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Software development with limited resources in a developing country

A study of the effects of limited resources on the development of a person-based family health-system in India

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Problem Description

Software development with limited resources is a challenge encountered by most developers at one time or another. The limited resources in question can involve many things like: Time, money, manpower, knowledge etc. Developing countries, due to their general lack of resources are particularly well suited as arenas for the study of this concept

The research questions we aim to explore are:

1) How can limited resources affect one's work organizationally?
2) How can technological decisions affect the resource pool?

Our case involves a study of the effects of limited resources on the development process of a person-based family health system in India. Our results indicate that a lack of most specific resources often manifests itself into a more general lack of the resource: Time. Technological decisions can influence time through alteration of the resource pool. Making a technological decision in a limited resource environment should therefore be motivated by the management of time for facilitating the execution of critical tasks.

Assignment given: 01. May 2006
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1 Introduction

Software development in an environment with limited resources is a challenge encountered by most developers at one time or another. The limited resources in question can involve many things like: Time, money, manpower, knowledge etc. In the face of such adversity it is necessary to look for ways to cope, but the choices one makes can have serious implications for the project one is working on. In this thesis I will try to look closer at these implications, and how they affect the project.

1.1 The research setting

We will examine the issue of development in an environment with limited resources through a case of implementation and integration of IS (Information Systems) in a developing country. More specifically a case developing a person based health information administrative system in the state of Gujarat in India.

Developing countries are generally troubled with both a lack of resources and with systems for administration that are often insufficient for the job, and therefore can benefit greatly from the appropriate use of IS technology. These two factors combine to make developing countries particularly well suited as arenas for the study of the effects of limited resources on IS development.

The research questions we aim to explore are:

3) How can limited resources affect one's work organizationally?
4) How can technological decisions affect the resource pool?

It will be impossible to cover all eventualities potentially caused by a lack of resources in the course of one thesis; as such we will contain our observations to factors within the realm of our particular research setting. Although some of the findings will undoubtedly be context specific to the location of the study, it should

also be possible to learn lessons that will have general applicability on a wider scale of scenarios.

1.2 Organization of this thesis

The chapters of this thesis are divided into three main sections:

- **Theory and Literature Review:**
  The theory and literature review part of this thesis consists of chapters: 2, 3 and 4. It deals with the theory of IS in developing countries and issues regarding implementation and integration of such.

- **Case Study:**
  This part consisting of chapters: 5, 6 and 7, describes the background, research methodology and case study of this thesis.

- **Analysis and Conclusions:**
  The final parts consisting of chapter 8, 9, 10 and 11, analyses and discusses findings from the theoretical and empirical parts of the thesis in order to draw conclusions related to the research questions set out in this chapter.

2 Information systems in developing countries

The study of IS (information systems) in developing countries differs from the study of IS in developed countries in a number of ways. Very few would question the value of ICT (Information and Communication Technologies) in an industrialized western country, but there has been some debate as to whether ICTs are relevant to developing countries. According to Walsham and Sahay (2006) in their review of relevant publications from 2000-2006 on the issue, the answer is as following:

> *"...this debate has been resolved with a clear yes answer. The question has become not whether, but how ICTs can be beneficial."*

Another difference is the presence of what in the article is referred to as the "digital divide". The digital divide is the description given to the difference between those people with access to IS technologies and the ability to use them effectively, and those without. This is particularly relevant in developing countries, as the cost of acquiring and owning computers is often well out of range of the general populace, and even those that have access to basic hardware and software often lack the necessary infrastructure (Internet connection, stable supply of electricity etc.) and the appropriate knowledge to utilize it to its full extent.

It is also a problem making IS introduced into developing countries "stick" after the original research team has left or outside funding is discontinued. Two broad themes present themselves regarding this. Braa, Monteiro and Sahay (2004) define these themes as the problems of sustainability and scaling:

> *"The first concerns the challenge to make an information system work, in practice, over time, in a local setting. This involves shaping and adapting the systems to a given context, cultivating local learning processes, and institutionalizing routines of use that persist over time (as well as when the*

researchers leave and external funding is over). We term this the problem of sustainability.

The second challenge, which we term that of scalability, concerns the problem of how to make one, working solution spread to other sites, and be successfully adapted there. Beyond merely the technical aspects of scalability, our concerns lie in how to reproduce and translate the necessary learning processes alongside the spreading of artifacts, funding, and people."

Through their work with developing HIS (Health Information Systems) in various developing countries like Africa and India, they have found that in order to achieve the sustainability, it is advantageous to work actively to achieve scalability as well.

Their proposed way of achieving this is through the use of a model they refer to as "networks of action". The key to this approach is to enlist the involvement of a network of actors that are likely to be affected by the development the IS system is aiming to contribute to. These actors, as a network will through the sharing of experience and knowledge mutually enhance each others ability to both use and benefit from the system, both on a local and on a larger scale. This increases the systems robustness, and by extension it's ability for sustained survival.

"...local interventions need to be part of a larger network to be robust. In short, scalability is a prerequisite—not a luxury—for sustainability of local action. Establishing networks creates opportunities for sharing of experience, knowledge, technology, and value between the various nodes of the experience"

In other words these two challenges are connected in such a way that in order to succeed, one should try to device an action plan that aims to accomplish both aspects in parallel.

2.1 Key challenges

While research and projects within the field is making great progress, not all work done has been successful. The authors define four key challenges that need to be addressed:

2.1.1 How Can IS Promote "Development"?

In order to debate this, we need to take a closer look at the definition of development. According to Madon (2000) there have been two primary views of development that have been particularly relevant in contemporary thinking: The views of the globalists and the localists.

The globalists basically argue that development is about accomplishing and building on stages of economic growth primarily made possible in developed countries as a consequence of the industrial revolution.

> *"The globalists draw on the arguments made by the post-industrialists in favour of a new stage of development centred on the production, diffusion and use of information and communication technologies throughout society - a vision which first took hold in the USA in the 1960s, against a context of increasing prosperity and automation."*

The localists, also called the neo-populists, define development more in line with what would benefit communities with regards to self-reliance and autonomy on a local level than with their ability to emulate success stories from the prosperous west.

> *"Such views offer an alternative development strategy to the linear growth model. This alternative view is based on the notion that developing countries have their own trajectory of development which does not necessarily follow the same pattern as experienced by the advanced, industrialised countries."*

Eventually these two differing viewpoints have to some extent merged into a fusion definition that includes economic, social, political and environmental aspects of earlier thinking.

> *"Development has come to be conceived of and measured not only in economic terms, but also in terms of social wellbeing and political structures, as well as in terms of the physical environment as reflected in the UNDP Report on Human Development published annually since 1992."*

The definition of development is quite broad and focuses both on local and global issues. In order to handle these issues, knowledge is a prerequisite. Local knowledge is very important in this context, but there is also an abundance of outside knowledge that can be tapped to accomplish a variety of development goals.

Another important aspect is to facilitate communication between different groups. While communication between groups in itself is not enough to instill neither change nor development, the tool of communication certainly can be a facilitator for the different groups to be able to assist each other.

IS, particularly in conjunction with the Internet, can help both with the acquisition, interpretation and delivery of knowledge and the enabling of communication between groups.

The health care sector in developing countries, an area where information and coordination is particularly important, is a sector that has a lot of potential for improvement through the use of IS. According to Braa, Monteiro and Sahay (2004):

> *"There is a growing recognition by international agencies (notably the World Health Organization—WHO), government authorities, and researchers from different domains including information systems, development theory, and public health, that improved health information systems (HISs) can significantly contribute to help address health service delivery problems."*

2.1.2 Promoting cross cultural collaboration

ICT technology has the potential to improve cross cultural collaboration through communication technologies like Email and fax, which enable near instant

communication over long distances. However studies like Walsham 2002 show that the technology in itself is not enough to enable smooth collaboration. Differences in culture still manifest themselves, and more often than not turn into conflicts that have the potential to make collaboration problematic. Liu and Westrup (2003) argue that ICT-enabled coordination is only effective when linked with other approaches such as the use of expatriates and face-to-face contacts.

From this it seems reasonable to assume that even though ICT has the potential to simplify collaboration through faster and more efficient communication, local culture still plays a large enough role that one need to combine the technology with the presence of local representatives to reap collaborative benefits. This becomes increasingly important in developing countries, as their culture is often quite different from that of developed countries. Finding the appropriate balance between technology and local culture is one of the key challenges in this regard.

2.1.3 Cultivating local adaptations

As the world's economy becomes more global, it is often assumed that cultures will become more and more homogenized due to increased communication and exposure with each other. Giddens (1990) refers to the concept as

> *"The intensification of world-wide social relations that links distant localities in such a way that local developments become a function of events occurring many miles away and vice versa."*

There are however indications that while this to some extent may be true, it is far from a completed transformation, especially in developing countries.

Authors like Bada (2002) points out an example of how an IS implementation in a developing country (in this case business process reengineering in a bank in Nigeria) have been successful primarily because local adaptations were done on traditional IT implementation practices. The author emphasizes the need to not just understand these cultural adaptations, but indeed embrace them in order to accomplish the desired goal.

Walsham and Sahay (2006) states that even bringing an existing technology to a new local context in relatively close proximity (like a neighboring village), also involves some implicit elements of cultural transfer and mutual learning.

A good example of this is described in Puri and Sahay (2003) where they look at the design of a GIS (Geographical Information System) in India. In this study it was shown that in order to achieve appropriate land management practices, using the system alone was not enough. The developers needed to collaborate with locals that had relevant knowledge not captured in the GIS, for example of where water streams were located.

2.1.4 Focus on marginalized groups.

According to Walsham and Sahay (2006) many people in developing regions are being marginalized by the fact that they find themselves on the wrong side of the digital divide, witch can also be described as a variation of being outside the margins of what Castells (1996) refers to as "network society". The bridging of this digital divide can for instance come about through the introduction of helpful technology, but this is often resisted by local habits, routines and power structures.

Mosse and Sahay (2003) argues that in order to accomplish the development one is aiming to achieve, in addition to technology one needs to establish so called "counter networks" to the existing dominant networks of human and nonhuman actors operating within the local context. The existing networks are often deep rooted socio-cultural structures, and can be described as the change resisting aspects of local culture. The author argues that this resistance can be reduced by understanding the reciprocal relationships between the local communication practices and the technology one is trying to introduce.

2.2 Technological Issues

IS research is a field primarily rooted in the domain of technology, and so technology obviously plays a major part in the research on IS in developing countries. The

primary technological issues faced by those working within this field are issues pertaining to balancing the global practices with the local. I will in this section try to outline some of the relevant issues researchers are particularly focused on.

2.2.1 Standardization versus localization

For reasons mentioned above like the tensions that often manifest themselves between global and local practices, there is tension on a technological level between standardization versus localization. On the one hand there is much demand for standardization of IS solutions in order to facilitate easier implementation by reusing best practices from developed countries, but on the other hand cultural differences and the digital divide often contribute to make these practices unsuitable for the context of a developing country. In order to make progress it often becomes necessary to make software more specifically suited to the local needs.

Braa and Hedberg (2002) describe a project under the banner of HISP (Health Information System Project) concerned with improving health data in an effort to better the general health care in South Africa. Their approach to solve the above mentioned tension involved using a combination of standards at different hierarchical levels in the software and providing the option for local tailoring of specific parts. This system has later been expanded to other countries as well, including India where the empirical work for this thesis took place, and we will return to it in more detail later on.

A study by Thompson (2002) also concerning health information systems in South Africa highlights the importance of involving the local health workers in order to create a match between the IS and the data the health workers can provide. He looks at how data generated primarily from manual forms often will cause a mismatch between the needs of the IS and the local knowledge of the health workers providing the data. His proposed solution is to involve the local health workers in the design of the data collection methods in a bottom-up fashion, in order to create a data input and interpretation system that engage the total scope and competence of the persons involved.

2.2.2 Trends in technological approaches

Walsham and Sahay (2006) points out that the most focused on technological approaches to improve the state of IS in developing countries are: The Internet and ERP (Enterprise Resource Planning). They also point out that Open Source and Free Software is becoming more relevant:

> *"A currently fashionable technological debate revolves around the use of open source and free software, and indeed it is clear that some developing countries, such as Brazil, are taking strategic initiatives to encourage the open source route."*

2.3 Methodology within the field

The question of methodology is an important aspect of any research field and IS in developing countries is no exception. According to Walsham and Sahay (2006) most research in the field is done using qualitative methods, primarily in the form of interpretive studies:

> *"With respect to labeling their methodological approach, the majority of the studies, if they address this explicitly, claim to be interpretive. Very few studies in our survey adopted a positivist approach with stated hypotheses, instruments for data collection, statistical inference etc."*

Action research, an approach aimed at gaining understanding of the local context parallel with doing work directly beneficial to the geographical area, is something that theoretically would be very well suited to work on IS in developing countries. However, according to the authors, at the time of writing it was not a very widespread approach.

> *"Perhaps surprisingly, bearing in mind the importance of action in addressing issues of development, action research studies are somewhat rare"*

A notable exception to this is the earlier mentioned work done by Braa and Hedberg (2002), where the authors used the principles of action research to involve themselves with the building of a system for health data management in South Africa.

Another interesting field related to methods IS in developing countries, is outsourcing. Not only because outsourcing often is a major activity in some developing countries like India, but because work logistics are sometimes similar when developing IS for developing countries and when outsourcing.

If the people doing the development are in one country and the people receiving the benefits are in another, you have a similar scenario to that of a traditional outsourcing project. The difference it that while in traditional outsourcing the client is usually from a developed country and the vendor from a developing country, the roles are reversed when doing development in developing countries.

According to Tiwana (2004) the most usual approach to outsourcing are of a nature that lends itself to what the authors refer to as black boxing. Black boxing is the practice of sending a detailed specification to the developing party, who can do the work described in the specification because they have done similar work before, often on a routine basis. For some projects effective software development requires organizations to break out of the black-box mold. This is usually when the project is conceptually innovative or involves novel software development processes. These forms of novelty are divided into the categories of process and concept novelty.

> *"Conceptual novelty occurs when the project concepts and ideas are completely new to the vendor or the project attempts to solve a problem for which no precedent solution exists. Process novelty occurs when the project concepts are relatively well-understood but the vendor uses new development processes and tools."*

Where as black boxing is usually the standard way of doing things within the field of outsourcing, IS in developing countries usually involves some kind of conceptual novelty.

"Although the black-box approach to software development outsourcing is effective for routine projects, projects that use novel concepts or processes require some knowledge overlap in client and vendor organizations."

But this novelty can be dealt with in the same way as outsourcing projects do it: If there is conceptual novelty, the vendor need to increase its knowledge of the domain specific business knowledge

2.4 A conceptual approach to the study of IS in developing countries

Taking the information, issues and experiences mentioned above into consideration the authors Walsham and Sahay (2006) suggests that in order to classify existing work, identify gaps and suggest future opportunities for research, studies performed within the field of IS in developing countries should all conform to a common conceptual framework. They suggest the following framework of four questions to be addressed by studies within the field:

1) What is the development to which the application of ICTs aims to contribute?
2) What are the key issues being studied related to ICTs?
3) What is the theoretical and methodological stance?
4) What level and focus of analysis is being adopted?

2.4.1 The conceptual approach applied to this thesis

With regards to this thesis, the four above mentioned questions can be answered as follows:

1) The development to witch the application of ICTs aim to contribute is better family related health administration in the Indian State of Gujarat. Please see chapters 5 for background information on the area and the existing health administration system.

2) The key issues being studied are technological and organizational implications of limited resources. This will be described in more detail regarding our case during chapter 7, and analyzed more thoroughly in chapters 8, 9, 10 and 11.
3) The work done for this thesis will be interpretative research within an action research environment. Please see chapter 6 for more details of our methodology.
4) We will focus on the organizational and technological implications of the development process regarding the system developed as part of the case study in chapter 7. These issues will be discussed more extensively in chapters 8, 9, 10 and 11.

As we will be discussing both technological and organizational aspects of development, it is necessary to look more closely at development from an organizational point of view. This is the focus of our next chapter.

3 Organizational politics and software implementation

There is some discussion as to what the definition of a software implementation is. Most dictionaries define implementation in the broadest terms as carrying something into effect. Many programmers define it as the act of planning and coding the software, while project managers often go a bit further and include the actual deployment as well. We will take the broadest possible view in our definition, and also include the longer term modifications usually performed after the system has been deployed.

