| | V | Digital Signature Certificate Usage | R | Digital signature is not available. |
| **11.** | | **System Functions** | | |
| | I | Search | G | Search option is available but is limited to searching organization units, data elements and for indicators. |
| | II | Feedback | Y | Feedback can be given through email Id. However no dedicated team allocated for looking into it. |
| | III | Help | G | Help files are available in each section. |
| | IV | System flexible to adapt to any Disease Program? | G | System is completely flexible to adapt to any program. This is one of the strong points of DHIS. |
| | V | Disease Specific Educational Content | R | Disease specific and RCH program specific educational content is not available. |
| | VI | Error handling | R | Error handling is poor in DHIS. The system throws up unsightly error messages. On encountering an |

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| | | | | error it only specifies to user one option –"go back." |
| | VII | Deployment | | |
| | a | Online | G | DHIS is deployed in online mode now. |
| | b | Offline | G | Offline function is available in DHIS but is not being used. Uttarakhand state was using offline application but now it has also switched to on online application. |
| **12.** | **Other** | | | |
| | I | Mobile user interface | Y | Data input function exists from mobile to system in the form of SMS. However output from system to mobile is yet to be developed. |
| | II | Capacity building/Change Management Methodology after initial implementation | Y | Formal capacity building in a structured way was not undertaken due to administrative and structural rigidities |
| | a | Skill Building | Y | Skill building is done in most of the states as class room hands-on training. One HMIS support person is provided in each state by NHSRC for continuous training and support. |
| | (i) | One time training | G | States which requested DHIS support are provided with one time training as well as continuous training and support. |
| | (ii) | Ongoing handholding and support | Y | For handholding and support, NHSRC provided one HMIS person in each state. However formal capacity building in a structured way was not undertaken due to administrative and structural rigidities. |
| | b | End user hardware infrastructure | Y | Capacity building is the responsibility of state and funds were provided from the centre. However formal capacity building in a structured way was not undertaken due to administrative and structural rigidities. |
| | c | Human Resource | Y | Capacity building is the responsibility of state and funds were provided from the canter. However formal capacity building in a structured way was not undertaken due to administrative and structural rigidities. |
| | d | Protocol for HMIS related process | Y | The need for changing from paper based protocols to IT based protocols has been felt. However IT based protocols have not been defined yet. |
| | III | Capacity building/Change management budget available as part of initial budgeting | Y | Capacity building is the responsibility of state and funds were provided from the centre. However formal capacity building in a structured way was not undertaken due to administrative and structural rigidities. |
| | IV | Capacity building/Change management process signed off during implementation | G | Capacity building of state and district was part of the contract. However formal capacity building in a structured way was not undertaken due to administrative and structural rigidities. |
| | V | Software support through multi-year maintenance contract | G | Software support is provided by HISP India. |

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| | VI | Hardware support through multi-year maintenance contract | Y | NHSRC provided support for servers initially. Now states manage their own server and network. Few states have moved DHIS to their own servers in state. |
| | VII | Source code available? | G | Yes |
| | VIII | Open source Technology? – Proprietary v/s Open Source | G | Open source technology. |
| | IX | Obsolete technology? | G | No |
| | X | Software upgrades being done? | G | Yes, software is being updated periodically. |
| | a | Software Configuration Management | G | DHIS is a product. It is implemented in many countries. Therefore we can assume it has good configuration management. |
| | b | Software Product Life Cycle Management | G | DHIS works on participatory method of development and based on implementation experiences it gets updated. |
| | XI | Hardware upgrades being done? | G | Server updates are done by NHSRC but desktop hardware upgrade is states responsibility. |
| | XII | Infrastructure for scalability – e.g. SAN, Data Centre, Web Farm | G | Scalable hosting. |
| | XIII | Capex or Opex financing model? | | Capex |

### E. Did the system achieve the objective?

| | **Main objectives** | **Remarks** |
|---|---|---|
| **1** | Should enable local level data analysis and use of information. | DHIS is a completely flexible system that allows data analysis at all levels of hierarchy. However the usage of the system at local levels hasn't reached the desired levels due to lack of effective capacity building by the states and change management measures. |
| **2** | Should improve information culture and evidence based decision making. | Information culture and evidence based decision making hasn't been institutionalised in a big way due to lack of effective capacity building by the states and change management measures. |
| **3** | Local level program managers must be able to identify problems and take corrective actions. | Although DHIS provides the function, but the local program managers still struggle with their daily problems due to lack of effective capacity building by the states and change management measures. |
| | **Supporting objectives** | |
| **1** | Development of highly flexible system for reporting aggregate facility data. | DHIS is a highly flexible system for reporting aggregate facility data. |
| **2** | System should be based on open source platforms. | DHIS is based on open source platforms. |
| **3** | System should be able to collect data and provide analysis at each level of hierarchy. | DHIS collects data and provides analysis at each level of hierarchy. |

| | | |
|---|---|---|
| **4** | Flexibility for users to customise forms, data elements, indicators and reports. | DHIS provides full flexibility for users to customise forms, data elements, indicators and reports. |
| **5** | Ability to fit any public health program in any geography. | DHIS has the ability to be implemented for any public health program. |
| **6** | Ability to be integrated with other reporting systems. | DHIS can be integrated with other systems via a standard. However it lacks HL7 support. |
| **7** | Provide data validation and data quality check. | DHIS provides function to define rules for data validation and data quality check. |
| **8** | Provide dashboards for decision makers. | DHIS provides a dashboard function for advanced level users. However the usage of the system at local levels hasn't reached the desired levels due to lack of effective capacity building by the states and change management measures. |

**Discussions:**

1. **Flexibility to adapt to other programs-** DHIS is a very flexible system. It has the ability to be implemented for any public health program. The user can do primary level of customisation such as defining their own data elements and indicators. A skilled user (developer) can do further customisation of designing data entry Forms and defining report formats.
2. **Low Adoption -** The existing paradigm gives high [75-90%] attention to hardware and software and low [10-25%] attention to capacity building. This is lopsided because change management in Public Health requires considerable time and efforts. The system was started in 2008 and 20-22 States adopted the DHIS for deployment. With time its usage dwindled. Currently only 12 states are using DHIS for their HMIS data reporting. Some of the issues related to its low adoption are given below-

a. **Ownership of system-** Some States have taken the ownership of DHIS application and are doing ok. Whereas many others have not adopted DHIS as their own application and are looking towards NHSRC for providing external support.

b. **Duplication and confusion-** After the arrival of NRHM web portal and MCTS, duplication of the systems and processes has created confusion in the minds of the users. Lack of clear direction has led many States to stop using DHIS. Many of them have not even switched completely to web portal/MCTS. The valuable data has therefore become a casualty. This is a death knell for change management from paper based system to the electronic system. If the confusion prevails for too long the users will become weary of the situation and dump electronic systems all together.

c. **Lack of local DHIS experts -** States lack DHIS experts for hand holding the users. The flexibility of the system will remain unused if the local user does not graduate from basic

to intermediate to advanced level. Local users lack the skills for defining program specific data element. Therefore DHIS customisations have to be done by HISP and NHSRC.

d. **Local hardware capacity -** The state's policy and procedures for hardware procurement and maintenance is insensitive to technology obsolescence. States face challenges for upkeep of hardware – repair of faulty hardware and/or upgrade of obsolete hardware. As a result the field staff loses interest in using the software system, even though the software system maybe working fine.

e. **Training –** Initial training on the use of DHIS has been provided by the NHSRC but the sustained effort for refresher trainings is lacking. NHSRC has provided some HMIS experts in the absence of States taking the ownership of the DHIS and developing their own experts, but that is also inadequate.

f. **Slow system response –** The interviews of the NHSRC stakeholders revealed that the systems slows down when lots of users login. Slowness of any system can be due to reasons such as – slow connection speed, lengthy and heavy form design, complex business logic layer, memory leaks or database design issues. Study of the technical architecture is not in scope of this study but we recommend a detailed Technical evaluation and Load testing to further investigate the slowness issue.

g. **Error management protocols –** DHIS throws up unhandled error messages during operation. This is a big distraction and hindrance to the users. It is recommended that error handling is done within the DHIS code to prevent this issue hitting to the user.

h. **Local level data analysis & use of information –** Lack of skills on use of data. Culture of using the data for local decision making is lacking in the District, Block and below. Efforts are being made to provide local use of information but how to use the information is not very clear to the user.

3. **Integration with other systems –** DHIS follows the WHO standard of SDMX.HT for integration with other systems. However it lacks widely accepted integration standards such as HL7 v2.x in string format and HL7 v3.0 in XML format.

### F. Recommendations

Get the data into the electronic system. We can't leave the data out. Fix the issues and run the existing systems.

1. Look at the big picture – Make the MCTS, DHIS2 and Web portal work in tandem to complete the big picture. Although each of these systems has a different approach to the same problem of IMR and MMR, but each has certain set of dedicated users. It is very important to get all the data into the electronic system. Can't leave out any of the data from the electronic system. Else the whole concept of going electronic will collapse

because partial data is meaningless in the long-run. Also lot of funds and time have been sunk into all the 3 systems. Therefore it is advisable to invest in integrating the 3 systems.

2. Integration – A central Data Warehouse is required to which all the 3 systems feed their respective data through HL7 based integration. This is to ensure that the data is not lost. The data warehouse can be used for reporting numbers consolidated from all the 3 systems.
3. Change Management – There needs to be greater and sustained focus on capacity building and change management in terms of people, process and technology. Put in place sustained training, hand holding and help desk support. Constant interventions are required to change the human behaviour. The resistance to change is a problem that needs to be removed step-by-step over time. Sudden change makes the *frog jump out of the hot water*. History of Healthcare-IT systems clearly indicates that one can't achieve adoption by forcing the workers to do anything. The only successful model to improve adoption is a democratic way which is inclusive and not the autocratic way.

**Sources of Data for the report:**

| Sl. | Sources of Data | Remarks |
|---|---|---|
| **1** | Interview of stakeholders | Had a meeting with John Lewis of HISP. |
| **2** | System Requirement Specifications Document | Available |
| **3** | Functional Design Document | NA |
| **4** | Technical Design Document | NA |
| **5** | System Architecture Document | NA |
| **6** | Test Cases and Test Report Document | NA |
| **7** | User Manual | Available |
| **8** | Other | Overview of DHIS from various reports, research papers etc. |
| **9** | Live System Demo | Available |

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# I. National Anti Malaria Management Information System (NAMMIS)

National Anti Malaria Management Information System [NAMMIS] was sponsored by National Anti Malaria Programme (NAMP), now renamed as National Vector Borne Disease Control Programme (NVBDCP), and developed by TCS between 2002-2003 for reporting malaria incidence and timely intervention.

## A. Problem Statement:

Early detection, prompt treatment and effective vector control has been an issue in the manual system. Evidence based Logistic planning has been a distant dream due to lack of timely access and analysis of the data in manual systems. Manual systems haven't been effective for staff training, effective feedback, monitoring and evaluation.

## B. Objective of developing the Electronic System:

National Malaria Control Program has been developed with a focus on Early case Detection and Prompt Treatment (EDPT) and Vector Control (VCT). It was expected that computerisation should also help in Logistics Planning (LPL) in addition to the some information on expenditure, entomology, IEC and training. Objectives of developing NAMMIS can be divided into main and supporting objectives.

### 1. Main Objectives:

I. Early case Detection and Prompt Treatment - Information for timely intervention wasn't available from manual system. It gave the relevant information with a delay of 2.5 months.
II. Local analysis and use of information -Analysis of data at the District, Block and PHC level was required so that they could get actionable information at the local level itself.
III. Data Sharing - Sharing of data between States was required because diseases don't know state boundaries.
IV. Real time data need- Real time alerts of Malaria Falciparum are required for prevention of spread. Traditionally alerts were sent via telegram.
V. Vector Control (spraying activities) – Optimise spraying as per disease spikes.
VI. Urban Malaria Scheme (UMS) - Optimise intervention as per disease spikes.

### 2. Supporting objectives:

I. Logistics Planning - stock entry and planning of requirement for insecticides, anti-malarials and larvicides.
II. Sentinel Hospitals - capture of patient-wise details from certain hospitals for research and analysis.
III. Information, Education and Communication (IEC) regarding the disease
IV. Training - detail of training activities
V. Key elements related to expenditure and staffing
VI. Malaria health map
VII. Entomology - capture of vector density and vector susceptibility

Considering above objectives NAMMIS was developed in consultation with various stakeholders, and users in Centre as well as in the States.

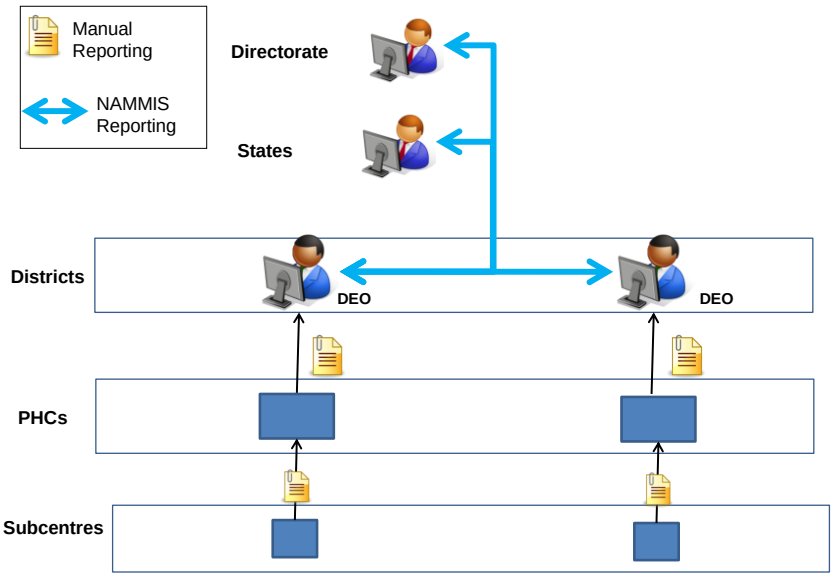
C. **Brief overview of system:** Pre-NAMMIS data was reported manually from the field and compiled at various levels before reaching to the directorate. States had their own reporting variations and some States even had their own software (e.g. Gujarat, Andhra Pradesh). Therefore the Directorate realised the opportunity to computerise the system and rationalise the information collected in different States.

**Information Flow-**

Form M1 to M4 are used to collect data and reporting from the field for case detection & management and Form VC1 to VC12 are used to collect data and reporting vector control from the field. Using these forms, compiled data is sent to the next level on fortnightly basis. Lowest unit of data collection is Sub-Centre, Ward & Sentinel Hospitals.

From the villages, data is collected by male workers and manually compiled at Sub-Centre to make aggregated Sub-Centre report. Sub-Centre report is sent to the PHC and from the PHC it reaches the District. In the District data entry operator enters the data into computer application.

**Reporting System – Data Flow**




**Reports-** Various reports can be generated by the users depending on their level of access. Very little data analysis is allowed at the lower levels. Apart from this all users have facility to see bulletins available in the application. Map-based analysis can also be seen by all the users.

## D. Gaps & opportunities

The detailed study of the system was done based on a pre-defined set of parameters. The details of the findings are given in the table below. Red and Yellow items are the gaps and their corresponding remarks explain the opportunities for improvements.

| S.N | | Functionality | | Comments |
|---|---|---|---|---|
| **1.** | | User Friendliness | | |
| | I | Simplicity - Average Number of panels, keystrokes and mouse clicks | Y | NAMMIS application has very simple outlay which is easily understandable but has navigation problems. Average 10 key strokes are required to complete a task in the application. |
| | II | Time to fill one form with average number of data elements<br>* 0-15 minutes<br>* 15-30 Minutes<br>*30- 60 minutes<br>* More than 60 minutes | G | To fill one form it takes around 15-30 minutes of time. |
| | II | Field Defaults | G | Field defaults are present wherever required. |
| | III | Mandatory Fields Indication | G | Mandatory field are star (*) marked in red color. |
| | IV | Use of Tabs | G | Use of Tabs is noted. |
| | V | Field Tab Order | G | Tab order is sequential. |
| | VI | Color Definition | Y | In NAMMIS application screens are uniform whereas sections are colored differently for clear identification. Color coding is also available to identify periodicity of data entry for each form (red-monthly, green-yearly, blue-as & when) and type of output report (green-query, red-report). However in data entry similar color-scheme is used to show importance of task, which is confusing to the user. |
| | VII | Section Segregation | G | This function is noted in NAMMIS. Sections are segregated with different colors. |
| | VIII | Scrolling | G | Only vertical scrolling is present in the system. |
| **2.** | Data Entry & associated functionality | | | |
| | I | Data entry by reference | R | No data entry is done by reference. |
| | II | Data entry by value | G | Data entry is done by value only. |
| | II | Data entry - Manually | G | Manual data entry function is available in application. |
| | III | Data entry- by excel import | G | Data entry by Exe file import is available. Application has offline function in which after data entry Exe file is generated, which can be further uploaded in online application. |
| | IV | At every level does it allow data entry of figures consolidated from facilities below it? | Y | NAMMIS has functionality of data entry for Sub-Center (M4) which has consolidated data from ASHA records (M1 Form) and no data from any other level can be entered in application. However data entry point is District and District user have the access to enter data in application for all SC. |

| | | | | |
|---|---|---|---|---|
| | V | At every level does it allow data entry of individual facilities below it? | R | Only District is allowed to enter data for all its Sub-Centers. |
| **3** | Data Quality check functionality | | | |
| | I | Data validation | | |
| | a | During data entry- front end validation | G | Strict validation rules are inbuilt in front-end, where two comparable data element's value is compared for any mismatch. |
| | b | During data entry-validation done from back-end | G | Back end validations are present in NAMMIS application e.g. in the report section if start date is greater than end date system throws error message that start date can't be greater than end date. |
| | c | After data entry | Y | At some places post data entry validations are present in the form of reminders or caution messages. e.g. If the user tries to save the Performance Parameter Weightage Master screen without filling all the fields, the system gives the message that "Please complete entries for All Weightages". |
| | d | Validation Rules for Imports | G | Validations for offline Exe file uploads are available and online systems rejects import files if there are any validation errors. |
| | e | Auto Validation for Excel Based Imports | R | This function is not available. |
| | II | Identify duplication | G | Duplication identification facility is available. |
| | III | Assess completeness | | |
| | a | Of all Reporting Units | Y | In NAMMIS application District, State and Directorate users can see data completeness through "tick report" which has three indicators 1. Green tick mark-i.e. data entry completed by all facilities. 2. Red tick mark i.e. data entry completed by some facilities and not by all 3. Red cross i.e. no data entry by any facility.<br>However this function doesn't help to identify data entry status for each facility. |
| | b | Timeliness | R | There is no function available to assess timeliness of data entry. |
| | c | Differentiate between zero & non-zero | R | System doesn't differentiate between zero and blank and considers each blank as zero in the application. |
| | IV | Data Confirmation | R | Data confirmation as a separate function is not available. After data entry user can only save data; which is considered as confirmation. However system asks for a confirmation before deleting of each record from the database. |
| | V | Data Modification | G | Data can be edited by users any number of times till year end data freezing process is done on their data. Request to freeze data comes from the State to Directorate at the end of calendar year.<br><br>During data editing, system allows editing of one |

