

SCALABILITY OF MHEALTH ASSESSMENT RESULTS TO STRENGTHEN THE HEALTH SYSTEM

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ABSTRACT

Mobile phones are providing unique opportunity to serve the remote population of the country for the health care needs. This paper looks at the results derived from the study on Front Line Health Workers using the mobile phone for reporting and how those results can be applied to strengthen the health system. This study is conducted in Saharsa district in Bihar state in India in Jul 17. Total 106 FLW were contacted for the study.

It was observed that, when the FLW uses mobile phone for preparing the immunization due list at Sub centre level the data quality improves ($\chi^2 = 11.52$, $p < 0.021$). When FLW uses the phone for reporting the sterilisation complication data her credibility increases in the community ($\chi^2 = 16.02$, $p < 0.001$). Reporting over mobile phone does increase the data quality and it turn increases the credibility of FLW in community ($\chi^2 = 49.12$, $p < 0.000$) and increase the self-confidence of the FLW ($\chi^2 = 21.04$, $p < 0.002$). FLW do follow up the beneficiary with the use of automated reminders through mobile software, it is has increased the acceptance of FLW in community ($\chi^2 = 25.29$, $p < 0.001$). When phone hanged sometime, it decreases the credibility of FLW in community ($\chi^2 = 7.73$, $p < 0.052$) and acceptance in the community ($\chi^2 = 9.37$, $p < 0.052$).

Clear designing of the program, Rigorous training, Post training support, Attraction of new technology, Relief from carrying the registers, comfort with the digitized data are the major contributing factors for the success of the mobile based reporting project.

Inconsistent mobile network, malfunctioning of mobile phone, non-timely information of malfunctioning mobile from the field and support provided to it, non-timely data recharge and use of mobile phone by children of the FLWs were the major challenges that were faced during the project period.

The project staff suggested that use of mobile should be restricted for official purposes only. Only the data entry software should open on that phone and not any other website. We also need to devise a better mechanism to deliver the repaired mobile phone in time to the FLWs. Mobile phone should be sturdy and a long life. The data recharge should be done on time.

This study envisages the data driven health system and coined a term for the same as “Derocary”. The study suggests that the use of mobile phone for reporting would bring in the required change in the health system.

INTRODUCTION

Chronic problems of the health system can be solved by the use of mobile-based solutions. They can be applied in reporting from the field, reminder for medication, identification of high-risk cases, emergency response network and many more. This paper looks at the results derived from the study on Front Line Health Workers using the mobile phone for reporting and how those results can be applied to strengthen the health system.

A study in Rwanda, where total of 432 Community Health Worker were trained and equipped with mobile phones, through which they can send SMS to health system. As a result of this total of 11,502 pregnancies were monitored. A total of 362 SMS alerts for urgent and life threatening events were registered. Study registered a 27% increase in facility based delivery from 72% twelve months before to 92% at the end of the twelve months pilot phase. Major challenges were telephone maintenance and replacement. District health team capacity to manage and supervise the system was strengthened by the end of pilot phase. Highly committed CHWs and effective coordination by the District health team were critical enablers. ⁱ

Computerized reminders significantly increased the rate of delivery of therapies to hospital based patients. ⁱⁱ Computer reminders achieved a median improvement in process adherence of 4.2% (interquartile range (IQR): 0.8% to 18.8%) across all reported process outcomes, 3.3% (IQR:0.5% to 10.6%) for medication ordering, 3.8% (IQR: 0.5% to 6.6%) for vaccinations, and 3.8% (IQR: 0.4% to 16.3%) for test ordering. ⁱⁱⁱ An interventional study in tertiary care hospital in Malaysia, provides the results that there was a higher medication adherence level in the intervention group (who received automated reminders over their mobile phone) than the usual care group ($\chi^2(2) = 18.614$, $p < 0.001$) ^{iv} A study in Dar es Salaam, Tanzania with 87 Community Health Workers, evaluated an escalating reminder system that sent SMS reminders directly to the CHW before notifying the CHW's supervisor after several overdue days. The reminders resulted in an 86% reduction in the average number of days a CHW's clients were overdue (9.7 to 1.4 days), with only a small number of cases ever escalating to the supervisor. However, when the step of escalating to the supervisor was removed in the second study, CHW performance significantly decreased ^v