Before starting an implementation process within an organization, it may be wise to give some thought as to what criteria must be fulfilled in order for the implementation to become successfully deployed. One of the primary reasons to implement something in the first place is usually to enable some sort of change, either within the organization itself or some other entity currently being interacted with by the organization.

Kling (1984) examines a number of theories regarding change within organizations. Theories like technological evolution which states that only the systems with the most amount of desirable behavior survives in the marketplace, and economic rationality which states that only the most cost efficient systems will survive, both make very valid basic points. Particularly in organizations that has a clear vision and knows exactly where it wants to go.

Many organizations however may not always have this clear cut vision, and to accommodate this, Kling refers to the theory of organizational drift. Organizational drift occurs when the organization reacts to changing variables in its environment, like rapid changes in the technological landscape or conflicting demands by potential users of the system. Organizational drift can be described as something that occurs when the organizational momentum is being disturbed by groups pulling in different directions.

One of the many reasons why an organization may be drawn in different directions is that different factions within the organization often have differing and conflicting agendas. This issue is examined closer in a theory Pettigrew (1978) refers to as organizational politics. This theory postulates that political process is a major deciding factor with regards to what direction an organization will be heading in.

According to Kling (1984), unless an organization is in agreement over the direction it intends to go in, organizational politics will play a much bigger part of system development than the forces postulated in theories like organizational drift, economic rationale and technological evolution.

> *"If coalitions in organizations differ on the trajectories they prefer, the actual trajectory of a CBIS (computer based information system) will be the byproduct of conflict: domination, sabotage, or compromise."*

This implies that a successful implementation depends on two things: A technical solution with the potential to change an aspect of the organization in a positive fashion, and the preferences and motivations of those it will affect.

3.1 Identifying the desired changes

The particular type of change desired may be diverse, for example: More efficient process handling or a more comfortable working environment. Usually clients will have a list of features or a specification detailing how they want the system to be implemented in order to accomplish this desired change.

Orlikowski (1996) examines a number of different theories that aim to explain how change comes about. Models like planned change and technological imperative take deterministic approaches. Planned change postulates in the simplest of terms that organizational change primarily comes as a result of decisions taken by its leadership in order to adapt the organization to its' environment. In other words, it postulates that if you implement the system in accordance to the specifications set out by the organization's managers, change will happen. Technological imperative states that

change happens because new technology becomes available, and that organizations change in order to take advantage of it and to not be left technologically behind.

Both of these approaches have some validity in explaining how things around us change in certain situations, but practical implementation of IT technology have shown repeatedly that technology does not always become accepted and used purely on its own merits or because an organization's leadership dictates its adoption.

Orlikowski (1996) further points out that the above theories also fails to take into consideration the concept of what she terms as emergent change: The recognition of patterns in the absence of explicit, *a priori* intentions. A good example of this would be the often encountered problem of user defined specifications. Users will often specify that they want a functionality to work a certain way, but once it has been implemented and the user tries it out, they realize that what they "really" wanted was something else. The user has perceived a superior way the functionality could be implemented as a result of using it the way it was originally proposed. But this realization would have been difficult to conceive before the user had an opportunity to use the functionality as part of the greater system context.

In order to take these factors into consideration she proposes the theory of situated change perspective. This theory postulates that in addition to the influences in the above mentioned theories, the use and implementation of systems is to a rather large extent also influenced by the users' improvisations over time. These improvisations are difficult to predict because they depend on the users knowledge and motivations.

> *"In this perspective, organizational transformation is not portrayed as a drama staged by deliberate directors with predefined scripts and choreographed moves, or the inevitable outcome of a technological logic, or a sudden discontinuity that fundamentally invalidates the status quo. Rather, organizational transformation is seen here to be an ongoing improvisation enacted by organizational actors trying to make sense of and act coherently in the world"*

3.2 The cultivation of support from those the changes will affect

According to Thomas (1977), one of the most important aspects of Pettygrew's earlier mentioned theory of organizational politics, is the concept of political support. He states that political support is primarily a function of the perceptions of the people potentially affected by the change. Kling (1984) further states that there are two dimensions around witch organizational politics revolve: Structural dimensions and Ideological dimensions

3.2.1 Structural dimensions

Infrastructure and technology (and other assets for that matter) are often distributed in such a way that particular groups have better access to, more control over or get more benefit out of it than other groups. These groups, which can be considered more "privileged" than others, have a tendency to advocate policies that maintain the *status quo* of the organization. This can be an impediment to organizational change.

> *"Those groups which successfully develop and maintain favorable arrangements amplify existing structures incrementally"*

In order to build support for your implementation it is advantageous to identify these groups and try to make them see the merits of your proposed implementation. The alternative would be to have these groups working against you during the developing process, or refusing to use the system after it has been deployed.

3.2.2 Ideological dimensions

Ideological dimensions within organizational politics influence decisions, strategies and actions by associating them with the concepts of good or bad. Not in practical terms as in: "Linux is a good operating system because it enforces file permissions", but on an ideological level as in: "Linux is good because it promotes the open collaboration of developers worldwide".

The way this manifests itself is through language. Kling points out that one of the most effective ways to gather support for an idea or a technology is to imbue the language you use when describing it, with attributes that associate it with a good way of living. If one further is able to make the people one wishes to gain support from adopt the use of this language, it builds legitimacy for one's viewpoint. Pfeffer (1981) quotes Morris on the subject of shared language:

> *"Sharing language with other persons provides the subtlest and most powerful of all tools for controlling the behavior of those other persons to one's advantage"*

3.2.3 Balancing who does the work and who gets the benefit

According to Grudin (1989) in a paper primarily concerned with groupware, he makes a point that is also valid for other application implementation projects: There must be a balance between who does the work and who benefits from it. His example involved the use of an automatic meeting scheduler that failed to work in practice. The working principle was that everyone in an organization would keep a schedule that kept track of their time, and based on this schedule the system would find the best time to schedule meetings between two or more persons based on the free timeslots in their schedule. The reason this system failed to work in practice was that the schedules were not being properly updated by key members of the organization, and the resulting lack of free time slots in their schedule made it impossible for the system to generate an automatic schedule involving these persons. According to the author, the primary reason for this was that while some were able to gain benefits from the system (primarily the secretaries, who would normally be doing the scheduling), it added additional uncompensated work to other groups.

In order to balance this equation it is important to make sure that those you wish to gain support from is not given extra work as a result of your implementation without also receiving some benefit or compensation from it. To quote the author:

"…the best solution is to try to insure that everyone benefits directly from using the application. This may mean building in additional features. It certainly means eliminating or minimizing the extra work required of anyone, or rewarding them for doing it."

3.3 Implementation, taking organizational politics into account

Implementing a system in such a way that the organization you are deploying it in gets productive use from it without incurring a number of problems is not trivial. There are however a number of things that can be done to ease the process.

With regards to setting the specifications, or the "needs and wants" of the system, most people who have done any practical system development have probably experienced that it is quite reasonable to expect the first set of specifications not to be the final ones. This is a relatively well known phenomenon and is even taught in programming classes as a byproduct of iterative system development. However, the reasons for this are not often given thorough explanation. The concept of emergent change from Orlikowski's (1996) situated change perspective theory may be a good indication as to why: Because the system itself represents a change in the environment once it is deployed, the specifications will necessarily change as new knowledge results from this process. Anticipating that this will happen and doing what can be done to incorporate this new knowledge as the system is being built will go a long way towards making the system better for the people that will be using it.

As regards making changes within the organization in general… Many people don't really want change. Granted, some people that don't want change have to accept it non the less, due to being powerless to oppose decrees from their leaders, but this is often not the case. In fact most people have the power to object to change in the workplace indirectly, simply by refusing to use the new system. We will not go into detail as to why this may happen, as there may be as many reasons for this as there are people in the organization.

Also, as pointed out in the theory of organizational politics, there are often conflicts of interests within the organization concerning how things should be done. These conflicts will make the implementation process more difficult if what is being implemented is not what the winning side of the conflict is advocating. In order to avoid this it is advantageous to make the conflicting groups perceive with enthusiasm the merits of the system, preferably even before they actually get to lay their hands on it.

The assumption that organizational politics more than likely will influence the implementation of any system makes it prudent to try and identify potentially conflicting factions early on. The sooner this is achieved the better, so the best time to do it is probably before even starting the implementation process. If agreement can not be achieved between the factions, one should ally one self with the winning group in order to build support that may come in handy at a later time. How one goes about achieving this is of course the difficult part.

Another factor that has the potential to influence implementation is systems already in use by the organization. This will be discussed in the next chapter.

4 Integration with existing systems

During the field work for this study, I encountered several situations where I was requested to consider the issue of integration between the system we were implementing, and other already existing systems. This is quite a common request when developing software for an organization that already has a lot of data. Usual reasons for this are as follows:

When developing or using information systems within an organization, one often finds that the data generated or being used by the system one is developing, is dependent on data from other parts of the organization. As a result of this, managers, workers and system developers have realized that data needs to be able to travel from one area to another.

The relevant data in question is often already handled by a system that performs its job in ways that over time have come to be considered good enough. In order to keep work routines as stable as possible the organization wishes to keep old system running as normal if at all possible, and therefore new systems have to be able to relate to the existing legacy systems in one way or another.

Computerized data as opposed to data on physical paper has become considered the ideal delivery system over the last decades, and it has more or less become taken for granted that a business or an organization should have all its' data accessible in as seamless a fashion as possible. This is where system integration comes in.

4.1 Types of integration

How an organization best can achieve an integrated state is not generally agreed upon. Hasselbring (2000) refers to two broad categorizations of integration: Vertical and horizontal. Both approaches describe integration with regards to three abstraction layers:

1) **Business Architecture:** This layer contains the inter-organizational processes the organization would refer to as it's "work". For instance: In a retail store this would be the actual processes of ordering goods, selling them and charging money.

2) **Application Architecture:** This layer contains the software used in order to make the business architecture able to operate. Some organizations are so similar to other organizations that there has been developed off-the-shelf software that supports the most common functions of that particular type of organization's business architecture. However, more often than not, organizations have very specific needs that require the use of custom made software.

3) **Technology Architecture:** This layer contains the actual technology required for the Application layer to be able to function. This usually includes some sort of hardware in the form of the actual computer infrastructure, but also software like the operating system, database system and other types of "multi purpose" software. The line between Technology Architecture and Application Architecture can be blurry, and it is sometimes difficult to decide which layer a particular piece of software belongs to.

4.1.1 Vertical integration

In vertical integration, each organizational unit's business architecture is served by an application-architecture capable of supporting all inter-organizational processes of the organizational unit. The application architecture is again served by a technology architecture that is suitable for its needs.

Hasselbring (2000) points out that in reality, organizational units are rarely fully vertically integrated. There is usually need for a certain degree of communication outside the organizational unit, and this is where horizontal integration becomes relevant.

4.1.2 Horizontal integration

Horizontal integration is the practice of integrating the different layers of the above mentioned stack, with corresponding layers in a different organizational unit.

Integration between business layers within an organization is usually done in order to streamline the organizations work practices. This is not directly the task of the system developer, but more what experts of the organization's particular domain are concerned with. The reason it becomes relevant for system developers as well, is that this process generally require the other two layers to be integrated on a technological level.

Integration between Application layers is often referred to as: Enterprise application integration. The challenge inherent on this level is that the software involved is often heterogeneous between organizational units. In other words there are usually a number of different software packages that are not directly compatible with one another that handle different aspects of the business logic. The way to solve this problem is to establish communication links between the existing software, usually accomplished by the use of some kind of messaging service software. The actual links established in this process is dependent on the individual organizational units' needs, what software one is linking and the technologies used to implement the links.

One of the more popular forms of enterprise application integration is ERP (Enterprise Resource Planning) systems. ERP systems are very expensive pre made software packages that aim to gather all the organizational units' data into a single database, and have a predefined framework that is used quite strictly to perform communication and transactions with this database.

Markus and Cornelius (2000) points out that whilst many organizations have reaped substantial benefits through the introduction of ERP systems, some organizations have had to scale back or even abandon the use of them, sometimes at high costs. The reason for this is that ERP systems often require adaptations to be made on the organizations' business side in order to adapt to the software, as opposed to the more practical approach of adapting the software to the business. In many cases this is

unwanted or unacceptable. Soh (2000) points out that this is particularly relevant in Asian countries, due to cultural and administrative differences between the east and the west and the fact that ERP systems often are built around western business practices and routines.

Integration between Technology layers is also called: Middleware integration. Much like there is a blurry line between the application layer and the technology layer in the above mentioned stack, the line between enterprise application integration and middleware integration is also somewhat diffuse. Middleware integration is however more general in nature. The reason for this is that communication at this level tends to be less specific to the business logic of the organizational unit and more of a general syntactic nature.

4.2 The integration process

According to Monteiro (2003) the reasons for integration is to streamline, or to make processes more efficient.

> *"Poorly co-ordinated and largely independent work processes are integrated in an effort to remove redundant operations, sort out ambiguity and cut back on secondary, administrative overhead."*

As Hasselbring (2000) points out, true vertical integration is rarely seen in practice due to the need for communications with other organizational units that may contain incompatible legacy systems. There are however cases where the same developer is making both the new software and has previously made the existing software that is to be integrated with. In such a case there is a golden opportunity to try and make a fully vertically integrated system.

This is not usually the case though. More often than not, one has to integrate with a system made by someone else, using technologies incompatible with the ones planned for the new system.

In these cases, integration on the application layer may be advantageous if dealing with a system that have legacy software in place that perform the kind of actions that are common enough that integration software is made available “off-the-shelf” by third parties. ERP systems are a good example of this kind of software. One should however be careful with this approach, as it can create undesirable dependencies upon the third party that may be hard to break if the requirements of the organization grow outside the bounds set by the software, thus causing system lock-in. Also, due to the fact that application layer integration is very domain specific, often very little work done in one case can be transferred to a case within a different domain.

Integration on the technology level usually is of a more general and semantic nature, so re-use should be easier here. From a general standpoint it therefore seems more advantageous to make the integration on this level, particularly if it can be done with standardized components. This will make it potentially easier integrating with other systems in the future.

5 Research setting and background information

In this chapter I will give a brief account of HISP: the organization I was affiliated with, Gujarat: The state of India I was stationed in, and the "Eligible Couples" health program which I was doing research and implementation work on.

5.1 HISP

The HISP (Health Information Systems Project) organization is a network of people including: Researchers, doctors and information system developers that aim to implement sustainable HIS (health information systems) in developing countries, primarily through the use of action research.

According to Braa, Monteiro and Sahay (2004), the primary goal of the HISP research is to:

> *"...design, implement, and sustain HIS following a participatory approach to support local management of health care delivery and information flows in selected health facilities, districts, and provinces, and its further spread within and across developing countries."*

5.1.1 DHIS

HISP has several projects in different developing countries of the world, but for the purposes of the work done with regards to this thesis, their most relevant project is the DHIS (District Health Information Software) system. It is beyond the scope of this thesis to delve too much into the specific details of this system, but in the most general of terms it can be described as a customizable database application for aggregation and analysis of health data. Please see Braa, Monteiro and Sahay (2004) for a more detailed account.

This system has already been successfully deployed in other parts of India, and at the time of writing it was going through an implementation phase in the state of Gujarat where I was stationed. The work this thesis describes needs to be understood as very much dependent on the success of this particular initiative.

5.2 The State of Gujarat

Gujarat is situated on the west coast of India, has a geographical size of 196 024 square kilometers and accounts for 6.19 percent of the total area of the country. It is bounded by the Arabian Sea in the west, by the states of Rajasthan in the North and North-East, by Madhya Pradesh in the East and by Maharashtra in the South and South East.

Gujarat state came into existence as a separate state the 1st of May 1960, when the Bombay State was divided into Maharashtra and Gujarat. The state capital is Gandhinagar. Gujarat State at the time of writing consists of 25 districts, subdivided into 225 taluks (also called blocks), having 18618 villages and 242 towns.

Gujarat has two official languages: Gujarati which is derived from Sanskrit, and Hindi. Although many speak English and Hindi the people of the lower classes and in rural areas often only speak Gujarati.

5.2.1 Health system

The health system in Gujarat is a mixture of private hospitals (primarily in urban areas) and government run institutions. We will be focusing on those run by the state. Gujarat state has a variety of different health centers

- **Community health center (CHC)**
  This is a general purpose block level health center, that service approximately 500 000 people. There are 253 CHCs in Gujarat and they are usually situated at the block head quarters.

- **Post partum unit (PPU)**
  This is a center for child delivery and post partum care.

- **First referral units (FRU)**
  This is a type of center patients are referred to for procedures not commonly available at a PHC due to lack of necessary equipment, staff or facilities. An example would be surgery.

