
PROJECT DRISTHI

Milestone 1 Completion Report

October 2011 - August 2013

Collaborators



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Project Name:

Development and Impact Assessment of an mHealth Package for Rural India focusing on Reproductive, Maternal, and Child Health, in support of the Government of India (GoI) National Rural Health Mission (NRHM).

Abbreviated Name:

Dristhi (Drudgery-free, Reliable Information Service Towards Health Impact)

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Acronyms

ANC	Antenatal Care
ANM	Auxiliary Nurse Midwife
API	Application Programming Interface
ARI	Acute Respiratory Infection
ASHA	Accredited Social Health Activist
BPL	Below Poverty Line
CMC	Computer Maintenance Corporation
CNA	Community Needs Assessment
DPT	Diphtheria Tetanus, and Pertussis vaccine
EC	Eligible Couple
ERC	Ethics Review Committee
FHW	Female Health Worker
FRHS	Foundation for Research in Health Systems
FPR	Finger Print Reader
GoK	Government of Karnataka
GoI	Government of India
HH	Household
HMIS	Health Management Information System
IFA	Iron Folic Acid
IMR	Infant Mortality Rate
JSY	Janani Suraksha Yojana
IVR	Interactive Voice Response
MCH	Mother and Child Health
MCTS	Mother and Child Tracking System
MHW	Male Health Worker
MMR	Maternal Mortality Ratio
MWRA	Married Women of Reproductive Age
NRHM	National Rural Health Mission
OA	Out of area
ODK	Open Data Kit
OPV	Oral Polio Vaccine
PHC	Primary Health Center
PNC	Postnatal Care
RMNCH	Reproductive, Maternal, Newborn and Child Health
RSG	Research Steering Group
SAG	Strategic Advisory Group

SC

TFR

UI

WHO

Sub Center

Total Fertility Rate

User Interface

World Health Organization

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Executive Summary

The current Health Management Information System (HMIS) of India, under the National Rural Health Mission (NRHM), is largely paper-based, time consuming, labour intensive, and consequently underutilized for supporting health service delivery. Health workers and program managers at all levels feel they need an information system that is drudgery-free, gives reliable information, and is user-friendly. Simple to use mobile technologies offer enormous promise in this area; they can be used to improve health worker performance by providing instantaneous communication and feedback, to deliver educational content, alerts and reminders for needed care, to provide remote support from experts and to monitor performance.

Since the Dristhi project began in October 2011, the project partners have undertaken extensive needs assessment research, gap analysis of the existing health information system and participatory research with the intended users of the mHealth package to help define its core IT and health contents. The “Dristhi Package”, as it is called in this report, is intended to support the work of Auxiliary Nurse Midwives (ANMs) who form the backbone of the National Rural Health Mission (NRHM) in India. ANMs carry considerable responsibility for ensuring that women and children receive reproductive, maternal, newborn and child health (RMNCH) services as envisaged under the NRHM.

The project implementation plan (PIP 2009-10, pg4) of the NRHM-Karnataka was focused on achieving set goals related to Maternal Mortality Ratio (MMR), Infant Mortality Rate (IMR) and Total Fertility Rate (TFR) through interventions related to mother care, child health and family planning, backed by new strategies like institutional strengthening, human resource development, and incentives to beneficiaries under different schemes¹. The key RMNCH services in listed the State NRHM plan were: 3 antenatal check-ups, consumption of Iron Folic Acid (IFA) for 100 days, safe delivery, postnatal care visits by a health worker within 2 weeks, family planning services to those

¹ **Janani Suraksha Yojana (JSY):** Financial assistance to the BPL, SC and ST pregnant women (age >19 years) during first two deliveries. The assistance is Rs. 500 if delivered at home, Rs. 600 for urban institutional delivery, Rs. 700 for delivery in health centres in rural areas, and Rs. 1500 for caesarean delivery. The money is transferred through online directly to the beneficiary bank account.

Prasooti Aaraike: Financial assistance to the BPL, SC and ST pregnant women. The beneficiaries will get Rs. 1000 during the second trimester ante natal check-up (i.e. between 4th and 6th month) and Rs. 1000 during the third trimester ante natal check-up (i.e., between 7th and 9th month), totalling Rs. 2000 paid through bearer cheque.

Madilu Kit: A Kit contains 19 items will be given below poverty line families, and delivered in government hospitals to encourage poor pregnant women to deliver in health centres in order to considerably reduce maternal and infant mortality in the state.

Thayi bhagya Yojana: The scheme provides totally free service for the pregnant women belonging to BPL families in accredited private hospitals. Such accredited hospitals will be paid Rs. 3.00 lakhs per 100 deliveries. (Post natal assistance for Scheduled Castes / Scheduled Tribes / Below Poverty Line (BPL) families).

who want them, full immunization, and treatment of children with diarrhoea / Acute Respiratory Infection (ARI) (PIP, 2009-10, Chapter 3).

Within these service areas, the project partners selected 8 specific results that needed to be achieved for ensuring anticipated reduction in maternal and child morbidity and mortality (Table 1). Selection of these specific results was made based on the evidence provided by the 3 rounds of National Family Health Surveys, District health surveys, and various studies that showed why those results needed focusing upon in Karnataka (Appendix 1). For example, during antenatal period health workers needed to ensure reduction in severe anemia through treatment; safe delivery should be preceded by appropriate delivery planning; and postnatal home visits by health workers should result in timely diagnosis and treatment of postnatal complications etc. These result areas also provided the scope for using mHealth products to prioritize clients and undertake appropriate follow-up.

Table 1 RMNCH outcome areas selected for impact

S.No	8 RMNCH Outcome Areas
1	Treatment for severe anemia among pregnant women
2	Effective handling of obstetric emergencies
3	Effective handling of postpartum complications
4	Contraceptive use among priority couples
5	After care for sterilization and IUD acceptors
6	Regular supply of condom and oral pills to method users
7	Full immunization among children aged 9-12 months
8	Identification and treatment of sick children

The Dristhi mHealth package was built using the Android platform and leverages existing mHealth technologies (MoTeCH suite, Enketo) to reflect the current workflow and information needs of ANMs. Its scope includes the data contained in ANMs' paper-based registries, periodic reports that AMNs have to submit to their supervisors, as well as the real time service data they report to the Mother and Child Tracking System (MCTS). The mobile technology used in developing the Dristhi application makes the application easy to use and is in the public domain as open source (free of charge). Developing Dristhi on the Android platform drew from the recognition of platform adoption trends in Smartphone and tablets in most low and middle income countries.