| | | | | |
|---|---|---|---|---|
| | | | | field at a time. When the user clicks on Edit, automatically edit link gets replaced by update and cancel link, by clicking on update the data gets saved but few data in it is still non editable.<br><br>System records date of data entry and last modification dates in database for each facility data. |
| **4.** | | Data load on system | | |
| | I | Form elements | | |
| | a | Indicator to data element ratio | G | 23/236 = 10 indicators per 100 data element. |
| | b | Number of forms to be filled from each facility | Y | There are four form for which data is to be entered on monthly basis and 11 forms to be filled on yearly basis, 6 form are used on as and when basis. However from each Sub-Center only one form. i.e. M-4 is filled on monthly basis. This form is to be filled every fortnight in application but users fill this form on monthly basis in online application. |
| | c | Form design | G | Forms are simple and are not lengthy. Few forms such as spray form has some drop downs. |
| | II | Data archiving | R | No archiving functionality is available. |
| | a | within the database | R | This function is not available. |
| | b | in a separate database | R | This function is not available. |
| | III | Case load per data entry unit | Y | Data entry point in NAMMIS is District and on an average 150-200 Sub-Centers are there is each District for data entry. However data entry is fortnightly and which makes monthly data entry load to 300-400 forms per district. |
| | IV | System response time | Y | 5-10 seconds response time in login or opening any screen.<br>It takes 1.5-2.5 minutes for data entry screen to upload at the speed of 1.4Mbps |
| **5.** | | Unique identifier | | |
| | I | Patient | G | Hospital ID number is used in the application as unique identification number for each patient in one hospital. However no document mentions how this number will be generated with-in hospital. |
| | II | Provider | G | Provider identification number is used in the NAMMIS but there is no mention of how this number will be generated in the application. |
| | III | Facility | G | On the back-end each facility is given numeric code. |
| | IV | Encounter | R | Not present. |
| **6.** | | Report generation | | |
| | I | By Design | | |
| | a | Static – predefined | G | Predefined reports are available to generate. |
| | b | Dynamic – can be configured by user | R | No functionality available for user to develop his/her own report. |
| | c | Report generation by programming/ SQL | G | This functionality is available in the application. |

| | | | | | |
|---|---|---|---|---|---|
| | | | Queries | | |
| | | d | Online Analytical Processing (OLAP) for user | R | OLAP features are not available in NAMMIS application. |
| | | (i) | Consolidation | Y | Data can be consolidated only at District & State level and only in one standard form. No functionality to consolidate data for PHC & Block. |
| | | (ii) | Drill down | R | No drill down is possible as data cannot be consolidated at each level. |
| | | (iii) | Slicing-dicing | R | Slicing-dicing is not possible in NAMMIS. |
| | II | | By use | | |
| | | a | Number based aggregated only | G | Reports in the NAMMIS have granular data of the Sub-Centres and consolidated data of all the Sub-Centres in the District. |
| | | b | Analyzed (indicator based) | Y | In some static reports, indicators are also included. |
| | III | | User can generate aggregated report for his level and level below. | Y | Only District & State can generate report for all Sub-Centers. This report has disaggregated data of all Sub-Centers. |
| | IV | | User can generate disaggregated report for his level and level below. | Y | Only District & State can generate report for all Sub-Centers. This report has disaggregated data of all Sub-Centers. |
| | V | | Data Mart | R | This function is not available. |
| | VI | | Dashboard for decision makers | R | No dashboard is available. |
| | | a | Showing values only | | |
| | | (i) | Numbers and tables | G | Both number & tables are available but are not available as part of dashboard. |
| | | (ii) | Indicators | Y | Some reports have indicators included but are not available as part of dashboard. |
| | | b | Graphical – Charts | G | Pie charts, Bar Graphs can be viewed in reports but not as part of dashboard. |
| | VII | | GIS-Map based data analysis | G | This function is available. Maps have two levels - National & State. From both levels District can be identified but no analysis is possible below District level. |
| **7.** | | | System Flexibility (to define your own) | | |
| | I | | Data fields | R | This function is not available. |
| | II | | Indicators | R | This function is not available. |
| | III | | Forms | R | This function is not available. |
| | IV | | Formats | R | This function is not available. |
| | V | | Reports | R | This function is not available. |
| | VI | | Dashboard | R | This function is not available. |
| | VII | | Rules Engine – To define Clinical Protocol and Disease Management based Rules | R | This function is not available. |

| | | | | |
|---|---|---|---|---|
| | VIII | Workflow Engine – To define user defined public healthcare program specific workflow | R | User cannot define their workflow, but admin can change the levels and hierarchy. |
| **8.** | Standards | | | |
| | I | Data Definitions – | | |
| | a | Vocabulary Standards | | |
| | (i) | For local - | G | NAMMIS uses predefined and standardized codes and code values as per requirements provided by Directorate |
| | (ii) | For global – e.g. SNOMED, | R | Standard not being used. |
| | b | Size | R | This function is not available. |
| | c | Type | R | This function is not available. |
| | II | Disease & Diagnosis code sets – Local codes, ICD 9, ICD 10 | R | Disease and Diagnosis Codes not being used. |
| | III | Procedure & Service Code sets – eg Local codes, CPT, CAP | R | Procedure & Service Code not being used. |
| | IV | Interoperability standards for integration – eg HL7, DICOM, SDMX.HT | R | No integration and interoperability standards are being used. |
| **9.** | Data Privacy | | | |
| | I | Role-based access | G | This function is available and users are given access based on their role. |
| | II | Data locking | R | Data locking functionality is not available. |
| | III | Password Protection | Y | There is no specific password protection policy in NAMMIS. As per current features password doesn't require special characters, no character limit is defined and it doesn't expire. To protect from misuse each session expires after 10 minutes of inactivity and user has to re-login. |
| | IV | Field Based Access Rights | R | No field-based access rights functionality is available in NAMMIS. |
| **10.** | Data Security | | | |
| | I | Data Changes/ Error corrections (Audit trails) | Y | System records the log for when and by whom changes are done but there is no function available to know what changes are being made by the user. |
| | II | Roll-back facility | R | This functionality is not available in application. |
| | III | Data back-up including tiered backup | G | NAMMIS server is hosted in NIC, where NIC takes system back-up every month. Similarly Malaria Directorate also takes back-up every month in external hard disk drives. |
| | IV | Encryption - PKI usage | R | This functionality is not available. |
| | V | Digital Signature Certificate Usage | R | This functionality is not available. |
| **11.** | System Functions | | | |
| | I | Search | Y | Limited search options are available only for admin |

| | | | | |
|---|---|---|---|---|
| | | | | user, through which admin can search users of the system. |
| | II | Feedback | G | In place of feedback there is an option of "Discussion forum". This link enables users to post questions/queries and get responses. |
| | III | Help | G | NAMMIS has a dedicated section for help for all users where contact details of maintenance team are available. With this FAQs and User Manual are also available. |
| | IV | System flexible to adapt to any Disease Program? | R | System is not flexible to apply to another program. |
| | V | Disease Specific Educational Content | R | No disease specific educational content is available. |
| | VI | Error handling | G | There are very limited errors in NAMMIS and system has good error handling system. |
| | VII | Deployment | G | System has both online and offline deployment. |
| | a | Online | G | This function is available. |
| | b | Offline | G | This function is available. |
| **12.** | Other | | | |
| | I | Mobile user interface | R | This function is not available. |
| | II | Capacity building/Change Management Methodology after initial implementation | Y | After the first release of application, capacity building was done from the centre with the help of developing agency and later capacity building efforts were demand driven. |
| | a | Skill Building | | |
| | (i) | One time training | G | Initially directorate, with the help of development agency, has trained users in various groups. Each group had 5-7 States, and each State had one State-level user and two District-level users (one District data manager and one data entry operator). Initial training programs were planned for three days, where on first day orientation to system was given and next two days were used for hands-on training on application. |
| | (ii) | Ongoing handholding and support | Y | Post one time training rest of the trainings were done based on requirements from States. |
| | b | End user hardware infrastructure | Y | Initially all hardware such as computers, internet connectivity was provided by the Centre (malaria directorate). Capacity building is the responsibility of state and funds were provided from the centre. However formal capacity building in a structured way was not undertaken due to administrative and structural rigidities. |
| | c | Human Resource | Y | Data Managers in each District were provided from the Centre and in some Districts full time data entry operators were also provided from Centre. In rest of the places, other program data entry operators have played part time role. |
| | d | Protocol for HMIS related process | Y | Some protocols are defined and some of the protocols are still in the process of development. |
| | III | Capacity building/Change management budget | G | Initially States were provided with funds for end user hardware infrastructure and for recruitment of |

| | | | | |
|---|---|---|---|---|
| | | available as part of initial budgeting | | Data Manager and DEOs. |
| | IV | Capacity building/Change management process signed off during implementation | Y | Software development agency has provided one time training to all users. |
| | V | Software support through multi-year maintenance contract | G | For 3-4 years, maintenance support was provided to the NAMMIS application by development agency. |
| | VI | Hardware support through multi-year maintenance contract | Y | NAMMIS server is maintained by NIC.<br>End user hardware was procured by the Centre without any annual maintenance contract. States and Centre remain in confusion as to who will bear the expenses for hardware maintenance. |
| | VII | Source code available? | G | Yes |
| | VIII | Open source Technology? – Proprietary v/s Open Source | Y | Proprietary |
| | IX | Obsolete technology? | Y | System was developed on .Net 2003 which is older technology considering the recent updated version .Net 2010 available in market. |
| | X | Software upgrades being done? | G | Yes |
| | a | Software Configuration Management | G | Software configuration management was properly done by development agency. |
| | b | Software Product Life Cycle Management | G | Software life cycle management was properly done by the development agency. |
| | XI | Hardware upgrades being done? | Y | No. There is still confusion on who will upgrade the hardware. |
| | XII | Infrastructure for scalability – e.g. SAN, Data Centre, Web Farm | G | Scalable, hosted in NIC. |
| | XIII | Capex or Opex financing model? | G | Capex. |

## E. Did the system achieve the objective?

| **Main Objectives:** | | |
|---|---|---|
| I. | Early case Detection and Prompt Treatment | System has been developed to report data on fortnightly basis but States are reporting data on monthly basis. Predefined report becomes available to the Directorate with a delay of 1.5 months. |
| II. | Local analysis and use of information | Data analysis is not available. NAMMIS provides predefined reports at District level and above. |
| III. | Data Sharing | Strict hierarchy inhibits sharing of data between states. Directorate has the full overview and has to take reports for one state and pass to other with actionable information. |
| IV. | Real time data need | Data comes with a delay of 1.5 months. However the system allows near real-time alerts for immediate needs e.g. Malaria Falciparum case. |
| V. | Vector Control (spraying activities) | Very limited data available to take management action; only five small States are entering data in NAMMIS application. |

| | |
|---|---|
| VI. Urban Malaria Scheme (UMS) | Very limited data to take management action; only five small States entering data in NAMMIS application. |
| **Supporting objectives:** | Other objectives haven't been achieved through the system due to very low adoption of the system. |

**Discussion:**

1. **Reporting time delay** - NAMMIS has reduced time for reporting data from field. Now data reaches from field with about 1.5 month delay as compared to 2.5 months in manual reporting. The delay is inherent in the process because the paper data travels from the field to the District where it gets consolidated and converted to electronic format. However the alerts/reports e.g. of Falciparum incidence is available to the State and Centre soon after the District converts the paper to electronic format.
2. **Low Adoption** - The system was in use between 2003 and 2005. However the usage dwindled after that. 517 Districts (out of total 600 pan India) were trained to report on the system but now only 5 States/UT – Goa, TN, Chandigarh, Haryana and Gujarat- are entering data into the system. Over time the system has failed significantly in terms of adoption and usage. The possible reasons could be-
   I. Mandatory entry of population details - The system needs population data for data entry and data analysis. System has been developed in such a way that if population data is not entered, further data entry can not be done. In many States system usage reduced because accurate population data was not available in the application. This is not a good design!
   II. Lack of support for Annual Maintenance of computers- Hardware got obsolete, and wasn't upgraded by the States due to lack of knowledge at the time of writing the IT maintenance contract.
   III. Training - Training agency had been hired to provide initial training to all the Districts but the program suffered from Training issues for skill upgrades and induction of new staff. Constant hand holding could not be done for effective change management. As a result the adoption of the system remained low.
   IV. Network connectivity - Network connectivity issues to the Block, PHC and Village level was cited as a reason for lower adoption and usage of the system.
   V. Facility based reporting vs extra workload- The human resource was designed for paper based system where the data from SC, PHC, and Block was aggregated at the District level and all aggregated reporting to the state and centre was done by the District. Whereas the IT system was designed for facility based reporting. The District level human resources got over stretched when fortnightly facility based reporting thru the IT system, was applied to the existing process. Instead of working on the aggregated data the resources at District level were assigned with an additional task of entering the facility based data received from SC, PHC and Block. Their primary focus shifted from doing the District level tasks to just entering the data.
   VI. Flexibility- System had provisions for fortnightly data reporting from Sub Centres however the users of the system were not geared for such a change from monthly to fortnightly data reporting, which led to very limited data reporting in NAMMIS. System had no flexibility for the users to initially report data on monthly basis and then move to fortnightly when they were ready.

VII. Information overload is another contributory cause of fatigue and loss of interest. Out of 24 mandatory fields in every module, only 2-3 fields are really required for taking action and rest can be optional for additional information.

VIII. Application also had offline feature, its usage remained minimal because no support was provided to the users for offline data entry.

IX. Slow system response- Forms have to load a lot of options from the database, thus slowing down the system. It takes a long time for the user to do data entry. Slow system response is one of the reasons for low adoption.

3. **Local level data analysis & use of information** –
   I. Just as in the paper based system analytics was not provided at every level. Only the higher levels [Centre, State & in some cases District] had the analysis capability and the facilities in the lower hierarchy would be informed on need to know basis. Therefore there was no motivation in the lower hierarchy to enter data in electronic systems. There was nothing in it for them.
   II. Online analytical processing – The system has fixed predefined report formats. The flexibility to produce your own reports is lacking in the system. Lots of ad hoc reports are required which couldn't be thought of at the time of software system design.

4. **Integration with other systems** - The focus on NAMMIS was significantly reduced because the central agencies and states were asked to migrate to the new National Web Portal. The need for integration with the web portal was felt and discussed but was not implemented due to technical and administrative structural rigidities.

## F. Recommendations

Get the data into the electronic system. We can't leave the data out. Add a new system to plug the gap.

1. **Upgrade** - It is very important to get the data into the electronic system. Can't leave out the Districts that are no longer reporting the data in electronic system. The whole concept of going electronic will collapse because partial data is meaningless in the long-run. The existing NAMMIS system is archaic and has lived beyond its life – in terms of function and technology [built in .Net 2003]. Extremely poor adoption is evidence enough that the system has been rejected by the users. The Directorate obviously needs to upgrade to a better system [NAMMIS+].
2. **Procurement process for NAMMIS+** - NAMMIS+ should follow a well-defined procurement process starting from a workshop to write the detailed requirements. To make sure the system delivers as per the requirements - proper documentation of functional design, technical design, rigorous testing and long-term support services is required.
3. **NAMMIS+** should be a fully configurable and user friendly system. New system should be built based on the technical & operational learning from current system. Some of the issues which should be included in new system are discussed below-

i. Inputs – System should be flexible to take inputs in various ways - Consolidated numbers from District/Block; or Facility-wise; or Patient-based. Based on readiness of the States/Districts, the system should provide flexibility to define reporting periodicity and levels of reporting. Its ok to allow 1 state to enter consolidated numbers from District/Block; another state to do Facility-wise; and third state to accept Patient-based reports from the local HIS/EMR. The ASHA/ANM in another state should be able to enter data using mobile phones and interactive voice response [IVR]. The system should be flexible to convert all these inputs into consolidated data and indicators for public health management decision making.

ii. Analysis at all levels –Analytics capability should be provided at every facility so that they need not wait for actionable information of their own area. The local facility should be responsible for the health of their area rather than look upwards to the State and Centre. This is a great tool for change management as it motivates the staff to adopt the electronic system.

iii. Dedicated dashboard for data analysis with all OLAP functions- System should have OLAP functions for data analysis such as drill-down, slicing-dicing and consolidation features, roll-up, pivot. Dashboard should provide flexibility for the users to design their own reports for personalised data analysis.

iv. Clear policy of Data archiving & data back-up- Any system may get overloaded after some time if all data is stored in the system. There should be clear data archiving and data back-up policy defined for better system load management. No data archiving facility is currently available in NAMMIS.

v. System should support data privacy and have inbuilt data security features.

vi. Integration and interoperability standards- System should follow interoperability standards for data transfer.

vii. Disease & procedure codes- System should support disease and procedure codes for uniformity across all systems.

viii. Software & Hardware support- Current system adoption was low due to the lack of hardware support. Software life cycle management principle should be followed for better updates.

4. **Integration with other systems** - HL7 or XML based integration should be explored between old NAMMIS and the proposed NAMMIS+ system, to ensure that the data is not lost.

5. **Change Management** - Although the system seems to have been designed as per specifications given by the users, it suffers from adoption issues because of ineffective change management from paper based system to electronic system. History of Healthcare-IT systems clearly indicates that one can't achieve adoption by forcing the workers to do anything. The only successful model to improve adoption is a democratic way which is inclusive and not the autocratic way. Therefore there needs to be greater and sustained focus on capacity building and change management. Constant interventions are required to change the human behaviour. Current challenges stem from adoption issues related to training and hand-holding. Initial class room training should be followed by virtual Audio-Visual trainings and then computer based trainings and FAQs to help the user learn at will. Centralised call centre goes a long way in logging the problems of the users and provide help

desk support. Early adopters should be highlighted as champions and rewarded in some way to promote the adoption with other users. It is one of the most challenging tasks to bring about a cultural change in the users in terms of process orientation and change from paper based system to electronic system. However the success of any Health IT system depends on effective change management.

**Sources of Data for the report:**

| Sl. | Sources of Data | Remarks |
|---|---|---|
| 1 | Interview of stakeholders | 25/Oct/2011 - Had a meeting with the relevant stakeholders under the Chairmanship of Dr Akshay Dhariwal @ NCDC campus.<br>1/Dec/2011 – Had a second meeting with the IT team of NAMMIS. |
| 2 | System Requirement Specifications Document | Available |
| 3 | Functional Design Document | NA |
| 4 | Technical Design Document | Available |
| 5 | System Architecture Document | NA |
| 6 | Test Cases and Test Report Document | NA |
| 7 | User Manual | Available |
| 8 | Other | Overview Presentation from NVBDCP |
| 9 | Live System Demo | Available |

**References**:


- Operational manual for malaria implementation 2009 http://nvbdcp.gov.in/malaria11.html Accessed on 26/11/2011, 4:10 PM
- Malaria Control Strategies http://nvbdcp.gov.in/malaria11.html Accessed on 26/11/2011, 5:10 PM
- User Manual NAMMIS Application 2002.
- NAMMIS Software Requirement Specification 2002.
- NAMMIS System design Document 2002.

## II. Integrated Disease Surveillance Project (IDSP)

IDSP Application was sponsored by Integrated Disease Surveillance Project and developed by NIC between 2007-08 for collecting, compiling and reporting communicable disease data for early detection of outbreaks and to help initiate an effective response in timely manner.

**A. Problem Statement:** As country is passing through epidemiological transition many states are lagging far behind in mitigating the impact of communicable & non-communicable diseases. Through an effective disease surveillance system, outbreaks can be identified at initial level and corrective measures can be taken to improve health conditions. Any system that intends to address this challenge should be decentralized and state specific as states are at different level of preparedness and disease burden.

**B. Objective :** Main objective of IDSP project is "*to improve the information availability to the government health services and private health care providers on a set of high-priority diseases and risk factors, with a view to improving the on-the-ground responses to such diseases and risk factors.*

IDSP Project has four major components –

i. Establish & operate central disease surveillance unit to help coordinate and decentralize surveillance activities.
ii. Integrate and strengthen disease surveillance at district & state level for better coordination, data management and action.
iii. Improve laboratory services to upgrade laboratories and ensure quality.
iv. Impart skills through training support to achieve above objectives.

To achieve above objectives IDSP application has been designed & developed. Objectives of computerization of IDSP can be divided as follows.