- **Primary health center (PHC)**
  This is a smaller type of general purpose health center, that usually service about 30 000 -40 000 people. There are 1070 PHCs in Gujarat.
    - **Sub center**
      Each PHC may have several sub centers, and each sub center is assigned one Auxiliary Nurse and Midwife (ANM). The ANM is responsible for most family health care functions covered by the computer system we developed as described in the case-study section of this thesis, and so it is at sub center level we aim to deploy the system. There is usually a sub center for every 5000 people in non hilly areas and every 300 people in hilly areas. One sub center and its affiliated ANM typically serve 4-5 villages.

5.3 Medical Administrative hierarchy

Commissioner of Health

The commissioner of health administrates the implementation of health programs in the entire region. The EC project is one of these programs.

Chief District Health Officer (CDHO)

Below the commissioner of health are the CDHOs. Each district has a CDHO who is a medical officer at the district head quarters.

Program Managers

The CDHO is assisted by a set of program managers, one for each individual health program that is to be implemented in the district.

Block Health Office (BHO)

The BHO is a relatively new construct in the state of Gujarat, introduced to enable the practical implementation of the various national and state health programs at the block level. The system that turned out to be the focus of this thesis' case work: The eligible couples project, is one of these programs. The BHO is commonly situated at the CHC, and serves as the connecting agency between the various health centers in the block. PHCs, CHCs and other hospitals in the block report their activities to the BHO, and the BHO consolidates these reports and sends them upwards to the district office. The administrative and financial powers of the BHO are limited to the health centers included in the block, of which there usually are about 5-10.

Medical officers

Medical officers are in charge of one health center each.

5.4 The Valsad area

Valsad district is located in the southernmost part of Gujarat. The district covers 5,244 square kilometers, is divided into five blocks, and has a total population of about 1410680 as per the 2001 census. Its administrative headquarters with regards to health care is the town of Valsad, which is also classified as one of the five blocks.

Most of the empirical work of this thesis is done in the town of Valsad and its immediate surrounding areas. Valsad was at the time of writing the pilot site for the testing and deployment of health information systems by HISP in the region.

5.5 The EC program

The EC (Eligible Couples) program as mentioned above, is one of many health programs the government of India has been implementing on a national scale in order

to improve health conditions in the country. This particular program is designed to facilitate the welfare of pregnant women, the safe delivery of children and the proper vaccination of newborn in rural areas. In order to do so, men and women who are living together and likely to have children are registered as so called eligible couples in order to be given necessary medical follow-up from an ANM assigned to their village.

The kind of data registered by the EC project is compiled in several stages: The identification of so called eligible couples, detection of pregnancy, antenatal care, childbirth, and post birth follow-up.

5.5.1 What are the current practices of the project?

Eligible couples are identified on a household basis. ANMs are sent to knock on doors in villages in order to identify potential couples. Every married man and women found to be living together, where the women meets certain fertility criteria (generally being from 15-45) will be marked and registered as an eligible couple.

Pregnancy is largely detected through a menstruation cycle monitor program. ANMs visit a certain amount of women in a village each day to enquire about their menstruation. This way most woman are at least visited once a month, and it is possible to detect whether they are pregnant or not within an error margin of one menstrual cycle. The Women are advised to contact a doctor at the primary health center for check up upon confirmation of pregnancy by the ANM.

After the pregnancy has been established, the mother should be visited for regular checkups by the ANM. The ANM is responsible for providing the necessary antenatal care and recording data pertaining to these checkups.

The child delivery procedure is ideally performed by a doctor at a local health center or hospital. If this is not practical, a home delivery will be performed either by the ANM or a Dai (a traditional village midwife). Details regarding the delivery are expected to be recorded by the ANM.

After birth, the child and mother will again be visited by the ANM for checkups and the child will be given immunization shots and tonics against common diseases. Again this data is recorded by the ANM.

6 Method

This chapter will account for the methods used in collecting data for this thesis. The first part will describe relevant theory regarding the choice of research methods. The second part will describe data collection and practical application of the chosen method. The third part is an evaluation of the chosen method based on evaluation criteria put forth by Klein and Myers (1999).

6.1 The choice of research method

The choice of method for any research project is dependant on what kind of information one is looking to collect. There is a wide specter of different methodical traditions. Some general and other more specifically attuned to a particular field of research. According to Galliers (1992), within the field of information system research there are numerous different approaches commonly used: Laboratory experiments, field experiments, surveys, case studies, simulations, etc. The author points out that no approach is universally suited for everything, but that the different approaches all have their pros and cons pertaining to each individual project.

Methods can be classified as either quantitative or qualitative. The primary difference between the two is that while quantitative methods focus on the use of quantifiable values (how much, how often, how many etc.) in order to verify or dispute a hypothesis, qualitative methods are more concerned with identifying and describing factors that may be relevant in order to gain a broader or deeper understanding of the subject one is researching.

Another name for research based on quantitative methods is positivist research. Orlikowski and Baroudi (1991) describe positivist research according to information systems in the following terms:

> *"Generally speaking, IS research can be classified as positivist if there is evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from a representative sample to a stated population."*

As there were no set hypotheses or theories formulated for testing at the onset of this study, and as my approach would be to gradually collect research information whilst doing development work in the area, I chose to focus on qualitative methods. More specifically I chose an interpretative research approach. According to Walsham (1993) interpretive methods of research are:

> *"...aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context"*

Some of the activities performed during the timeframe of the study are closely related to those of action research but not quite. Action research is the practice of participating actively in the environment one is trying to gather information about, gradually building an understanding of the situation and its context, whilst at the same time incorporating this understanding into one's work. Braa and Hedberg (2002) describe a good example of successful action research in practice. This is a project regarding implementation of health systems in Africa. They describe action research as following:

> *"Action research has been typified as a way to build theory, knowledge, and practical action by engagement with the world in the context of practice itself"*

As mentioned in chapter two regarding methodological approaches within the field of IS in developing countries, action research is an approach that has the potential not only to provide the researcher with data about the setting, but also to contribute something of direct value to it. Walsham and Sahay (2006) describe the benefits of this approach as following:

> *"Action research would appear to be particularly relevant in contexts where resources are scarce, when it can be argued that outside researchers should not only go away with data for their own papers and academic careers, but also aim to make a specific contribution in the research setting itself."*

As HISP, the organization I was attached to is performing their work primary through action research in the Region, and I was working as a member of their community, a fitting label to my research approach would be: Interpretative research in an action research setting.

6.2 Data collection

The data was collected during a three months stay in the state of Gujarat in India, from the beginning of May to the end of July in 2006. I have also kept contact with people I worked with in the ten months that followed my departure from India up to and including May 2007.

The original plan with regards to timing was to initially spend two months there, then go back to Norway for a period of three months. I would then finally return to India for another month to evaluate progress and sort out difficulties. Due to time and budgetary constrains this proved impractical and it was therefore changed into a three months continuous stay.

The three months were originally meant to be used doing research and improvements on a computer system for administration of Antiretroviral Treatment (ART) centers in the region of Kerala. However due to change in political power relations in that region and practical considerations, the focus became changed to the implementation and integration of person based health systems for family welfare.

The reasons for the very last minute change of plans, was that the political administration in Kerala that up until then had been very supportive of the work the Health Information System Project (HISP) were doing in the region, were up for reelection. It was believed that there was a very good chance that they would loose

this election, and that the subsequent change in leadership would result in potential discontinuation of projects so far run by HISP on behalf of this administration.

On the other hand HISP was currently enjoying the good graces of the state administration of Gujarat whom had requested help with a number of projects. It was felt that resources could be put to better use if I would be willing to travel to the north of India to Gujarat instead of the south to Kerala. I was assigned a newly hired programmer that would help me with developing the so far undefined project I would be working on, and set out for the state of Gujarat.

My primary base of operations was the town of Valsad, witch is also the administrative headquarters of the Valsad district. The reasons for this choice of location was based on convenience regarding implementation work, as there already was an office with a delegation from HISP set up at this location. Valsad is not particularly close to either the state administration headquarters in Ghandinagar or to the rural areas primarily to be served by the EC system.

Our position was therefore quite isolated both from the actual users of the system and also from the political administration having commissioned it. As a result information was rarely available to me directly, and I would therefore have to try and make the most of the opportunities I had to talk to relevant people other than my fellow developers. These opportunities usually presented themselves during project meetings between HISP and representatives for the administration of Gujarat. Most information came through collecting and analyzing documents and through interviews. Notes were taken during conversations, and all activities of workdays that provided potentially relevant information were transcribed into a journal at the end of the day.

6.2.1 Project related meetings

There were three meetings with the government administrative personnel during the time of the study. These were often primarily being held to report on progress in other areas of the HISP organization, but they also provided excellent opportunities to talk directly with people that had some connection to the EC project. It was usually during

or in conversations immediately before or after these meetings, that the bigger picture regarding the system would make itself evident. The specifications of the system would as a result be formed in this process, primarily by the presentation of documents or through verbal exchange of ideas regarding functionality. Interviews would also take place after these meetings.

6.2.2 Document Analysis

The documents given to us were eight so called sub-center level registers written in Gujarati. Their functions were twofold: To serve as written journals concerning daily work done by the health workers dealing with family health issues and as reports to their superiors in the health system:

- Register 1: Common Diary for the Health Worker/ANM
- Register 2: Eligible Couple Survey
- Register 3: Family Welfare Survey
    - Sterilization Operations
    - Intra Uterine Device (IUD)
    - Contraceptive Pills
    - Condom Usage
    - Medical Termination of Pregnancy (MTP)
- Register 4, 5: Mother and Child Care Registers
- Register 6: Malaria Register
- Register 7: Stock Register
- Register 8: Birth and Death Register
    - Birth Register
    - Death Register
    - Stillbirth Register

In order to transform these documents into a computer system with similar purpose, they were first given to a doctor at the local health center for translation into English. In order to further decode unfamiliar medical lingo I would consult with members of

the HISP team that had previous experience either with family health care or similar computer systems in other regions of India.

6.2.3 Informal Interviews

In addition to document analysis, interviews were also performed with people familiar with the practices of the project. Interviews are structured conversations with a goal. There are many types of interviews and ways one might choose to perform them. I chose to use qualitative interviews. According to Thagaard (1988), qualitative interviews can be either highly structured or of a more informal nature like regular conversations. As my needs for information often presented itself emergently as a result of other information recently acquired, the interviews were informal variations of the "qualitative research interview". In this form the purpose and context of the interview is predefined and lays out the subjects that are to be talked about, but the actual questions asked about the subject are improvised during the conversation.

The people I interviewed were primarily people working with the administrative aspects of the health situation in Gujarat:

Table 1: List of different interview objects

INTERVIEW SUBJECTS	
2	Medical Doctors
2	Administrative consultants for the State of Gujarat
1	Senior coordinator in HISP
1	Local coordinator in HISP
6	**Total**

Some interviews were performed in order to clarify information I had previously acquired, and some were conducted in order to gain more insight into the practical aspects of family healthcare and the EC project.

6.2.4 Indirect communication with health workers

Direct contact with the health workers related to the EC system was unfortunately not possible, as there was a language barrier. The health workers only spoke their native language (Gujarati), and would therefore need translation into English. As a result most of the information regarding health worker related subjects was gathered second hand through English and Gujarati speaking members of the HISP organization.

6.2.5 Electronic correspondence

Some information was gathered through Email correspondence with members from other parts of the world affiliated with HISP and the State administration of Gujarat. There were two mailing lists:

Table 2: The relevant mailing lists

MAILING LISTS	
1	Regarding general discussion within the organization.
1	Regarding technical issues and development.
2	**Total**

In addition I would correspond through Email regarding more specific matters with a number of members of both HISP and the Gujarati administration:

Table 3: List of Email correspondents

EMAIL CORRESPONDENTS	
4	Developers from HISP
2	Senior coordinators from HISP
1	Local coordinator from HISP
1	Professor of Informatics at NTNU in Norway
1	Administrative consultant for the State of Gujarat
9	**Total**

6.2.6 Participatory involvement in work practices

Perhaps the most important tool of data gathering for this study was the fact that I was working with the Indian development team in Valsad as a part of it. The primary source of general understanding of the research context came as a direct consequence of being right in the middle of it sharing meals, journeys, frustrations and victories with the other actors of the HISP team and actors around us.

6.3 Reflections on the application of the chosen method

We have chosen to apply Klein and Myers' (1999) principles for conducting and evaluating interpretive field studies in information systems as a measuring stick with regards to our choice of methodology. Out of the seven principles we have chosen to focus on six of them:

- The fundamental principle of the Hermeneutic Circle
- The principle of contextualization
- The principle of interaction between the researcher and the subjects
- The principle of abstraction and generalization
- The principle of dialogical reasoning
- The principle of multiple interpretations

The final principle of suspicion has been left out due to the fact that no notable suspicions regarding the case were raised during the actual field study. Unfortunately I was not aware of these principles at the onset of my work and they have therefore not been applied rigorously whilst conducting the study. Rather they have been applied retroactively as an evaluating function to flesh out relevant issues pertaining to the context of the case study.

6.3.1 The fundamental principle of the Hermeneutic Circle

As mentioned earlier, I was not aware of the principle of the Hermeneutic Circle when I started my study. According to Klein and Myers (1999) the principle is better applied before starting your analysis than in retrospect:

> *"The value of this principle lies more in guiding future work than in evaluating work already published."*

As a result one might expect that the study would likely have a more consistent form had I given thought to the principles of the Hermeneutic Circle before my stay in the field.

6.3.2 The principle of contextualization

The fact that my study was done in India, a country whose customs, language and traditions I am only vaguely familiar with opens the door for the possibility that I am missing some of the more subtle meanings in interactions I had with many of the people I spoke to. In order to counter this as far as possible, I would ask my coworkers for clarification regarding what to me would be unfamiliar social or organizational issues that had the potential to impact our work. Of course these clarifications would necessarily be biased through my coworker's perceptions of the situation, and thus may ultimately be misleading.

As the language used for communication (English) was not native neither to me nor the subjects the potential for miscommunication increases. For instance: Health programs were referred to as "health schemes" by many of the people I spoke to. To me, the usage of the word "scheme" would imply that the plan might be of a somewhat suspicious and dubious nature, and would initially conjure up images of state controlled health measures designed for population control of specific ethnic or religious groups, something that would hardly be appropriate for a health program on a national level. The Indian usage of the word does however imply no such connotations.

One of the biases I encountered during my time in India was a profound and possibly inappropriate faith and respect in my ability to solve problems and create solutions. It seemed that the largely positive experiences the HISP employees had previously had with other developers from Norwegian universities in general had made developers from my country somewhat glorified in their eyes.

6.3.3 The principle of interaction between the researcher and the subjects

Working as a developer for HISP, my understanding of the development and project management team in Valsad would surely be colored by the fact that I was working with and as one of them.

Many of the decisions made with regards to timelines and specifications of the system we were developing were grounded on the basis that I as a person with a specific skill set was there to contribute. Had I not been there, decisions would likely have been made based on different criteria.

As I was working together with the HISP team I was stationed with on a daily basis, it would be unlikely that input from them would be unaffected by me being there. As they were all aware that I was working on a thesis in addition to helping them develop a system, they would likely modify their behavior as a result of my constant presence.

On the other hand, data regarding the health workers and government administrators would be less influenced by my presence, as I would have only sporadic contact with them, most often through Email and only sporadically in person.

Also as I was using much time programming the system in order to get something up and running during the timeframe available, there was no time to interact with the health workers doing the actual work in the field.

As a result of this, much of the information regarding work practices of the health workers and the organization of the state health system comes from second hand accounts derived from the interviews with the HISP employees. This might have decreased the interference caused by my presence as a researcher on the daily work patterns of the health workers and the government administration, but it may also have constrained the knowledge I was able to gather about them.

6.3.4 The principle of abstraction and generalization

In cases where the possibilities of drawing on general principles of software design presented themselves, I would generally try to conform to said principles. However the application of such in the context of an Indian setting might in some cases have been inappropriate due to the fact that my understanding of these principles stem from a predominantly western background.

6.3.5 The principle of dialogical reasoning

As the work progressed there were times when the intended course of action had to be changed in order to accommodate the actual needs of the setting. I had two primary points of reference upon starting the study that I would later have to revise:

1) I traveled to India expecting to do research on ART systems. My focus later changed to family related health systems, but particularly in the beginning of the study my mindset was still predominantly looking for information that might be relevant for my initial research context.