Initially, the project partners developed the application for the HTC Explorer Android smart phone. The technical backend heavily leveraged CommCare, a popular mHealth

platform along with MoTeCH. In April 2012, 5 ANMs from one pilot Primary Health Center (PHC) in Mysore were provided with the Dristhi application for testing and providing feedback. Over the course of the next 7 months (till October'12), feedback from these ANMs was fed into the design of the application, and features and functions were added such that Dristhi would become an electronic equivalent of their paper-based systems, with the added bonus of decision-support and automated reporting.

In November 2012, a formal user test was conducted by FRHS technical staff using 52 observation days involving 9 ANMs, where each ANM was shadowed by the investigators to study the functionality and usability of the app. This test concluded that the app was fully functional, but the ANMs encountered numerous difficulties while using it. The application also required the ANMs to work in a linear way, going question by question in a prescriptive sequence which they found constraining. Lastly, the application while able to collect data offline, was not able to show changes to the patient record until it synced with the server. This caused the ANM' to have a "slow" experience when using the app.

Subsequently, in December 2012, the Dristhi development team introduced 3 major changes in the app. First, the App interface was completely redesigned for a tablet interface incorporating a new smart register approach. Second, due to challenges integrating Enketo forms with the CommCare platform, the project stopped using the platform, instead rely on MoTeCH for its backend.

Third, the HTC smart phones were replaced by the Samsung Tablet 2² (Model 3100 with Android 4.1 (Jelly Bean) OS) because of the added value of screen real estate, which allowed for improvements in usability. The factors considered for selecting this specific handset were its screen size, native support for Kannada scripts (the local language), and being the best price for its features. These changes required substantial redesigning and re-architecting of the app over a period of 4 to 5 months of continuous effort. The Trust agreed to extend the MS-1 completion date till the end of August and approved a modest financial support from MS-2 budget to cover the 5 month extension period, from April to August, 2013.

During the extension period, the technical team improved the usability of the app by including new features such as displaying and editing client information via a "smart register" format; updating client information locally on the phone when internet connectivity is not available, and providing different search options for ANMs to quickly locate a patient record. The app was then field tested with 6 ANMs to demonstrate its

² Samsung recently released the Tab 3, an upgrade the project will be using as well.

usability in recording the RMNCH services and preparing the monthly State HMIS report for the month of July.

This report summarizes the status of MS-1 deliverables (Table 2), the Dristhi package features completed and tested in August 2013 and the research protocol for the control trial of the App, which will be implemented during Milestone-2. The protocol was submitted to the WHO technical and ethical review panels as well as the FRHS ethical review committee (ERC). FRHS-ERC approved the protocol with some recommendations (Appendix-2); WHO ethics review outcome is awaited.

Table 2: Status of MS-1 deliverables and the currently available features of the Dristhi package (v.2.0.15, dated Oct 7, 2013)

Registers	Status	Comments
Eligible Couple	Done	
Family Planning	Done	
Antenatal Care	Done	
Postnatal Care	Done	
Child Immunization and Illness	Done	
Reminders/Alerts		
Family planning follow-up	Done	
ANC Services	Done	
PNC Visits	Done	Reminders visualized in the App
Child Immunizations	Done	
Reports		
NRHM report (76 indicators)	60	Will be available on web portal when the portal ready
State HMIS (90 indicators)	71	Available on the App (v.2.0.15)
MCTS Report (57 indicators)	In process	API for MCTS tested with the HTC phone; not yet in Dristhi (v.2.0.15).
Block level monthly progress reports (7)	Done	Not yet integrated with Dristhi backend
Web Application		
Web Portal at PHC level	In process	
Activity monitoring dashboard	In process	
Print view of the registers	In process	
Print view of patient profile	In process	
Training and User Guides	Done	
Technical Support Manual	Done	Continuously updated
Dristhi Multimedia & Branding		
Educational Videos (15)	Done	Available on the app
Audio/IVR messages (18)	Done	
Dristhi Logo & Poster	Done	
Research deliverables		
Field Testing of App	Done	
Generation of Monthly Report	Done	
Research protocol	Done	
WHO Ethics review	In process	

1 The Project, Partners and Deliverables

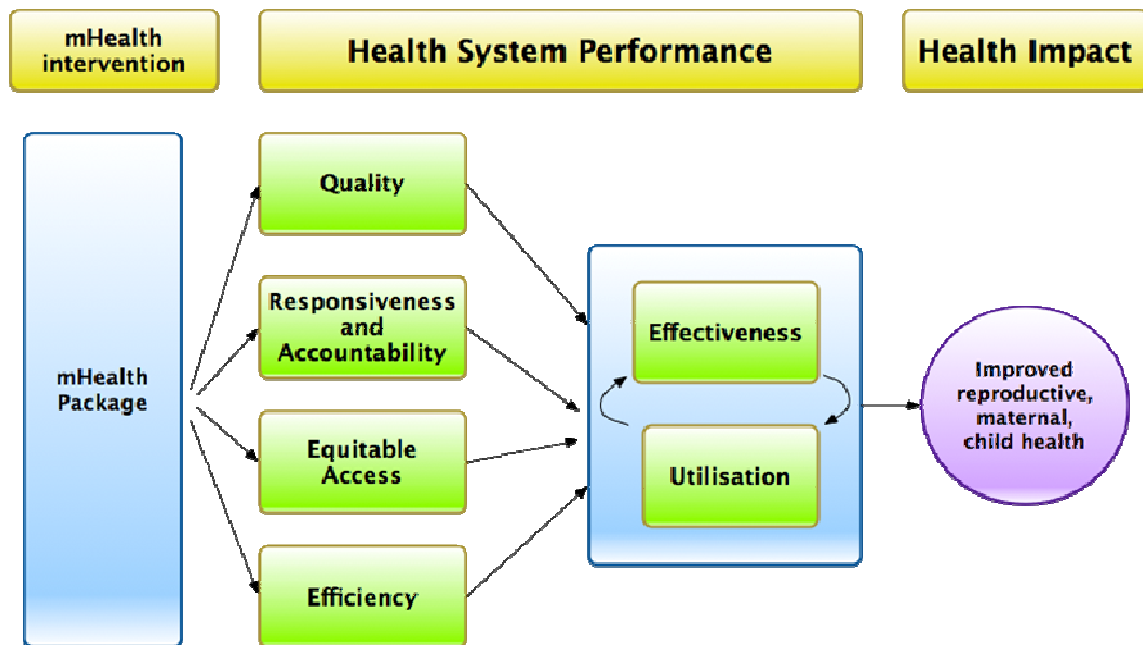
This section briefly describes the project, the partners, and the project activities to date.