1. **Speedy data reporting -**
   - Quick data transmission related to IDSP from lower facilities thru use of various mediums for data reporting such as IVR, Call Centers, Manual data entry etc. Including offline model for Private practitioners, district officers and data interface module.
   - Decentralized surveillance system - To establish a decentralized state based system of surveillance for communicable and non-communicable diseases.
   - Data Quality checks - System for validation, data verification, and error checking features in order to facilitate error free data availability.
   - Multilingual interface - Multilingual labels in order to facilitate data entry and limited report generation with multilingual features.
   - Financial data - Reporting of financial data and inventory data reporting.
   - Internal mailing system
2. **Early detection -**
   - Alerts and triggers based on data, to draw attention of decision makers and enable them for early intervention.
   - Data analysis - Monitoring, trend analysis, forecasting, and remedial actions at district, state and central level. Comparisons of diseases related data weekly, monthly & yearly. Provide a tool with vertical, horizontal, disease specific, location specific and season specific analysis in graphical and GIS based formats.

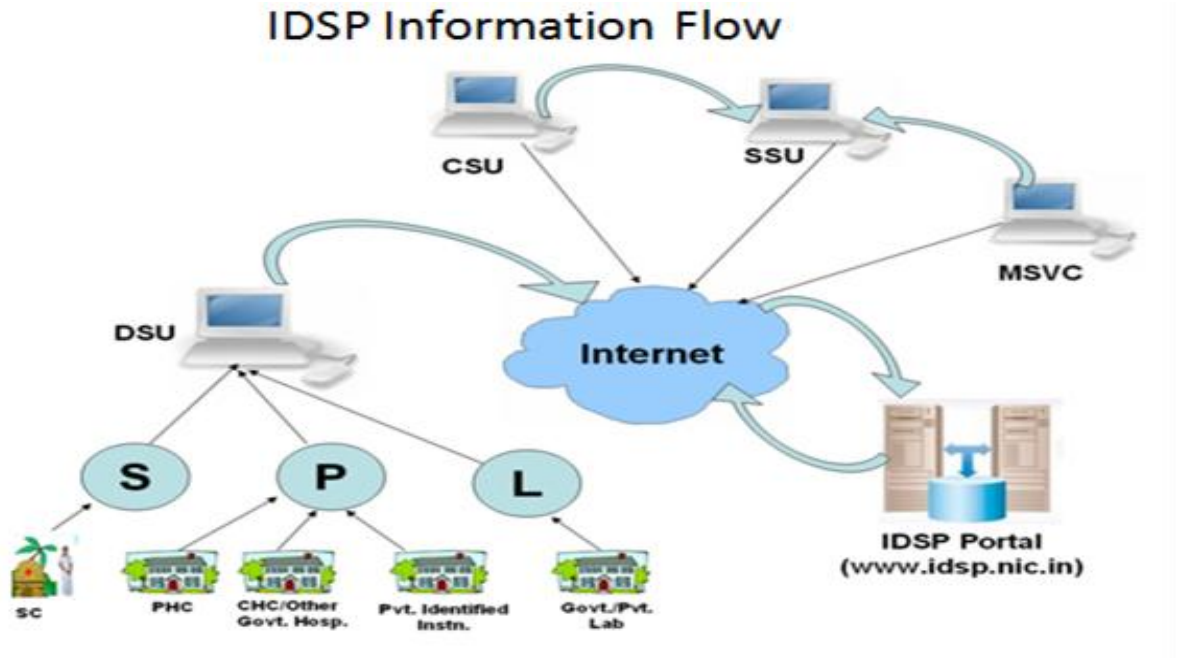
3. **Tele-education & distance learning** -
   - Virtual trainings through experts sitting in different locations.
   - To be used for telemedicine & Continuous Medical Education.
   - Reducing training time & cost
4. **Interactive electronic discussion –**
   - Connect central surveillance units to projects sites via video conference, discussion boards and chat rooms in order to provide timely guidance and expertise related to disease surveillance.
5. **Integration** –
   - Use IDSP's huge network connectivity investments thru ISRO & BSNL - for ICT enabled management of other national health programs.

### C. Brief overview of the System

IDSP system uses three forms to report data from field. Data entry point is District thru the District Surveillance Unit. System allows for reporting numbers only. Three forms P, S & L are used to report data on a weekly basis i.e. Monday thru Sunday.

| Reporting Form | Purpose | Reporting Unit |
|---|---|---|
| Form- S | Syndromic Surveillance | Filled by Health Worker of Sub centers, regularly on a weekly basis. |
| Form P | Presumptive Surveillance | Filled at PHC/CHC, Govt. / Private Hospitals, Private Practitioners, only for positive cases. |
| Form L | Laboratory Surveillance | Filled by PHC/CHC lab, District/ Private lab, State lab, National lab, only for positive cases. |

Data is first collected from peripheral facilities and sent to the block; from the block paper data reaches the District for electronic data entry. Facility-wise data entry in the system is done at the District. A pilot for data entry at block level has been attempted in Chhattisgarh state.



## D. Gaps & Opportunities

The detailed study of the system was done based on a pre-defined set of parameters. The details of the findings are given in the table below. Red and Yellow items are the gaps and their corresponding remarks explain the opportunities for improvements.

| S.N | | Functionality | | Comments |
|---|---|---|---|---|
| **1.** | **User Friendliness** | | | |
| | I | Simplicity - Average Number of panels, keystrokes and mouse clicks | G | IDSP application is very simple & has user friendly navigation. Minimal clicks are required to perform any task. Average 7-8 keystrokes are required to complete any task in application. |
| | II | Time to fill one form with average number of data elements<br>* 0-15 minutes<br>* 15-30 Minutes<br>*30- 60 minutes<br>* More than 60 minutes | G | S Form- 10-15 Minutes<br>P Form- 5-7 Minutes<br>L Form- 5-7 Minutes, and 3-5 minutes for each line listing data entry.<br><br>Average time for data entry is 8-10 Minutes per form. |
| | II | Field Defaults | G | Field defaults are present wherever required. |
| | III | Mandatory Fields Indication | Y | Mandatory fields are marked with asterisk sign (*). In some places where Mandatory fields are not marked by any sign are identified with validations. If the user tries to skip any mandatory field, system shows error message to the user that these fields are mandatory to be filled before proceeding further. This is not a good design because the user should be told upfront about mandatory fields. |
| | IV | Use of Tabs | G | This function is noted. |
| | V | Field Tab Order | G | This function is noted. |
| | VI | Color Definition | G | IDSP application works with a predefined theme. All screens in the application are uniform. |
| | VII | Section Segregation | G | Sections are segregated using different colors. |
| | VIII | Scrolling | Y | Vertical as well as horizontal scrolling is present. Horizontal scrolling is used in reports section where week by week data can be seen using horizontal scroll.<br>Horizontal scroll should be avoided as it forces user to use the mouse and it slows down the work. |
| **2.** | **Data Entry & associated functionality** | | | |
| | I | Data entry by reference | R | No data entry is done by reference. The system was not designed for it. |
| | II | Data entry by value | G | All data entry is by value only.<br>Line listing data entry is free form of data entry. However line listing is limited to confirmed cases in L-form. |
| | II | Data entry - Manually | G | This function is available. |
| | III | Data entry- by excel import | R | Data can't be entered by using Excel import or any offline method; only manual online data entry facility is available. |
| | IV | At every level does it allow data entry of figures | R | Consolidated data entry is not possible. The system lacks the ability to take consolidated data entry. |

| | | | | |
|---|---|---|---|---|
| | | consolidated from facilities below it? | | |
| | V | At every level does it allow data entry of individual facilities below it? | Y | District is allowed to enter facility-wise data in system. Chhattisgarh is the only state doing a pilot for facility-wise data entry from block level. |
| **3** | **Data Quality check facility** | | | |
| | I | Data validation | | |
| | a | During data entry- front end validation | R | Front end validations are available but are thrown up after data entry, during data save. |
| | b | During data entry- validation done from back-end | R | Back end validations are available but are thrown up after data entry, during data save. |
| | c | After data entry | G | Front end and Back end validations are thrown up after data entry, during data save. |
| | d | Validation Rules for Imports | R | This function is not available because imports are not possible. |
| | e | Auto Validation for Excel Based Imports | R | This function is not available because imports are not possible. |
| | II | Identify duplication | Y | The system does not allow duplicate data entry for the same week. There is no way to identify duplication in line listing records. |
| | III | Assess completeness | | |
| | a | Of all Reporting Units | Y | System generates Login status report and reporting status report. Through Login status report login status of all the users for the week are identified; whereas the Reporting status report tells about the number of facilities that have entered atleast one data element for the week. However there is no way to identify % completeness of data entered by each facility. |
| | b | Timeliness | G | Data is to be submitted weekly latest by Wednesday of next week. A report identifies number of facilities that reported data on time, number of facilities that did late entry and number of facilities that did not do any entry for each week. |
| | c | Differentiate between zero & non-zero | G | Null is the default value. Null is a blank but not zero. Null is considered as no data reported. User has to manually enter zero to show no cases identified. This is a best practice that should be adopted for other public health systems too. |
| | IV | Data Confirmation | R | Data confirmation facility is not available. User is responsible for the data entered. Data save is considered as data confirmation. |
| | V | Data Modification | G | Data can be modified till 15 days from the date of data entry. After that system locks the data. After that the data can be modified only by the IDSP Admin. |
| **4.** | **Data load on system** | | | |
| | I | Form elements | | |
| | a | Indicator to data element ratio | R | Couldn't find any program management indicators. The system works on absolute numbers. |

| | | | | |
|---|---|---|---|---|
| | b | Number of forms to be filled from each facility | G | On weekly basis one S-Form has to be filled from every sub-center. Other facilities need to fill one P-Form per week and L-Form is used by the Lab wherever Laboratory has to report anything for any week. |
| | c | Form design | G | Form is very simple and has only text boxes to enter numeric data. |
| II | | Data archiving | R | Data archiving function is not available currently. However clustering is being planned. After that only last 2-3 years data will be available online, rest will be archived. |
| | a | within the database | R | This function is not available. |
| | b | in a separate database | R | This function is not available. |
| III | | Case load per data entry unit | Y | District is the Data entry unit. Every week the District receives S-Form data from each Sub-center and P and L Forms from other facilities. Total form load per data entry unit on an average is 180-200 forms/ week. |
| IV | | System response time | G | 3-5 seconds response time in login or opening any screen. It takes 30-45 seconds to generate a report at the speed of 2.2971Mbps. |
| **5.** | **Unique identifier** | | | |
| I | | Patient | Y | This function is not available in IDSP. Line listing [Patient-based] data entry is being done without any identifier. Difficult to identify duplicates without identifiers. Ideally the line listing should have Patient ID and Encounter ID. |
| II | | Provider | R | This function is not available. The login ID is role specific but not provider [person] specific. |
| III | | Facility | G | For each facility numeric codes is used as identifier. |
| IV | | Encounter | R | This function is not available. Ideally the line listing should have Patient ID and Encounter ID. |
| **6.** | **Report generation** | | | |
| I | | By Design | | |
| | a | Static – predefined | G | All reports are static and are available to user in predefined format. |
| | b | Dynamic – can be configured by user | R | There is no flexibility for the user to configure their own reports. |
| | c | Report generation by programming/ SQL Queries | G | This function is available through which IT team at IDSP generates ad-hoc reports. |
| | d | Online Analytical Processing (OLAP) for user | R | All reports are static and are available to user in predefined format. |
| | i | Consolidation | Y | Consolidation is done at block, district & state. However monthly consolidation is not possible in application. |
| | ii | Drill down | Y | System can produce predefine reports only. Flexibility of Drill-down in reports is not available. However limited drill-down is available for hierarchy of facilities i.e. the user can see facility wise breakup. |

| | | | | |
|---|---|---|---|---|
| | iii | Slicing-dicing | Y | System can produce predefine reports only. Flexibility of Slicing-Dicing of data is not available. |
| | II | By use | | |
| | a | Number based aggregated only | G | Number based aggregated report can be generated. |
| | b | Analyzed (indicator based) | R | System doesn't generate any program management indicator based reports. Some data status reports can be shown in % [indicator]. |
| | III | User can generate aggregated report for his level and level below. | Y | Reports can show disaggregated data for each facility under a block; as well as aggregated data for all blocks under one district, and all districts aggregated data under one state. |
| | IV | User can generate disaggregated report for his level and level below. | Y | Reports can show disaggregated data for each facility under a block; as well as aggregated data for all blocks under one district, and all districts aggregated data under one state. |
| | V | Data Mart | R | This function is not available. |
| | VI | Dashboard for decision makers | R | Dashboards are not available. However some reports can show disaggregated data, aggregated data and graphical representation in a single window – this is too much data and too little actionable information for any decision maker. |
| | a | Showing values only | | |
| | i | Numbers and tables | G | This function is available. Reports can show disaggregated data and aggregated data in a tabular form. |
| | ii | Indicators | R | System does not show any program management indicators. |
| | b | Graphical – Charts | G | This function is available. Some reports can show disaggregated data, aggregated data and graphical representation in a single window. |
| | VII | GIS-Map based data analysis | R | This function is not available. |
| **7.** | **System Flexibility (to define your own)** | | | |
| | I | Data fields | R | This function is not available. The system doesn't allow any flexibility. |
| | II | Indicators | R | This function is not available. The system doesn't allow any flexibility. |
| | III | Forms | R | This function is not available. The system doesn't allow any flexibility. |
| | IV | Formats | R | This function is not available. The system doesn't allow any flexibility. |
| | V | Reports | R | This function is not available. The system doesn't allow any flexibility. |
| | VI | Dashboard | R | This function is not available. The system doesn't allow any flexibility. |
| | VII | Rules Engine – To define Clinical Protocol and Disease Management based Rules | R | This function is not available. The system doesn't allow any flexibility. |
| | VIII | Workflow Engine – To define user defined public | R | This function is not available. The system doesn't allow any flexibility. |

| | | | | |
|---|---|---|---|---|
| | | healthcare program specific workflow | | |
| **8.** | **Standards** | | | |
| | I | Data Definitions – | | |
| | a | Vocabulary Standards | | |
| | i | For local - | G | Local IDSP Program Vocabulary is used to report data in terms of predefined forms – S, P and L. |
| | ii | For global – e.g. SNOMED, | R | This function is not available. The system doesn't use any global standards. |
| | b | Size | R | Size of each data entry box is not defined anywhere. Could be an issue while integration with other systems. |
| | c | Type | R | Data type of each data entry box is not defined anywhere. Could be an issue while integration with other systems. |
| | II | Disease & Diagnosis code sets – Local codes, ICD 9, ICD 10 | R | This function is not available. |
| | III | Procedure & Service Code sets – eg Local codes, CPT, CAP | R | This function is not available. |
| | IV | Interoperability standards for integration – eg HL7, DICOM, SDMX.HT | R | This function is not available. Integration with other systems has been planned but not implemented due to prioritization. Also the difference in reporting cycles between different programs is a major issue in integration i.e. weekly, fortnightly, monthly etc. |
| **9.** | **Data Privacy** | | | |
| | I | Role-based access | R | The login ID is role specific but not person specific. Full Role-based access is planned but is not implemented. |
| | II | Data locking | G | Data is locked 15 days after the data entry i.e. the data can be edited for 15 days after the data entry. |
| | III | Password Protection | Y | Password policy is adopted where password is of 8 characters; but it doesn't expire and doesn't require special characters to be used in it. |
| | IV | Field Based Access Rights | R | This function is not available. |
| **10.** | **Data Security** | | | |
| | I | Data Changes/ Error corrections (Audit trails) | Y | Data modification - when and by whom gets recorded in system, but there is no way to identify what changes were done. |
| | II | Roll-back facility | R | This function is not available. |
| | III | Data back-up including tiered backup | G | IDSP is hosted at NIC and full data back-up is taken at every 7 days in local server. However every night daily data back-up is also taken. |
| | IV | Encryption - PKI usage | G | The system uses MD5 encryption. |
| | V | Digital Signature Certificate Usage | R | This function is not available. |
| **11.** | **System Functions** | | | |
| | I | Search | Y | There is no specific search function. However system allows to search reported outbreaks. |

| | | | | |
|---|---|---|---|---|
| | II | Feedback | G | Feedback by users can be given by email and online through the IDSP application. |
| | III | Help | G | Help files are not available. However application has lot of resource material available intended to help the users. |
| | IV | System flexible to adapt to any Disease Program? | R | System is built very specific to IDSP. It is not a flexible system. It cannot be adapted to report any other program. |
| | V | Disease Specific Educational Content | G | Lots of educational content related to communicable diseases is available in IDSP application. |
| | VI | Error handling | Y | Error messages are frequently encountered. |
| | VII | Deployment | | |
| | a | Online | G | This function is available. Application has online deployment only. |
| | b | Offline | R | This function is not available. |
| **12.** | **Other** | | | |
| | I | Mobile user interface | R | This function is not available however SMS based alert facility is planned in the application. |
| | II | Capacity building/Change Management Methodology after initial implementation | G | In this program capacity building was done by the IDSP Directorate. The capacity building fund is provided to states from the Directorate and states are required to submit expenditure report to the Directorate. Next financial year money is released only when states submit the expenditure report.<br><br>For first round of capacity building two national workshops were organized to train the users. Followed by video conferencing based training programs and state visits to train the users. 1-2 training programs per state per year are organized as part of ongoing training. Computer based trainings are provided for the user to take the training at will. |
| | a | Skill Building | | |
| | i | One time training | G | One time training was done through national and state level workshops and video conferencing. |
| | ii | Ongoing handholding and support | G | 1-2 training programs per state per year are organized as part of ongoing training. Central data management team also provides ongoing handholding support. |
| | b | End user hardware infrastructure | G | IDSP procured the hardware and signed the AMC and delivered it to the states. IDSP engaged the vendors to provide local support. |
| | c | Human Resource | Y | Three members team is established in each district recruited by states and supported by Directorate which includes one Medical Officer, one Data Manager and one Data Entry Operator. |
| | d | Protocol for HMIS related process | Y | Some of the protocols are defined and some are still in the process of development. |
| | III | Capacity building/Change management budget available as part of initial | G | All capacity building is done by centre only. |

| | | | | |
|---|---|---|---|---|
| | | budgeting | | |
| | IV | Capacity building/Change management process signed off during implementation | G | NIC had provided initial trainings to the Directorate. After that the Directorate took the lead for capacity building. |
| | V | Software support through multi-year maintenance contract | G | NIC is providing complete support to the application. |
| | VI | Hardware support through multi-year maintenance contract | G | Directorate supplied hardware with three years AMC. Later the districts were asked to do AMC at local level, which will be paid by the Directorate. |
| | VII | Source code available? | G | Available with NIC. |
| | VIII | Open source Technology? – Proprietary v/s Open Source | G | Open source |
| | IX | Obsolete technology? | G | No, JAVA JSV is used in IDSP application. |
| | X | Software upgrades being done? | G | Software upgrades are provided by NIC based on request. |
| | a | Software Configuration Management | Y | No software configuration management is being followed. |
| | b | Software Product Life Cycle Management | Y | Product life cycle management approach is not followed. It is a stand alone application rather than a product. |
| | XI | Hardware upgrades being done? | G | Server is managed by NIC and end user hardware is also upgraded as per the need. |
| | XII | Infrastructure for scalability – e.g. SAN, Data Centre, Web Farm | G | Scalable, hosted at NIC. |
| | XIII | Capex or Opex financing model? | G | Capex. |

## E. Did the system achieve the objective?

| | | |
|---|---|---|
| 1 | Speedy data reporting | Decentralized system for surveillance system has been put in place and adoption of the system is very good. However non-communicable disease data is not being reported from the system. |
| 2 | Early detection | System is not able to identify trends, outbreaks and forecast. Alerts & triggers are not possible for unusual events. |
| 3 | Tele-education & distance learning | Virtual trainings are done on regular basis. System has helped to reduce training cost and time significantly. |
| 4 | Interactive electronic discussion | Video conferencing facility is available through ISRO & BSNL network. |
| 5 | Integration | There is no integration with any other system. |

**Discussion-**

1. **Good adoption** - IDSP has provided software, end user hardware, network and a dedicated team at district to report facility-wise data. Currently 90-95% districts are reporting data in system.
    a. Very basic application design and ease of use has helped the user to adopt the system. The culture of data entry has developed. A simple analogy - *people have learnt to drive the cycle and are ready to graduate to motorized vehicle now.*
    b. Contracted with ISRO and BSNL for providing network to all districts.
    c. Local hardware support at district level - IDSP directorate procured the hardware with AMC and gave it to the districts. After expiry of the AMC, Directorate has given freedom to the districts to locally arrange AMC for end user hardware support.
    d. Dedicated staff at District level has helped in better adoption.
    e. Sustained training has helped in better adoption.
2. **Early detection** - System's inability to identify alerts for outbreaks can be attributed to the technical as well as program design issues. For one sub-center with a population of 5000, 20 cases of a disease in a week can be an alert for outbreak. However these 20 cases when aggregated to a district or block may not be identified as an outbreak.
3. **Lack of system flexibility** - System is not flexible for users to report consolidated data. Only facility-wise data can be entered. States which are not able to report facility-wise data are reporting consolidated data in excel sheet through email. There is no flexibility for users to design their own reports based on their local requirements.
4. **Indicators** - From the data analysis perspective, it is clear that system is geared towards raw data entry but has not focused on program management indicators.
5. **Private sector reporting** - Just as in other public health systems, reporting from private sector is very low. Reporting from private sector is limited to those hospitals which have some agreement with public hospitals. For disease surveillance this lacuna accentuates the problem, because without private sector reporting the complete incidence and prevalence cannot be identified.
6. **Integration** – Integration with other systems hasn't been planned yet. However we can see a functional challenge in integration – IDSP follows a weekly reporting periodicity which is in sharp contrast to fortnightly and monthly reporting in various other diseases reporting programs.