2) My background as a software developer and interface designer would likely be the primary "glasses" I would view the world in at the outset of my study. It would only gradually change to become more focused on the non technical issues also relevant to the setting.

6.3.6 The principle of multiple interpretations

The system designed as part of this study is a system that would be described in differing lights depending on whether you were asking the health workers, the administrators or the developers. Unfortunately due to language barriers and the fact that we were unable to directly communicate with them, the views of the health workers are much less apparent than the views of the other two groups.

In addition time constraints made it difficult to have extensive contact with the administrators, so for better or worse the primary view of the application described in this thesis is rooted in the view of the developers.

7 Case description

This chapter describes the process and results of the three months of work I did in India concerning the implementation of the EC system as the case work for this thesis. It also describes parts of the aftermath that I consider relevant for this thesis.

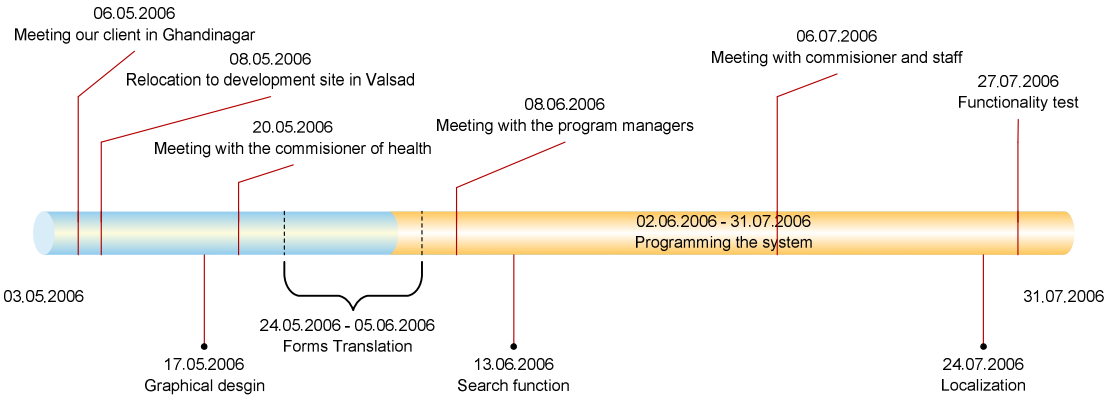

Figure 1: This is a timeline of the major events related to the EC system in the three months spent on site in India

7.1 First month

As mentioned earlier in chapter four regarding research methods, these three months were originally meant to be used doing research and improvements on a computer system for administration of Antiretroviral Treatment (ART) centers in the region of Kerala. However due to potentially changing power relations and practical considerations, the focus became changed to the implementation and integration of person based health systems for family welfare in Gujarat.

7.1.1 Meeting our client in Ghandinagar

Upon arriving in Gujarat we scheduled a meeting with a consultant working as a project coordinator regarding health programs for the government of Gujarat. We met

her in the government headquarters at the capital of Gujarat: Ghandinagar, where she introduced us to important people in the administration, including the commissioner of health.

We gathered as much information and materials about the ongoing projects as possible. As the project we would be working on was still undefined, I primarily focused on finding out about potential ART work being done in Gujarat, as that was what I had prepared for beforehand. We collected a number of paper forms used in registration and treatment of ART patients, talked to the persons in charge and scheduled a meeting with a doctor at the local ART center. It became apparent that they already had a basic system in place for administrating most of the ART activities. The system was made in Microsoft Excel by one of the doctors, and seemed to work pretty well for day to day administrative activities in the treatment center. It was made very clear that for the clinics to even consider using an ART system developed by HISP, the improvements compared to their existing one would have to be substantial.

Although the administration were very cooperative with regards to giving us access to all information we asked for regarding ART treatment, they were always even more eager to talk about and request help with another project which they considered more urgent and important. This project called EC (Eligible Couples), was clearly what the government really wanted help with at the moment. As the ART project seemed to be somewhat of a gamble with regards to whether we would even be allowed to deploy it, and as the EC system was clearly very much wanted, a change of focus was definitely in order.

7.1.2 Taking on the EC project

We received some information and some written materials regarding how this project was currently being run. As mentioned in the previous chapter, the EC program was at the time of writing already running in the state. It was however not operating flawlessly. At this time the system was administrated primarily through the use of paper forms. It was believed by the administration that a computerization of the system might make things better. More specifically, data accuracy at the sub-center

level was deemed in need of improvement so a computerization of the relevant forms would be our primary objective.

We were given binders with the Gujarati versions of the eight sub center level registers, along with a partial translation[1]. We got the English translations for Registers 4 and 5. The other registers were at the time only available in Gujarati.

7.1.3 Existing systems related to EC

There were a number of other systems we were shown during our stay in Ghandinagar that had relevant connections to the project:

RIMS

The government already had a partly completed system for administration of medical supplies called RIMS (Routine Immunization Monitoring System). Although the version we saw was not completely functional, as it contained no actual data and report generation was not possible, we were told that it was currently being used in the field. The system seemed to be dependent on batch processing as opposed to live data synchronization, as we were informed that data did exist on test sites, but that it had not been uploaded into the central repository yet. Impressions of the RIMS system were as follows:

- It was already in use, and was being further developed, and so could be considered a healthy and living system.
- It looked very professional.
- It was somewhat prestigious, as it was supported by the WHO (World Health Organization).

Due to the positive impression given and the level of prestige and resources already invested in this system, I decided that the administration of medical supplies would

[1] Please see appendix for copies and translations of these forms (Some of the eight forms were later decided to be irrelevant for the project and are therefore not included).

not need to be a focus of the EC system. As RIMS already existed for this very purpose and was not likely to disappear, implementing similar functionality into the system we were going to make would be a waste of time and a possible source of conflict. Integrating with it was however considered to be a possibility.

An unnamed Unicef Card derivative system

We were also shown a system based on the Unicef health card. The Unicef health card is basically a simplified, small, personal health record. This derivative version was basically the same with some enhancements: A paper card that functions as a portable medical patient record, but focusing on pregnancy and immunization related data. The patients themselves are responsible for keeping it and bringing it with them for visitations to health workers.

We were told that this system was just about ready to go live, and this gave us the impression that this was probably a system that had been worked on for some time, probably even before HISP was contacted to make a computer based EC system

Our impressions regarding this system, was that a working EC computer system would in many ways make the card system a redundant administrative object, which should be our goal. However the computer system would have one disadvantage compared to the card based system: The connection between person and data might get lost if the patient moves to a region where the system is not being used. In order to decrease the chances of this happening, the computer based system needs to be scaled to a national level of use and achieve good data coordination practices between all locations using the EC system. With the card system, the patients only need to carry their own data with them.

7.1.4 Relocation to development site in Valsad

After having met all the people we felt we needed to see in the administration headquarters of Ghandinagar and spending approximately one week on the road, we were eager to settle down and start doing some preliminary implementation work. The HISP organization had arranged for us to establish our base with another team from

HISP that were operating a small office in a rented apartment in the town of Valsad. As mentioned in the chapter 5, Valsad was the pilot site for deployment of the different systems developed by HISP in the region of Gujarat.

When we arrived, there were 2 HISP employees stationed at the office: One project leader and one technician. In addition there were five local people under training by the HISP personnel called: Facilitators, which would drop by on a daily basis. The facilitator's main purpose was to acquire competence with installing and using the HISP systems, so that they could provide support to the health workers that would be using the systems after they had been deployed and the HISP developers had left the area.

Our first priority was to set up shop for development work, and evaluate what resources we had available to us. So far we had been using cell phones to communicate while we were on the road, but now that we had reached our primary destination, we would have the opportunity to use an Internet connection in order to more efficiently communicate with other parts of the organization. Internet cafés in Valsad were slow and not very practical to be working in on a daily basis. We only managed to get transfer speeds of approximately 1 kb/second while sending scans of the documents we had received in Ghandinagar to one of the senior HISP coordinators. It was therefore decided that an Internet connection would be the first thing we would have to establish at our work place.

According to the facilitators, at the time of writing there was apparently only one service provider available in town. Upon calling them, they informed us that they would be able to provide us a dedicated connection, but we would have to wait until they got a new shipment of cable from Chennai in order to reach our location. This would take four days, but we eventually got connected although we still had issues with stability.

We also decided to inquire about the Internet status at the health centers. We were told by our contact at the administration that although computers had already been or would be provided for the deployment sites, few of the sites would have internet

connections. From this we concluded that we would most likely have to do data synchronization by batch processing using mobile storage units as opposed to online transfers.

At this point it was decided that the EC project would be the primary focus. There were however Email correspondence within HISP regarding ART systems that I found to be somewhat relevant for EC as well. One of the Vietnamese developers was at this time working on a new version of an ART system originally designed by HISP for use in Africa. The main problem with the existing version was that the interface was hard-coded and very specific to the needs of the particular area of Africa it had been developed in, so it needed a rewrite in order to be used in Vietnam. The new version had some very good ideas for making the interface input forms user definable. The motivation for this was to adapt it to other areas without having to change a hard-coded interface. The framework looked like something that might also be used to make other person based health systems. As the EC system would be a person based health system, there might be some potential for code reuse by building on what was being done in Vietnam.

From the experiences so far the following specifications of the system could be deduced:

- There would be three primary types of users of the system: Health workers (providing and possibly using the data), state administrators (using the data), and HISP facilitators (providing training and support).

- Data handling should in the long run be possible to do via the Internet and the system should therefore be implemented as a web based application. However, due to presently undeveloped Internet infrastructure in many potential deployment locations, the application has to be able to run locally as well.

7.1.5 Return to Ghandinagar

Eleven days after our arrival in Valsad we were summoned back to government headquarters in Ghandinagar for a meeting with the commissioner. In addition to the developers and a coordinator from Valsad, two of the senior HISP coordinators would be there as well. This would give us the chance to talk more about details regarding the project and how to implement it.

One of the coordinators strongly adviced us to use the same technology stack as the organizations flag ship application: DHIS, witch was based on Java with the additional frameworks: Hibernate, Spring, WebWork, and Velocity on top of a MySQL 5 database. The reason for this was that integration between EC and DHIS would be necessary somewhere in the near future.

The Vietnamese general interface framework for the ART system, which was built on PHP5 on top of a MySQL 5 database was proposed by me as another potential basis, as the EC system and the ART system would have more in common, both being person based as opposed to aggregate data based.

Informal discussion around this subject took place and both project managers indicated that using the DHIS architecture was preferable over the new ART system architecture if at all possible. It was agreed that since both alternatives share the same database server software: MySQL 5, we should standardize on that with the EC system as well, no matter what choice of programming language we made.

7.1.6 Meeting with the commissioner of health

Before the meeting I was told by one of the HISP coordinators that the commissioner was what can be described as HISPs champion within the state administration. He was the primary political power that had enabled HISP to initiate their various HIS projects in Gujarat.

The meeting with the commissioner took place at the central administration headquarters. The primary function of the meeting was presenting HISP's general progress in Valsad, and as such was only indirectly relevant for the EC system.

The commissioner was without a doubt a very commanding and charismatic figure, and gave the impression of being the kind of leader that gets things done. For example: During our meeting with him, the coordinator from Valsad mentioned that some data from one of the sub centers had not yet been given to the people in charge of inputting it into the DHIS system, and it was therefore somewhat holding up the deployment progress. The commissioner immediately proceeded to call the head of the sub center, demanding instant compliance and informing him that pay would be withheld until the data transfer had been completed (The data arrived not long after).

Although the meeting was primarily about things not specifically related to EC we are able to gain some more insight into the greater purpose of the system. The commissioner demonstrated a GIS (geographic information system) that showed various statistics regarding different health issues spread across maps and charts. He mentioned that the statistics he had access to at the moment were both incomplete and in places inaccurate. He explained that in order to make correct policy, correct data was needed, and he hoped the systems he had commissioned HISP to implement would provide it.

From this we were able to conclude that the direction he wanted us to take the system in was more about providing quality data for the administrators than it was about making a tool for the health workers.

Taking into consideration the commissioner's wishes for a data accurate policy making tool, it was clear that we needed to implement different levels of access control to the data in the system. In general terms, we should make it so that only the health workers have access to input and modification of data. Higher level administrators, although responsible for consolidating the data and sending it further up the hierarchy contribute nothing to the person data itself, but have the potential to contaminate it, and as such should therefore only have read access.

7.1.7 Return to Valsad

One of the senior coordinators from HISP retured with us back to Valsad after the meeting to help plan and organize our projects.

Back in Valsad, the forms we havd only Gujarati versions of were in need of translation. A doctor was recommended to us by the commissioner that should be able to help translate them, and so we visited the local hospital to meet him. He agreed to help us with the translation, and promised to have it done in a few days.

At the same time we had the opportunity to meet some ANMs. Unfortunately we were not able to communicate very well, as the ANMs only spoke Gujarati. This is common amongst people in rural areas of the region. ANMs have some formal training in health care related to their profession, but the use of English language is not a part of it.

This was however one of the sites that had already received their computer, so we examined it to decide what kind of hardware we had available to run the software on. Computers at the health center were quite similar to the ones at our office with regards to technical specifications. Their primary practical restriction was their CRT displays that were not capable of showing any resolutions above 1024x768. The interface should therefore be designed to fit all its necessary parts (including space taken by the browser software) within a screen estate area of no more than 1024x768 pixels if possible.

Back at the office, we tried out some technologies to see what we could use to build the system while we waited for the translations. One of the primary limitations in our resources was that there were no budget allowances for the acquisition of hardware or commercial software packages, so we needed to rely on free software.

PHP and MySQL as used by the Vietnamese ART system were easily set up on the office machines, as the local developers already had most of the necessary software and knowledge about using it. The local hardware seemed to handle it reasonably well, performance wise.

We also tried out various free Java tools, but had some problems getting the server side software to run on our workstations. Unfortunately no one at the office had the necessary knowledge to figure out the solutions to the problems.

At this time I also designed a basic layout for the application user interface using HTML. I chose to change the form layout of the original forms from a horizontal flow to a vertical flow. The primary reason for this was to make vertical scrollbars appear instead of horizontal scrollbars when the form became bigger than the screen. This is the most common behavior of web-pages and web-applications. Since we were trying to transition from a paper based to a computer based system, it was appropriate to prioritize consistency with common computer application behavior over the specific paper form layout of the existing registers.

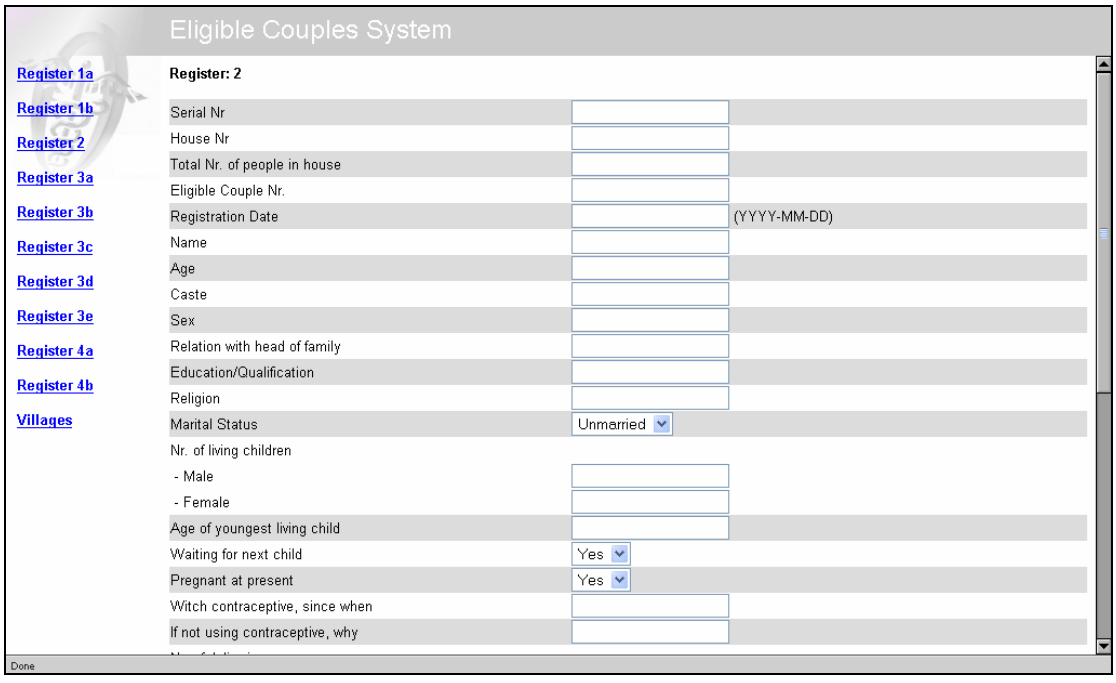

Figure 2: HTML prototype of the user interface

7.2 Second month

7.2.1 Deciding on a programming language

At this point we strongly felt that we needed to get started in order to have any chance of producing something substantial in the two months that were left. Unfortunately the senior coordinator had to leave for another state on family business, thus leaving the critical decisions regarding choice of programming language entirely in the hands of me and the Valsad team. The choice was between PHP and Java.