1.1 The project in brief

The project was conceived to provide answers to three research questions: (i) to what extent can an mHealth package strengthen the performance of care providers and contribute to improving RMNCH outcomes by offering improved quality, timeliness and use of data? (ii) What technical, financial, and operational factors contribute to those improvements? (iii) How could those be leveraged to scale up the use of m-Health?

The project proposed to identify and combine the best elements of separate but previously piloted mHealth technologies (ChildCount+, OpenMRS, Sana, CommCare, Open Data Kit, MoTeCH) into a unified platform to create an App to help India achieve its National Rural Health Mission (NRHM) goals. The results framework used in this project is depicted below.

Model of mHealth Intervention Pathways to Improve RMCH



1.2 Project Initiation

The project was initiated in Mysore on October 12, 2011 by the then-NRHM Director Shri. Selva Kumar. In consultation with the District Health Officers, 2 Primary Health Centers (PHCs) from Mysore District were selected as the pilot PHCs. The two PHCs were: Bherya PHC³, operating on 24 hours / 7 day basis and Keelanapura, a Day PHC operating from 9 to 5 on working day basis, representing the two types of PHCs existing in the State.

1.3 Project Team and Technical Partners

The project team consisted of members from the Foundation for Research in Health Systems in India, from Columbia University in New York, and from the WHO in Geneva, Switzerland, as well as technical partners from ThoughtWorks and Computer Maintenance Corporation (CMC), both in India.

1.4 Milestone - I

Milestone-1 involved information needs assessment, intervention development and pilot testing of the mHealth package in Mysore that in Milestone-2, will be used in the controlled trial in a Northern district, Koppal, in Karnataka, India. The FRHS-WHO team developed the research protocol and recruited research staff to undertake the assessment of information needs; to document the existing information, communication and work flows in the RMNCH program, and to review the existing mHealth applications in the State.

The Columbia-led technical team assessed the existing paper and information technology platforms and systems used by health workers; worked with the project partners to define the core functional requirements and technical components of the mHealth package; and developed the core systems package in consultation with NRHM and clinical staff.

MS-1 deliverables included a field-tested mHealth package consisting of: an integrated health engine for mother and child registry; SMS and IVR based alerts for key events, SMS to “at risk mothers”; IVR based messages on selected maternal and child health conditions to mothers and ASHAs; and integration with the existing m/eHealth systems

³ 24x7 PHCs typically have 2 doctors, 10-12 health staff and 6 to 30-bed in-patient facility, while a Day PHC usually has a single doctor in charge with 6-7 health staff, and 4-6 observation beds

(NRHM Web portal and MCTS) so health workers do not suffer a double burden of reporting.

2. Situation Analysis

To define the scope of the App, the project team carried out a situation analysis that included an understanding of: (1) the existing health information system in the State; (2) ANMs' work processes, (3) information used in performance reviews (4) ICT use in the existing health information system, (5) workload and mobile usage among health workers and clients, and (6) information needs of ANMs and mothers related to 8 targeted RMNCH outcomes (listed in Table-1, page 7). Findings from the situation analysis are briefly described in this section.

2.1 The Existing Health Information System

The FRHS team studied the existing health information system by observing the routine data collection and client interactions of 7 out of 9 ANMs in the two pilot PHCs (2 ANMs were on long leave then and therefore could not be contacted) and by attending monthly meetings held at the PHCs where patient data were discussed and field problems were addressed. Through these observations the team learned that ANMs maintained about 31 registers related to several public health programs, of which 18 were related to RMNCH services. The remaining registers were related to other programs like malaria, TB, leprosy, school health, etc. The RMNCH-related information was recorded in 5 main registers (with 9 sub-registers within):

- **Eligible Couple Register (1):** This register lists all MWRA by name, their demographic data, and family planning status. This register is updated once a year.
- **Family Planning Registers (4)⁴:** These registers contain information about couples using family planning methods by type of method (sterilization, IUD, the Pill, and Condom), duration of use, follow-up and contraceptives supplied to them.
- **Antenatal Care and High risk pregnancy Register (2):** These registers contain names of all pregnant women, antenatal care (ANC) services provided to them by date of service, date and delivery outcome details. The high risk pregnancy

⁴ Family planning register with 4 sub-registers within

register contains the name and address of high risk pregnant women and their obstetric history, HRP reason and advised treatment.

- **Postnatal Care Register (1):** This register contains the names of all delivered women, dates of postnatal visits and records of Post Natal Care (PNC) services provided to them.
- **Child Immunization Register (1):** This register contains immunization details of children less than 18 months of age.

In addition, they maintained 9 smaller registers to record information such as high risk pregnant women, births & deaths, children receiving vitamin A, child illness, supplies and stocks, mothers receiving benefits, and cases of RTI/STI -- all related to RMNCH services (Appendix 3). Information contained in all these registers needed to be integrated in the Dristhi App.

This study also found that these registers were poorly maintained: ANMs had left many fields empty and quite a few records were duplicates. Importantly, the study also found that there was no common link between registers, making it impossible to track the continuum in health care that mothers and children received.

Using the information recorded in the 18 registers mentioned above, ANMs create 3 types of reports:

- NRHM (form-6) report currently with 88 data elements (Appendix 4a),
- State-HMIS report with 90 data elements (Appendix 4b), and
- MCTS report with 57 specific services provided to mothers and children, by name (Appendix 4c).

Of the 178 RMNCH indicators that ANMs are expected to report every month, Dristhi is designed to report 166; 12 NRHM indicators are out of scope for Dristhi as they relate to services provided to adolescents; morbidity & mortality among adults, and service management like immunization sessions planned and held, ASHAs appointed and paid. Currently Dristhi covers two specific client groups - married women of reproductive age and children under age 5. Services provided to these two client groups form nearly 90 percent of ANM's total reporting load.