Several mhealth tools have been built and deployed in the field for community health workers, but little comparison has been done to help understand their effectiveness. This is largely because no framework exists in which to analyze the different ways in which the tools help strengthen existing health systems ^{vi}

The study was conducted to look at the assessment of mobile based reporting application for Front Line Health workers/Community based workers in state of Bihar. Main objective of the study is too

looking at the automated reminders through mobile phone and its impact on the service delivery by the FLW.

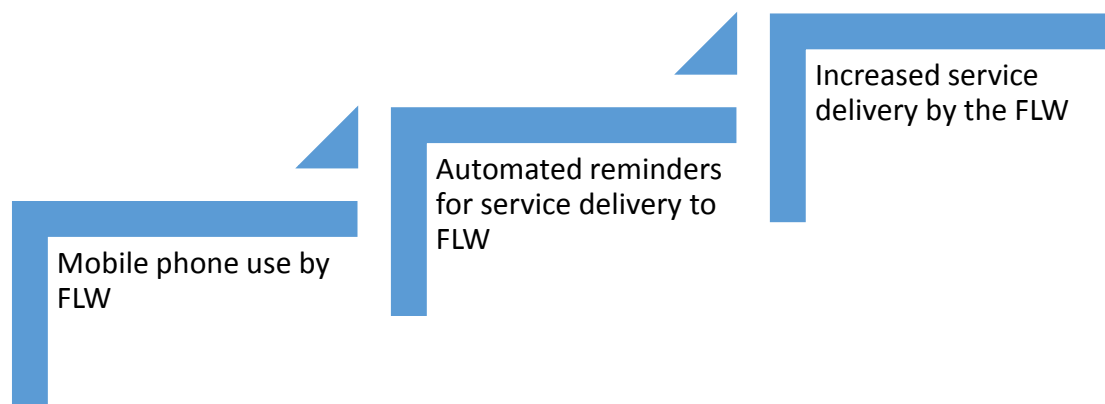


Figure one – Theory of change for automated reminders

The study is based on the theory that the automated reminder to FLW for service delivery will lower the missed cases of service delivery. It will support the FLW for timely service provision.

1.1 THE MHEALTH INTRODUCTION

mHealth is the use of mobile telecommunications and wireless multimedia to integrate and develop successful health care delivery systems. ^{“vii”} It combines two distinct factors present within the context of developing nations: the inherent need for improved health care delivery and the increasing penetration of mobile phones to the most rural areas. ^{“viii”} Mobile networks cover more than 90% of the world’s population, and the proportion of mobile phone users already outweighs those without one. ^{“ix”} While Internet services require ground infrastructure, connection junctures, and heavy equipment, mobile telecommunications provide an additional benefit of wireless and hands-free technology that can be maximized in developing health care systems.

There are a variety of ways in which mHealth can potentially be used to provide health care services. ^{“x”} Effective implementation, however, adds a new level of complexity, as simple phone dissemination to patients and/or health care personnel will not improve health outcomes alone.

In a study by, Yaovi M. in Benin, more than 92% of the all respondents (n=130) confirmed that mobile phones have the potential to improve health surveillance in the country. The most preferred methods by all respondents for effective implementation of such platform are phone calls (96.92%) followed by SMS (49.23%) and smart phone digital forms (41.53%). ^{“xi”}

The primary feature of mobile phones that has been best documented in the context of health is text messaging. Much of the literature regarding text messaging and health has been made available through the popular media, including news magazines and the Internet. Even though

studies are referred to in the popular media, there are very few actual empirical studies that have been published and made publicly available on the subject. In a recent article, aptly entitled, "A text a day," published by The Economist in March 2006, text messaging via mobile phones is gaining increasing attention as a means of reminding patients of appointments in the United Kingdom, United States, Norway, and Sweden

In India mHealth activity is also going on and it is mostly in pilot phase and works on one aspect of the program. National Health Portal lists links to 57 mHealth application and websites on its page^{"xii"}. It also lists some vernacular application. Like in Hindi and Marathi language. The mobile application in India is used for health education of Accredited Social Health Activist. 108 and 102 are emergency toll free telephone services in India that operates and provides ambulance services for maternal and child health care. Mobile are used in managing the emergencies and disasters and to provide telemedicine in remote areas. Community mobilisation is done through mobile phones via interactive voice recorded messages. In non-communicable diseases the mobile phones are used for the treatment compliance through automated reminders. Health surveys are now being conducted via mobile phones in India.