As mentioned earlier, Java was considered the preferred choice of the HISP coordinators at this time, as this was the language used in their primary application suite: DHIS. There were however some very good reasons for not going with it as well.

In order to conform to the coding practices used in the DHIS application (now up to version 2, and therefore sometimes referred to as DHIS2) we also needed to use the same four additional frameworks: Hibernate, Spring, WebWork, and Velocity. The main problem with this was that no one at the Valsad office had any knowledge in the usage of these frameworks. If we allocate a generous timeframe of one week to learn each framework, that would potentially cost us four weeks, thus effectively cutting our available time in half. A member of the Vietnamese development team provided an even more pessimistic time estimate in an Email communication:

> *"It can take you 2 months to integrate with dhis2 if you just start with it now."*

In addition, we were told by the Valsad HISP technician that one of the frameworks also had the unfortunate side effect of making the system not work correctly in Internet Explorer.

Reports from Africa, where availability of computers and infrastructure was even more limited than in India indicated that the relatively high resource demands of the DHIS system was a problem when running on the machines commonly available at

that location. Due to slow Internet speeds, distributed work with such a heavy framework was also a problem for developers stationed there. A report from one of the HISP developers indicated that downloading the entire source code package did in one case take over a week.

Limited selection of tools for programming in Java was also problematic for the Valsad team. The earlier mentioned problems with getting a working Java environment up and running on our development machines had still not been solved. At this time we had developers at the office that were in possession of a laptop with a working Java development environment. Unfortunately they were not able to replicate the environment to any other machines, and the laptop was being heavily used for work on the DHIS system.

Due to these reasons and the pressing need to start doing programming work as fast as possible, in order to have a chance of finishing during the two months that I had left in India, I decided to use PHP as the programming language for the EC system. The primary advantages to doing so at the time were:

- PHP servers and tools were already running on our workstations.
- The available developers were all familiar with PHP.
- Other patient based projects were currently being developed with PHP in other parts of the organization, so potential for code-sharing was still a possibility.

The primary disadvantage to this solution was that it decreased the opportunities to do a vertical integration between DHIS and the EC system. Horizontal integration on the database level would however still be possible, because we were as mentioned earlier, using the same database software in both systems.

Keeping the same database software also has the added benefit of enabling both applications to run locally on the same machine with only one database server installed.

7.2.2 Transforming the paper forms into electronic forms

All paper forms were finally translated at this point. There was some confusion with regards to understanding some entries, as some of the medical lingo was very domain specific. The Valsad project leader had some experience with a similar system from another part of India so when we were in doubt of a particular meaning we consulted her. This was a process that introduced a moderate chance that our interpretation of the translation would in places be wrong, and so the possibility that some fields would later on have to be relabeled to more accurately represent the original meaning was noted.

Some of the registers were eliminated from usage in the EC system. More specifically:

- **Register 6: Malaria**
  This register was discovered to belong to a different national health program dealing specifically with Malaria. This register could therefore be dropped for the purposes of this project.

- **Register 7: Stock Register.**
  This register was concerned with the administration of the available stocks of medication. As earlier mentioned we had decided that this would not be a focus of the EC system, as the government already had another system: RIMS dealing with this exact issue. This register was therefore also dropped.

In order to make the transition from a paper based system to a computer based system as easy as possible, we decided to make the data input part of the system contain as similar elements to the paper forms as possible. However, a computer system that was basically a copy of an existing paper system would not be much of an improvement, so we decided to make some adjustments in order to minimize input:

- We chose to eliminate all input elements containing repeated and therefore redundant fields that were previously filled in during earlier parts of the registration process.

- Fields that contained data values that could be interpolated by combining data registered elsewhere in the system were marked for automatically being filled in.

Please see the appendix for a complete overview of the remaining registers and their translations.

7.2.3 Meeting with the program managers

There was another meeting to present progress reports on HISP developments, this time with program managers for the different health programs. As mentioned earlier the program managers are the people responsible for the implementation of national level health programs, of which the EC program is one.

The presentation given by the HISP team was well received, and we had the opportunity to gain inputs from a larger pool of interesting people. We were mostly asked about the administrative potential of the EC application, thus reaffirming our belief that administration was the application's main purpose.

7.2.4 Problems of uniquely identifying persons in the system

One of the bigger problems with making a person based health system in a country like India is that there exists no administrative identifier (like a birth certificate number) that uniquely identifies one person from the next. In addition, the Valsad project leader told me that many people tend to name their children after deities symbolizing wealth or good fortune. As a result, some names are repeated quite a lot.

In order to find the correct person one was inputting data for in the system a search function that returned a number of identifying values in addition to the name would be necessary. I decide to try providing the full name and address as a combined identification indicator. This still has the disadvantage of making the system lose track of the person if the person changes place of residence, but it was a place to start.

We introduced a mandatory search page into the system interface that was displayed whenever a form was to be manipulated. The user needs to type in the name of the person whose record is to be manipulated, whereupon a list of potential names and address matches is presented. The user is presented with the option of generating a new entry if there are no matches.

7.2.5 Parallel work with the Vietnamese ART team

At this point we had come to the point where it would be necessary to start making the code that generates the input forms. We were as earlier mentioned, aiming for a solution where input forms could be dynamically generated based on criteria set up by a general framework. This was to more easily be able to change the input forms of the systems, and to enable the same program code to be used for other person based applications as well.

The HISP team from Vietnam seemed to be making great progress on the part of such a framework that would allow a user to generate general input forms. But it was at this time not complete enough that we could inherit their code base directly. As such we had to make a compromise:

What we did was to copy the basic database structure of the Vietnamese ART system and then we wrote our own code to parse the contents of these tables. In other words, we wrote our own data driven interface rendering code, but built it on the database structure of the Vietnamese system. We had to make some additions to the database structure in order to accommodate the particular needs of the EC system and the layout of our own database. As a result incompatibilities would likely crop up between the two systems if consolidation of code would be attempted, but once again our limited time and our need for immediate progress would weigh higher than the advantages of inter-organizational consistency.

7.3 Third Month

7.3.1 Meeting with the commissioner and his staff

At the start of the third month we had a scheduled meeting with the commissioner and his staff. This was the first time we had the opportunity to speak specifically about the EC system, and to present our progress on it. Our presentation was well received by the staff. The commissioner himself was unfortunately unable to attend.

After the meeting we had opportunities to speak with some of the government project leaders regarding both the EC and the DHIS system. An interesting piece of information gathered during these conversations regarding EC functionality was that some sort of in built monitoring system would be very much wanted by the administration. The reason for this was that apparently the ANMs were not always performing all tasks they were commissioned to do. One of the consultants described a case involving the post birth vaccination of infants:

> *"We tried implementing a system where the ANM marked the doors of houses with a piece of chalk after vaccinations, but this didn't help because the ANM would bribe little children with candy to mark all the doors in the street, while she visited only a few of them"*

We noted the suggestion as a possible feature, but explained that it would not be possible to include this in the first version of the system.

We also learned the reason why the commissioner was otherwise engaged during the meeting. Apparently the commissioner might be leaving his post in Gujarat to serve in another state. This was cause for some concern amongst HISP staff. As mentioned earlier the commissioner was the champion of the HISP organization inside the administration, and thus the main reason HISP had been able to perform their work in Gujarat as smoothly as they had. It was therefore decided that all possible HISP initiatives, including the EC project needed to be deployed in the field as soon as possible, in order to establish them as running projects.

The reason for this was tactical. One of the HISP coordinators described the situation like this:

> *"Plans from a previous administration are often cancelled when positions of power are changed, but projects that are already operatinal are more often left alone."*

In other words deploying the projects would to a certain extent safeguard them from cancellation in the event of the commissioner having to leave.

The implication of this was that we needed to make arrangements for a deployment of the system at the end of the month. Originally this time was scheduled to be used for user testing of the system. This further decreased our already limited timeframe, and so it was decided that we just had to try and make the system as bug free as possible and let the actual user testing take place post deployment.

7.3.2 Entering the final stage of development

Unfortunately development in the last month progressed at a slower pace than what would have been optimal. There were two primary reasons for this:

- Focus primarily shifted from the early phases of planning and creative development to the slower process of debugging and correction of errors.

- The time of year was the *Monsoon*, the tropical rainy season. Rainfall became more frequent and fierce, thus often knocking out electricity and Internet connections in our part of the town.

Thus the coding process took practically all available time of the final third month, leaving us unable to do much else.

7.3.3 Localization into Gujarati language

As mentioned earlier, the intended users for the system are ANMs that are usually not well versed in the English language. As such we needed the system to be localized to Gujarati language for these users. During the development phase, all text in the system had been displayed in English since none of the developers knew Gujarati, but we all knew English. As we were generating all the forms of the user interface dynamically from database tables, we had written the code so as to display all field and form names in either language, based on a flag set at login time. It would only be a matter of inserting the appropriate Gujarati text strings into the database.

There was however one minor problem with this. Even though our database tables were configured to handle the storage of both English and Gujarati characters, the software we were using to manipulate the database tables did not support this character set. It was therefore necessary to use SQL statements to insert this text from another application that were able to support the Gujarati character set, like a Web browser. We had to write a small program that ran in Mozilla to accomplish this. One of our local Gujarati facilitators typed in the actual Gujarati text strings.

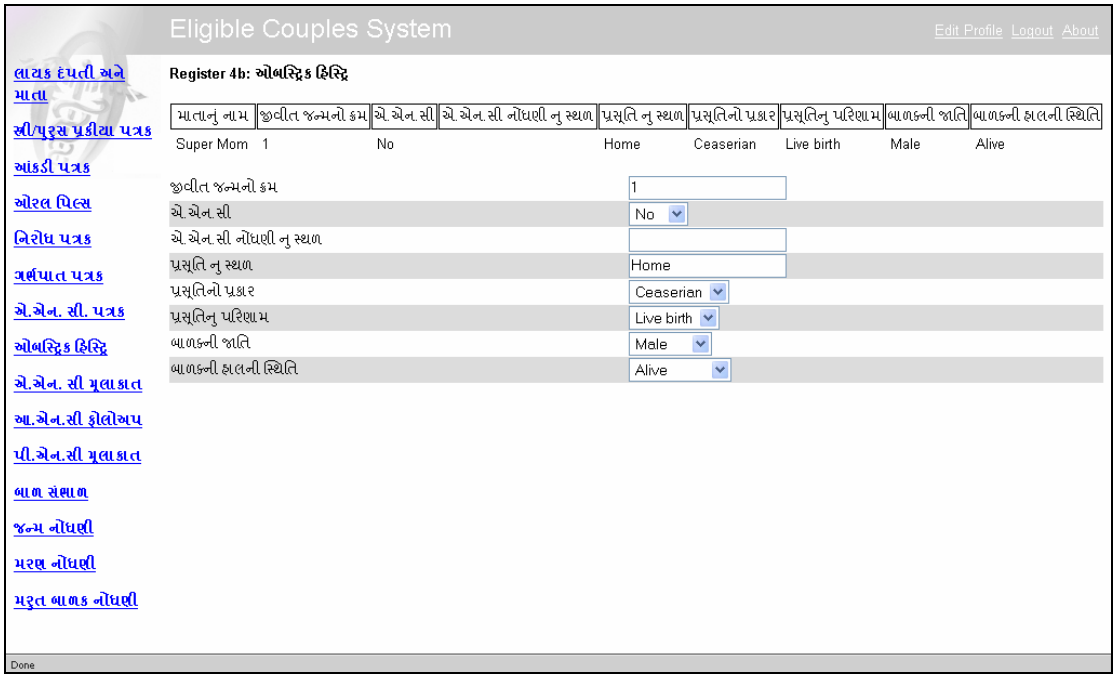

Figure 3: Section of the user interface in its final Gujarati form. Note that some parts remain in English.

7.3.4 Functionality test

After all the functionality necessary to store and retrieve data from the forms was complete, we did a functional walkthrough test. In order to make as much out of this as possible, I collaborated with the Valsad team project coordinator, whom previously had experience with the use of a similar system from another part of India. We also chose to do heuristic evaluation according to the ten general principles for user interface design by Nielsen and Molich (1990) and Nielsen (1994).

This highlighted a number of issues that were adjusted, primarily translation errors and inappropriate data types.

7.3.5 Arrangements for the transfer of ownership of the system

As I would be leaving India at the end of the month, there was at this time a need to transfer as much knowledge over to the Valsad team as possible before my departure. My main priority was to make sure the programmer I had been working with was able to understand the workings of the code that we had not collaborated on. From what he told me, the part that was primarily not understood was the way the database structure could be manipulated in order to make changes to the interface. As there was no time to produce comprehensive documentation during the course of development, a bare bone document detailing only parameters and conventions was written by me. I also gave notice that I would be available for assistance and questions over Email after I had resettled in Norway.

There would be great need to gather data on how users experienced the system after it had been deployed in the field. As I would not be present for this phase, I asked everyone to please forward feedback from the deployment to me.

7.4 Aftermath

The first correspondence after departing from India came two months later. It was a notice from the Valsad coordinator that they had presented the system at the district office, and that they would be installing the EC system in two BHOs. As the system

was so far very little tested, and the documentation written was the bare minimum required for practical use, requests for help and error reports was expected to follow. There was however no further correspondence until another month had passed.

At this time the team from Valsad had moved their offices to Ghandinagar at the request of the commissioner of health who was apparently still holding the reins in Gujarat, despite earlier fears that he would be transferred to another region.

7.4.1 Feedback regarding deployment

The project manager informed me that the program managers had some feedback regarding the values stored in the menstruation cycle form. As it were, each monthly checkup was marked with a checkbox but they would like to be able to write a date instead. In other words just adjustments of data types, nothing major functionality wise.

The most interesting part of this feedback was that it came from the program managers and not the ANMs. This would have to mean that the current users of the system would be the administrators of the health programs, and not the actual health workers in the field.

Requests for further information regarding this were redirected to the Indian programmer that had co-developed the system together with me. He informed me that no changes had so far been made to the system after the end of the development cycle, and that currently the system was being used for data entry at the BHOs, and that the program managers seemed very impressed with it. He also said that some additional programming would have to be done to accommodate usage amongst the ANMs. He informed me that he would try to send another feedback report when a bigger range of data had been input into the system:

> *"After they enter the data for about 12 months for at least one sub center each I will try to send the feedback"*

After about a week of not having received any reports, I was contacted by the project manager I had worked with in Valsad. She needed some information in order to write a report about the EC system to the State administration. I suggested that she should emphasize the importance of user-testing the software in the field in her report.

7.4.2 Good news and bad news

Two months after my departure from India, I received correspondence from the University of Oslo regarding an integration initiative between DHIS and EC. Some students had been assigned the task as part of a course, and they asked for and was given information regarding the EC system. This was considered great news, as it indicated that things were moving forward with the EC system. Although the students did voice a concern that finding out who was in charge was not easy.

At this time my professor was visiting India on HISP related business. As a part of this trip he had the opportunity to visit Valsad to observe the progress of the EC project. Two days after the information request from Oslo, I received an Email stating that the EC system was likely in trouble.

A technical issue prevented both EC to be open at the same time as DHIS, but more importantly the EC system was not being used at all by the ANMs. He mentioned a number of organizational reasons why this might be the case, and I shall discuss them more specifically in the next chapter:

- The ANMs don't really have time for additional reporting

- The paper versions of the eight underlying registers for the EC system might be of poor quality, and the ANMs might not be filling in the paper forms in the first place.
    - Hence it would then be a matter of having the AMNs fill in the registers in general, and then about using the EC module for this.

At this point it seemed certain that the deployment of the EC system had stalled. The final thing that happened with regards to the EC system was that the integration project in Oslo was completed[2].

[2] For further information please see the following URL:
http://www.hisp.info/confluence/display/RandD/Import+from+EC

8 Why was the system not being used by the health workers?

As mentioned in the previous chapter, even though the EC system was seeing some use from state administrators, the intended user group for the EC software: The ANMs, were not using it at the end of the deployment phase. There are a number of potential reasons that might explain this:

8.1 Increased workload with no tangible benefits

According to the professor that visited Valsad to check on the EC system after the deployment phase, one of the potential reasons why the system was not being used was that the ANMs didn't really have time to do additional reporting.