2.2 ANMs' Work Flow

To understand ANMs' work flow the study team shadowed 4 ANMs in pilot PHCs to observe their functioning in three types of situations: (1) during household visits (2) on outreach service days, and (3) on immunization days. Through these observations the team learned the following (Appendix 5).

- **Household Visits:** ANMs are required to undertake household visits 4 days a week to different villages in her area (she typically works in 2 to 4 villages covering on average a population of 4 to 5 thousand). During her household visits, she gives medicines for minor ailments and refers more serious ailments to the PHC. She provides counseling on FP, ANC, and PNC services, without using any visual aids. During household visits, she does not carry her registers; instead, she will take some notes in her diary and relies on her memory and update the registers later. She finds the registers too bulky to carry.
- **Outreach Services:** Outreach services take place once a week in different villages at a fixed place, usually at an Anganwadi Center⁵. Here ANMs provides prenatal check-ups and immunizations to about 15-20 mothers and children, at a time. Typically, she first collects the Thai cards from women who gather for services and notes down in her register the services she will provide to them that day. After giving those services she updates the Thai cards⁶ accordingly. One ANM reported carrying the Thai cards to her home to copy the data from her registers into the Thai cards. She returns the Thai cards to the mothers later in the week, she said. Another ANM was found to simultaneously recording the services in the Thai card and in her service register and return the Thai card to the mother immediately.
- **Immunization Days (at Sub Center / PHC):** The study team observed two immunization days, one at the Sub Center and another at the PHC. On immunization days, ANMs only provide immunization to children and pregnant women. ANM calls them one by one, provides the required dose and records the dose and the date of service in her Child Immunization register as well as in the

⁵ Anganwadi is a government sponsored child-care and mother-care center in India. It caters to children in the 0-6 age group, which are distributed in entire India for one for every 1000 population. It provides health education, nutrition, and immunization services during Ante Natal Care to the pregnant woman, nutrition and preschool education to child children 3 to 6 years, and nutrition and health education to adolescent girls.

⁶ Thai card - Thai Card is issued to a pregnant women soon after her name is registered for Ante Natal Care (ANC) checkup is an already existing programme of the health department which contains all the relevant information pertaining to the medical services provided to a pregnant woman.

Thayi card. ANMs attend to around 10-15 women and children on immunization days.

These observations suggested two potential areas for improvement with an mHealth app: (1) replicating her registers on the mobile phone, which would allow her to update services during household visits, instead of relying on memory; and (2) allowing the ANMs to access treatment protocols and support tools (i.e. video and pictures) on her mobile phone, which she can use during household visits and during service sessions.

2.3 Use of Information for Performance Review

The FRHS team also observed three types of routine meetings involving ANMs where HMIS data were reviewed: (i) ASHA⁷ Monthly Meetings, (ii) PHC Fortnightly Meetings, and (iii) Sector Level Monthly Meetings (a sector consists of 4-5 PHCs).

- **ASHA Monthly Meetings:** These meetings are held on a fixed day each month for ASHAs, ANMs, and health supervisors to attend. This meeting is a platform for ASHAs to discuss their problems and performances related to ANC, PNC, and Child immunization services in her area. ANMs check ASHAs' invoices, which contain the number of services she provided and the claimed amounts, to get Medical officer's authorization for payment.
- **PHC Fortnightly Meetings:** These meetings take place at the PHC once a fortnight to discuss the performance of PHC staff, especially the ANMs and male health workers. Medical Officers chair these meetings and the Lady Health Visitor (LHV), who is the supervisor of the ANMs, collects the service data from ANMs on all services they provided during the previous 15 days and records those in her register. ANMs also discuss with the LHV their problems, such as resistant clients, lack of supplies, lack of cooperation from ASHAs, etc. These meetings are attended by 15-20 persons and last for half a day.
- **Sector Level Monthly Meetings:** These meetings are held at the sector level, involving staff of 3 to 4 PHCs coming under that sector and are chaired by block or district level program officers. All medical officers and health workers (i.e. ANMs, male health workers, and health supervisors) from the sector attend these meetings. The meeting agenda usually is to discuss the monthly performance of ANMs and Male Health Workers with respect to 24 national

⁷ Accredited social health activists (ASHAs) are community health workers instituted by the government of India's Ministry of Health and Family Welfare (MoHFW) as part of the National Rural Health Mission (NRHM).

health programs. Typically, 60-65 persons attend these meetings. These meetings last for an entire day.

During these meetings, the FRHS team often observed the ANMs struggling to compile their reports -- copying service data from multiple paper records and calculating the monthly target achievements for each service indicator.

2.4 ICT use in the Health information systems in Karnataka

The study team gathered information on the existing ICT use in the health information system in Karnataka. These included the HMIS web portal, the Mother and Child Tracking System (MCTS), and the PHC Information System (Appendix 6).

- 1 **HMIS web portal:** This was launched in 2009 by the Government of India (GoI) to capture health data from public and private institutions in rural and urban areas. The portal is populated using the paper-based summary reports obtained from all health facilities.
- 2 **Mother and Child Tracking System (MCTS):** This system was designed in early 2010 to keep track of each pregnant woman by name - from her pregnancy registration till the end of her postnatal period and of each child's immunization record from birth to 16 years of age. This system is meant to ensure continuum of services to all women and children. Data entry for the MCTS in Karnataka State is done via web entry and SMS. Since its introduction in 2011, more than 1.2 million mothers and 0.6 million children have been registered in this system in the State⁸. It requires ANMs to type and send about 100 SMS per week, one SMS for each service they provide to each client.
- 3 **The PHC Information System:** This is a daily reporting system that collects data on beneficiaries of various schemes (JSY, Madilu kit etc.), cases reported of various diseases, and patient and staff attendance at the PHC. This system uses Nokia mobile phones and a Finger Print Reader (FPR). PHC staff use mobile phones to take pictures of the beneficiaries and geo-stamp the pictures for location authenticity. The system also sends alerts regarding any epidemics in the surrounding areas.

⁸ <http://web3.kar.nic.in/mchdashboard/FrmDashBoardHomePageTabular.aspx>

2.5 Workload and Mobile phone usage among ANMs, ASHAs, and Clients

Between March-June 2012, a study was undertaken to understand use of mobile phones in general and specifically for health-related matters by health workers and their clients. This study used semi-structured questionnaires and involved interviewing 25 ANMs, 31 ASHAs and 25 Mothers from 6 PHCs within Mysore Block.