Mobile applications are also being developed for Allopathy and Ayurveda in India. ^{"xiii"} In public health care system mobile application or mobiles are being used for data collection, logistic management, training, emergency support, disaster management. This is possible because India has ICT development index score of 1.75 and the country ranks 117 globally ^{"xiv"}

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Mobile applications (apps) can help people manage their own health and wellness, promote healthy living, and gain access to useful information when and where they need it. These tools are being adopted almost as quickly as they can be developed. According to industry estimates, 500 million

smartphone users worldwide will be using a health care application by 2015, and by 2018, 50 percent of the more than 3.4 billion smartphone and tablet users will have downloaded mobile health applications. These users include health care professionals, consumers, and patients. ^{xxix}

1. METHODS

2.1 RESEARCH DESIGN

This cross-sectional study was conducted in two selected blocks of Saharsa district in Jul 17. It is situated in the state of Bihar in India. In these two blocks, the Front Line Worker (FLWs) were using the mobile phone for doing their routine work and reporting. It was under the project name "Continuum of Care Services" which was run by Care-India. The project started in Apr 2014 and got over in Dec 16. The FLWs were provided java phones. The application was built on commcarehq, supported by Dimagi inc. team.

2.2 SAMPLING DESIGN

The study contacted 109 FLWs and asked questions about their experience of the program. All of the FLW were using mobile phones for their personal use.

The sample size of the study is calculated by formula given in Figure Five.

Where - n (Sample size), Z (Confidence level), P (Prevalence), d (Deviation from prevalence) DEFF (Design effect).

$$n = \frac{Z^2 \alpha / 2 P(1 - P)}{d^2} * DEFF$$

There are three types of respondents Front Line Health Workers, beneficiaries and project officials.

The sample size for each of category of respondents are as follows:

- 1) Front Line Health Workers – 120
- 2) Beneficiaries – 233
- 3) Project officials – All available at block, district and state level

1- Sample size of FLW and Beneficiary

3.5.1 SELECTION OF FRONT LINE HEALTH WORKERS

For calculating the sample of FLW the value of Z is taken as 1.96 and P is at 50% with d at 10%. The design effect is taken as 1 because the sampling would be done by Simple Random Sampling method. This is possible, as the list of ASHA and ANM is available with the block level health office. By the formula, in figure one, the sample size comes to 96. The non-response at 10% is taken into consideration to arrive at the final sample size of 106.

In total there are 600 FLW working in the pilot blocks. Among them, 500 are ASHA and 100 are ANM. We used population proportionate to Size method to arrive at the sample for each group. The proportion of ASHA is 0.8 and ANM is 0.2 in the total of 600. The same rates are applied to sample size of 120. It provides the sample for ASHA at 100 and for AWW at 20.

3.5.2 SELECTION OF BENEFICIARIES

For calculating the sample for the Beneficiary level the value of Z is taken as 1.96 and P is at 50% with d at 10%. The design effect is taken as 2. This is because the two-stage cluster sampling is used. The cluster is defined as the working area of FLW. It is 106 as per the above sampling. Now in each area beneficiaries are to be contacted for an interview. Using the formula in figure one, the sample size comes to 212. The non-response at 10% is taken into consideration to arrive at the final sample size of 233. So in 106 clusters, we need 2 beneficiaries per cluster to cover the sample. To achieve the 233 number, the study will cover 3 respondents in 2 clusters. Every FLW has a list of the beneficiary of their area, with them. It will be used for choosing the respondent. Simple random sampling will be used at this level.