## F. Recommendations

Fix the issues and run the existing systems.

1. Data entry Flexibility – Provide flexibility in the system in terms of district/block wise consolidated as well as facility wise granular data entry.
2. Data analytics flexibility – Allow the users to generate their own reports at all levels. This motivates the users and promotes local management of local issues.
3. Indicators – Build indicators based forms, so that the users are not collecting superfluous data.

4. Integration – Build integration capability to take feed from other systems and send out data in a specific format. Consider HL7 based integration. This is to ensure that the data is not lost.
5. Change Management – There needs to be greater and sustained focus on capacity building and change management in terms of people, process and technology. Put in place sustained training, hand holding and help desk support. Constant interventions are required to change the human behavior. The resistance to change is a problem that needs to be removed step-by-step over time. Sudden change makes the *frog jump out of the hot water*. History of Healthcare-IT systems clearly indicates that one can't achieve adoption by forcing the workers to do anything. The only successful model to improve adoption is a democratic way which is inclusive and not the autocratic way.

**Sources of Data for the report:**

| Sl. | Sources of Data | Remarks |
|---|---|---|
| **1** | Interview of stakeholders | Had a meeting with IDSP Directorate. |
| **2** | System Requirement Specifications Document | NA |
| **3** | Functional Design Document | NA |
| **4** | Technical Design Document | NA |
| **5** | System Architecture Document | NA |
| **6** | Test Cases and Test Report Document | NA |
| **7** | User Manual | Available |
| **8** | Other | IDSP program book is available. This gives broad discussions about the IT system requirements. |
| **9** | Live System Demo | Available |

**References:**


- IDSP System user manual Accessed from *idsp.nic.in/idsp/UserManaula/ModuleC.pdf on 23/11/2011, 01:30 PM.*
- IDSP Manuals & Guidelines Accessed from http://idsp.nic.in/ on 22/11/2011, 10:30 AM.
- Data Management presentation done on 14-15 July 2011 meeting at IDSP, NCDC. Accessed from http://idsp.nic.in/ on 01/12/2011, 12:00 PM.
- Information Technology presentation done on 14-15 July 2011 meeting at IDSP, NCDC. Accessed from http://idsp.nic.in/ on 01/12/2011, 02:00 PM.

## III. Strategic Information Management System (SIMS) – NACO

NACO for its program management collects data on components related to HIV/AIDS through various mechanisms such as Sentinel Surveillance System, Behavioural Surveillance Surveys and other evaluations/operation research studies. However day to day routine monitoring data is collected through Computerised Management Information System (CMIS). NACO from NACP-I (2001) was using CMIS for routine data reporting. CMIS had four separate offline applications for different program component data reporting. However with NACP III, NACO decided to use a centralised system which should integrate all program components into single system. Strategic Information Management System (SIMS) was developed for this purpose by VYAM Technologies and sponsored by NACO.

### A. Problem Statement:

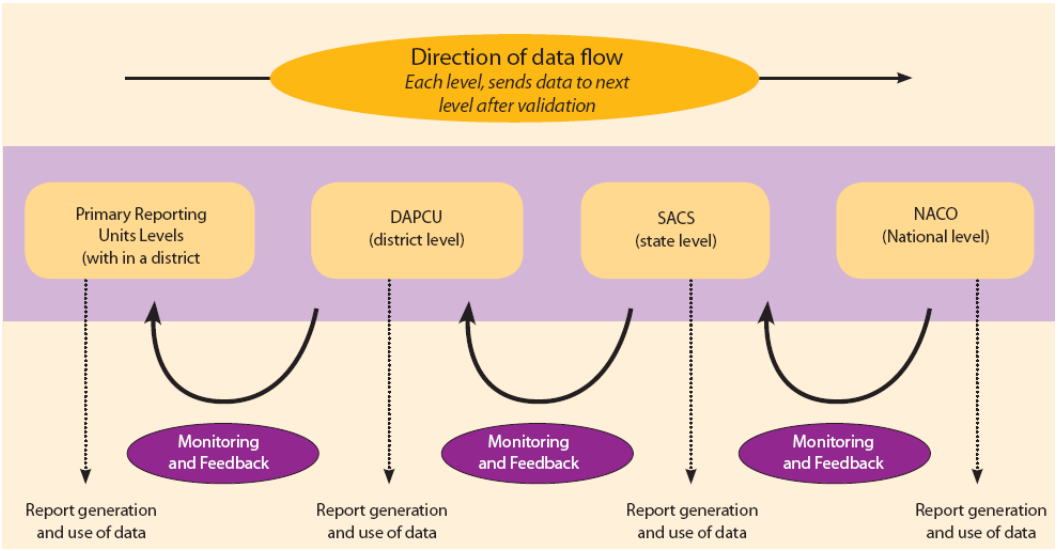
CIMS had four different applications and all of them were installed offline at State level and in some States at District level. Data compilation and access from a single point were not possible. Also data quality was very poor and data which was sent to NACO and entered at state level never matched with each other. It was thought that centralised system will help better/easy access to the system and will also improve data quality. Developing nationwide Strategic Information Management System was one of the four components of NACP III which says "NACP-III aims at strengthening data collection, compilation, analysis and its use".

### B. Objective of developing the Electronic System:

Objectives of developing SIMS can be divided into followings.

I. Track HIV epidemic in country.
II. To respond to the epidemic in timely manner.
III. Track program performance.
IV. To integrate all program data into one system.

### C. Brief overview of system



## Computerised Management Information System

- Computerised MIS is a three-tier data flow system with the capability to handle State and District data for monthly, quarterly and annual reports.
- Monthly reports in CMIS are received from 35 SACS and 3 Municipal AIDS Control Societies with over 10000 reporting units.
- CMIS had four offline applications of which two had line-listing data entry facility and rest were reporting aggregate data.

| Systems | Purpose |
|---|---|
| Computerised Management Information System (CMIS) for ICTC & Targeted Intervention (TI) | Line listing Data reporting |
| Computerised Project Financial Management System (CPFMS) | Aggregate Numbers reporting |
| Anti Retroviral Treatment CMIS (ART-CMIS) | Line Listing data entry |
| Condom Program CMIS | Aggregate Numbers reporting |

- CMIS enables NACO, SACS and district units to use programmatic information reporting.
- Data is first collected from lower data reporting units to District AIDS Program Control Unit (DAPCU) and from DAPCU it goes to State. At the State level, District data is entered in CMIS. Few States such as Andhra Pradesh & Karnataka have started Facility-wise data entry at District level. After data entry, system generates a .sch file which is sent to NACO office.
- Systemic approach to improve timeliness and completeness of data reporting has been carried out and now almost 90% of facilities are reporting data in CMIS.

## Strategic Information Management System

- Launched in August 2010, SIMS is internet based centralised application which has integrated all program components into one system.
- Pilot implementation for SIMS has been done from 1st August 2011 in Delhi. After which 6 high focus States have started data entry into SIMS from September 15th, 2011. From 1st December 2011 country-wide implementation has started.
- System provides basic modules such as data entry, data completeness assessment, customised report generation. GIS (global information system) is also planned but is not implemented yet.
- System has provisions for data entry validations and quality check.
- System is proposed to be developed on data warehouse approach which will provide drill-down, slice and dice facility.

- One time data entry and report generation at any level is possible in SIMS. System will also provide offline data entry interface.
- SAS has been integrated for data analysis. Key indicators to be generated for local level use.
- Various monthly formats are already rolled out and some of the formats are still in the process of development. 24 forms will be used for monthly data entry in application as and when it is ready.

Currently both systems are running in parallel, and CMIS will be stopped when SIMS data entry will stabilize.

**D. Gaps & opportunities**

Due to administrative and time constraints functional assessment of system on standard parameter list was not possible.

**Sources of Data for the report:**

| Sl. | Sources of Data | Remarks |
|---|---|---|
| 1 | Interview of stakeholders | 19/Dec/2011 - Had a meeting with the NIC team & eMAMTA team @ Juni Commissionerate Gandhinagar. |
| 2 | System Requirement Specifications Document | NA |
| 3 | Functional Design Document | NA |
| 4 | Technical Design Document | NA |
| 5 | System Architecture Document | NA |
| 6 | Test Cases and Test Report Document | NA |
| 7 | User Manual | Available. |
| 8 | Other | -Presentation of National NACO M&E System, Accessed from M&E Unit NACO<br>-Strategic Information Management, National AIDS Control Programme, Phase III, India<br>-Annual Report 2010-11, National AIDS Control Organisation, Department of AIDS Control |
| 9 | Live System Demo | Available. |

# State Public health IT Systems

## I. Tamil Nadu HMIS

TN State has a rich history of ICT innovations in health care. Currently there are 15-18 data sources from different programs. TN Healthcare Management Information System [HMIS] and Hospital Management System [HMS] are sponsored by the State and developed by TCS.

### A. Brief History of Health IT Systems:

- 1992 – Foxpro based public health IT system. The data entry was at district level.
- 1993 – Malaria tracking IT system was developed by NIC. The data entry was at district level.
- 1999 – OCR based ISMR project by DANIDA for Institutional services monitoring report. This helped build the electronic data culture in the state's public health setup.
- 2002 – Pulse polio data entry system was adopted in TN.
- 2005 – NAMMIS and EDSIS/IDSP were rolled out in TN and was adopted well.
- 2007 – The electronic data culture was well established in public health. Many new IT systems were added for monitoring the public health programs. TCS started implementing the HMIS in 2007.

TN has developed a culture of dealing with electronic data due to a long history of Healthcare IT systems. TN state has now established the state health data resource centre [SHDRC] to integrate most the following data sources and build a data ware house for data driven planning, monitoring and evaluation. DHIS is working with SHDRC to build a data warehouse by integrate IT systems from Directorate of Medical Services [DMS], Directorate of Public Health [DPH] and Directorate of Medical Education [DME].

SHDRC has done an initial assessment of different data sources but a detailed analysis of data elements is planned for developing the Architecture for integrating everything. The list of data sources is attached in the table below.

| Sl. | Directorate/ Dept. | IT System/ Data Source |
|---|---|---|
| 1 | Directorate of medical and rural health services [DMS] | 120 out of 270 hospitals have started using HMS for patient based tracking. HMS can feed the consolidated public health data to HMIS. 107 out of 270 hospitals have become CEMONC – comprehensive emergency obstetrics and new born care hospitals. Adoption of HMS and HMIS is improving because it has screens for CEMONC.<br><br>Rest of the District hospitals and sub-district hospitals report their consolidated public health data in paper and the District enters the data into Excel/ISMR format. Parts of this data are also uploaded into HMIS. Wide scale adoption of HMIS hasn't happened in DMS due to hardware, network, capacity building, and change management issues. |
| 2 | Directorate of public health and preventive medicine [DPH] | DPH is a good user of HMIS but is suffering from paucity of human resource, capacity building and change management issues. 75% of PHCs are doing the Data entry online because good network connectivity is provided at PHC level. Data cards are provided |

| | | |
|---|---|---|
| | | wherever internet is not available. |
| 3 | Directorate of medical education [DME] | Piloting HMS in 2 medical colleges. Will adopt HMS based on the readiness of the medical colleges and the outcomes of the pilot. HMS can feed the consolidated data to HMIS. |
| 4 | TN medical services corporation | IT system for procurements – requirements, tender, responses, short listing, purchase etc. |
| 5 | TN state AIDS control society | TN has its own MIS for AIDS. Will be moving to SMIS from NACO. |
| 6 | Directorate of Indian medicine | Paper based data. Wish to convert the manuscripts to electronic formats. |
| 7 | Directorate of family welfare | PICME system for pregnancy and infant cohort monitoring and evaluation. Was implemented in 2008 for tracking all RCH data. PICME is a TN equivalent of MCTS. It is a patient based tracking system where the system generates a UID for all mothers. The women are given additional benefits if the woman produces her UID card for every service. |
| 8 | State TB cell | RNTCP - National system for tracking TB |
| 9 | National leprosy eradication program | National system for tracking leprosy |
| 10 | State blindness control society | National system for tracking Blindness |
| 11 | State health transport corporation | Hospitals run by TN State transport department |
| 12 | Directorate of drug controller | IT system for procurement, monitoring and control of drugs |
| 13 | National rural health mission | DHIS2 – takes data from HMIS |
| 14 | Revised national TB control project | RNTCP - National system for tracking TB |
| 15 | TN Dr MGR university | Medical university has paper based research data and its own IT systems |
| 16 | Corporation of Chennai | Municipal Hospitals for urban health in Chennai |
| 17 | Municipal administration | Health centres run by municipalities in other cities |
| 18 | State bureau of health intelligence | National system |

## B. Brief overview of HMIS

Area wise reporting: HMIS system is area wise reporting based on the family health register. The system was designed for HSC level reporting; later option of consolidated as well as granular data entry was given from PHC level. The ANM/VHN identifies every pregnant woman based on family health register. The ANM/VHN tracks the pregnant woman even if she migrates or gets the services done in another facility and reports the services from her area. Area wise reporting helps in taking care of the entire population in the area. However this has a flip side - this method makes it difficult to track facility wise utilisation and productivity.

ANM/VHN are reporting data online from about 75% of PHCs because good network connectivity is provided at PHC level. Data cards are provided wherever internet is not available.

Dept. of Health has issued an order to all Directorates to stop using all old systems e.g. ISMR, Excel, Paper etc. and standardise on HMIS. All Directorates are in various stages of transition with DPH leading the pack. Capacity building and change management issues are the main causes of slow transition.

HMIS has about 700 forms, but the users are encouraged to use only 2 forms to get used to the system. Likewise there is 1 single master report that has all the granular and consolidated data. The staff is being encouraged to use this single report. The aim is to get the staff used to the system, after that they can experiment with other parts of the system.

### C. Gaps & opportunities

The detailed study of the system was done based on a pre-defined set of parameters. The details of the findings are given in the table below. Red and Yellow items are the gaps and their corresponding remarks explain the opportunities for improvements.

| S. N | | Functionality | | Comments |
|---|---|---|---|---|
| **1.** | | **User Friendliness** | | |
| | I | Simplicity - Average Number of panels, keystrokes and mouse clicks | G | The HMIS application is simple to use. |
| | II | Time to fill one form with average number of data elements<br>* 0-15 minutes<br>* 15-30 Minutes<br>*30- 60 minutes<br>* More than 60 minutes | G | It takes < 5 minutes to fill the forms on an average. |
| | II | Field Defaults | G | Most of the fields are Null by default. The system detects zero, non-zero and alphabets. |
| | III | Mandatory Fields Indication | G | Nothing is mandatory. |
| | IV | Use of Tabs | G | It is a combination of mouse and keyboard. |
| | V | Field Tab Order | G | It is a combination of mouse and keyboard. |
| | VI | Color Definition | G | Predefined color definition is seen. No option to change the colors. |
| | VII | Section Segregation | G | Section segregation is present |
| | VIII | Scrolling | G | Grid system for data entry |
| **2.** | | Data Entry & associated functionality | | |
| | I | Data entry by reference | R | All data is by value only |
| | II | Data entry by value | G | All data is by value only |
| | II | Data entry - Manually | G | Yes |
| | III | Data entry- by excel import | R | No |
| | IV | At every level does it allow data entry of | Y | Data entry level is PHC. Consolidated and granular Data can be entered for sub-centres but not for |

| | | | | |
|---|---|---|---|---|
| | | figures consolidated from facilities below it? | | blocks and above. |
| | V | At every level does it allow data entry of individual facilities below it? | Y | Data entry level is PHC. Consolidated and granular Data can be entered for sub-centres but not for blocks and above. |
| **3** | | Data Quality check functionality | | |
| | I | Data validation | | Yes both front and back end |
| | a | During data entry- front end validation | G | Front end and backend validation exists during and after data entry. |
| | b | During data entry- validation done from back-end | G | Front end and backend validation exists during and after data entry. |
| | c | After data entry | G | Front end and backend validation exists during and after data entry. |
| | d | Validation Rules for Imports | R | No |
| | e | Auto Validation for Excel Based Imports | R | No |
| | II | Identify duplication | G | User can't enter data for duplicate dates |
| | III | Assess completeness | | |
| | a | Of all Reporting Units | G | Report for form and section wise completeness available |
| | b | Timeliness | Y | Functionality is there but not implemented |
| | c | Differentiate between zero & non-zero | G | Yes. Most of the fields are Null by default. The system detects null, zero, non-zero and alphabets |
| | IV | Data Confirmation | R | No workflow in the system |
| | V | Data Modification | G | System records who and when the change was done but no details of exactly what was changed. There is no data locking. Full Audit trail exists for some critical data e.g. service record of staff. |
| **4.** | | Data load on system | | |
| | I | Form elements | | |
| | a | Indicator to data element ratio | Y | 25 indicators out of 700 forms. |
| | b | Number of forms to be filled from each facility or the Case load per data entry unit | Y | About 700 forms but the users are being encouraged to use only 2 forms. Rest is for future use. |
| | c | Form design | G | Form design is favourable for low skilled user working on a slow network connection. |
| | II | Data archiving | R | No |
| | a | within the database | | No |
| | b | in a separate database | | No |
| | III | Case load per data entry unit | G | PHC is data entry point where the SC data can be entered in consolidated or granular mode. Given that the users have to fill only 2 forms every month, the case load is not heavy. |
| | IV | System response time | G | < 2 sec for each screen @ >512 kbps speed |
| **5.** | | Unique identifier | | |