As mentioned in chapter 3 regarding implementation, Grudin (1989) postulates that in order for a system to be successful there must be a balance between who will have to do more work and who gets to do less. If this balance is too one sided, the faction that needs to do more work will likely resist the system by refusing to use it, thus causing the system to fail.

The EC system does not really offer anything of value to the health workers in its current incarnation. If anything, the opposite is actually true. If the system was to be successfully deployed and the ANMs were required to use it, they would only have another task to perform on top of their current workload.

Currently, the only way for health workers to input data into the system is by using a shared computer at their headquarters. This means that they still have to record the activities of their workdays on paper, because if not they would likely forget important details by the time they get to the data input terminal. Adding the computer input aspect to the already busy schedules of the ANMs will result in one more thing that they have to do, and thus can not be described as a reasonable request unless it

would also make another aspect of their work less time consuming or more fulfilling. This situation might be alleviated if the government was able to supply the ANMs with portable computer equipment that they could use to input the data directly into the system on site. This could enable the paper forms to be eliminated, if the computerized input system was less time consuming or more rewarding to use than the process of filling in paper forms. Then the ANMs would have an actual reason for wanting to use the system.

As the situation stands there is likely no economic possibility of giving the health workers portable computer equipment, and even if it were they would still likely need appropriate training in order to use it in a manner yielding benefits.

This was an issue not particularly surprising to the development team. In fact, the original plan as mentioned earlier was to use the final weeks for user testing. Nobody would have really wanted to deploy the system before we felt we had given the ANMs a good reason to use it. However, time constraints and the sudden fear that we would loose our champion in the administration: The commissioner of health, led to a hasty finalization and a premature deployment. This it a good example of how increasing lack of the time resource can cause premature deployment for fear of loosing a window of opportunity. This is a mistake often observed in more commercial software development as well. I'm sure we can all think of at least one piece of prestigious software that was released unfinished to hold a deadline, only to need extensive fixing afterwards.

8.2 Uncertain quality of the data input source material and report practices

There is also the question of whether the quality of the existing paper forms is up to standards. As mentioned in the case study, a lot of redundant data fields were assimilated during the conversion to electronic versions. Perhaps this redundancy is problematic in the paper versions, and perhaps there are other problems as well.

We were working primarily on the assumption that the existing paper forms were good enough to be used as a basis for the EC system, but if it turns out that we built our system on flawed source material, this would be a good indication as to why the system is not being used by the health workers.

Report forms of low quality may also contribute to the refusal of the workers to even hand them in. The suggestion regarding whether the ANMs are filling in the paper forms to begin with was raised at the time the deployment was considered stalled. We had already been indicated from speaking to representatives of the government that they do not explicitly trust the ANMs to be honest in the reporting of their activity. We earlier mentioned a conversation with one of the consultants following the final project meeting, whom had this to say on the subject of reporting practices previously tried out:

> *"We tried implementing a system where the ANM marked the doors of houses with a piece of chalk after vaccinations, but this didn't help because the ANM would bribe little children with candy to mark all the doors in the street, while she visited only a few of them"*

While we originally expected that ANMs would do their best to follow orders from their superiors, as India is a culture where respect for superiority is a very central concept, the above example indicates that in practice this may not always be the case any more than it is in the west. We know that data regarding their work is in need of improvement, as that is the reason why the EC system was commissioned in the first place. If it turns out that the reason for this is a lack of reporting through the old paper based system, it can also be expected that the computerized version will suffer from the same problem.

In fact, the usage of a computerized system will make a lack of reporting even more visible, as the computer system would make it easier for the administrators to monitor the activities of their health workers. The ANMs might therefore choose not to use the system in order to make their reporting practices less explicit.

8.3 The digital divide and lacking English language skills

Another possible reason for the ANMs non usage of the EC system could be directly related to what in chapter 2 of this thesis is referred to as the digital divide. As mentioned, the difference between those that are able to use computers and those who are not is often quite big in developing countries.

Computer software is often designed for people proficient in English. Even though there are localized versions in many languages of most common application types, chances are that most people have during some time of their computer learning process, gained some of their computer literacy from programs they were able to use primarily because they were also able to understand English. Even applications used in developed countries for common tasks like: Email, Internet browsing, word processing and entertainment, often require a minimum of English knowledge in order to be used and understood.

The operating system of the machines intended for the ANMs were English versions of Windows, and the EC system itself even though translated into Gujarati, had some small parts of its user interface that were always displayed in English.

As mentioned in chapter 7 the ANMs were not proficient English speakers. It is likely that the ANMs would have had little opportunity to acquire the necessary computer literacy necessary to be comfortable working with a computer based data input application like the EC system, even tough it had been translated into their own language.

9 Reflections on organizational factors

In order to improve the results of both the development work and the research done in conjunction with this thesis, it might have been advantageous to have done certain things differently. We will discuss some of these options here, with regards to how they relate to the research questions of how limited resources affect organizational factors.

Organizational factors of our work were affected by lacking resources in the way that some tasks like the need for short term progress in the development of the code were prioritized over other tasks that were also deemed important, but less so than actually building the system. In retrospect it seems likely that the following actions could have been prioritized higher:

9.1 Stronger bonds with the intended users should have been forged

The reasons the system failed to elicit support from its intended user group: The ANMs, is probably a result of our lack of contact with them. This lack of contact was primarily caused by a language barrier, but also by our implicit understanding that time constraints were tight and that the needs of the political administration were to be our primary concern.

As a result, this lack of contact resulted in us not understanding their needs and motivations well enough, and in addition lead to what Mosse and Sahay (2003) would describe as a failure to establish a proper counter network to the established dominant networks of human and nonhuman actors operating within the local context. This is a likely explanation why work routines for the ANMs stayed intact even as a result of a potentially work changing system being introduced.

Spending more time with them and including them more as users in the development process would likely have brought on a closer fit with their system needs. It would

also likely have inspired stronger support from them as a group, as described by Pettigrew's (1978) theory of organizational politics.

9.2 Time could have been managed differently

As mentioned in chapter 6, my timeframe for staying abroad was three months. The plan with regards to my stay in India was originally to spend two months there initially, and then go back to Norway for a period of three months. I would then finally return to India for another month to evaluate progress and sort out difficulties. Due to time and budgetary constrains this proved impractical and it was therefore changed into a three months continuous stay, instead of the original two part plan.

Another advantage of the original plan of splitting the time in India into two parts would have been the option of doing the development work in the intervening three months outside of India. If this had been done, development could have been done in cooperation with the Indian team through the Internet over a longer period of time. This would have freed up the time spent in India for observation of and interaction with the intended user base, and the final month could then have been used for testing and deployment. This would have required more time, but this time would have been of a different variety than the time spent in India. To explain this more thoroughly, it might be advantageous to coin new terms to make an explicit separation of the two kinds of time relevant to this time management. I will call them: Task critical time, and non critical time

9.2.1 Task critical time

Task critical time is the time where a window of opportunity to do something is present which you will not have the possibility of doing at another time. A good example to illustrate this would be the time the moon passes in front of the sun during a total eclipse. That would be the only time to observe the eclipse in question. This observation can not be postponed or rescheduled to the next convenient day. If you are going to do it, you have to do it during this critical time period. The window of opportunity for observation of the eclipse is therefore task critical time.

9.2.2 Non critical time

Non critical time is often no less important than critical time, but it differs from it because it can be scheduled to a more convenient timeslot. In our case, a good example of non critical time would be the actual time needed to code the system. This would be an action that while it absolutely needed to be done, could have been scheduled to points in time where other more critical events were not taking place.

9.2.3 Evaluating critical and non critical tasks

In the EC case, if we had followed the original timeframe, we could have scheduled the non critical task of coding the system to the intervening period between stays in India. This would have freed up time spent in India for critical tasks like: Interaction with our intended user base, user testing and deployment supervision. All of which were activities only possible within the critical timeframe of the months spent in India.

9.3 Human resources could have been differently distributed

As mentioned in the previous chapter there was a technical issue with the deployment of the EC system that prevented it from running simultaneously with DHIS. Closer examination of this issue by a member of the EC development team revealed that the problem was caused by the startup scripts of both applications trying to start the database server. As mentioned earlier, they were both programmed to be running on the same database software, in order to among other things, make it possible to run them both simultaneously on one machine. Having both applications attempt to start two different instances of the database server on the same machine with the same parameters did however cause a conflict. This conflict would easily have been identified by a member of the development team had one still been in the area.

At the time of deployment, this was however not the case. The Valsad technical and organizational staff had as earlier mentioned, at this time been moved to Ghandinagar. It is reasonable to expect that this technical problem could have been solved by

leaving at least one member of the development team behind in Valsad to supervise the deployment.

This can be explained theoretically by the use of Tiwana's (2004) theory of knowledge requirements in novel development relations. This theory is really designed for use in outsourcing, but the general principle is regarding where knowledge is located and therefore has applicability in this case as well.

In a standard action research or interpretive development project, the developers can be described as vendors that have the process knowledge and the people receiving a new system to make their work more efficient are the client that possesses concept knowledge. In order to implement the system the client needs, the vendor has to overcome the project concept novelty. This is achieved by acquiring the necessary amount of concept knowledge from the client, until the concept is no longer novel. The system can then be developed.

In HISP, the scaling and deployment practices are based on leaving the facilitators behind in regions post deployment to oversee technical issues after the developers have left to pursue development work in another area. If the developers leave before deployment, what is left behind is a knowledge hole which the facilitators need to fill. The facilitator usually already has some concept knowledge, but due to the novelty of the freshly developed system they have no process knowledge. If problems arise during deployment, which is likely, this lack of knowledge will in most cases collapse the deployment. The only remedy for this situation is to leave a developer behind until he has passed on all necessary knowledge about process to the facilitators.

9.4 Sustainability and scaling should have been a focus

As mentioned in the case study in chapter seven the EC system eventually stalled after the end of the three month period of development. This indicates that we were not able to make the system sustainable. According to the principles regarding how to make IS in developing countries take root mentioned in Braa, Monteiro and Sahay (2004) one of the prerequisites to sustainability is scaling

The reason scaling affects the chances of sustainability, is because more people using the system equals a greater network of supporters. The word: Use, is an important qualifier in this regard. Evidence points to the fact that it is not enough to simply deploy the system in several locations. It also has to actually be used in order to build the earlier mentioned network of supporters. In order for it to be used, there is a minimum amount of usability required. If the potential users are not able to or have no reason to make use of the system, the system will remain dormant.

9.4.1 Implementation of an ANM scheduler

In order for health workers to get positive incentive to use the system, it would be a good idea to extend it with a feature that had the potential to save them some administrative work. The idea of a scheduler that automatically generates a list of people that needs to be visited by the ANM based on relevant criteria was a suggestion that was discussed many times during implementation. We were hoping to have the opportunity to implement it, but we unfortunately did not have time to do so.

It would be a very logical extension of the system as the main tasks performed by the ANMs are of a predictable and cyclic nature:

- Once pregnancy has been established, antenatal care takes place on a set schedule.
- After the birth of the child, postnatal care takes place on a set schedule
- Immunizations of the children are to be performed on a set schedule as well.

Usually, an ANM is responsible for more than one village at the same time. To account for this it would be advantageous to implement some sort of geographical logic into the system to enable grouping of visitations by village. The purpose of this would be to enable the ANM to visit the least amount of villages per day, while seeing to as many woman and children as possible. The villages chosen would be the ones with the most needed visitations. This would be a suitable organization of the schedule, as the activities performed, while important to be done in a timely manner, can in some cases be postponed a day or two without negative consequences.

It would be a lot more efficient on the ANMs' time to perform their daily work on a per village basis, instead of a schedule based on criteria like time of registration or last visit.

The addition of the scheduler functionality would have given the ANMs positive incentive to use the system. This would likely have increased the chances of a successful deployment. A successful single deployment is a prerequisite for deployment on a large scale, and it is likely that scaling would have had a bigger chance of occurring with this feature. This scaling would likely have contributed to sustainability.

10 Reflections on technological decisions

There are a number of issues worth discussing with regards to the technological choices we made when implementing the EC system. The primary issue is our choice of programming language and the second regards the possibilities for integration with other software within the HISP organization.

10.1.1 PHP vs. Java

As earlier mentioned we chose to use PHP instead of JAVA to develop the EC system. This was a decision taken despite the fact that HISP senior coordinators would have preferred us to use JAVA. The reasons for this are many as detailed in chapter 7, but the primary reasons were twofold:

- We were having lots of trouble setting up Java in our development environment and although we had programmers with Java programming skills, we had nobody with the relevant software competence to fix the setup issues.

- We needed to get started fast and suspected that we didn't have the time to learn the required additional frameworks.

In other words, limited resources in the form of time constraints and lack of software environment knowledge forced us to adopt a solution that would give us results quickly. The question of whether the best solution in the long term was to use PHP instead of JAVA is however open to debate.

An issue witch is relevant in this context is the earlier mentioned relationship mentioned by Walsham and Sahay (2006) between standardization versus localization. It would perhaps be advantageous for administrative reasons if HISP were to standardize their software suites on programming languages and frameworks, but this is probably most advantageous in organizations consisting of many people

distributed over several geographical regions, sharing common technical skills. It is questionable whether HISP is this kind of organization. The HISP organization is diverse, with many different kinds of skills in its member base, and a member base that is often fluctuating. Students working for HISP as part of their thesis are a very good example of members that are only temporarily involved, and usually have diverse and varying skill sets. In other words, while some people are permanent fixtures of the organization, there is also a high presence of temporary members as well. These members bring with them different skills often depending on their location. Cultivating this diversity over standardization might be seen as paying heed to localization within the organization itself.

10.1.2 Integration of EC with DHIS

However, since the HISP organization is the developers of both software packages, they have the opportunity to create a tight vertical integration between both systems by standardizing on programming language and technological framework. The advantage of this would be that it would be easier for the core developers to maintain the system as a consistent whole in the long run. As a result of us having already used a different programming language for EC, this would involve the reimplementation of one of the systems. The obvious candidate for reimplementation would of course be the EC system, due to its much smaller size, prestige and user base.

However, since there is already an import mechanism in existence, enabling the flow of data from one system to the other, this would likely not be worth the effort. As mentioned in chapter 7, another group of students working on behalf of HISP has already made a module that is able to export data from the EC system into DHIS. This module was made to take advantage of the fact that both systems share the same database server software. This is exactly the kind of horizontal integration the Valsad team had in mind when implementing the EC system.

At the moment, resources would likely be better spent analyzing what works and what needs improvement in the system as it is. Lessons from this analysis will undoubtedly

also come in handy in the event of a future re-implementation with regards to receiving the benefits of vertical integration.

10.1.3 Integration with HISP's Vietnamese ART system

Another reason for our choice of PHP as a programming language was the existence of another system under the HISP umbrella more closely related to EC than DHIS that also used PHP. As mentioned in chapter 7, when we had come to the point where it would be necessary to start making the code that generates the dynamic input forms we used the framework of a data driven solution developed by the Vietnamese development team. This framework was originally made to serve in the Vietnamese version of HISP's ART system, but it had the potential to be used as a general input form generation framework. This system later changed its name to: oEPR (Open Electronic patient record)[3].

One of the primary strengths of this data driven relationship is that it is possible to change existing forms or create new forms in the EC system simply by manipulating values in a database.

The oEPR having been in development after the EC system stalled has an inbuilt graphical user interface to accomplish this. By integrating with the oEPR it should be possible to use this interface to manipulate tables in the EC system as well.

There is however some work that needs to be done in this regard. Even though the two systems are written in the same programming language, and share a similar database structure, they have undoubtedly developed in two different directions over time. Both systems were finalized independently of each other and neither was complete at the time the EC developers decided to borrow from oEPR. In particular the way each system interacts with data from more than one table at the time has been developed separately in each camp.

[3] For further information please check the following URL:
http://www.hisp.info/confluence/display/HISP/Open+Electronic+patient+record

If either of the two systems gains widespread usage, this would likely be an integration option worth considering.

10.1.4 Summing up the choice of technology

Taking the above mentioned factors into account, it is reasonable to say that the EC system as coded in PHP has both potential advantages and disadvantages compared to a Java implementation.