Data was gathered from ANMs and ASHAs concerning their workload, skills in using mobile phones, and challenges they experience in using mobile phones, especially for health-related work. Information was also obtained from mothers to determine their skills in using mobile phones in general and how they use the mobile phone in situations related to their health. Findings from this study were used to inform the functional requirements in development of the app to ensure that the app was appropriate for the intended users' workload, usage needs, and phone skill level.

Major findings from this study were (Appendix 7):

ANM Workload:

- ANMs reported having on average 827 households allotted to them for service, wherein there were an average of 688 married women of reproductive age;
- ANMs allocated 4 days per week to conduct routine household visits, visiting up to 100 households per day;
- ANMs reported an average of 6 deliveries each month in their areas (range: 3 to 12);
- ANMs reported making 7 postnatal visits per month (range 3 to 10);
- ANMs reported maintaining about 28⁹ registers and one diary and preparing 3 reports each month. They also send about 50-60 SMS per day to the MCTS regarding specific health services they provide¹⁰.

Mobile phone use:

- All ANMs, all ASHAs, and 87% of mothers had access to mobile phones, either their own or of a family member, mainly husband;
- All ANMs and ASHAs and 36% of mothers owned their mobile phones. This factor needed to be considered while deciding priority for developing the alerts component (SMS, IVR) in the project;

9 28 registers + household register and Community Need Assessment register.

10 Mother and Child Tracking System in Karnataka requires registration of the Pregnant Woman and Child through the web, and the services provided to the Mother and Child should be updated through SMS, each service and each client as one SMS.

- 96% of ANMs, 65% of ASHAs and 44% of mothers said that they were able to read SMS in English. ANMs indicated that they preferred using English because their mobile phones usually did not support Kannada script;
- 48% of ANMs reported using mobile phones "many times" to refer pregnant women for emergency obstetric care; and
- 10% of mothers reported using their phone for calling the ASHA or ANM for health-related matters; most of them reported a preference for person-to-person communication with health workers.

Challenges in their work, as commonly reported by ANMs were: being required to collect a lot of data, managing difficult clients (i.e. hard to convince, not complying with advice), delivering appropriate services on time, and preparing accurate and timely reports.

2.6 Information Needs of ANMs and Mothers Related to the 8 targeted RMNCH outcomes

Another formative research study was undertaken to determine the information needs of health workers and mothers related to the 8 RMNCH problem areas selected for impact.

This study was carried out by analyzing case studies as narrated by ANMs (3 per each problem area), ASHAs (2 per each problem area) and mothers (3 per each problem area), about the problems women had suffered in the recent past, their experiences in providing / getting health services to deal with those problems, and the information they needed or would have liked to have in dealing with those problems. In total, 63 cases studies were compiled in addition to the interview data from 24 ANMs, 15 ASHAs and 24 mothers from 6 randomly selected PHCs within Mysore District.

These case studies were used to identify typical service delivery loops related to the 8 health outcome areas wherein the Dristhi app could intervene to improve the outcomes (Appendix-8)¹¹. For example, in cases of pregnant women with severe anemia, the case studies showed that the main hurdles to effectively treating severe anaemia were: ANM

¹¹ Though the needs assessment exercise involved 8 outcome areas as originally proposed, ANMs were found to play a minor role in nutrition services. Hence the service loop related to 'treating ill and malnourished children' was removed from the current Dristhi scope.

failing to enlist and follow-up anemic women in their 3rd trimester; women not taking the prescribed treatment and advice because of side effects or lack of family support; or presence of other complications not noticed. The Dristhi app could help mitigate these hurdles to some extent by prioritizing 3rd trimester pregnant women for ANC visits; by making family members aware about the pregnant women's need for care and support; and by explaining to women (through educational videos) about other factors that can cause severe anemia and why it is important for them to deliver at higher level hospitals where blood transfusion services are possible.

In cases related to aftercare for family planning, ANMs reported strongly recommending, but not insisting, certain contraceptive methods to women based on their parity. Both, mothers and ANMs reported there is no regular system of recording of medical history or doing physical check-up (except the anemia test) before providing IUD and the Pill though there is a system (of recording medical history and doing physical checkup) before conducting sterilization. IUD and Pill acceptors are usually told only about the benefits; nothing about the likely side-effects but told to come back if they have any problems. This finding suggested the need to include a checklist of contraindications in the app that ANMs could use while recommending appropriate family planning methods; for women.

All case studies were similarly analyzed to decide on the content of Dristhi forms and functionalities needed in the app, such as checklists, prioritization features, reminders, and communication through video and IVR (Appendix 9).

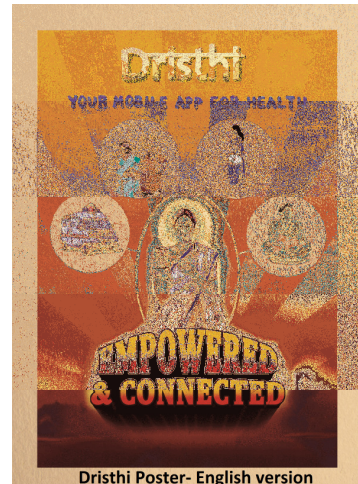
3 Technical Platform Review

In February 2012, Dristhi team members started creating different usage scenarios, storyboards, and detailed narratives about how information is currently gathered, compiled, and used. Team members from ThoughtWorks then submitted a Gaps Analysis Report, providing a brief account of the current workflow of ANMs and improvements proposed in the Dristhi project. The report outlined the various features that needed to be built into the Dristhi App, such as: interlinking registers; making aggregated data available for the ANMs on their phones, generating monthly reports; and receiving reminders and alerts from the system about health services that are due (Appendix 10).

3.1 Dristhi Core Technical Package

After the submission of the Gaps Analysis Report, the Dristhi team defined the core technical package, which comprised the following functional components:

- **Care Protocols:** Care protocols including clinical decision support tools and treatment guidelines, to capture client data on mobile phones that can replace paper registers and forms.
- **Client Registers, Client Profiles:** Register views of client data for Family Planning, Antenatal care, postnatal care, and Child health, as well as client profile pages where the ANMs can view a full service history of the client and services due.
- **Treatment Schedules and Reminders:** Automatically generated reminders and schedules based on the Government of India's care guidelines to remind ANMs when important services are due, such as ANC visits, TT injections, child immunizations, etc.
- **Risk Profiling and Prioritization:** Automatically profiling of clients at risk, using a combination of care protocols, medical history and treatment schedules, to help ANMs prioritize them for care.