| | | | | |
|---|---|---|---|---|
| | I | Patient | R | No identifiers |
| | II | Provider | R | User ID is for the facility not person wise |
| | III | Facility | G | Yes, User ID is for the facility not person wise |
| | IV | Encounter | R | No |
| **6.** | | Report generation | | |
| | I | By Design | | |
| | a | Static – predefined | G | Predefined report formats are available for users to generate at will. Large size reports have all the data. |
| | b | Dynamic – can be configured by user | R | No functionality available for user to develop his/her own reports. |
| | c | Report generation by programming/ SQL Queries | G | This functionality is available. |
| | d | Online Analytical Processing (OLAP) for user | R | OLAP features are not available. |
| | II | By use | | |
| | a | Number based aggregated only | G | This report can be generated. |
| | b | Analyzed (indicator based) | Y | Limited indicator based report can be generated from the system. |
| | III | User can generate aggregated report for his level and level below. | G | Yes, the same report has granular and aggregated numbers |
| | IV | User can generate disaggregated report for his level and level below. | G | Yes, the same report has granular and aggregated numbers |
| | V | Data Mart | R | No |
| | VI | Dashboard for decision makers | R | No |
| | a | Showing values only | R | No |
| | (i) | Numbers and tables | R | No |
| | (ii) | Indicators | R | Only data completeness indicators present. No reports with program management indicators. |
| | b | Graphical – Charts | R | No charts are used. |
| | VII | GIS-Map based data analysis | R | No |
| **7.** | | System Flexibility (to define your own) | | |
| | I | Data fields | R | No |
| | II | Indicators | R | no |
| | III | Forms | R | No |
| | IV | Formats | R | No |
| | V | Reports | R | No |
| | VI | Dashboard | R | No |
| | VII | Rules Engine – To define Clinical Protocol and Disease Management based Rules | R | No |

| | | | | |
|---|---|---|---|---|
| | VIII | Workflow Engine – To define user defined public healthcare program specific workflow | R | No |
| **8.** | | Standards | | |
| | I | Data Definitions – | | No |
| | a | Vocabulary Standards | | Yes, local |
| | (i) | For local - | G | Local vocabulary as per standard RCH forms |
| | (ii) | For global – eg SNOMED, | R | No |
| | b | Size | G | Size of each data elements is defined |
| | c | Type | G | Data type of each data element is defined |
| | II | Disease & Diagnosis code sets – Local codes, ICD 9, ICD 10 | G | Yes, codes available for mortality, morbidity and MRD |
| | III | Procedure & Service Code sets – eg Local codes, CPT, CAP | R | No |
| | IV | Interoperability standards for integration – eg HL7, DICOM, SDMX.HT | Y | XML to DHIS2 |
| **9.** | Data Privacy | | | |
| | I | Role-based access | Y | User ID is for the facility not person wise |
| | II | Data locking | Y | Record locking is there but not implemented |
| | III | Password Protection | Y | Password is atleast 8 characters including special characters. Admin can reset but doesn't expire |
| | IV | Field Based Access Rights | R | Yes, PHC, CHC, District record locking is available |
| **10.** | Data Security | | | |
| | I | Data Changes/ Error corrections (Audit trails) | G | System records who and when the change was done but no details of exactly what was changed. There is no data locking. Full Audit trail exists for some critical data e.g. service record of staff. |
| | II | Roll-back functionality | R | No |
| | III | Data back-up including tiered backup | G | Hosted in Lcot datacentre. They have a daily backup. |
| | IV | Encryption - PKI usage | G | Yes |
| | V | Digital Signature Certificate Usage | R | No |
| **11.** | | System Functions | | |
| | I | Search | G | In few places |
| | II | Feedback | G | TNHSP help desk |
| | III | Help | Y | No help files. But very good support from TNHSP help desk, email etc. |
| | IV | System flexible to adapt to any Disease Program? | Y | Need programmer intervention |
| | V | Disease Specific Educational Content | R | No |

| | | | | |
|---|---|---|---|---|
| | VI | Error handling | G | Yes |
| | VII | Deployment | | Online via Lcot datacentre |
| | a | Online | | Yes |
| | b | Offline | | No |
| **12.** | Other | | | |
| | I | Mobile user interface | R | Not implemented yet. Though it is in planning. |
| | II | Capacity building/Change Management Methodology after initial implementation | Y | One time trainings of 4 days each done at PHC level. However no evidence of sustained help for change management. |
| | a | Skill Building | G | |
| | (i) | One time training | G | One time trainings of 4 days each done at PHC level. However no evidence of sustained help for change management. |
| | (ii) | Ongoing handholding and support | Y | One time trainings of 4 days each done at PHC level. However no evidence of sustained help for change management. Help desk and email support covers to some extent; but more is required to increase adoption. |
| | b | End user hardware infrastructure | G | TNHSP handles the hardware procurement and support. Funded by NRHM. |
| | c | Human Resource | Y | State is suffering from paucity of human resource. Mismatch between human resource and data entry load. |
| | d | Protocol for HMIS related process | G | Process were changed for electronic data entry and usage |
| | III | Capacity building/Change management budget available as part of initial budgeting | G | Yes, funded by NRHM |
| | IV | Capacity building/Change management process signed off during implementation | G | Yes, contracted to TCS |
| | V | Software support through multi-year maintenance contract | G | TCS provides regular software updates |
| | VI | Hardware support through multi-year maintenance contract | G | Yes, TNHSP handles the hardware procurement and support. Funded by NRHM. |
| | VII | Source code available? | G | Yes, TCS is sitting in TNHSP premises and supporting it on behalf of TNHSP |
| | VIII | Open source Technology? – Proprietary v/s Open Source | G | Yes, JSP is open source |
| | IX | Obsolete technology? | G | No |
| | X | Software upgrades being done? | G | TCS provides regular software updates |
| | a | Software Configuration Management | G | TCS follows full SDLC including configuration management |
| | b | Software Product Life | Y | TCS follows full SDLC including configuration |

| | | | | |
|---|---|---|---|---|
| | | Cycle Management | | management. However this has been developed as an application for single use, not like a product. It is not modular and configurable like a product that is ready for implementations in different public health programs. |
| | XI | Hardware upgrades being done? | G | TNHSP, 3 yrs AMC |
| | XII | Infrastructure for scalability – e.g. SAN, Data Centre, Web Farm | G | Lcot datacentre |
| | XIII | Capex or Opex financing model? | G | Capex |

**D. Did the system achieve the objective?**

After HMIS implementation RCH monitoring in TN state has become data driven and care is based on protocols. ANM/VHN are reporting data online from about 75% of PHCs. 65% of the deliveries are done in Govt facilities now. This is an indication of people getting a reasonable service.

**Discussion:**

1. **Reporting time delay** – TN HMIS has reduced time for reporting data from field. Reports are available to the staff and officials soon after the data gets converted from paper to electronic format from the PHC level.
2. **Federated design** – HMIS is for reporting consolidated SC data from PHC level. The HMS is the patient based reporting from hospitals and point of care. The consolidated numbers from HMS can be uploaded to HMIS. This is a good design to delink public health data from patient-based tracking.
3. **Mismatch between HR capacity and reporting needs** - The human resource was designed for paper based system where the data from SC, PHC, and Block was aggregated at the District level and all aggregated reporting to the state and centre was done by the District. Whereas TN HMIS system is designed for reporting directly from PHC. The resources at PHC level were assigned with an additional task of entering the data received from Sub-centres. Data entry is an additional burden on the PHC resources.
4. **Local analysis and use of information**– The users have predefined report formats only. Local level users are not provided with options to analyse their own data for decision making. The flexibility to produce your own reports is lacking in the system. An online analytical processing [OLAP] functionality would have gone a long way to enable the users to produce their own reports.
5. **Integration with other systems** – TN HMIS uses web services [XML] to integrate with DHIS2. The data from HMIS is uploaded to DHIS2 for data warehousing and data analysis.
6. **Private sector and urban areas data** - Currently data is not reported from urban area and from private providers. Private providers are not comfortable with sharing data. We all know that diseases don't know boundaries and narrow domestic walls. Therefore the big picture of epidemiology is still a distant dream.

## I. Recommendations

Capacity building required for improving adoption of the existing systems. Integrate data sources to build a health information exchange.

1. **Mismatch between human resource and data entry load** – It is recommended to add dedicated staff at PHC level for data entry. Current adoption suffers from mismatch between human resource and data entry load.
2. **Change Management** - History of Healthcare-IT systems clearly indicates that one can't achieve adoption by forcing the workers to do anything. The only successful model to improve adoption is a democratic way which is inclusive and not the autocratic way. Therefore there needs to be greater and sustained focus on capacity building and change management. Constant interventions are required to change the human behaviour. The resistance to change is a problem that needs to be removed step-by-step over time. Sudden change makes the *frog jump out of the hot water*.
3. **Integration and Data Analysis** – TN is well positioned to build a state level health information exchange [HIE]. The SHDRC move to integrate various data sources for data warehouse and data analysis is the right direction.

**Sources of Data for the report:**

| Sl. | Sources of Data | Remarks |
|---|---|---|
| 1 | Interview of stakeholders | 14/Dec/2011 - Had a meeting with the TNHSP, DPH, DME, DMS and TCS teams in Chennai. |
| 2 | System Requirement Specifications Document | NA |
| 3 | Functional Design Document | NA |
| 4 | Technical Design Document | NA |
| 5 | System Architecture Document | NA |
| 6 | Test Cases and Test Report Document | NA |
| 7 | User Manual | NA |
| 8 | Other | NA |
| 9 | Live System Demo | Available. |

# II. Gujarat eMAMTA

Gujarat State has a rich history of ICT innovations in health care. Currently there are 5-6 IT applications running for different programs. Gujarat state was initially using DHIS 2 application for consolidated data reporting but later switched to eMamta for patient based reporting from 2010. eMamta application is sponsored by State and developed by NIC.

## A. Problem Statement:

Gujarat state is lagging behind in immunisation coverage. There is a significant difference between the immunisation coverage as calculated by Gujarat state and that done by a reputed third party survey. Gujarat Govt. has now understood that it is important to track mothers and children for entire range of services because immunisation starts ante-natal and continues post-natal and beyond.

## B. Objective of developing the Electronic System:

Objectives of developing eMamta can be divided into followings.

### 1. Main Objectives:

I. Track mothers and children for entire range of services because immunisation starts ante-natal and continues post-natal and beyond.
II. For monitoring and evaluation, provide reports filtered on the following criteria - by individual patients; by village; by period; by service providers.
III. To track the mother and child on an individual patient-based data and import it into the facility-based HMIS, so as to avoid double data entry and improve the data reliability.

### 2. Supporting objectives:

I. Identifying the accurate requirement and utilization of services in specific categories
II. Identifying gaps in service delivery
III. Communicating directly with the beneficiaries and service providers through system generated SMS alerts
IV. Assisting the program managers in planning the programs and policy formation through better monitoring and evaluation.
V. Better financial and physical monitoring of program resources and Human resource.
VI. In accordance with the Family based approach, the information could be integrated with data from School Health, ICDS, Education and thus help in giving a holistic picture on individuals regarding health, education and nutrition.
VII. Provide real time denominators for population based indicators.
VIII. Help track migratory population and ensure complete services delivery.
IX. Identify cohort or focus groups for specific programs.
X. Integration of eMamta was also considered as an objective.

## C. Brief overview of the Gujarat public health IT system

Gujarat has developed a culture of dealing with electronic data due to a long history of Healthcare IT systems. Gujarat state has now decided to integrate most the following data sources to build the big picture for better planning, monitoring and evaluation.

| ACCOUNTABILITY | TRANSPARENCY | RESPONSIVENESS | DECISION MAKING |
|---|---|---|---|
| Dept website, Hospitals website, Medical college website | Intra-FDCA application [Food and Drug Control Admin] | GPS mobile van monitoring system | eMamta, HMIS |
| Customized Tally – ERP for NRHM funds | Medical education admission committee | GVK – EMRI 108 [Emergency Management and Research Institute] | GHMIS [Gujarat Hospital Management Information System] |
| School health program | DLIMS [Drug Logistics Information System] | IDSP [Integrated Disease Surveillance Project] | BADEA [Birth, Death entry application and reporting system] |

**eMamta :** The idea of tracking immunisation and pregnancy services ante-natal to post-natal and beyond has led to the conceptualisation & development of eMamta system. Similar initiatives were taken in Rajasthan where the mother was registered in the system during ANC registration. However Gujarat went one step ahead and included Annual District Family Health Survey (DFHS) data in the application as baseline and linked tracking of each pregnant mother with their family records. The system works in three phases:

I. **Family Health Survey:** Gujarat State was doing Annual District Family Health Survey (DFHS) from Community Need Assessment Approach (CNAA-2000) but data was kept on paper. This DFHS survey is done by health workers. They compile it and send it to the respective blocks, from blocks it is compiled and sent to District and from District it reaches the State. With the eMamta this data has become electronic and is included as the baseline data for eMamta; DFHS survey data is now directly entered electronically at PHC level. First time DFHS data entry was done in 2009-10 and now each it is updated electronically after the DFHS survey in Q1 every year. In the application each family is provided with a unique family healthcare ID, which helps capture the migration details and prevent loss of cases due to migration. In other words eMamta is designed for Area-wise reporting. Currently system has 4.5 crore family records against total 6 crore families in the state.

II. **Registration of pregnant mothers and children:** The system generates the Health ID primarily based on DFHS# but it also has place to record 9 other supporting IDs such as Voter ID, Ration card#, PAN# etc. eMamta can switch to ADHAAR when it becomes available universally. All women who get pregnant and children of age up to 6 years are registered and are provided a unique mother/child health ID.

III. **Tracking of healthcare services through monthly work plans:** The services provided to the pregnant mothers including ANC, delivery, PNC and immunization are captured in eMamta. Data is collected in standardised paper forms from the SC and from

there it reaches PHC for electronic data entry; where the Data Entry Operator enters data into eMamta.

IV. **Work Plans -** System generates monthly work plan for every ANM and a print-out is given to the ANM for follow-up with the patients.

V. **Mobile interface -** Mobile based alerts are sent to beneficiaries and officers for information and as reminders. Messages can be sent both in English and Gujarati, though the SMS in Gujarati should be supported by Gujarati font in the Mobile Phone.

### D. Gaps & opportunities

The detailed study of the system was done based on a pre-defined set of parameters. The details of the findings are given in the table below. Red and Yellow items are the gaps and their corresponding remarks explain the opportunities for improvements.

| Serial Number | | Functionality | | Comments |
|---|---|---|---|---|
| **1.** | | **User Friendliness** | | |
| | I | Simplicity - Average Number of panels, keystrokes and mouse clicks | G | e-Mamta is simple applications with very limited number of strokes required to complete a task. Average 5 key strokes are required to complete one task. |
| | II | Time to fill one form with average number of data elements<br>* 0-15 minutes<br>* 15-30 Minutes<br>*30- 60 minutes<br>* More than 60 minutes | G | Family Health Survey data entry – 7 to 10 minutes for each family.<br>For ANC registration – 5-7 minutes.<br>Data entry for encounter (ANC visits, PNC, Child immunisation etc) – 3-5 minutes.<br>Average data entry time 5-6 minutes. |
| | II | Field Defaults | G | Field defaults are present wherever required. |
| | III | Mandatory Fields Indication | G | Mandatory fields are highlighted with the asterisk (*) sign. |
| | IV | Use of Tabs | G | Use of tab is noted. |
| | V | Field Tab Order | G | Tab order is sequential. |
| | VI | Color Definition | G | Application works with predefined single colour themes. |
| | VII | Section Segregation | G | Sections are well segregated using colour coding. |
| | VIII | Scrolling | G | Only vertical scrolling is available where-ever required. |
| **2.** | | Data Entry & associated functionality | | |
| | I | Data entry by reference | G | Data entry by reference is available in child health section where birth weight of child is entered based on references. |
| | II | Data entry by value | G | This function is noted. |
| | II | Data entry - Manually | G | Manual data entry functionality is available. |
| | III | Data entry- by excel import | R | Data entry using excel import is not provided. Entire offline data entry is not possible because at the time of data entry system generates a unique number for each case. If offline data entry is done auto generated numbers will not be unique and duplication of numbers will be an issue. Offline date entry can be done for services after the unique ID |

| | | | | |
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| | | | | has been generated, but that hasn't been implemented. |
| | IV | At every level does it allow data entry of figures consolidated from facilities below it? | R | eMamta is built for patient-wise data entry. It does not have any functionality to allow consolidated data entry. It is a good practice to allow consolidated data entry in case the granular data entry cannot be done due to administrative and cultural constraints. |
| | V | At every level does it allow data entry of individual facilities below it? | G | Patient-based individual encounter records are entered in eMamta where District has the privilege to enter data for any facility within district but currently PHC is the data entry point for sub-centres data. |
| **3** | | Data Quality check functionality | | |
| | I | Data validation | | |
| | a | During data entry- front end validation | G | Front-end validations are available. |
| | b | During data entry- validation done from back-end | G | Back end validations based on Java script are available. Server side validations and SQL Validations are also available. |
| | c | After data entry | G | Post data entry validation functionality is not available and is not required due to presence of real time data entry validation. |
| | d | Validation Rules for Imports | R | This function is not available as offline data entry is not developed in the application. |
| | e | Auto Validation for Excel Based Imports | R | This function is not available. |
| | II | Identify duplication | G | Duplication identification facility is available in the application as the application works with unique ID numbers both given manually by health worker and auto generated by system for individual beneficiary. Facilities are also provided with unique ID number so no duplicate entry in the system can be done. |
| | III | Assess completeness | | |
| | a | Of all Reporting Units | G | eMamta has several reports to identify data entry status from individual facility on daily, weekly and monthly basis.<br>User login status report can also be generated to know the access of the user to the system. |
| | b | Timeliness | Y | Timeliness of data entry can be assessed by comparison of work plan and the service delivery reported from each ANM for every month.<br>However there is no cut-off date fixed for data entry for the ANMs so it is difficult to enforce timeliness of data entry. |
| | c | Differentiate between zero & non-zero | G | By default blank is considered as null; and where-ever text has to be entered and is left blank – the application considers it as null. |
| | IV | Data Confirmation | R | There is no data confirmation functionality in the application. Users themselves have the onus of confirming the data by clicking on "Save details" button. Other than that there is no functionality to confirm data. |

| | | | | |
|---|---|---|---|---|
| | V | Data Modification | G | Data modification can be done before some specific milestone events have occurred, after that some of the encounter data can not be changed. E.g. Data can be changed for services rendered before delivery, but the system doesn't allow any change after the delivery data is entered. You require administrative privileges to change data after the milestone. |
| **4.** | | Data load on system | | |
| | I | Form elements | | |
| | a | Indicator to data element ratio | Y | 8 indicators and 126 data elements. |
| | b | Number of forms to be filled from each facility or the Case load per data entry unit | R | The number of forms to be filled in a patient based system is significantly larger than facility based reporting. In patient based reporting the load of data entry is equal to the patient load under the facility multiplied by the number of forms per patient.<br>In this case the only measure of patient load per Block is birth rate [22.22 births/1000 population] divided by the total number of PHCs multiplied by the number of encounters per case.<br>In eMamta data entry starts with the updation of records in family health survey. After this there are two programs and each program has certain encounters. Each encounter can be considered as one form.<br><br>- Pregnancy tracking- 5 encounter (including registration)<br>- Child tracking- 8 encounter (including registration)<br>Obviously the system requires a higher number of human resources to take this data entry load. |
| | c | Form design | Y | Form is simple and is not lengthy but has many dropdowns. Pages with lot of Dropdowns tend to be slow to load on slow speed networks. |
| | II | Data archiving | R | Data archiving function is not available in the application. However system has 4.5 Crore family records as baseline data-base. |
| | a | within the database | R | This function is not available. |
| | b | in a separate database | R | This function is not available. |
| | III | Case load per data entry unit | R | The number of forms to be filled in a patient based system is significantly larger than facility based reporting. In patient based reporting the load of data entry is equal to the patient load under the facility multiplied by the number of forms per patient. |
| | IV | System response time | G | < 2 sec per page @ speeds > 512 kbps. The system response time is not a problem because there is a dedicated ICT cell in the Dept of Health which takes care of hardware and network procurement and maintenance. Also there is a |