In this regard it is likely that programming language might not be the most critical issue in the debate. This issue is the organizational implications resulting from the choice of either option. Our choice to go with PHP primarily motivated by a lack of various resources definitely saved us time in the short run. The HISP organization has the potential to keep saving time in the short run by keeping the application in the programming language it is, but there also is a potential for time and resource rewards in the long term by re-implementing it in Java. This will however need to be paid for by short term time expenditure while the application is converted.

The wise thing to do for the any organization is likely to establish some general guidelines regarding the use of programming languages and other technology, and stick to them. During the debate over which programming language to use for the EC system, one of the developers of the DHIS system had this to say on the matter:

> *"...we need to establish some general guidelines for HISP development, as an aid for new people in the project. The implicit assumption for a while has been that the DHIS2 stack would be used by all, but I think experience has shown that to be too restrictive. Of course, we will always have to deal with the integration of external systems - and we probably need to prioritize our focus on this."*

These guidelines will need to be made on the grounds of HISP's available resources, which are beyond the scope of this thesis to discuss, but they are likely to also be of a limited nature.

11 Conclusions

In this thesis I have described how we despite limited time and resources were able to construct the basics of a patient based health system in a developing country. Although the system was not successfully deployed amongst the user group we originally envisioned to be its primary users, the fact that another user group: The health program administrators, was able to find some use of it indicates that we at least managed to create the groundwork for something of value. If used as a base for further development it should be possible to build it into something useful for both groups.

On a case specific level it is clear that there were a number of organizational tasks that should have been considered to be defined as critical tasks while work was going on in India, and as such should have been prioritized higher:

- Involving the ANMs in the system development through user participation.
- Closer follow-up with regards to the deployment process and the process of making the system sustainable before handing it over to new developers.

The actual coding of the system, while important could have been rescheduled to outside the critical timeframe, meaning programming should have been done during the time spent outside India.

It is likely that adding an ANM scheduler component to the system would have potentially helped greatly with accomplishing the goals of both the above mentioned organizational tasks, and as such could also be considered critical.

On a technological level, it is clear that the technological decisions we made saved us some critical time in the short run, but potentially at the cost of future time losses.

On a more general level, there are three patterns that seem to crystallize themselves based on observations regarding lacking resources and its implications.

The first is that lack of whatever resource is limited in the work setting; often gradually manifest itself into a more general lack of the resource: Time. The reason for this is likely that everything you lack but need can usually be acquired with the proper effort through the expenditure of time.

The second is that the understanding of time needs to be divided into two parts: Non critical time and task critical time. Task critical time functions as a window of opportunity to do critical tasks. Non critical time is time that can be used for things which, while necessary to the project, does not have a set window.

It is important to identify and prioritize critical tasks that are only possible to do in windows of task critical time. The other tasks can not always but sometimes be scheduled for later execution.

The third is that technological decisions can influence the resource pool. As all resources can be logically reduced into savings or expenditure of time, technological decisions can in an abstract sense be seen as a way to manage time. Making a technological decision in a limited resource environment should therefore be motivated by an ambition to facilitate the execution of critical tasks, by optimizing blocks of task critical time.

In closing, I would also like to point out that sometimes, no matter how skillfully you manage time; there might still not be a proper balance that allows completion of the full project. But this is no reason not to try. A small step in the right direction is still better than no step at all.

Glossary

ANC: See antenatal care.

***Anganwadi* worker:** A support worker for the health personnel, of which there usually is one per village.

ANM: See auxiliary nurse and midwife.

Antenatal care: In obstetric practice, the obstetrician will see a pregnant woman on a regular basis to check the progress of her pregnancy. Pertaining to the EC project the ANM takes on the role of obstetrician. The main rationale for these visits is surveillance for diseases of pregnancy which are detectable.

Auxiliary nurse and midwife: The ANM is responsible for most family health care functions covered by the eligible couples program. They are stationed one each on a sub centers around the region.

Dai: A *dai* is a traditional village midwife, usually with no formal medical training.

INC: See intra natal care.

Intra Natal Care: The care of the mother received in the time period during birth.

Neo Natal Care: The care received by the child after birth. Its primary purpose is immunization of the child through the administration if vaccination shots and tonics.

Nirodh: A *nirodh* is a condom.

PNC: See antenatal care.

Postnatal care: Postnatal (Latin for "after birth") is care for the mother that begins immediately after the birth of a child and lasts for about six weeks.

Taluka: A *tehsil* or *taluka* is an administrative subdivision, and the two terms are functionally equivalent; with the usage preference being determined by the region. As an entity of local government, *tehsils/taluka* have fiscal and administrative powers roughly equivalent to the division of counties found in many non Asian countries. A *taluka* is part of a larger District (the division below that of a sub national state), and typically contains villages and/or municipalities. *Taluka* usually have a population ranging between 230000 to 265000 people.

Teshil: See *taluka.*

Appendix – Original paper registers

In this appendix, I will be presenting the paper forms used to administrate tasks regarding the “eligible couples” project. These forms were what we primarily used as a basis to build the EC system.

I will present each register by first providing the translation of the registers fields, followed by a copy of the actual register itself in its original Gujarati language.

Unless otherwise specified, the format of the translation will be a sequential listing of the field or column headings as presented on the original form from left to right. These headings will be numbered sequentially for easier comparison with the actual form. If a column has sub headings, these will be sequentially designated with alphabet letters.

Please notice in the original forms that columns often have a seemingly random number attached to it on the following row. This number is used for administrative purposes of which the details are not relevant for this text. These numbers do not correspond with the sequential numbering presented in the translation.

Register 1 - Common Diary for the Health Worker/ANM

Heading fields

(Start of form Line repeated 3 times)

1. Name of health worker
2. From Date
3. To date

(Line with 4 fields and a 5th field right-aligned on the following line)

1. Occupation
2. Headquarter
3. P.H.C.
4. Taluka
5. District

Table 1

1. Serial number
2. Village name
3. Population in 2001
4. Total number of houses
5. Total number of families
6. Total number of eligible couples
7. Total number of protected couples
    a. Tubectomy (female)
    b. Vasectomy (male)
    c. Oral contraception pill
    d. Condom
8. Total number of children below 1 year
9. Total number of children between 1-5 years

Table 2

1. Serial number
2. Village name
3. Number of trained Dai
4. Number of untrained Dai
5. Number of fever treatment depots (FTD)
6. Number of drug distribution centers (DDC)
7. Number of village health guides
8. Number of Anganwadi workers
9. Number of Oral Regeneration Salt (O.R.S) Stores
10. Number of Nirodh (Condom) depots
11. Number of private medical practices
12. Number of primary schools

Table 3

1. Serial number
2. Names of villages in the area
3. Names of trained Dai
4. Names of untrained Dai
5. Names of Anganwadi
    a. Health workers
    b. (Not translated)
6. Names of Village Health guides

કર્મચારીનું નામ : ૧. _____ તા. _____ થી તા. _____

૨. _____ તા. _____ થી તા. _____

૩. _____ તા. _____ થી તા. _____

હોદો_____ મુખ્ય મથક _____ પ્રા. આ. કેન્દ્ર _____ તાલુકો _____

જિલ્લો _____

અ.નં.	વિસ્તારના ગામના નામ	૨૦૦૧ની વસતિ	કુલ ઘરની સંખ્યા	કુલ કુટુંબની સંખ્યા	લાયક દંપતીની સંખ્યા	રક્ષિત દંપતીની સંખ્યા				૧ વર્ષથી નીચેના બાળકોની સંખ્યા	૧ થી ૫ વર્ષ નીચેના બાળકોની સંખ્યા
						ઓપરેશન	આંકડી	ઓ.પીલ્સ	નિરોધ		
૧	૨	૩	૪	૫	૬	૭	૮	૯	૧૦	૧૧	૧૨

અ.નં.	વિસ્તારના ગામના નામ	તાલીમી દાયણોની સંખ્યા	બિન તાલીમી દાયણોની સંખ્યા	એફ. ટી. ડી. સંખ્યા	ટીડીસીની સંખ્યા	વીલેજ હેલ્થ ગાઈડની સંખ્યા	આંગણ વાડીની સંખ્યા	ઓ. આર.એસ. ડેપોની સંખ્યા	નિરોધ ડેપોની સંખ્યા	ખાનગી તબીબોની સંખ્યા	પ્રા. શાળા ની સંખ્યા
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અ.નં.	વિસ્તારના ગામના નામ	તાલીમી દાયણનું નામ	બીન તાલીમી દાયણનું નામ	આંગણવાડી		વીલેજ હેલ્થ ગાઈડનું નામ
				વર્કરનું નામ	તેડાગરનું નામ	
૧	૨	૨૩	૨૪	૨૫	૨૬	૨૭

Register 2 - Eligible Couple Survey

Table 1

1. Serial number
2. House number
3. Number of people in house
4. Eligible couple number
5. Registration date
6. Name
7. Age
8. Caste
9. Sex
10. Relation with head of family
11. Education/Qualification
12. Religion
13. Marital status (Unmarried, Married, Widow, Divorced)
14. Number of living children
    a. Male
    b. Female

રજીસ્ટર

લાયક દંપતિ સર્વે

ક્રમ	ઘર નંબર	ઘરમાં કુલ સભ્યો	લાયક દંપતિ	નોંધણીની તારીખ	નામ	ઉમર	જ્ઞાતિ (અ.જા. /અ.જ.જા /અન્ય)	જાતિ પુ/સ્ત્રી	કુટુંબના વડા સાથે સંબંધ	શિક્ષણ	ધર્મ	વૈવાહિક દરજ્જો (કુવારા /પરિ./ વિધવા / ત્યકતા/ વિધુર)	હયાત બાળકોની સંખ્યા	
													પુત્ર	પુત્રી
૧	૨	૩	૪	૫	૬	૭	૮	૯	૧૦	૧૧	૧૨	૧૩	૧૪	૧૫

Table 2

15. Age of youngest living child
16. Whether waiting for next child (Yes/No)
17. Pregnant at present (Yes/No)
18. If using contraceptive, which and since when
19. If not using contraceptive, why
20. Total number of deliveries
    a. Type of delivery
        i. Hospital
        ii. Home
    b. Live births
    c. Child deaths
        i. Below 1 years
        ii. Between 1-5 years
    d. Maternal deaths
21. Diseases related to pregnancy (Information regarding RTI and STD)
22. T. B., leprosy, Blindness, permanent disability
23. BPL family (Yes/No)
24. Remarks

નં. ૨

રજીસ્ટર

છેલ્લા હયાત બાળકની ઉમર	હાલમાં બીજા બાળકની ઈચ્છા ધરાવે છે ? (હા/ના)	હાલમાં સગર્ભા છે ? (હા/ના)	કુ.ક.ની કોઈ પધ્ધતિ અપનાવેલ છે ? કઈ ? કયાર થી ?	વર્ષ દરમ્યાન કુ.ક.ની કોઈ પધ્ધતિ અપનાવવાની ઈચ્છા છે ? હા તો કઈ? ના તો કેમ?	કુટુંબમાં છેલ્લા / ગત વર્ષ દરમ્યાન થયેલ						પ્રજનન / જાતિય રોગ સંબધી વિગત (હોય તો)	ક્ષય, રકતપિત , અંધાપો, કાયમીઅંપગતા, થેલેસીમીયા, સીકલ સેલ એનીમીયા વગેરે હોય તો તેની વિગત	દંપતિ BPL કુટુંબ છે ? (હા/ના)	વિશેષ નોંધ
					કુલ પ્રસૂતિ		જીવીત જન્મ	બાળમરણ (૫ વર્ષ સુધીની વયના)		માતા મરણ				
					સ્ત્રી	પુ.		૧ વર્ષ સુધીના	૧ થી ૫ વર્ષના					
૧૬	૧૭	૧૮	૧૯	૨૦	૨૧	૨૨	૨૩	૨૪	૨૫	૨૬	૨૭	૨૮	૨૯	૩૦

Register 3a - Sterilization Operations

Table 1

1. Serial number
2. Eligible couple number
3. Beneficiary's name
4. Address
5. Age
6. Religion
7. Caste
8. Sex
9. Date of operation
10. Education/Qualification
    a. Husband
    b. Wife

અ. પુરુષ / સ્ત્રી

ક્રમ	લાયક દંપતિ નંબર	લાભાર્થીનું નામ	સરનામુ	ઉંમર	ધર્મ	જ્ઞાતિ (અ. જા./ અ.જ.જા./ અન્ય)	જાતિ (સ્ત્રી/પુ.)	ઓપરેશન ની તારીખ	શૈક્ષણિક લાયકાત	
									પતિ	પત્ની
૧	૨	૩	૪	૫	૬	૭	૮	૯	૧૦	૧૧

Table 2

11. Number of living children
    a. Male
    b. Female
12. Age of youngest living child
13. Post operation follow-up information (after 1 month)
14. Complications if any
15. Place of operation
16. Name of surgeon
17. Name of motivator
18. Welfare scheme adopted
    a. Girls welfare
    b. Janani Suraksha Yojana
    c. Chiranjeevi Yojana

ઓપરેશન રજિસ્ટર

હયાત બાળકો		છેલ્લા હયાત બાળકની ઉંમર	ફોલોઅપની વિગત	કોમ્પ્લીકેશન, જો કોઈ જણાયુ હોય તો	ઓપરેશનનું સ્થળ	સર્જનનું નામ	મોટીવેટરનું નામ	કઈ યોજનાનો લાભ લીધેલ છે/લઈને ઓપરેશન કરાવેલ છે તે		
પુત્ર	પુત્રી							દિકરી યોજના	જ.સુ. યોજના	ચિરંજીવી યોજના
૧૨	૧૩	૧૪	૧૫	૧૬	૧૭	૧૮	૧૯	૨૦	૨૧	૨૨

Register 3b - Intra Uterine Device (IUD)

Table 1

1. Serial number
2. Eligible couple number
3. Beneficiary's name
4. Address
5. Age
6. Religion
7. Caste
8. Sex
9. Copper T insertion
    a. Date
    b. Place
    c. Person

બ. આંકડી

ક્રમ	લાયક દંપતિ નંબર	લાભાર્થીનું નામ	સરનામુ	ઉમર	ધર્મ	જ્ઞાતિ (અ. જા./ અ.જ.જા./ અન્ય)	જાતિ (સ્ત્રી/ પુ.)	આંકડી મૂકયાની વિગત		
								તારીખ	સ્થળ	આંકડી મૂકનાર
૧	૨	૩	૪	૫	૬	૭	૮	૯	૧૦	૧૧

Table 2

10. Education
    a. Husband
    b. Wife
11. Total number of children
    a. Sons
    b. Daughters
12. Age of last child
13. Follow-up details
    a. 1st month
    b. 2nd month
    c. 3rd month
14. Copper T removal
    a. Scheduled removal date
    b. Removed date
15. Remarks

રજિસ્ટર

શૈક્ષણિક લાયકાત		હયાત બાળકો		છેલ્લા હયાત બાળકની ઉંમર	ફોલોઅપની વિગતો-કોમ્પ્લીકેશન જો હોય તો નોંધવું			આંકડીનો વપરાશ બંધ કર્યાની વિગત		રીમાર્કસ
પતિ	પત્ની	પુત્ર	પુત્રી		પ્રથમ માસમાં	બીજા માસમાં	ત્રીજા માસમાં	કાઢી નાખ્યા તારીખ	નીકળી ગયા તારીખ	
૧૨	૧૩	૧૪	૧૫	૧૬	૧૭	૧૮	૧૯	૨૦	૨૧	૨૨

Register 3c - Contraceptive Pills

Table 1

1. Serial number
2. Eligible couple number
3. Beneficiary's name
4. Address
5. Age
6. Religion
7. Caste
8. Oral pills start date
9. Education/Qualification
    a. Husband
    b. Wife
10. Total number children
    a. Male
    b. Female

ક. ઓરલ પીલ્સ

ક્રમ	લાયક દંપતિ નંબર	લાભાર્થીનું નામ	સરનામુ	ઉંમર	ધર્મ	જ્ઞાતિ (અ. જા./ અ.જ.જા./ અન્ય)	ઓરલ પીલ્સ શરૂ કર્યા તારીખ	શૈક્ષણિક લાયકાત		હયાત બાળકો	
								પતિ	પત્ની	પુત્ર	પુત્રી
૧	૨	૩	૪	૫	૬	૭	૮	૯	૧૦	૧૧	૧૨

Table 2

11. Age of last child
12. Oral pills cycle completion
    a. April
    b. May
    c. June
    d. July
    e. August
    f. September
    g. October
    h. November
    i. December
    j. January
    k. February
    l. March
13. Oral pills stop
    a. Date
    b. Reason
14. Complications (if any)
15. Remarks