The beneficiary is defined as the woman residing in the given FLW working area. She should have received the services from the FLW. The most important is that the FLW had started using the mobile phone for reporting.

3.5.3 SAMPLING FOR OFFICIALS WORKING AT BLOCK, DISTRICT AND STATE LEVEL

All of the block and district level officials working the selected block and district will be contacted for the study. The state-level officials, who are looking after this project will also be contacted for the interview.

1.3 METHODS OF DATA COLLECTION

In this study, the FLW was interviewed for their experience with the mobile phone-based application during the project phase. The Frontline workers Anganwadi Worker (AWW) and Accredited Social Health Activist (ASHA). The AWW are posted at the village level, they are pre-school teachers at the village level. But they look after the community mobilization for MCH services. ASHA is voluntary worker looking after 1000 population. She supports the community mobilization for all health programs.

Beneficiaries from the ASHA area and officials looking after project were contacted for the interview and responses were collected from them. The data was collected using three different study tools. The questionnaire for frontline health worker was used to collect the information on background characteristic, project implementation experience. The checklist for officials was used to collect the

project experiences and learnings from the staff who worked on the project. Schedule for beneficiary was used to collect the experience in receiving the service from a mobile user FLW.

The questionnaire was developed for the study, is comprised of nominal and ordinal questions. Likert scale is also used to get the opinion of the FLW and officials. The questionnaire for officials was divided into sections as informed consent, identification, project learning, and insights. The questionnaire for FLW was divided into sections as informed consent, facility identification, background characteristic, project implementation learning and work satisfaction. For FLW the questionnaire is structured one and for officials, we used a checklist.

2. RESULTS

FLWs use the mobile phone primarily for reporting purpose. But it also used for reminders and for IEC activities with beneficiaries. So when the FLW uses mobile phone for preparing the immunization

due list at Sub centre level the data quality improves ($\chi^2 = 11.52, p < 0.021$). When FLW uses the phone for reporting the sterilisation complication data her credibility increases in the community ($\chi^2 = 16.02, p < 0.001$). Reporting over mobile phone does increase the data quality and it turn increases the credibility of FLW in community ($\chi^2 = 49.12, p < 0.000$) and increase the self-confidence of the FLW ($\chi^2 = 21.04, p < 0.002$). FLW do follow up the beneficiary with the use of automated reminders through mobile software, it is has increased

Table - One			
Variable 1	Variable 2	Pearson chi2	P value
Immunization due list on time prepared	Data quality improved	11.5256	0.021
Sterilisation complication reporting increased	Credibility of FLW increased	16.2054	0.001
Data quality improved	Credibility of FLW increased	49.1271	0
Data quality improved	Self-confidence of FLW increased	21.0469	0.002
Mobile hanged during reporting	Credibility of FLW increased	7.7335	0.052
Mobile hanged during reporting	Acceptance of FLW increased	9.3728	0.052
Follow up of beneficiary increased	Acceptance of FLW increased	25.2991	0.001

the acceptance of FLW in community ($\chi^2 = 25.29, p < 0.001$).

Mobile phone should run smoothly through the day to achieve the required reporting level. But in this project the phone hanged sometime, thus decreasing the credibility of FLW in community ($\chi^2 = 7.73, p < 0.052$) and acceptance in the community ($\chi^2 = 9.37, p < 0.052$)

The study contacted the project staff at block and district level. In-depth discussion was done with them.

3.1 MAJOR CONTRIBUTING FACTOR TO SUCCESS OF THE MOBILE BASED REPORTING PROGRAM

All of the officials agreed that the program was very clearly designed. The activities are planned in very crisp clear manner, thus they were no confusion at any level about the individual role in implementation of program.

According to the officials the training for the FLW on this mhealth program was very rigorous. It ran over a year, with capsular modules model in it. Every month the training would cover a specified topic.

Post training support was another key to success, it was rigorous.

"We keep handholding till the FLW was able to operate the phone on her own. The FLW were type in vernacular language (Hind) using mobile key pad which was not QWERTY." By Program officer at District Level

Officials cited that the attraction to the new technology (mobile phone) is driving the FLWs to use the mobile phone for reporting. It is a good sign that the FLWs are accepting the new technologies, which gives us hope for the future of wearable mobile technologies.