3.2 Dristhi Client Data

The Dristhi platform database consists of ANMs' Eligible Couples (ECs), Antenatal Care (ANC), Postnatal care (PNC), and Child register data. The EC Dristhi register is intended to cover demographic information of all married women of reproductive age. Dristhi is pre-populated with EC data created by digitizing the ANMs' existing paper EC registries into Excel files. ANMs can then register new ECs directly in the App. ANMs can also enter new ANC, PNC, and Child cases belonging to the ANM's area by going through the EC record of that woman, so her background information gets linked to her ANC, PNC, and Child cases. This linking of registers minimizes the need to enter the same information in different registers. For Out of Area (OA) clients, the ANM can enter the case directly into the app, instead of going through the EC profile.

3.3 Dristhi case management

Dristhi case management functionality includes:

- Weekly/monthly work plans, consisting of client-specific color-coded service reminders, which can be filtered by type of service, village, risk and priority status;
- Ability to flag high-risk and priority clients for care.
- Care checklist for ANM to use to ensure positive outcomes. For example, preparing women who are high risk for obstetric complications to be ready with transport arrangements, money, location of delivery place and ASHA's phone number.
- Checklist of danger signs for post-partum mothers and newborns that the ANM/Staff Nurse reads out to the delivered woman on the first day after delivery, and the ability to reinforce those messages using video embedded in the Dristhi app and audio messages received through IVR.

3.4 Reporting

To simplify the reporting process, the monthly and annual reporting forms that ANMs are required to submit are automated. Specifically, the following reports are automated:

1. **State HMIS report:** covering 90 indicators. These are available to the ANM on the tablet in real-time, so that she can track her progress and automatically generate her monthly activity report.
2. **NRHM Report (Form-6):** covering 76 indicators related to RMNCH services. Dristhi generates this report for each ANM, which she would download from the Dristhi website, add data on the remaining 12 indicators that are out-of-scope for Dristhi, and upload the Form-6 to the NRHM-HMIS website. This form could

be directly uploaded to the NRHM web portal if the GoI eventually allows the Dristhi application to have access to its Application Programming Interface (API). Since this option is unlikely to materialize in one state (unless Dristhi is accepted at the GOI level), the project team has created a partially automated report to be uploaded by the ANM.

3. **MCTS Report:** This report with 55 indicators was proposed to be directly uploaded to the MCTS portal if the Government of Karnataka (GoK) would allow access to its API¹². The GoK has agreed to provide a user ID to Dristhi to upload structured service SMS to the MCTS portal on behalf of the ANM. This aspect of the platform will be completed after receiving the user ID.

3.5 Development of the Dristhi Platform

The Dristhi mHealth system was originally built on top of several established open source mHealth platforms: CommCare and MoTeCH. The CommCare platform, developed by Dimagi, was used to provide both server-side functionalities as well as support on the Android client for the Dristhi application. Specifically, CommCare offered support for case management, care modules, and client data management. The India-hosted version of CommCare, which Dristhi used, was linked to MoTeCH for backend services such as scheduling, risk profiling, health events alerts and messaging. MoTeCH is a Bill and Melinda Gates Foundation-funded platform developed by the Grameen Foundation with technical support from ThoughtWorks. MoTeCH provided the Dristhi technical team with a solid foundation to build upon, offering a robust and valuable library of functionalities needed for the Dristhi application. These functions included a scheduling engine and SMS/IVR gateway, which greatly facilitated the development of the Dristhi app. Working with these two platforms, however, introduced the challenge of needing to coordinate technical development schedules, especially as new functional requirements were identified that CommCare could not easily handle.

In the first version of the Dristhi Application, the client care protocol modules were initially programmed into CommCare as XForm modules. Advanced form logic was programmed into these protocols to help streamline the ANMs' workflows while providing the necessary logic to identify high priority/high risk clients¹³. To help facilitate

12 This access is expected after the government of Karnataka has the opportunity to review the fully functional App after it is presented to the government officers.

13 In Eligible Couples – At priority couples means: Eligible Couple having more than 3 children, Age of youngest child is less than 2 years, and less than 18 yrs. of age.

In Pregnant Woman and Delivered Woman: Short primigravida, Severe anemia with pregnancy, Pregnancy induced hypertension/eclampsia, Previous caesarean section, Multiple pregnancy

the development of the modules, the team at Columbia developed an XLSForm standard¹⁴ (and tools around it) to allow authoring of these modules using Excel. This gave team members with less technical knowledge, the ability to edit the form content without needing support from ThoughtWorks. This development was important because it is expected that the care protocols will continue to evolve over time.

The current DRISTHI mobile is a hybrid app, using HTML5/CSS User Interface (UI) on tablet, with JQuery, Twitter's Bootstrap, and Handlebars.js for the user interface, with an Android-native backend for the communication and SQLite with SQL Cipher for storage on the tablet. Enketo is used for data entry from the UI and Ziggy acts as communication API between Enketo and SQLite. MoTeCH/Java on backend on the server side with spring MVC and Couch DB at back end. PostgreSQL is used for reporting on server.

The Dristhi platform backend application was developed on top of the MoTeCH platform, developed by the Grameen Foundation with programming support from ThoughtWorks. The Dristhi backend MoTeCH app provides most of the management of the Dristhi client data, health event scheduling and the more complex risk protocols and the care protocols that could not be programmed on the tablet. The Dristhi MoTeCH backend is composed of the following core components:

- **Health Event Scheduling:** support for the scheduling of health events such as ANC visits, and immunizations, based on the NRHM's MCH schedules. This includes support for prioritized schedules such as women who are at risk who require more frequent ANC visits.
- **Health Prioritization Rules Engine:** Dristhi is able to detect for patterns in a patient's health history (results of last pregnancy, low pregnancy weight, etc.) and flag them as being at risk to the ANM.
- **SMS, IVR Messaging and Video:** Currently Dristhi backend server is able to send SMS and IVR audio messages. For mothers, 18 pre-recorded audio messages have been developed for use through Dristhi backend server. In addition 15

Mal presentation, Ante Partum Haemorrhage, RH Incompatibility, Pregnancy with medical disorders like heart disease, diabetes etc. Intrauterine growth retardation In Children: children of low birth weight.