| | | | | |
|---|---|---|---|---|
| | | | | Gujarat wide area network GS1 that provides speeds > 512 kbps even at PHC level. |
| **5.** | | Unique identifier | | |
| | I | Patient | G | Available. This is an alpha numeric identifier. However system accepts multiple identifiers and currently 9 different identifiers can be used for one case. However system identifies each beneficiary by system generated unique ID number. |
| | II | Provider | G | For users unique ID is used, which is linked with their role. System Roles can be transferred or changed based on change in user's administrative role. |
| | III | Facility | G | Each facility is also given a numeric code. |
| | IV | Encounter | R | Not available. |
| **6.** | | Report generation | | |
| | I | By Design | | |
| | a | Static – predefined | G | Predefined report formats are available for users to generate at will. |
| | b | Dynamic – can be configured by user | R | No functionality available for user to develop his/her own reports. |
| | c | Report generation by programming/ SQL Queries | G | This functionality is available. |
| | d | Online Analytical Processing (OLAP) for user | R | OLAP features are not available. |
| | II | By use | | |
| | a | Number based aggregated only | G | This report can be generated. |
| | b | Analyzed (indicator based) | Y | RCH indicators report can be generated from the system. |
| | III | User can generate aggregated report for his level and level below. | G | Each user has the facility to generate reports for their level and level below. |
| | IV | User can generate disaggregated report for his level and level below. | G | This report can be generated from system. |
| | V | Data Mart | R | Data Mart function is not available. However for large size predefined reports, the system runs a scheduled batch process every night and the data is saved as canned reports to reduce system processing time when the user demands the canned reports. |
| | VI | Dashboard for decision makers | Y | Dashboard module is present but reports are static and mostly relates to data completeness. Dashboard function is available for higher level users from district & above only. |
| | a | Showing values only | | |
| | (i) | Numbers and tables | G | Both number & tables are available. |
| | (ii) | Indicators | Y | Only data completeness percentage is present. No program management indicators are used. |

| | | | | |
|---|---|---|---|---|
| | b | Graphical – Charts | Y | Few charts are used to show data completeness. |
| | VII | GIS-Map based data analysis | R | This functionality is not available. |
| **7.** | | System Flexibility (to define your own) | | |
| | I | Data fields | R | User cannot define their own data fields |
| | II | Indicators | R | User cannot define their own indicators |
| | III | Forms | R | User cannot define their own forms |
| | IV | Formats | R | User cannot define their own formats |
| | V | Reports | R | User cannot define their own reports |
| | VI | Dashboard | R | User cannot define their own dashboard |
| | VII | Rules Engine – To define Clinical Protocol and Disease Management based Rules | R | User cannot define their own rules. |
| | VIII | Workflow Engine – To define user defined public healthcare program specific workflow | R | User cannot define their workflow. (user has to follow the predefined hierarchy) |
| **8.** | | Standards | | |
| | I | Data Definitions – | | |
| | a | Vocabulary Standards | | |
| | (i) | For local - | G | Vocabulary used as per standard MCH tracking format from NRHM |
| | (ii) | For global – eg SNOMED, | R | Not defined in any documentation. |
| | b | Size | R | Not defined in any documentation. |
| | c | Type | R | Not defined in any documentation. |
| | II | Disease & Diagnosis code sets – Local codes, ICD 9, ICD 10 | R | Not defined in any documentation. |
| | III | Procedure & Service Code sets – eg Local codes, CPT, CAP | R | Not defined in any documentation. |
| | IV | Interoperability standards for integration – eg HL7, DICOM, SDMX.HT | Y | No interoperability standards are used in eMamta. Uses web services [XML] for integration with some systems. |
| **9.** | Data Privacy | | | |
| | I | Role-based access | G | This function is available. |
| | II | Data locking | Y | Data locking functionality is milestone based. i.e. data gets locked when user completes data entry for some encounters. |
| | III | Password Protection | Y | Users have been assigned with ID & password and password expires in every 180 days. Special characters are required in password. However Password protection is weak. |
| | IV | Field Based Access Rights | R | This functionality is not available. |
| **10.** | Data Security | | | |
| | I | Data Changes/ Error | G | System has facility to detect what changes done by |

| | | | | |
|---|---|---|---|---|
| | | corrections (Audit trails) | | whom and when. However the system doesn't have the details of what was changed to enable roll-back. |
| | II | Roll-back functionality | R | Roll-back functionality is not available in application. |
| | III | Data back-up including tiered backup | G | Data back-up is taken in the NIC servers and NIC decides periodicity of backup. |
| | IV | Encryption - PKI usage | G | This function is available. |
| | V | Digital Signature Certificate Usage | R | Digital signature functionality is not available. |
| **11.** | | System Functions | | |
| | I | Search | G | Search option is available to search individual cases. Records can be searched by using name or by using ID. |
| | II | Feedback | G | Helpdesk option exists for feedback to the developers and designers of system.<br>Call centre [help desk] is developed at State Office to help solve user queries and record their issues. From call centre technical issues are forwarded to IT cell and other issues are forwarded to implementation unit in State office. |
| | III | Help | Y | Help files were available earlier but now removed from the system. However sustained trainings and help desk is very effective. |
| | IV | System flexible to adapt to any Disease Program? | Y | Programmatically same design can be used for another program; however it is not flexible for the administrator to apply to another program. |
| | V | Disease Specific Educational Content | R | Disease specific or RCH program specific educational content is not available. |
| | VI | Error handling | G | Error handling is fair. User receives error alerts with options and not unhandled error messages. |
| | VII | Deployment | | Online only |
| | a | Online | G | eMamta is currently functioning online and offline is not planned. |
| | b | Offline | R | There is no offline function in the application. |
| **12.** | Other | | | |
| | I | Mobile user interface | Y | System can send registration status SMS and due service SMS to users and beneficiaries.<br>The system has capability to send work plans on the mobile of the users, but is not implemented yet. |
| | II | Capacity building/Change Management Methodology after initial implementation | Y | Capacity building for use of eMamta was done by the State with the help of NIC. |
| | a | Skill Building | G | Skill building is done in mostly as class room hands-on training. Initial orientations for districts is done at state level followed by phase-wise trainings at regional level where five districts were called in each training for hands-holding and support. |
| | (i) | One time training | G | One time trainings were provided to the districts with subsequent phase-wise trainings. |

| | | | | | |
|---|---|---|---|---|---|
| | | (ii) | Ongoing handholding and support | G | Many rounds of trainings for the users at district levels are provided followed by local level training for user on eMamta forms. Six months ago regular refresher trainings were organised in regions but now training is organised based on needs. |
| | | b | End user hardware infrastructure | G | Data entry point is PHC and for each PHC hardware is provided from the state, procured by Gujarat Informatics Ltd with a warranty of five years. |
| | | c | Human Resource | G | Before eMamta was implemented in the state, data entry operators were doing data entry for HMIS (in DHIS) from PHC. eMamta has used existing human resource for data entry and reporting. |
| | | d | Protocol for HMIS related process | G | Protocols related to eMamta data reporting are in place. Similarly protocols related to District Family Health Survey data collection and reporting is also in place. |
| | III | | Capacity building/Change management budget available as part of initial budgeting | G | Separate provision for budget has been made for eMamta implementation. |
| | IV | | Capacity building/Change management process signed off during implementation | G | As NIC and state health department are working in close coordination, frequent refresher trainings are provided on timely basis. Similarly users' feedback is also included in the application time to time. |
| | V | | Software support through multi-year maintenance contract | Y | Software support is provided by NIC team that is doing the ongoing development of the system. Did not find any evidence of a maintenance contract. Documents related to system design, development and implementations were not found. |
| | VI | | Hardware support through multi-year maintenance contract | G | Initially hardware provided to districts with five year contract. State has dedicated Gujarat State Wide Area Network with 4Mbps data speed. The users were also provided the liberty to procure broadband data card for uninterrupted connectivity. |
| | VII | | Source code available? | G | NIC has developed the system, so the source code is available with NIC. |
| | VIII | | Open source Technology? – Proprietary v/s Open Source | G | Proprietary – Microsoft .Net 2.0 (2005), Sequel Server, Sequel Reporting has been used for developing the system. |
| | IX | | Obsolete technology? | G | Latest technology – Microsoft .Net |
| | X | | Software upgrades being done? | Y | Yes, system is updated continuously as requirements keep changing from users. Continuous changes without a product lifecycle management and release management is technically risky for the IT system. The system can be rendered unstable if too many changes are done without keeping detailed documentation and configuration management as per standards e.g. CMMI. |
| | | a | Software Configuration Management | R | Haven't noted any evidence of product life cycle management, release management, configuration management and SDLC documentation as per standards e.g. CMMI. |

| | | | | |
|---|---|---|---|---|
| | b | Software Product Life Cycle Management | R | Haven't noted any evidence of product life cycle management, release management, configuration management and SDLC documentation as per standards e.g. CMMI. |
| | XI | Hardware upgrades being done? | G | Gujarat Govt. takes care of hardware procurement, maintenance and support. |
| | XII | Infrastructure for scalability – e.g. SAN, Data Centre, Web Farm | G | Scalable hosted in NIC. |
| | XIII | Capex or Opex financing model? | G | Capex |

**E. Did the system achieve the objective?**

After eMamta implementation RCH monitoring in Gujarat state has become data driven and care is based on protocols. However it is important to understand if the system has achieved the intended objectives.

| | **Main Objectives:** | **Remarks** |
|---|---|---|
| **1.** | Track mothers and children for entire range of services because immunization starts ante-natal and continues post-natal and beyond. | After eMamta implementation state has improved ANC first trimester registration and delivery reporting. Similarly infant & maternal mortality reporting has also improved. Now the whole system is data driven and users understating has improved about complete care based on protocols. |
| **2.** | For monitoring and evaluation, provide reports filtered on the following criteria - by individual patients; by village; by period; by service providers. | System provides a framework to monitor the different RCH services. The data entry culture has developed. Now the state has started focusing on data analysis - some reports can be generated from the system but some are yet to be developed. |
| **3.** | To track the mother and child on an individual patient-based data and import it into the facility-based HMIS, so as to avoid double data entry and improve the data reliability. | Gujarat RCH data is being tracked through eMamta and the data on relevant forms is uploaded to MCTS every night. |

**Discussion:**

1. **Reporting time delay** – eMamta has reduced time for reporting data from field. Patient based alerts are available to beneficiaries and officials soon after the data gets converted from paper to electronic format.
2. **Mismatch between HR capacity and reporting needs** - The human resource was designed for paper based system where the data from SC, PHC, and Block was aggregated at the District level and all aggregated reporting to the state and centre was done by the District. Whereas eMamta system is designed for patient based reporting directly from PHC. The resources at PHC level were assigned with an additional task of entering the patient based data received from Sub-centres. Data entry is an additional burden on the PHC resources.

3. **Monolithic design** – The system is following a monolithic design where it is becoming a sort of EMR for the patient based reporting. In some ways the design is a parallel to the centralised model that has failed in NHS UK. Ideally the public health system should be decentralised where the patient based reporting should be left to the EMR and the public health system gets a consolidated view of the granularity in the EMR. In the absence of an EMR, there is an attempt by eMamta to fill the gap all the way down to the patient level. Seems to be too early in the game. The first step should be to get the field staff into the habit of reporting consolidated figures in the electronic system. The EMR can be introduced at the point of care to capture the patient based details at a later stage.
4. **Local analysis and use of information**– Local level users are not provided with options to analyse their own data for decision making. However they have predefined report formats. Work plans are also provided to ANMs based on standard protocols.
5. **Ad Hoc reports** - The flexibility to produce your own reports is lacking in the system. Lots of ad hoc reports are required which couldn't be thought of at the time of software system design. NIC spends a lot of time producing these ad hoc reports. Rather an online analytical processing [OLAP] functionality would have gone a long way to enable the users to produce their own reports.
6. **System is in flux** - The requirements of the system were never frozen and are constantly changing. It is very disturbing for the end user when confronted with partly developed/changing functionality and unhandled error messages. This becomes a huge adoption issue with lower education levels of end users. There is no evidence of product life cycle management, configuration management and release management. There is no traceability of any requirements document, design documents, test plans and test reports. No evidence of version control for each release. The system has turned into an application that is constantly in flux. Technically this is a dangerous situation because it renders the system unviable for the long-term use. A detailed technical evaluation was out of the scope of this study; however it is recommended to technically audit eMamta as per SDLC, PLM, ITIL and CMMI standards.
7. **Integration with other systems** – eMamta uses web services [XML] to integrate with MCTS. The data from eMamta is uploaded to MCTS every night as a scheduled batch process.
8. **Private sector and urban areas data** - Currently data is not reported from urban area and from private providers. DFHS is not organised in urban area therefore baseline data is unavailable. Private providers are not comfortable with sharing data in eMamta. We all know that diseases don't know boundaries and narrow domestic walls. Therefore the big picture of epidemiology is still a distant dream.

## III. Recommendations

Capacity building required for improving adoption of the existing systems. Integrate data sources to build a health information exchange.

1. **Add consolidated reporting** – System should allow granular reporting as well as consolidated reporting at different levels. Based on capacity building, let the Districts decide the granularity level from which they want to report. Therefore it is

recommended to add functionality in eMamta to allow consolidated reporting for districts/ blocks/ CHCs/ PHCs. Then do a massive change management to push the facilities that are lagging behind in adopting the reporting in electronic systems.

2. **Change Management** - Patient based reporting is the right thing to do but it is a huge cultural change from the traditional paper based system that works on aggregated data. History of Healthcare-IT systems clearly indicates that one can't achieve adoption by forcing the workers to do anything. The only successful model to improve adoption is a democratic way which is inclusive and not the autocratic way. Therefore there needs to be greater and sustained focus on capacity building and change management. Constant interventions are required to change the human behaviour. The resistance to change is a problem that needs to be removed step-by-step over time. Sudden change makes the *frog jump out of the hot water*.
3. **Fix the technical issues** related to requirements, design, product life cycle management, release management etc. Technically stabilise the system so that the long-term viability improves and the data is secure.
4. **Integration and Data Analysis** – Gujarat is well positioned to build a state level health information exchange [HIE]. The thought process to integrate various data sources for data warehouse and data analysis is the right direction.

**Sources of Data for the report:**

| Sl. | Sources of Data | Remarks |
|---|---|---|
| 1 | Interview of stakeholders | 19/Dec/2011 - Had a meeting with the NIC team & eMamta team @ Juni Commissionrate Gandhinagar. |
| 2 | System Requirement Specifications Document | NA |
| 3 | Functional Design Document | NA |
| 4 | Technical Design Document | NA |
| 5 | System Architecture Document | NA |
| 6 | Test Cases and Test Report Document | NA |
| 7 | User Manual | Available. |
| 8 | Other | - Presentation on eMamta from nrhm.hmmis.nic.in/.../EMamta%20Mother%20and%20Child%20 on 12/12/2011, 12:00 PM<br>- eMamta Name Based Mother & Child Tracking Application, An e-Governance Bulletin from GUJARAT INFORMATICS LTD Accessed from http://www.gujaratinformatics.com/pdf/E-Mamta.pdf , on 12/12/2011, 3:30 PM |
| 9 | Live System Demo | Available. |

# III. Andhra Pradesh Historical HMIS Development

**Introduction-** Andhra Pradesh has a long history of Information System development for health care which can be traced back to SMART (Simple, Moral, Accountable, Reliable and Trustworthy) governance initiative of Chandra Babu Naidu government during 1999-2004. During the same period state has started two major health information system initiatives namely India Health Care (IHC) & Family Health Information Management System (FHIMS).

Both these initiatives were name based information systems backed by Multipurpose Household Survey (MPHS). The name-based MPHS data base was created by revenue department for their own purposes and had massive database of 75.7 million citizens, 25 million land records to help provide a social security identification number for every citizen of the state. Initially compiled in 1995 later MPHS was computerized and put up on a central server for public access. Later government directive made MPHS as standard database to be used by all departments as baseline to prevent multiplicity of databases. Although a good initiative to reduce duplication, this effort hasn't produced any productive outcome for the government health department.

**MPHS database & associated challenges**- Compiling MPHS database with socio-economic indicators was a huge challenge. As the MPHS database was initially developed by revenue department, most of the demographic indicators were not part of it. To make it useful for health department several rounds of updation has been done in the database.

- Initially database was updated in 1998 and 2003 to include more demographic indicators such as births, deaths & migration.
- Later in January 2000, Human Development Survey (HDS) was done to update MPHS database. However HDS and MPHS data can't be merged due to difference in basic parameters and survey outcomes (MPHS-name based, HDS-aggregated numbers), differences in basic reporting units (MPHS- household, HDS- village). Apart from this both MPHS & HDS had their own serious data quality issues.

Around the same time (June 2000) India Health Care project was undertaken by Infodev (The Information for Development Programme), an agency of the World Bank to upgrade MPHS database.

**India Health Care Project-** The larger objective of this initiative was to reduce infant mortality and maternal mortality by improving the quality of antenatal care and child health through improved information management. The project was eventually implemented in 200 sub-centers (spread across 32 health centers).

Key objectives:

- To reduce or eliminate the redundant entry of data prevalent in paper registers,
- To generate monthly reports automatically for health assistants,
- To make data electronically available for further analysis and compilation at higher levels of the healthcare system.

Under this initiative health workers were provided with the Personal Digital Assistants (PDAs) to collect, compile and report health data. Similar application has been installed in

the PHC desktop to capture data from PDAs. It was expected that PDAs would help reduce paper work and replace health workers register in coming future.

The data reporting through PDAs failed significantly because of various reasons given below-

- Poor user interface- PDAs had monochrome black & white screen with very small letters making it very hard for health staff to see the screen. Reading was also difficult in day time due to sun glare.
- Time consuming- PDAs had very insufficient memory and the devices were slow, thus taking a lot of time of health worker for data entry and retrieving.
- Technical incompatibility- It was difficult to upload data from PDAs to desktop computer due to some technical problems in database.
- Mismatch between requirement and availability- The base line name based data used in PDA had very limited health parameters and had quality problems which didn't match with the data requirements of health workers (e.g. eligible couple details) during field visits. Various records of the families were either missing or had wrong entries.
- Poor battery life- PDAs had battery with limited power capacity and due to frequent power cuts in the villages charging batteries was a challenge. PDAs had technical limitations and in case of complete discharge, all data in PDAs was erased.
- Lack of support and maintenance- There was absence of technical support and maintenance and in case of theft or loss it was expensive to procure PDAs.

All this led to non-use of devices on the job. Health workers who were initially enthusiastic lost interest due to the poor quality of the survey database, recurring software problems, insufficient memory capacity, absence of timely and on-going technical support and maintenance.

Project failed to achieve its desired objectives due to above cited reasons and high cost.

**Family Health Information Management System (FHIMS)-** FHIMS was an offshoot of the IHC project and was piloted in one district (Nalgonda) of Andhra Pradesh in 2002. Health Department from the IHC project realized that it is important to have a more elaborated database at PHC, District office and State office level to fulfill a) Family Welfare needs b) Help control of communicable diseases and c) Help in PHC management. Detailed objectives of the project are outlined below-

- Name-based follow up of family welfare services: antenatal services and immunization, early identification and timely referral of high risk antenatal cases;
- To improve the full immunization rates;
- To facilitate the health assistants to easily get the schedule of services to be rendered in each habitation during a month.
- To reduce the burden of manual record keeping by the field staff and all the higher levels;
- Contain the spread of communicable diseases and blindness by tracking incidence of diseases;
- Improve functioning of PHCs by facilitating effective service delivery;
- Streamlining inventory and infrastructure management at the health centers; and,

- Managing career and training issues of field personnel.