Relief from the burden of carrying registers with her in the field for recording and reporting was the critical factor for use of the mobile phone for reporting by FLW. FLWs were comfortable with digitized data. They showed same preference towards the soft data.

3.2 MAJOR CHALLENGES

Officials explained the challenges that may hamper the program's success.

Inconsistent mobile network posed a threat to the success of the program. But it is not in the purview of the program to address. So officials choose the best network available in Saharsa district. Mobile phones were malfunctioning, they will do. But the real problem was with the timely knowing that which phone is malfunctioning, timely repairing it and timely delivering it to the concerned FLW. Officials found it hard to deal with this problem.

Another challenge was that of timely data recharge. The phones of the FLW were to be recharged every month. But it did not happened, due to management issues, initially all the 600 phones numbers were given a single vendor for recharging. It took him 15-20 days to complete it. So overall

in the year, the uptime of the phone was of 9 months only. Later two vendors were allocated with each to recharge 300 phones.

“Children of the FLWs were taking phone with them. Some of them are removing the memory card of the mobile and using it in their phone” By Program officer at District Level

One very surprising situation quoted by the district officials. It is about the use of mobile phone by children of the FLWs. It was not envisaged that such a thing would happen. That created problem in data uploading as most of the time phone was with the children. Discussion based on the IEC video could not be conducted with the beneficiary, as the audio and video files are saved on the memory card and software access it from there. But the card is taken out by the children so one cannot play the video. The quality of the discussion with the beneficiary goes down.

3.3 SUGGESTION FOR FUTURE IMPLEMENTATION

Based on their experiences, project officials gave suggestions for the better implementation of the program elsewhere.

Use of mobile should be restricted for official purposes only. Only the data entry software should open on that phone and not any other website. Need to devise a better mechanism to deliver the repaired mobile phone in time to the FLWs, so that the reporting cycle can be followed on time. Mobile phone should be sturdy and a long life. The data recharge should be done on time.

Training was cited as most important by the officials. It must of good quality and post – training follow up should be there.