14 XLSForms convert to XForms which is a widely adopted open form standard which CommCare, ODK and most leading mobile data collection tools use as their form definition. XLSForms merely provide a human readable abstraction of the XForm that makes the editing of forms for non-technical people possible.

video messages have been developed and imbedded in the App for ANMs to play during their interactions with clients (Appendix 11)¹⁵.

Seven out of the 18 audio messages and one video related to postnatal care and complications are being tested in a separate research project called **m-Check**. The Mother/Baby 7-day m-Check programme has been developed by the WHO Patients for Patient Safety Champions, a network of patients from around the globe who are committed to improving patient safety by empowering patients. The program has developed a paper tool (Image below) to help mothers and their family members identify danger signs in a woman who has recently given birth or in her newborn baby and encourage the mother or her family to seek appropriate care. The purpose of this pilot project is to assess the feasibility of implementing this tool and its impact on health seeking behavior and knowledge of danger signs for mothers who give birth. The study is underway in 3 health facilities in Mysore block, other than the 2 pilot PHCs selected for Dristhi development and testing.



Danger sign - Mother

**Danger sign - Child
mCheck tool**

In the mCheck study, 500 women delivering in the 3 health facilities are enrolled to receive the paper tool with a nurse/ANM explaining the tool, followed by mothers receiving audio messages for the first 7 days after delivery, using the mobile phone numbers they provide during enrolment. Effectiveness of this tool and accompanying audio messages is being assessed using a "before-after" study design involving 500 women before and after.

If found to be effective, the mother/baby m-Check tool and accompanying audio messages will be used along with the Dristhi app for scale-up in the controlled trial.

¹⁵ Appendix 11 presents only the English transcripts of Video and IVR audio messages, which are recorded in Kannada (the local language); we could not insert the transcripts as sub-titles in the video as the scripts were too long.

4 Development and Pilot testing of DRISTHI App

4.1 Usability Testing of Dristhi v.1

In November 2012, the Dristhi app was formally field tested with 9 ANMs from Bherya and Keelanapura PHCs, comprising 52 observation days in which FRHS field investigators remained present with the ANMs in the field while they tried to use the app during real service encounters with clients. Prior to November 2012, the app was being informally tested by two ANMs at Bherya PHC, who gave feedback to improve the application design and usability.

Before the field test was initiated, the Dristhi team organized two training sessions, each session of one day duration, for the 9 ANMs and gave them the mobile handsets and Dristhi User Guide. Data from their EC and ANC registers were pre-populated on their devices. Their general feedback during the training was that they liked the app, but they expressed concern about its complexity. Following the training, five FRHS field investigators began to shadow the ANMs daily to help them use the app.

Over a period of one month, the field investigators observed 52 ANM days in which the Dristhi app was used. The field test brought to light multiple usability issues such as (Appendix-12):

(1) Data syncing with the CommCare server took a long time – anywhere between 5 to 45 minutes, when syncing needed to be done about once every minute for the app to function adequately. This suggested the need to be able to sync data locally on the device without having to rely on CommCare.

(2) Incompatible workflows with the Dristhi app. In the clinic setting, ANMs often provided services to clients in groups. For example, they would give Oral Polio Vaccine (OPV) to 5-6 children together and then start giving Diphtheria tetanus, and pertussis vaccine (DPT) to the same group of children. In Dristhi, it was not possible to open records of different clients at once since CommCare forms were linear, nor was it possible to see more than 2 questions at a time on the app. As a result, the ANMs were not able to easily jump between questions when collecting data on a client. The Dristhi team therefore decided to explore other options for structuring the forms so all questions would appear on a page similar to paper.

(3) ANMs found it time-consuming to search for specific clients from a typical case-list of 700-800 clients, even with the village filter feature. This made it difficult to update client records during service delivery, especially difficult when many clients were waiting.

4.2 Follow-up of the Dristhi v.1 Test

After analyzing these field test results, the technical team concluded that the app was functional but not sufficiently useable by the ANMs. The technical team then decided to add a smart search feature to deal with this problem and to make a few fundamental changes in the next version of the app, including:

- Redesigning the app for tablets, which enabled more screen real estate and health content easily viewed across multiple clients.
- Reflecting ANM registers, designing a “Smart Register” approach with different service modes in all registers: EC, FP, ANC, PNC, child health, so that she shifts to different services of same client without changing registers.
- Saving data on the tablet and showing the updates immediately even if no data connection is available.
- New forms that showed all questions (including logic) on the same screen.
- Discontinuing CommCare so constant server connectivity would not be required.

4.3 Selection of Tablet

Initially the HTC Explorer was chosen because it had a significantly better processor and screen resolution (despite its small size) compared to similar phones at its price point of 8000 INR (\$135 USD). In field tests, ANMs faced challenges with using Dristhi version-1 in part due to limited screen “real-estate”. In December 2012 the technical team selected the Samsung Galaxy Tablet 2¹⁶ (with Android Jelly Bean OS), as it offered the best features (in terms of screen resolution, processor, battery, etc.) for its price point (about double that of the HTC phone, \$280 USD). The larger screen size meant being able to design a larger and more user-friendly app interface, and the new OS allowed local Kannada script to be displayed on the screen. Though the formative research had shown ANMs in Mysore District were comfortable using English for reporting (the government's web-based HMIS also uses English), the team felt that the situation in

¹⁶ Samsung Tablet Configuration: CPU: Dual-core 1 GHz, Display: 7.0”, 3G Voice Calling, RAM: 1GB, Storage 8 GB.

Northern Karnataka, i.e. in Koppal, might require use of Kannada. Therefore, functionality for bi-lingual forms was incorporated after the switch to the new OS.

This Tablet provides a better use experience for the ANM and also provides full encryption of all data. It requires data connectivity for some functions like submitting data and getting reports. One SIM card / ANM with a basic data plan costing INR 98 (~\$2 USD)/month is adequate to undertake the necessary uploading and downloading of data by each ANM.

4.4 Status of Dristhi App v.2

As of August 27, 2013, Dristhi v2.0.14, used in the field test has:



Dristhi App icon

- All smart registers designed and implemented
- Registers and client profile pages implemented
- New Enketo form technology implemented
- Offline submissions working
- Auto syncs with server working

Smart Register views for EC, FP, ANC, PNC and Child registers are shown in Appendix 13.