For the above purpose a new application has been developed and implemented in Nalgonda district. FIMS software was developed with 17 modules involving different activities of PHC including family welfare services, various health services (such as disease control program) and administrative aspects (such as budget and logistics support). The software was developed on an Oracle backend using Visual Basic as front end.

FHMIS project was piloted in 67 PHC in one district of Andhra Pradesh, later it was scaled to entire state including 22 district and 1319 PHCs. This scaling involved updation of MPHS data by household survey, installation of computer and FHMIS, entering survey data, training the health staff and other related activities: such as printing of the MPHS book, and appointing of data entry operators at every PHC. Initially software had offline data entry function but later offline entry has stopped.

The system was running in state for few years after its scale-up but didn't achieve its desired objectives and later collapsed. The reasons for lack of adoption of the system can be attributed to followings-

1. **Lack of ownership**- Data Entry Operators (DEO) were hired initially for six months to do data entry at PHC level and motivate health assistant to take up the data entry job later-on but DEOs failed to motivate health assistants for data entry. Also there was no incentive for the health assistants to do this additional job. Health assistants never asked for the schedules and haven't considered it as a support tool.

2. **Multiple bugs in the system**- Software had multiple unattended bugs with varying degree of complexity, which interfered with the health workers job. Without any support these bugs reduced interest of health workers in using system.

3. **Incompatibility between household survey and software**- Baseline database wasn't compatible with the routine task of the health worker.

4. **Poor trainings**- Limited people have received basic orientation on use of computers through 5 days one time training programs. There was a significant gap in training required and the training provided. Post training support and refresher trainings were not part of the overall capacity building efforts.

5. **Access issues**- Some PHCs did not receive user IDs & password to use the system and to generate reports.

With the introduction of National Rural Health Missions (NRHM) and National HMIS Web Portal, state shifted to aggregate data reporting and started using HMIS Web Portal for aggregate district data reporting since 2008 onwards. Later with the increasing national interest to report name based data State also started reporting name-based data for pregnancy and immunization tracking using DHIS-2.0 from August 2011.

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# Appendix

# Appendix- I

## List of Parameters for the Study

| S. No. | Functionality | | | Comments |
|---|---|---|---|---|
| **1.** | **User Friendliness** | | | |
| | I | | Simplicity - Average Number of panels, keystrokes and mouse clicks | A good gauge of simplicity is often the number of panels that must be displayed and the number of mouse clicks or keystrokes that are required to accomplish a particular task. All of these should be minimized. The fewer things users have to see and do in order to get their work done, the happier and more effective they will be. This is especially important on slow speed connection to the server. [http://cfg.cit.cornell.edu/design/concepts.html] |
| | II | | Average Time to fill one form in the application:<br>* 0-15 minutes<br>* 15-30 Minutes<br>* 30- 60 minutes<br>* More than 60 minutes | In a good design, all the forms should be of approximately same length and similar data element types and should take approximately the same amount of time to fill. It's a bad design to have forms of different lengths. A long form should be split into 2 if it needs a lot of scrolling.<br>Long and heavy forms are slow to load on a slow speed network connection. It is frustrating for the user to keep waiting for a long and heavy form to load. |
| | III | | Field Defaults | Fields should have relevant defaults. Leaving it blank always isn't a good idea. Nor is it a good idea to pre-populate things that you want the user to pay attention and select. Field Default should help the user to fill the form quickly but also it shouldn't act as spoon feeding. |
| | IV | | Mandatory Fields Indication | Mandatory fields should be marked by an * or different color or some method to attract attention. Users should know what is optional and what must be filled. |
| | V | | Use of Tabs | User should be able to navigate the form with Tab key without using a mouse. |
| | VI | | Field Tab Order | Tab order should follow the field order in the form. Else the user takes much more time to navigate and search the field. |
| | VII | | Color Definition | The entire application should have a uniform color definition. Pages with different color schemes confuse the user. No color is also ok if it is consistent across the application. |
| | VIII | | Section Segregation | Sections should be properly segregated to help the user to quickly identify the section of interest. |
| | IX | | Scrolling | Ideally the form design should not require any scrolling at all. However 2 pages of vertical scroll are usually acceptable. Horizontal scroll is a bad design because it slows down the users work. |
| **2.** | **Data Entry & associated functionality** | | | |
| | I | | Data entry by reference | Data is entered based on reference number from a coding table or external source. |
| | II | | Data entry by value | Data is entered by alphanumeric/numeric value as per the users own will. |
| | II | | Data entry - | Manual data entry is the most common form of input. |

| | | | | |
|---|---|---|---|---|
| | | | Manually | |
| | II I | | Data entry- by excel import | Import of data thru an Excel or another format/source. |
| | IV | | At every level does it allow data entry of figures consolidated from facilities below it? | Example - District able to enter consolidated data of Block, DH, CHC, PHC, SC; Block able to enter consolidated data of CHC, PHC, SC; ANM able to enter consolidated data of her SC. |
| | V | | At every level does it allow data entry of individual facilities below it? | Example - District able to enter individual facility data - DH, CHC, PHC, SC; Block able to enter individual facility data of CHC, PHC, SC; Facility able to enter individual patient data. |
| **3.** | **Data Quality check facility** | | | |
| | I | | Data validation | Data is validated before commit to the database. |
| | | a | During data entry- front end validation | Validation is done by the rules written in the front-end itself. The front-end doesn't communicate with back-end for data entry validation.<br>It's a good design to do as much data validation on front-end itself on slow connections. The load on the system goes up significantly if the front-end communicates with the back-end for validation during data entry. |
| | | | During data entry- validation done from back-end | Validation is done by the rules written in the back-end. The front-end communicates with back-end for data entry validation.<br>Very expensive data validation method on slow connection. The load on the system goes up significantly if the front-end communicates with the back-end for validation during data entry. |
| | | b | After data entry | Data validation of the entire form is done on submit. The validation could be front-end or back-end or combo. All the data entry errors need to be pin-pointed to the user with very detailed comments. Else the user gets confused about what needs to be corrected. |
| | | c | Validation Rules for Imports | The system has validation rules for importing in a standard format such as Excel. Any error is flagged for the user to take action. |
| | | d | Auto Validation for Excel Based Imports | The system has validation rules for importing in a standard format such as Excel. System has intelligence to take basic corrective actions automatically. Any error that can't be autocorrected is flagged for the user to take action. |
| | II | | Identify duplication | Identify any duplicate data entry and flag it. |
| | II I | | Assess completeness | Completeness of the data entry ideally expressed as % fields left blank or filled with junk characters and within a specified time. |
| | | a | Of all Reporting Units | Completeness of the data entry from all reporting units. |

| | | | | |
|---|---|---|---|---|
| | | b | Timeliness | Timeliness of the data entry meaning the data is being submitted on time and not after the last date in each reporting cycle. |
| | | c | Differentiate between zero & non-zero | A blank can mean zero, not reported, doesn't exit or anything else. The ambiguity must be removed. Leaving the field blank/Null should not mean Zero. System should be able to distinguish between Zero and Null value. |
| | IV | | Data Confirmation | User should be able to confirm the data before final locking. |
| | V | | Data Modification | System should allow data to be modified by the user before it is locked for the period. Any changes done should be recorded in Audit Trail. |
| **4.** | **Data load on system** | | | |
| | I | | Form elements | The data entry form with its data elements is meaningful. |
| | | a | Indicator to data element ratio | It is good if the ratio is high because it indicates that more number of indicators are being derived from the same set of data elements |
| | | b | Number of forms to be filled from each facility | Submitting the required data will be slow if large numbers of forms have to be filled by the district/block at a low speed network. |
| | | c | Form design | Assuming the forms have to be used in the field on slow connectivity, the form design will play a very important role in terms of downloading the form, validation and submission. It should not have lot of pictures, flash, dropdowns, lengthy forms etc. The form design should be very lightweight for Public Health. |
| | II | | Data archiving | Functionality to archive old data. Load on data processing increases with size of transaction data. IT system usually takes longer to produce reports when the system has to process a lot of transaction data. |
| | | a | within the database | Archiving old data is a good practice to speed up the reports based on transaction data. The archiving can be done within the same database. |
| | | b | in a separate database | Archiving old data is a good practice to speed up the reports based on transaction data. The archiving can be done within the same machine but in a separate database. |
| | II I | | Case load per data entry unit | For a normative block the average time taken to fill all forms for all the units in the block i.e. Facility or Patient. |
| | IV | | System response time | The average time taken for a page to load at a fixed speed of the network. Ideally it should be < 2 seconds per page; anything > 5 seconds per page is too high, because the user loses interest. |
| **5.** | **Unique identifier** | | | |
| | I | | Patient | Does the system have a unique patient identifier e.g. ADHAAR from UIDAI? Very important for patient based tracking systems. The public health system needs to store only the unique ID not the full medical record of the patient. The patient medical data can be in the source systems and the public health system can drill-down to the relevant medical record on-demand. |
| | II | | Provider | Does the system have a unique doctor/ANM/ASHA |

| | | | | |
|---|---|---|---|---|
| | | | | identifier? Very important to provide role-based access and ensure only the person who needs to see the data can see the data [data security]. Also required for strict Audit Trails. |
| | II I | | Facility | Does the system have a unique identifier for the facilities? Very important for data analysis, resource planning and plotting on the GIS. |
| | IV | | Encounter | Does the system have a unique identifier for the medical record generated in every encounter/visit? The public health system needs to store only the unique ID not the full encounter data. The encounter data can be in the source system and the public health system can drill-down to the medical record of the relevant encounter/visit on-demand. |
| **6.** | **Report generation** | | | |
| | I | | By Design | |
| | | a | Static – predefined | Predefined reports that can't be changed by the user. |
| | | b | Dynamic – can be configured by user | User can make changes to the report format or generate his/her own reports. |
| | | c | Report generation by programming/ SQL Queries | Programmer can produce the report as per user's requirements. User can't do the reports on his/her own. |
| | | d | Online Analytical Processing (OLAP) for user | The user can easily drag-and-drop and create his/her own reports and save format for further use. User can navigate through the database and screen for a particular subset of the data, changing the data's orientations and defining analytical calculations - slice, dice, drill-down, drill-up, roll-up, pivot. |
| | II | | By use | |
| | | a | Number based aggregated only | Report shows only aggregated numbers. |
| | | b | Analyzed (indicator based) | Reports analyze the indicators and display the inference. |
| | II I | | User can generate aggregated report for his level and level below. | Users have the right to generate reports on aggregated data for his own level and below. |
| | IV | | User can generate disaggregated report for his level and level below. | Users have the right to generate reports on granular data for his own level and below. |
| | V | | Data Mart | Data marts or data cubes built for producing specific reports. |
| | VI | | Dashboard for | Customized Dashboards for key decision makers - where |

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| | | | decision makers | they can see a list of indicators that they need to see daily. |
| | | a | Showing values only | Dashboard showing values only. There is no analysis and inferences. |
| | | i | Numbers and tables | Dashboard shows numbers and tables only. There are no indicators. |
| | | ii | Indicators | Dashboard with useful indicators. |
| | | b | Graphical – Charts | Dashboard with graphics and charts for easy understanding. |
| | VII | | GIS-Map based data analysis | Data displayed on geographical maps. |
| **7.** | **System Flexibility (to define your own)** | | | |
| | I | | Data fields | Flexibility given to the users to define their own data fields. |
| | II | | Indicators | Flexibility given to the users to define their own indicators. |
| | III | | Forms | Flexibility given to the users to define their own forms. |
| | IV | | Formats | Flexibility given to the users to define their own formats. |
| | V | | Reports | Flexibility given to the users to define their own reports. |
| | VI | | Dashboard | Flexibility given to the users to define their own dashboards. |
| | VII | | Rules Engine – To define Clinical Protocol and Disease Management based Rules | Flexibility given to the users to define their own clinical protocols. |
| | VIII | | Workflow Engine – To define user defined public healthcare program specific workflow | Flexibility given to the users to define their own work flows. |
| **8.** | **Standards** | | | |
| | I | | Data Definitions – | System should have clear Data definitions |
| | | a | Vocabulary Standards | System should have vocabulary standards. This is very important for integration purposes. The receiving system should be able to understand the vocabulary of the sending system. |
| | | i | For local - | Local standards are ok but become a hindrance in integration with systems that do not follow local standards. |
| | | ii | For global – e.g. SNOMED, | Global standards are a good design because it standardizes the terminology across all systems. |
| | | b | Size | Number of characters allowed for a field is very important to define upfront. Data will be lost in integration - If the sending system has 4 characters but the receiving system has only 2 characters. |
| | | c | Type | Type of data is also important to define as part of the design – integer, long, float etc. Data will be lost in integration - If the sending system has Long data type but the receiving system has only Integer data type. |

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| | II | | Disease & Diagnosis code sets – Local codes, ICD 9, ICD 10 | It is always a good practice to standardize the Diagnosis as per ICD diagnosis codes published by WHO, so that the data is universally understood. |
| | II I | | Procedure & Service Code sets – e.g. Local codes, CPT, CAP | It is always a good practice to standardize the Procedure/Service as per CPT codes published by WHO, so that the data is universally understood. |
| | IV | | Interoperability standards for integration – e.g. HL7, DICOM, SDMX.HT | Public Health systems should have ability to accept and send out data in standard messaging formats such as HL7, DICOM etc, so that it is easy to integrate with other systems. |
| **9.** | **Data Privacy** | | | |
| | I | | Role-based access | Role-based access control (RBAC) is a data privacy standard globally. RBAC is an approach to restricting system access to authorized users. Within an organization, roles are created for various job functions. The permissions to perform certain operations are assigned to specific roles. Members of staff (or other system users) are assigned particular roles, and through those role assignments acquire the computer permissions to perform particular computer-system functions. Since users are not assigned permissions directly, but only acquire them through their role (or roles), management of individual user rights becomes a matter of simply assigning appropriate roles to the user's account; this simplifies common operations, such as adding a user, or changing a user's department. |
| | II | | Data locking | System should lock the data at the end of the reporting period. Users will not be allowed to make changes after this. Only super user rights are required to make changes after that. |
| | III | | Password Protection | ID and password is the basic data privacy standard. |
| | IV | | Field Based Access Rights | Healthcare data needs to be protected and only the person who needs to see it should see it. This discretion should be available at the field level. |
| **10** | | | **Data Security** | |
| | I | | Data Changes/ Error corrections (Audit trails) | Log all the add/edit/delete with when, why, who and where. |
| | II | | Roll-back facility | With admin privileges - Ability to roll back to an earlier state if the change was made in error or by someone without authority to make the change. |
| | III | | Data back-up including tiered backup | System should have the protocols for taking a back-up of the transaction data and reports. Tiered back-up should be taken if there are layers of databases e.g. In online-offline system. |

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| | IV | | Encryption - PKI usage | All data that has to move thru the network should be encrypted using a secure key. |
| | V | | Digital Signature Certificate Usage | Each user generating/validating/locking the data must be signed by a digital signature. |
| **11** | | | **System Functions** | |
| | I | | Search | System should have functionality to search fields, forms, reports etc. |
| | II | | Feedback | System should have a method for the user to give feedback and provide support. The feedback can be in the form of email, call center etc. |
| | III | | Help | System should provide Help files to help the user navigate thru the system. |
| | IV | | System flexible to adapt to any Disease Program? | A well designed public health IT system should be able to adapt to any disease program. |
| | V | | Disease Specific Educational Content | Does the system provide and disease specific education content. |
| | VI | | Error handling | Ugly error messages shouldn't appear to the user. All possible errors should be handled and thrown to the user as a pop-up if user is required to take any specific action. |
| | VII | | Deployment | How has the system been deployed in the field? |
| | | a | Online | Completely online? |
| | | b | Offline | Offline deployment where the system has local databases and the data sync happens whenever network speed is good. |
| **12** | | | **Other** | |
| | I | | Mobile user interface | Can the system take inputs from a mobile platform, and push out data to the mobile of the user as a SMS or MMS or thru mobile browser. |
| | II | | Capacity building/Change Management Methodology after initial implementation | Changing from paper based system to electronic system needs a massive change management. |
| | | a | Skill Building | People have to be trained, retrained and supported to develop skills to use and manage electronic systems. |
| | | i | One time training | Initial training to introduce the user to the system. |
| | | ii | Ongoing handholding and support | Very important to provide ongoing training and hand holding to change human behavior and adopt the new IT based processes. |
| | | b | End user hardware infrastructure | Was the user enabled with relevant hardware such as desktops, laptops, tablets etc? Who is responsible for providing the hardware support? |
| | | c | Human Resource | Was the adequate number of people and skills provided to run the program in the field? |

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| | | d | Protocol for HMIS related process | Were the paper based processes modified to suite Electronic systems? |
| | III | | Capacity building/Change management budget available as part of initial budgeting | Budget was available for capacity building? |
| | IV | | Capacity building/Change management process signed off during implementation | Capacity building was part of the implementation project plan or contract? |
| | V | | Software support through multi-year maintenance contract | Software vendor or in-house technical team should provide constant patches, upgrades and support. |
| | VI | | Hardware support through multi-year maintenance contract | Hardware needs constant support during usage. Hardware vendor or in-house technical team should provide constant support. This includes server, network, datacenter, and end user devices – desktop, laptop, tablet etc. |
| | VII | | Source code available? | Best option- The Software vendor should handover the software source code to the Govt. so that Govt. can setup their own technical team to manage the software after/if the vendor exits. Else very tight long-term maintenance contracts must be negotiated with the proprietary software vendor. |
| | VII I | | Open source Technology? – Proprietary v/s Open Source | Open source technology gives a sense of control because the source code of open source is available and in-house teams can manage it in absence of a vendor.<br>For proprietary software - need to have a multi-year [10 yrs] maintenance contract negotiated with the Proprietary software vendor and option to extend.<br>Although cost wise it is the same in the long-term. Open source costs less initially as there is no license cost but maintenance costs are high unless the maintenance cost is shared across many implementations. |
| | IX | | Obsolete technology? | Technology lifecycle is about 3-5 years. Technology gets obsolete and is ready for replacement. A good software/hardware vendor offers constant upgrades. |
| | X | | Software upgrades being done? | The software vendor is providing patches, upgrades and support? |
| | | a | Software Configuration Management | Software product versions are being managed in a dedicated configuration management server by the vendor or in-house team? It's a good practice, because lot of software working and software compatibility depends on versions. |

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| | | b | Software Product Life Cycle Management | Public Health software should be built like a product so that the same product is applicable for various diseases, programs and geographies.<br>A software product is flexible and can be implemented for different situations and programs. It learns from various implementations and gets enriched over time. Whereas a software Application is built as a single monolithic Application for a single purpose. It is difficult to be reused for another situation or program. A single Application lives its life and dies unless it grows into a product. |
| | XI | | Hardware upgrades being done? | The hardware vendor is providing support? This includes server, network, data centre, and end user devices – desktop, laptop, tablet etc. |
| | XII | | Infrastructure for scalability – e.g. SAN, Data Centre, Web Farm | The IT system is hosted on a reliable and scalable IT Infrastructure. IT infrastructure should be able to take the load of the transactions. Also it can easily grow with the load e.g. a scalable data center. |
| | XIII | | Capex or Opex financing model? | If all the capital investments have been done upfront or the hardware and software has been taken on lease – pay-per-use model. |

# Appendix -II
# Background Note on Health Informatics:
**(For steering committee meeting 29th- 30th November 2011)**

All working groups papers have discussed their information technology requirements and advanced suggestions for how IT architecture should be developed with respect to the health sector. The High Level Expert group has also a sub-section dedicated to this theme. This note describes in summary the main points of convergence between the different recommendations, the areas of divergence and the concerns underlying different points and the way forward such that there is a broader consensus on what is to be done in the 12th Plan Period.