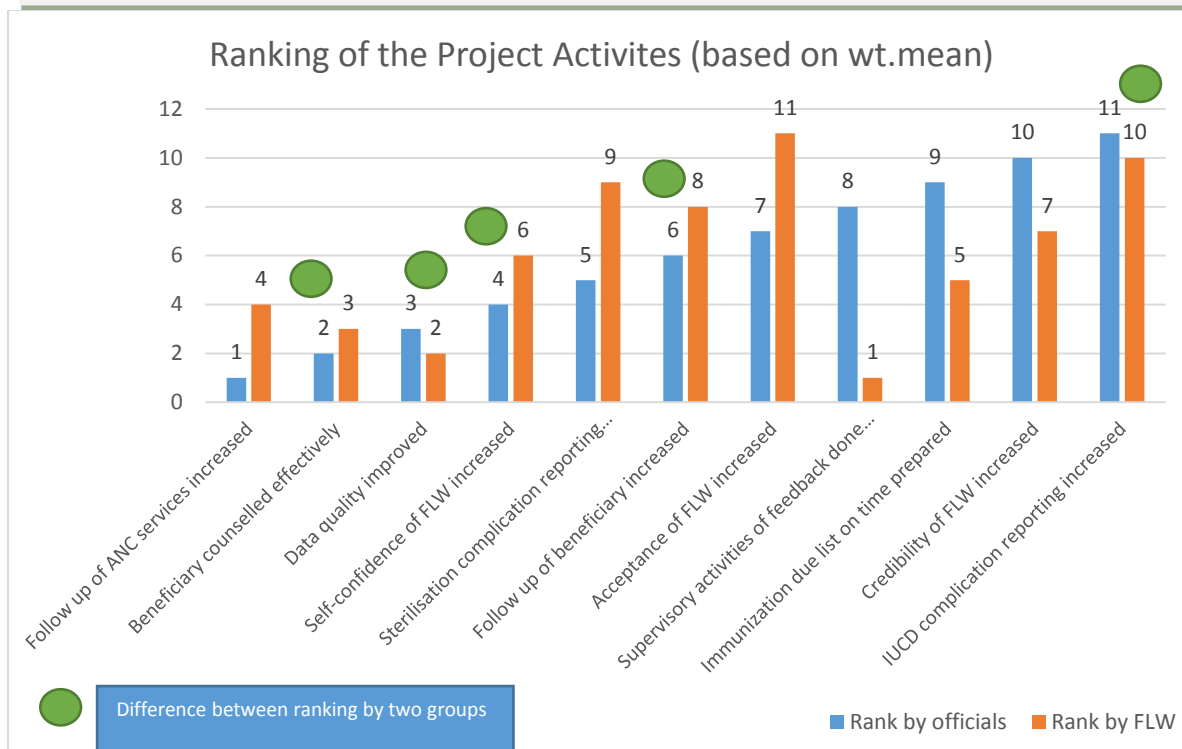


Figure – Two – Ranking of different project implementation aspect by FLW and Officials – a comparison

The comparative analysis of ranking shows that both cadres agreed upon 5 responses out of 11. Both expressed that the beneficiary was counselled effectively using the content stored on the mobile phone. The content on the mobile phone helped the FLW to remain focused on the topic during the interaction with the beneficiary. Also, the beneficiary got the complete and correct information on the topic.

Officials were asked to give responses on a Likert scale to the aspects of the project implementations. The weighted mean of the response to each question calculated and ranged from good to poor scale. The same set of questions was asked to the FLW and their responses were also ranked accordingly. This shows that the learning’s of the project were same across the cadre.

Variable (1=full agree, 5= full disagree)	Rank by officials	Rank by FLW	Mean (officials)	Mean (FLW)
Follow up of ANC services increased	1	4	1.33	1.43
Beneficiary counselled effectively	2	3	1.57	1.43
Data quality improved	3	2	1.57	1.37
Self-confidence of FLW increased	4	6	2.55	1.82
Sterilisation complication reporting increased	5	9	3.15	3.31
Follow up of beneficiary increased	6	8	3.16	2.48
Acceptance of FLW increased	7	11	3.18	3.38
Supervisory activities of feedback done on time	8	1	3.22	1.37
Immunization due list on time prepared	9	5	3.3	1.49
Credibility of FLW increased	10	7	3.61	1.85
IUCD complication reporting increased	11	10	4.2	3.31

Table – Two– Ranking of different project implementation aspect by FLW and Officials

3. DISCUSSION

Strengthening of Health System through Darocracy

- Per FLW 30 days saved (when data come real time, existing is monthly reporting)

18,000 days saved

600 FLW

District

FLW

- ↑ Acceptance of FLW in community
- ↑ Credibility of FLW in community
- ↑ Self confidence of FLW
- On time data
- Hanging of mobile phone

Officials

- Good program Designs
- Supportive supervision
- Lack of timely repair and delivery of mobile phone to FLW
- No timely recharge
- Use of phone by children of FLW

30,00,000 days saved

1,00,000 FLW

State

- FLW to carry out IEC and BCC activity with more impact
- Supervision to become real time
- Real time analysis of data
- Need to develop the mobile application which do not hang

- Improved program design
- Real time supportive supervision
- Develop system for AutoDetect of faulty mobile in the field
- Develop system for timely delivery of repaired phone to FLW
- Need a tie up with any mobile company for timely recharge
- Need to internalise the fact and develop solution for the same

3,81,00,000 days saved

12,70,000 FLW

Country

- Scope to design more effective IEC and BCC initiatives
- Strengthening of supervision of FLW cadre
- Possibility of temporal and spatial analysis
- Application of statistical analysis due to real time data availability
- ↑ value of the data
- Transition to data driven health systems
- Improved managerial functions of the health system
- ↑ Transparency in the health system
- Initiation of Darocracy in Health system

- Need to develop tie ups with mobile company to roll out at national level
- Improved and robust program design to tackle the issue of children using the phone



Figure Three- Strengthening of Health System through Derocarcy

Figure three explains the strengthening of the health system through the use of data. Here data means real-time data. The mobile-based reporting system provides real-time data. It is saving 30 man-days per FLW.