Work plans are automatically generated and appear in the smart registers based on the upcoming scheduled health services for the ANM's clients. Work plan reminders are color-coded based on when the service is due, allowing the ANM to plan her work week. Features like the sort menu and village filter, for example, enable the ANM to efficiently locate and enter services for her clients during village visits and other service encounters.

The Dristhi app produces activity reports for the ANM, matching her monthly reporting formats of State HMIS¹⁷.

The other technical functionalities that are in the process of development are: (1) option to "view, download and print" registers and reports from the web-portal, (2) Block Dashboard report and (3) automatically sending SMSs to the MCTS Server for the roughly (55) services. These developments are also expected to be completed by October end'2013.

¹⁷ 71 State HMIS indicators are available in Dristhi v.2.0.15, expected to release on 15th October, 44 of those from Dristhi v.2.0.14 were field tested.

4.5 ANMs' feedback on Dristhi v.2.0.14

ANMs provided the following feedback on the current version of the App:

- **Enketo forms:** ANMs felt that showing all questions at the same time (using Enketo forms) rather than showing each question separately makes the app easy to use and saves time. They suggested marking the mandatory fields in red color for easy visibility. Mandatory fields are now marked by a red asterisk (*).
- **Larger Dristhi screen:** ANMs were happy about the large screens of tablet as they could see a lot of information and many clients at the same time.
- **Smart Registers:** ANMs liked the design of smart registers with its features like filtering cases by villages and by services, which would help them find cases quickly. ANMs suggested adding search by EC number, which was later added.
- **Reports:** ANMs felt that automatic reporting from Dristhi would reduce their workload and help improve the report quality because one cannot manipulate the Dristhi data while preparing the report.

4.6 Dristhi App Field Testing Procedure

As part of a continuous quality control process, the Dristhi team developed 402 scripts to test various functionalities of the app and to identify bugs as they may occur as new functionalities get added. As the app evolves, these scripts will continue to be updated to identify bugs in the system that need to be fixed.

The testing scripts categorized bugs into three categories:

- **Low Priority:** A Bug that will not cause failure in execution of the product
- **Moderate Priority:** A Bug that will cause an observable product failure or departure from requirements
- **High Priority:** A Bug that will stop the system functioning and need immediate resolution.

With **Dristhi v2.0.14**, 258 scripts were tested¹⁸ of which 211 were successful. The 47 tests that failed were medium priority bugs and are in the process of being fixed (appendix 14). An example of a medium bug is that in the reporting module, the number of women who were registered early for ANC (<12 weeks) were also added to the number shown for late registration. Most of these bugs are logic based and are fixed as they are identified. This is an ongoing process.

Finally, the technical team developed a Dristhi User Guide and Troubleshooting Manual, which will be used to train the ANMs and technical staff during the control trial of the App, planned in Milestone-2 (Appendix 15, 16, 17).

5 Milestone-2 research protocol methods

The cluster-randomized controlled trial in Koppal District will address four research goals, namely: (1) confirm that the Dristhi as a smart register system reflects the service delivery and reporting needs of ANMs; (2) determine whether the implementation of Dristhi leads to improvements in specific health system RMNCH process in client management and reporting; (3) determine whether the implementation of Dristhi leads to improved service coverage and outcomes; and (4) assess the programmatic and scale-up implications for deployment of Dristhi among rural health workers.

The cluster randomized controlled trial will be carried out in Koppal District in northern Karnataka with 50 ANMs using the app and 50 ANMs as control. The trial will extend over 18 months. The research protocol and tools for the evaluation have been developed and submitted for ethical review to the respective committees of the WHO and FRHS. FRHS obtained the ERC approval, WHO is in the process of reviewing it.

The ANM will be the unit of randomization. The study will combine cross-sectional and cohort approaches in the study design. For Family Planning and Child Immunization outcomes, a cross-section, before-after difference-of-differences analytical approach will be employed, while for ANC, Delivery, and PNC outcomes, a cohort approach will be employed. Additionally, we will deploy a monitoring team for continuous assessment of coverage rates over time and fidelity of reported data to services provided and health outcomes.

¹⁸ 258 out of 402 functionalities were available in the app by August 2013. Since then several functionalities have been added; the testing is an ongoing process

Originally, the team had proposed PHCs as the unit of randomization, involving 60 PHCs (about 250 ANMs) spread over 2 districts (Koppal and Bagalkot). In December 2012, the research team proposed to the RSG to restrict the research study to one district (Koppal), with 50 ANMs in each arm of the trial. However, the number of women to be interviewed in each arm, before and after the trial, remained the same as the original design (99,000). The methodology of the sample size determination is described in the Control Trial Protocol (Appendix 18)¹⁹. This change offered research value in terms of: increased number of clusters from 30 to 50 in each arm; improved potential integrity of the intervention deployment; and importantly the efficiency of how data will be collected.

Survey instruments were developed to gather relevant data to evaluate the 8 health outcomes, assess ANMs comfort levels in using the App as well as the cost, quality and use of data as compared to the data collected through the manual system. The survey methodology will involve listing all households from the experimental and control areas. From those lists, married women of reproductive ages (MWRA), pregnant women, postnatal women and mothers of children age <3 will be selected systematically for interview. Pregnant women listed during the baseline will be followed to record their pregnancy outcome. In addition, a system of concurrent monitoring will be established in the experimental and control areas where supervisors will visit a small number of women per month to authenticate the reported data as described in the research update. (Appendix 19)

Koppal has about 175 ANMs. To select 50 matched-pairs of ANMs, to be randomly assigned to the intervention and the control groups, the research team developed and validated an ANM proficiency tool with 20 ANMs in Mysore. ANMs who scored high on this tool were found to perform better on the app ($r=0.86$). This tool will be used to assign proficiency scores to all ANMs in Koppal district. These scores will then be used to match ANMs of similar proficiency levels to ensure that ANMs in the intervention and control groups have similar capacity to use the app. (Appendix 20)

¹⁹ Appendix 18 presents the protocol reviewed by the FRHS-ERC in December 2012; the WHO team is currently in the process of finalizing the protocol for WHO-ERC which may have some additions and procedural changes as compared to the protocol presented in appendix 18. After getting comments from the WHO review committee, those differences will be reviewed in the RSG and if found substantial in terms of their ethical implications, FRHS would seek another review.

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