One vision that emerges across papers – which could be an overarching goal or ambition, is a health information system, based on universal registration and biometrics, which is dynamic and constantly updated health record of every citizen-family, which begins with universal vital registration, which is portable and accessible to service providers and to the families themselves. Based on this foundation a network links all service providers, public and private laboratories and also generates the aggregate figures needed at different levels for policy making and management decision as well as generates the alerts needed for disease surveillance. Data fidelity is assured by triangulation with data from periodic surveys and community based monitoring.

On the other hand working papers are also pointing out specific needs for information. These could be listed as follows:

1. Registration of Births and Deaths – for demographic purposes and to provide base-lines
2. Service Delivery in the public health system- the main role of the current HMIS system- helping to make decentralised district and sub-district level management decisions as well as support better resource allocation from state to districts and within districts to facilities/providers.
3. Morbidity and Mortality profile as emerges from care seeking at public and private hospitals. This helps estimate burden of disease and facilitates policy decisions at state and national levels. Placed on a GIS platform it could identify geographic concentrations- endemicity- of disease.
4. Disease surveillance to detect and act on disease outbreaks and epidemics.
5. Nutrition surveillance - Monitoring under-nutrition and wasting and acute changes in nutritional levels.( linked to ICDS programmes).
6. Programme Monitoring support for national health programmes: helps identify programme gaps or areas where there are greater challenges.
7. Support human resource management within the public health system.
8. Support financial management – from resource allocation, resource transfers, accounting and utilisation to financial services – making of payments to facilities, providers, beneficiaries.
9. Provide hospital information service- to improve the quality of care to patients through electronic medical records, to improve hospital administration and to provide data inputs to the district health management information system.

10. Provide a platform for continuing medical education and for consultation support to doctors from advanced centres of learning and a platform
11. Reduce the burden of work of service providers in record keeping, and easy retrieval of records relevant to their work
12. Support regulatory functions of the state- by creating a nation-wide registration of clinical establishments, manufacturing units, drug testing laboratories, licensing of drugs, approval of clinical trials.
13. Support the organ retrieval and transplantation programme.
14. Support to emergency response systems and referral transport arrangements.
15. Improved access of public to public health information and of individuals to their own health records.
16. Improved transparency of government systems.

There are other unproven and unstated ambitions that information systems acquire- like policing the system for fraud, or improving accountability of services- and it is not quite clear how an information system acquires this.

The starting point of dialogue on planning for these needs is to confess that in fact we have been actively trying to solve these needs for at least 15 years in continuity, and despite considerable expenditure, these past efforts have not yielded desired results. Based on evaluation and studies of past systems we could draw attention to a few major constraints that have bedevilled past efforts:

a. Lack of clarity about how exactly the system would be used. The system is geared to an "information fetish"- a continuous acquisition of numbers and records without obvious use. The burden of work in recording and reporting the information is disproportionate to both the time spent on service provision and/or the use made of information.
b. Problems in the organisation of work processes and information flows, which computerisation would not overcome and may even exacerbate. A tendency to blame all data quality issues on errant reporting by service providers and a failure to address the multiple sources of data unreliability.
c. Mismatch between the health systems capacity in a given context, and the level of technology introduced and expectations made for information gathering and reporting. A sort of one size fits all approach to technology introduction. Also a failure to design systems that cater to the decentralised user, which means an inability to use of information for local action, which in turn leads to a vicious cycle between poor data quality and poor use of information.
d. Design problems of software: A failure to design systems that see information needs as dynamic and varied across levels and users and over time. This combines with inadequate third party testing and certification of software/applications, poor interoperability across systems, vendor lock-ins, and high investments in servers and software which rapidly go obsolete, with no long term development plans.
e. Poor integration of systems and an inability to share information across systems. Also a lack of a data policy, data standards, and standards of interoperability or institutional mechanisms to develop and enforce these standards.

These problems are not unique to India alone. The working paper that addresses ICT in some detail notes that "the use of IT as outlined above seems to be the most promising and cost-effective. Nevertheless a work of caution may be in order. A recent editorial in Lancet, (Issue no 9791, pg 542, Aug 13, 2011) described the fate of a similar project planned in the UK in 1992, that aimed at creating a fully integrated centralised electronic care records system o improve services and patient care. The budget for the undertaking was a substantial 11.4 billion pounds. Nine years on the Department of Health has spent 6.4 billion pounds on the project so far, but failed to meet its initial deadline and has had to abandon the central goal of the project because it is unable to deliver a universal system ."

The challenge of the 12th Plan is how to move towards the larger vision, from the place where we are today , while respecting the different levels of subjective and objective readiness of the health systems, health technologies and health care providers to make this transition.

The 12th Plan shall therefore commit the nation to achieve the following:

a. Define the role of the centre as primarily defining, in a participatory and scientific way, the data definitions, data standards, data quality requirements and standards of interoperability, which all publicly financed application of information technology in the health sector, must necessarily sub-scribe. This will need a steering committee with representatives from the department of IT, department of health and a certification/monitoring mechanism that is able to check and enforce compliance with. A data policy would also be put in place that would define how long the health data must be stored and in what electronic form and with what back-ups and what provisions for the right to access, security of information and privacy. The centre would also have to develop procurement policies which permit open source technologies to be considered and which allow arrangements that could support a software that is constantly evolving- as different from one, which is a one-time product.
b. The department of health would encourage and support the development and deployment of systems for each of the above use in a decentralised way, but with enforcing the standards mentioned earlier so that there can be data sharing across systems- and so that the service providers do not have to enter the same data element more than once. Thus if malnutrition data of a block is available on one system and the deaths and incidence of acute respiratory infection are available on another system, each of these systems should be able to acquire the information of the other system in a seamlessly and electronically. "The approach would be towards permitting multiple systems which meet the well defined and regulated standards with each user level or institution able to access information most useful at that level- rather than one single system to which all data entry and interpretation in the nation must conform. If such architecture is created, the 12th Five year plan period would see a massive expansion in the integrated use of health informatics..."
c. Development of such state level and programme specific systems would be financed under the NRHM or respective programmes. But financing would be conditional on the systems being consistent with these national standards and the national health-care IT architecture. There would be technical support made available for helping

states to articulate the system requirements, develop appropriate tender document and procurement procedures and subsequently to test and certify the software for functionalities, usability and security as well as for compliance with the national data standards and standards of interoperability. States that do not have the capacity to build their own systems in any of the areas listed above can choose from a suite of open source applications available with the central government, and adapt and deploy it for their use. The emphasis on all such software development is on the use of the information- not on information gathering as an end in itself.

d. A computer with internet connectivity should be ensured in every PHC and higher facility- in this plan period and also extend to sub-centers in those states which are ready for that transition. (All sub-center which have mobile access would also have the ability to connect to internet and can be computerised- but because a much higher level of skill development would be required and there are other skill development priorities in the sub-center- this is not being made mandatory for sub-centers).
e. The center would have three national web-portals- one for collecting information related to health management information systems, another for its regulatory and stewardship functions and a third as a public interface on health information and for health promotion. These could be integrated into one- but to prevent information overload and maintain user friendliness, it is perhaps best kept as three portals with inter-connectivity. These web-portals would be able to communicate with and complement state systems and acquire their information needs from them.
f. The center would specify its minimum information requirements- for policy, for resource allocation and for management purposes- and the states would ensure that their systems are designed to deliver this electronically to the web-portals at desired levels of frequency and quality. State and district health systems are designed primarily for local action, but as a collateral benefit, they would be able to generate the information needs as required by the center and send it in the format required.
g. Some of the states which are ready to make the transition to electronic medical records and they would be encouraged to do so. Others are in a position to introduce hospital information systems which support administrative and public health action while introducing EMRs only for in-patients or for certain category of patients who by definition need sustained and highly portable follow up records- and not try to get all patient interactions on EMR. This too should be allowed. Still others would only be able to generate the public health data requirements- which is the minimum permissible- and this too should be understood. The real danger is in trying to transit to EMRs when the professional community, especially in public hospitals is not yet subjectively prepared for such a transition and when there are still a number of policy and technical questions to be resolved.
h. The major part of public investment in information technology in health care would go to institutional capacity building for understanding and use of information. Incurring large expenditures on hardware and software without making a matching input in capacity development and institutionalisation would be an error. As part of this, every state should have the skilled human resources needed at state and district level. This would require a mix of those with IT skills and public health informatics

skills. Statisticians and demographers have a role to play, but without much better grasp of public health information and information technology would be unable to contribute to the changing nature of this area of work. State centres for health information, either stand alone, or embedded in existing institutions would be essential and district teams of three to five persons for managing information flows and interpreting information would also be essential.

i. The use of ICT in a) health education and health communication and b) in the generation of health knowledge would be expanded. These two functions would be located in two appropriate national centers- one dealing with public health and health promotion and the other with health research.
j. All district hospitals would be linked by telemedicine channels to leading tertiary care centers and all intra-district hospitals would be linked to the district hospital and optionally to higher centers. The availability of "skype" and similar applications for audio visual interactions makes telemedicine a near universal possibility and could be used to ameliorate the professional isolation that professionals posted in rural and remote areas face.
k. M-Health- the use of mobile phones to speed up transmission of data and reduce burden of work in reporting, to improve connectivity between providers, and as a vehicle of health communication would be built up.
l. With respect to governance, the advantages to transparency of government processes are many and obvious and these should be fully enforced. Not only is it a matter of complying with the right to information, but even district health plans and procurement processes should be visible. The role of IT in ensuring accountability of peripheral staff and even more its role in prevention of fraud for eg in checking on payments to beneficiaries- needs to be ascertained by careful evaluation- before it is generalised. At any rate policing should at best be a minor, collateral function of ICT in the health sector.
m. All ICTs in health, whether in state or the centre should be professionally evaluated for performance against stated objectives and this should be used to improve on the HMIS architecture. ICT projects should begin with approved functional and technical design documents which would provide one reference point for evaluation. The other consideration is the value addition that the application of ICT provided to reaching health and social goals.

**Reference Pages:**

1. Approach to the 12th Five year Plan, para 9.23, page 121. 9.41, pg.125
2. Background Paper for Steering Committee on Health for the 12th Five Year Plan- pg 3, para 4.7, pg 6, para V.2.,4, pg 9, and pages 18 to 20 paras 49 to 58., pg 21 para V.
3. HLEG Report on Universal Health Coverage: pg 38 para recommendation 3.6.3. pg 263 to 265, recommendation 5
4. Working Group on National Rural Health Mission in the 12th Five Year Plan pg. 36 para 5.14, Pg 83, para 9 to 11,
5. Working Group on Communicable diseases pg. 78 para 6. Pg 134,139,pg 209,
6. Working Group on Tertiary Care Institutions for the 12th Five year Plan. Pg 57 to 64, chapter 6, ICT in health care,
7. Working Group on AIDS control in the 12th Five Year Plan, Pg 35- 36 para 4.7 Strategy 5.Strategic Information Management Systems
8. Working Group on Drugs and Food Regulation for the 12th Five Year Plan, Recommendation : Drugs A.12 & Food D.iv E-governance.
9. Working Group on AYUSH in the 12th Five Year Plan Pg 19, para 5m pg 34,
10. Working Group on Health Research in the 12th Five Year Plan Pg 21, para vii,

# Appendix III
# Planning Commission Health Informatics Steering Committee Note

## Public Health Informatics Group Discussion
## Inputs to Steering Committee

Presentation in
Steering Group meeting
Planning Commission,
Govt of India

# References to Informatics

## Key Inputs to the 12th Plan Process

- 1. Approach to the 12th Five year Plan, para 9.23, page 121. 9.41, pg.125
- 2. Background Paper for Steering Committee on Health for the 12th Five Year Plan- pg 3, para 4.7, pg 6, para V.2.,4, pg 9, and pages 18 to 20 paras 49 to 58., pg 21 para V.
- 3. HLEG Report on Universal Health Coverage: pg 38 para recommendation 3.6.3. pg 263 to 265, recommendation 5
- 4. Working Group on National Rural Health Mission in the 12th Five Year Plan pg. 36 para 5.14, Pg 83, para 9 to 11,
- 5. Working Group on Communicable diseases pg. 78 para 6. Pg 134,139,pg 209,
- 6. Working Group on Tertiary Care Institutions for the 12th Five year Plan. Pg 57 to 64, chapter 6, ICT in health care,
- 7. Working Group on AIDS control in the 12th Five Year Plan, Pg 35- 36 para 4.7 Strategy 5.Strategic Information Management Systems
- 8. Working Group on Drugs and Food Regulation for the 12th Five Year Plan, Recommendation : Drugs A.12 & Food D.iv E-governance.
- 9. Working Group on AYUSH in the 12th Five Year Plan Pg 19, para 5m pg 34,
- 10. Working Group on Health Research in the 12th Five Year Plan Pg 21, para vii,

# Bridging the Gap

**Vision statements in HLEG and Background notes**

- Overarching goal is a health information network that links all service providers in public and private sector and also generates the aggregate figures for policy and management decision
- A system based on universal registration and biometrics which is dynamic health record of every citizen, portable and accessible to service providers and patients
- Generates the alerts for disease surveillance

**Immediate needs as Identified in working group papers**

# Expectations of a HMIS

- **Improve Information flows and analysis to aid better public health management to achieve the 8 goals:**
- Reduced IMR, MMR, TFR, child malnutrition , anemia in women and girls, improved sex ratio, reduce burden of communicable and NCDs, Reduced OOPs. **Also**
- Disease surveillance needs.
- Regulation needs
- Knowledge generation-
- Transparency
- Improve **quality of care** of the individual patient by providing referral linkages, portable, retrievable records
- Enable **rights based perspective** by increasing public access to Health information and increasing individual access to patient health records.

***Use evaluation to show the link between any ICT deployment and the purpose it is expected to serve.***

# Looking Back-
## 15 years of ICT in health: .

- Past efforts have not yielded desired results : Need to identify causes in terms of people, process and technology,

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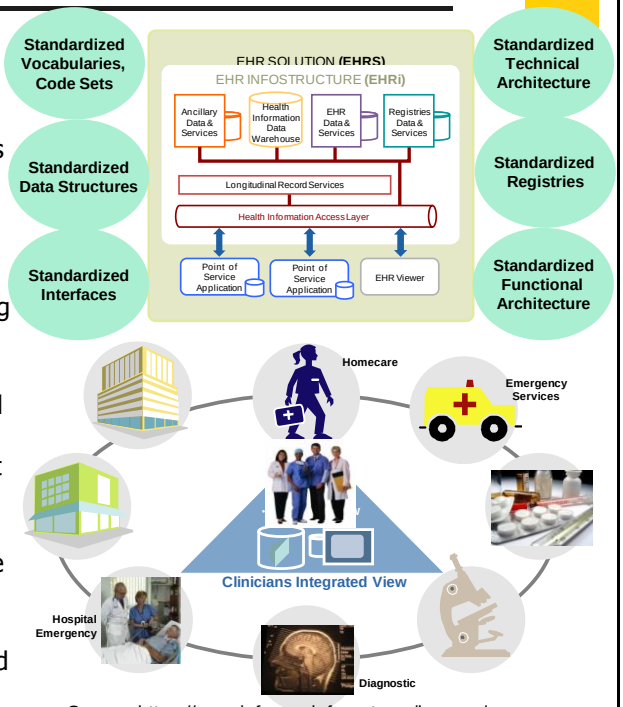
| **People** | • No culture of use of information for planning – information becomes an end in itself:<br>• Planning at district level not established<br>• Data analysis not geared to meeting needs of the Decentralised user – what's in it for them? |
| **Process** | • Process Errors in information flow get accentuated in the IT system<br>• Duplication of systems raises confusion and fatigue<br>• Problems of integration between multiple systems: both extent & direction<br>• Technology introduction not matched to level of institutional capacity |
| **Technology** | • Information overload and lack of actionable information in system design<br>• Procurement insensitive to software lifecycle and technology obsolescence<br>• Lack of standards – technology architecture, data standards, interoperability standards |

# Learn from Others

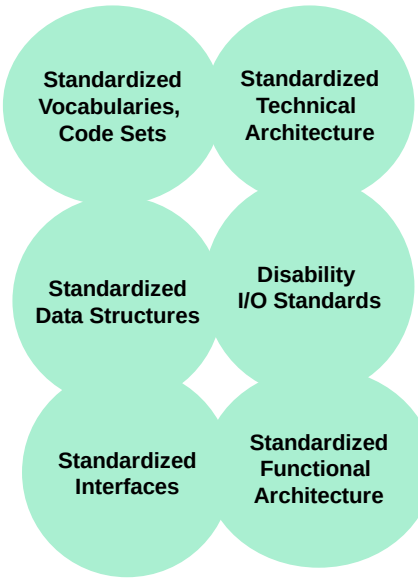
- "NHS UK has failed in building a fully integrated centralised electronic care records system.
- NHS has spent 6.4B out of 11.4B pounds in 9 years, but failed to meet its initial deadline and abandoned its original architecture"
- CHI Canada has learnt from mistakes done in UK and is successfully developing a fully integrated de-centralised electronic care records system
- Canada has published a standards based Healthcare-IT Architecture [blue print] and the financing to the states is subject to compliance with the blue print
- NEHTA Australia and MoH Singapore are learning from UK and Canada to improve the public health informatics model further
- India can learn from these successes and failures.




Source: https://www.infoway-inforoute.ca/lang-en/

# 12th Plan Commitments- 1. Setting Standards

- Centre to define standards for data and interoperability and appoint a Committee/ Authority to ensure compliance
- Define Data policy – how long stored, in what form, back ups, rights to access, security, privacy
- Committee/ Authority to develop/adopt software product lifecycle standards such as ISO, ISMS, CMMI, ITIL and PMBOK
- Technical Architecture – standards of interoperability, security standards, privacy, consistent with integration and future evolution needs
- Functional Architecture – user friendliness, processes of validation, confirmation, error correction ( who does what, when and where)
- Financing of Health Information systems linked to compliance to standards



# 12th Plan Commitments: 2.Getting the architecture right

- Architecture provides a way of exchanging health information across systems such that the big picture can emerge e.g. Malnutrition data of a block in one system and the deaths and incidence of acute respiratory infection from another system
- *Dynamic* Architecture: prefers open source software:
- This allows states and regions to develop solutions which are appropriate to their level of **health systems developmen subjective readiness** and **technical feasibility**
- Not a one size fits all solution – also allows multiple information flows, which can be used for triangulation, integration should respect information priorities of different users.


# 12th Plan commitments: 3. Integration within and across systems.

- Centre would specify its minimum information requirements- for policy, planning and monitoring:
- State/District Health Systems built for local action, but feed the centre's minimum information requirements . Same for vertical programmes- allow multiple systems but enforce integration.
- Integration: Less duplications, More use- :Staff shouldn't have to enter same data into different systems; information in one system should be available to all systems through central repositories/portals.
- Ensure a multi-modal connectivity to ensure fail-safe connectivity down to the PHC, SC levels.
- M-health: speed up transmission of data and reduce burden of work in reporting ,improve connectivity

## 12th Plan commitments: 4. ICT for quality of care:

- Computer with internet connectivity in every PHC and higher facility in this plan period, also extend to sub centres in those states which are ready .
- Based on readiness, introduce EMR at the point of care and roll-up the data for public health purposes
- Begin with EMRs linked to Hospital Information systems in all medical colleges and district hospitals.
- Allow patient access to information on STPs and his/her own records as part of health rights framework.
- Connect the primary, secondary and tertiary care through HIS(hospitals), EMR and Telemedicine- all district hospitals in telemedicine link.
- Advantages to transparency of government processes are many and obvious and should be fully enforced.

## 12th Plan commitments: 5. Capacity Building

- Major part of public investment in IT for institutional capacity building for understanding and use of information.
- Generation of appropriate human resources for ICT in health.
- The use of ICT health education and health communication and b) in the generation of health knowledge. These two functions would be located in two/three appropriate national centres/portals- one dealing with public health and health promotion and the other with health research.
- Use good third party evaluations to learn from and improve and scale up systems.

# THANKS!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