રજિસ્ટર

છેલ્લા હયાત બાળકની ઉંમર	ઓરલ પીલ્સ સાયકલની વહેંચણી												વપરાશ બંધ કર્યાની વિગત		કોમ્પ્લીકેશન જો કોઇ હોય તો	રીમાર્ક્સ
	એ.	મે.	જુ.	જૂ.	ઑ.	સ.	ઓ.	ન.	ડિ.	જા.	ફે.	મા.	તારીખ	કારણ		
૧૩	૧૪	૧૫	૧૬	૧૭	૧૮	૧૯	૨૦	૨૧	૨૨	૨૩	૨૪	૨૫	૨૬	૨૭	૨૮	૨૯

Register 3d - Condom Usage

Table 1

1. Serial number
2. Eligible couple number
3. Beneficiary's name
4. Address
5. Age
6. Religion
7. Caste
8. Start date of condom use
9. Education/Qualification
    a. Husband
    b. Wife
10. Total number of children
    a. Male
    b. Female

ડ. નિરોધ

ક્રમ	લાયક દંપતિ નંબર	લાભાર્થીનું નામ	સરનામુ	ઉંમર	ધર્મ	જ્ઞાતિ (અ. જા./ અ.જ.જા./ અન્ય)	વપરાશ શરૂ કર્યા તારીખ	શૈક્ષણિક લાયકાત		હયાત બાળકો	
								પતિ	પત્ની	પુત્ર	પુત્રી
૧	૨	૩	૪	૫	૬	૭	૮	૯	૧૦	૧૧	૧૨

Table 2

11. Age of last child
12. Condom cycle completion
    a. April
    b. May
    c. June
    d. July
    e. August
    f. September
    g. October
    h. November
    i. December
    j. January
    k. February
    l. March
13. Stop date of condom use
14. Remarks

રજિસ્ટર

છેલ્લા હયાત બાળકની ઉંમર	નિરોધ નંગની વહેંચણી												વપરાશ બંધ કર્યા તારીખ	રીમાર્કસ
	એ.	મે.	જુ.	જૂ.	ઑગ.	સ.	ઓ.	ન.	ડિ.	જા.	ફે.	મા.		
૧૩	૧૪	૧૫	૧૬	૧૭	૧૮	૧૯	૨૦	૨૧	૨૨	૨૩	૨૪	૨૫	૨૬	૨૭

Register 3e - Medical Termination of Pregnancy (MTP)

Table 1

1. Serial number
2. Eligible couple number
3. Beneficiary's name
4. Address
5. Age
6. Religion
7. Caste
8. MTP
    a. Date
    b. Place

ઇ.એમ.ટી.પી.

ક્રમ	લાયક દંપતિ નંબર	નામ	સરનામું	ઉંમર	ધર્મ	જ્ઞાતિ અ. જા./ અ.જ.જા./ અન્ય	એમ.ટી.પી. અંગેની વિગત	
							તારીખ	સ્થળ
૧	૨	૩	૪	૫	૬	૭	૮	૯

Table 2

9. Education/Qualification
    a. Husband
    b. Wife
10. Total number of children
    a. Male
    b. Female
11. Age of last child
12. Weeks of pregnancy before MTP
13. Follow-up information
14. Complications (if any)
15. After MTP, family planning adopted
16. Remarks

રજિસ્ટર

શૈક્ષણિક લાયકાત		હયાત બાળકો		છેલ્લા હયાત બાળકની ઉંમર	એમ. ટી. પી. વખતે ગર્ભના અઠવાડિયા	ફોલોઅપ	કોમ્પ્લીકેશન જો કોઇ હોય તો	એમ.ટી.પી. બાદ અપનાવેલ કુટુંબ કલ્યાણ પધ્ધતિ	રીમાર્કસ
પતિ	પત્ની	પુત્ર	પુત્રી						
૧૦	૧૧	૧૨	૧૩	૧૪	૧૫	૧૬	૧૭	૧૮	૧૯

Register 4 - Mother and Child Care

Information about the mother

1. Serial number
2. House number
3. Street
4. Village
5. Sub center
6. PHC
7. Name of pregnant woman
8. Age
9. Caste
10. BPL (Yes/No)
11. Number of living children
12. Parity
13. Date of ANC registration
14. LMP (Late menstruation period) date
15. Duration of pregnancy (in months)

Table 1 - Obstetric history

1. Parity
2. ANC
3. Place of ANC registration
4. Place of delivery
5. Type of delivery
6. Delivery result (Livebirth/Still birth/Abortion)
7. Sex of the baby (Male/Female)
8. Present condition of baby
9. Accepted mode of family planning

Table 2 - ANC

1. Date of visit
2. Duration of pregnancy
3. Weight of mother
4. Presence of pedal edema (Yes/No)
5. Presence of pallor in palms (Yes/No)
6. Night blindness
7. HB%
8. Urine
    a. Albumin
    b. Sugar
9. B.P.
10. Fetal Lie
11. Fetal presentation
12. F.H.S.
13. T.T
14. Iron/Folic acid
15. Risk indicators
16. Referral
    a. Reason
    b. Place

Intra natal care follow-up

1. E.D.D. (Excepted date of delivery)
2. Planned place of delivery
3. Delivery (Normal/Complicated)
4. Referral reason
5. Referral place
6. Delivery type
    a. Hospital/Home
    b. Normal/Caesarian
7. Place of Delivery
8. Date of Delivery
9. Home delivery kit given (Yes/No)
10. Person conducting the delivery (name, occupation and relation)
11. Institutional delivery (SC/PHC/CHC/District hospital/Private hospital). Name to be mentioned
12. Whether availed any beneficiary scheme (Chiranjivi/JSY/Dikiri Yojana)
13. Payment in RS
14. Payment date
15. Maternal death (Yes/No), If yes
    a. Place
    b. Reason
    c. Time (ANC/INC/PNC)

માતા સંભાળ

૧. અ. નં. : ..... ૨. ઘ નં. : ..... ૩. ફળિયુ : ..... ૪. ગામ :..... ૫. પેટા કેન્દ્ર : ..... ૬. પ્રા. આ. કે. : .....

૭. સગર્ભાનું નામ : ..... ૮. ઉમર : ..... ૯. જ્ઞાતિ : અનુ. જાતિ/અ.જ.જાતિ/ અન્ય ૧૦. બીપીએલ : હા/ના

૧૧. હાલમાં જીવીત બાળકની સંખ્યા : ..... ૧૨. પારા : ..... ૧૩. સગર્ભાની નોંધણીની તા. : ..... ૧૪. છેલ્લા માસિકની તા. : ..... ૧૫. ગર્ભાધાનના માસ : .....

અ. પહેલાંની પ્રસુતિની વિગત (Obstetric History) :

પ્રસુતિનો ક્રમ	ANC	ANC નું સ્થળ	પ્રસુતિનું સ્થળ	પ્રસુતિનો પ્રકાર	જીવીત જન્મ/મૃત જન્મ ગર્ભપાત	બાળકની જાતિ પુ./સ્ત્રી	બાળકની હાલની સ્થિતિ	કુ. ક. ની અપનાવેલ પધ્ધતિ
૧૬	૧૭	૧૮	૧૯	૨૦	૨૧	૨૨	૨૩	૨૪

બ. હાલની પ્રસુતિની સંભાળ (ANC) :

મુલાકાતની તારીખ	સગર્ભાવસ્થાના માસ	વજન (કિ ગ્રા.)	પગે સોજા	હથેળીમાં ફીકાશ	રતાંધળા પણું	HB	પેશાબ		BP	Lie	ગર્ભનું Presentation	FHS	T.T.	IFA	જોખમી ચિન્હો	રેફરલ	
							Albumin	Sugar								કારણ	સ્થળ
૨૫	૨૬	૨૭	૨૮	૨૯	૩૦	૩૧	૩૨-અ	૩૨-બ	૩૩	૩૪	૩૫	૩૬	૩૭	૩૮	૩૯	૪૦	૪૧

ક. Intra natal Care follow up :

૪૨. પ્રસુતિની સંભવિત તારીખ (EDD) : .....૪૩. પ્રસુતિના સ્થળનું આયોજન : .....૪૪. પ્રસુતિ : સામાન્ય/જોખમી

૪૫. રેફરલ : (અ) કારણ : .....(બ) સ્થળ : .....૪૬. પ્રસુતિનો પ્રકાર : (અ) સંસ્થાકીય/ઘરેલું(બ) સામાન્ય/સીઝેરીયન

૪૭. પ્રસુતિનું સ્થળ : ..... ૪૮. પ્રસુતિની તારીખ : .....૪૯. હોમ ડીલીવરી કીટસ અપાયેલ છે ? હા/ના

૫૦. પ્રસુતિ કરાવનાર (નામ/હોદો/સંબંધ) .....

૫૧. સંસ્થાકીય પ્રસુતિનું સ્થળ : SC/PHC/CHC/Dist. Hosp./Pvt. Hosp. (નામ અને સ્થળ દર્શાવવા) .....

૫૨. કઈ યોજનાનો લાભ લીધેલ છે ? ચિરંજીવી / JSY / દિકરી યોજના : ..... ૫૩. ચુકવણીની વિગત રૂા. ..... તા. .....

૫૪. માતા મરણ : હા/ના, હા-તો (૧) સ્થળ : ..... (૨) કારણ : ..... (૩) સમય : ANC/INC/PNC

Register 5 - Mother and Child Care

PNC Mother

(The filled in text of each row in the first column indicates the time the ANM is scheduled to visit the mother. The times are as follows: 1st Day, 3rd Day, 7th Day and One Month)

1. PNC visit
2. Date
3. Place
4. History of PPH
5. Fever
6. History of breast engorgement
7. Any other complaint
8. Iron/Folic acid
9. Any other treatment
10. Referral
    a. Reason
    b. Place
    c. Date
11. Family planning method adapted

PNC Child

(Above Table)

1. Date of birth
2. Registration of birth
3. Place of birth
4. Sex of baby

(The filled in text of each row in the first column indicates the time the ANM is scheduled to visit the child. The times are as follows: Immediately after birth, 1st Day, 3rd Day, 7th Day and One Month)

1. Date
2. Place
3. Weight
4. Bath
5. Breast feeding
6. Colostrums
7. Kangaroo care
8. Umbilical cord
9. Boils of spit
10. Fever/convulsions
11. Any other illness
12. Treatment
13. Referral
    a. Reason
    b. Place

Newborn baby Weight/Age chart

(Not translated)

Neo Natal Care

(Row names designate the child's age)

1. 1st month
2. 2nd month
3. 3rd month
4. 4th month
5. 5th month
6. 6th month
7. 7th month
8. 8th month
9. 9th month
10. 10th month
11. 11th month
12. 12th month
13. 18th month
14. 60th month

(Column names designate the data)

1. Date
2. Place
3. Immunization
4. vitamin-A
5. IFA
6. Breast feeding
7. Weakness
8. Illness
9. Treatment
10. Referral

૧. પ્રસુતિ બાદની સંભાળ (માતા) [PNC Mother]

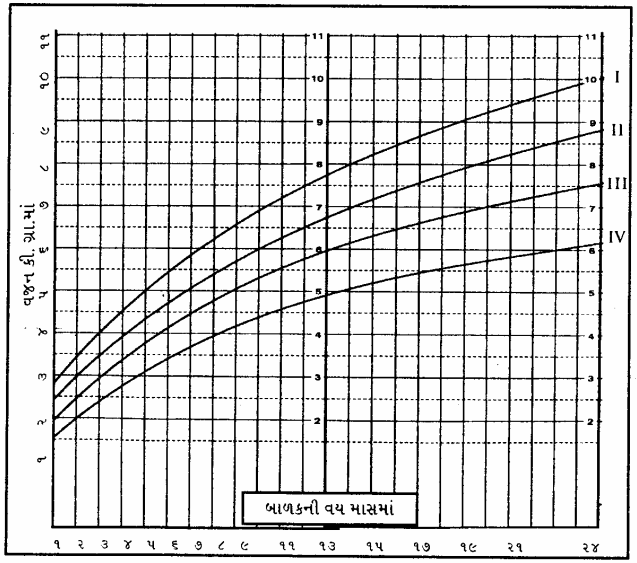
PNC મુલાકાત	તારીખ	સ્થળ	વધુ પડતો રક્તસ્ત્રાવ	તાવ	સ્તનમાં ભરાવો થવો/ સ્પર્શથી દુ:ખાવો થવો	અન્ય / બીજી ફરિયાદ	IFA ટેબલેટ	અન્ય સારવાર	રેફરલ			કુ. ક. ની અપનાવેલ પદ્ધતિ
									કારણ	સ્થળ	તારીખ	
પ્રથમ દિવસે												
ત્રીજો દિવસે												
૭મો દિવસે												
૧ માસે												

૨. પ્રસુતિ બાદની સંભાળ (બાળક) [PNC Child]

જન્મ તારીખ ..... જન્મ નોંધણી ..... જન્મ સ્થળ ..... બાળકની જાતિ : પુરૂષ / સ્ત્રી

PNC મુલાકાત	તારીખ	સ્થળ	વજન	સ્નાન	સ્તનપાન	કોલેસ્ટ્રોરમ	કાંગારૂ કેર	નાળની લાલાશ/ પ્રવાહીનું વહેવું/ચેપ	ચામડી પર પરૂની ફોલ્લીઓ	તાણ/ આંચકી	બીજી માંદગી	સારવાર	રેફરલ	
													કારણ	સ્થળ
જન્મ પછી તુરત														
પ્રથમ દિવસ														
ત્રીજો દિવસ														
૭મો દિવસ														
૧ માસે														

૩. નવજાતનો વજન-વય ચાર્ટ



૪. નવજાત શિશુ સંભાળ

ઉંમર/માસ	તારીખ	સ્થળ	રસીકરણ	વિટા-એ	IFA	સ્તનપાન	ખોરાક	બિમારી	સારવાર	રેફરલ
પ્રથમ										
બીજો										
ત્રીજો										
ચોથો										
પાંચમો										
છઠ્ઠો										
સાતમો										
આઠમો										
નવમો										
દશમો										
૧૧મો										
૧૨મો										
૧૮મો										
૬૦ માસ										

બાળ મરણ થયેલ છે ? : હા / ના હા, તો કારણ : મરણ સમયે બાળકની વય : ૭ દિવસ / ૮ થી ૨૮ દિ./ ૧ માસથી ૧ વર્ષ /૧ વર્ષથી ૫ વર્ષ.

Register 8a – Birth Register

1. Serial number
2. Date of registration
3. Date of birth
4. Sex of baby (Male/Female)
5. Name of mother and father with address including house number
6. Age of mother
7. Parity
8. Person conducting delivery
9. Place of delivery
10. Remarks

જન્મ રજિસ્ટર

અ. નં.	નોંધણી તારીખ	જન્મ તારીખ	બાળકની જાતિ પુ./સ્ત્રી	માતા-પિતાનું નામ અને સરનામું ઘર નંબર સહિત	માતાની ઉમર	પારા	પ્રસુતિ કરાવનાર	પ્રસુતિ સ્થળ	નોંધ
૧	૨	૩	૪	૫	૬	૭	૮	૯	૧૦

Register 8b – Death Register

1. Serial number
2. Date of registration
3. Date of death
4. Name and address including house number
5. Age of death
6. Sex (Male/Female)
7. Death reason
8. Signature

મરણ રજિસ્ટર

અ. નં.	નોંધણી તારીખ	મરણ તારીખ	મરણ થયેલ વ્યક્તિનું નામ સરનામું ઘર નંબર સહિત	મરણ વખતે ઉંમર	જાતિ પુરૂષ/સ્ત્રી	મરણનું કારણ	નોંધ
૧	૨	૩	૪	૫	૬	૭	૮

Register 8c – Stillbirth Register

1. Serial number
2. Date of registration
3. Still Birth Date
4. Sex of the child (Male/Female)
5. Name of mother and father with address including house number
6. Age of mother
7. Parity
8. Person conducted delivery
9. Place of delivery

મૃત જન્મ રજિસ્ટર

અ. નં.	નોંધણી તારીખ	મૃત જન્મ તારીખ	બાળકની જાતિ પુ/સ્ત્રી	માતા-પિતાનું નામ સરનામું ઘર નંબર સહિત	માતાની ઉંમર	પારા	પ્રસુતિ કરાવનાર	પ્રસુતિનું સ્થળ
૧	૨	૩	૪	૫	૬	૭	૮	૯

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