We put this information in the simulation model. The result of it showing that 18,000 man days are saved at district level when there are 600 FLW using the mobile phone for reporting. In the state of Bihar approximately 1, 00,000 FLW are there, thus a saving of 30, 00,000 man days at the state level. At country level approximately there are 12, 70,000 FLWs (considering one FLW per 1000 population), which is resulting in 3, 81, 00,000 of man-days at the national level.

At the state level, there is an opportunity for the health system to get the IEC and BCC activity to be carried out with more impact through the FLW, which have increased acceptance and credibility in the society and which are high on self-confidence after using mobile phone reporting. At the national level, this gives the opportunity to develop more effective designs of IEC and BCC activities.

At the district level, the data is coming on time with the use of mobile phones. This can result in real time supervision and data analysis at the state level. At the national level, this paves the road for development of real-time supervision of the FLW cadre. Also, the spatial and temporal data analysis can be applied as the data is coming mobile phone, so capturing geo-coordinates is easy. Alongside statistical analysis can also be applied. The mobile-based data increases the value of the data by making it available for analysis in real time with good accuracy. The analysis of the data and its use in the system will increase, thus making it data-driven health system. The study uses to describe it as Democracy. Making data online will increase the transparency of the system. It will make the managerial functions more effective.

We need to develop special phones for reporting from FLW, as they should not hang during the operations.

The officials echoed the responses of the FLWs. They need to develop tie-ups at the national level with some telecom company to design the special mobile phones for the country. Also, they need to develop robust program design to tackle the issue of children using the mobile phones.

The paper focuses on mobile-based reporting and its assessment to inform the strengthening of the health system in India. The FLWs working in Saharsa district, in the state of Bihar were contacted for the study. They were using the mobile phone for last 3 years. (2014 to 2017)

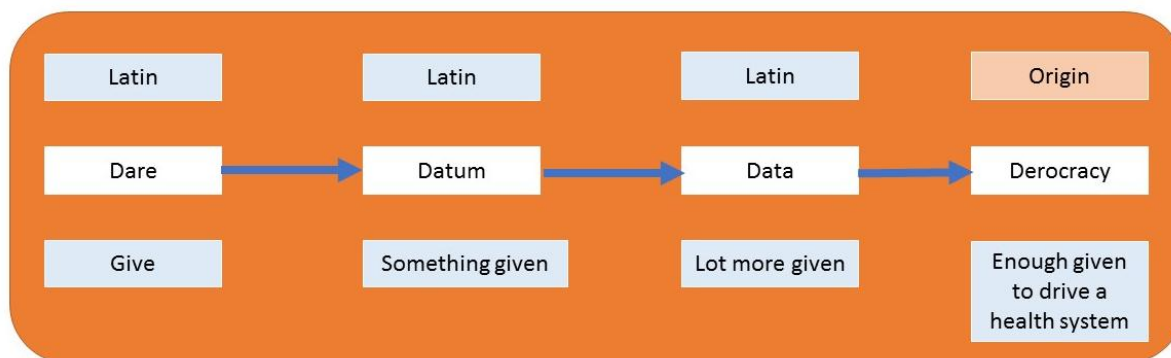


Figure Four – Origin of Derocracy

Derocracy is defined as data-driven health systems. It is derived from the word dare which means to give in Latin, which manifested to datum which means something is given. Data is the plural form of the datum. It conveys the meaning lot more in terms of information is given. So the study proposes a word Derocracy. It is envisaged as the health system running on information provided by data.

Building a mobile-based reporting system is a costly affair. Cost centers for the same are, Mobile phones purchase, Data recharge, Voice recharge, Maintains, Software or application of reporting development, mobile reporting platform hiring, training of the users, replacement of mobile phone at the designated time. Initial significant cost is required to set up the system and then it will gradually decrease over the years.

In terms of value chain initially the cost of the mobile phone is more valued, but as the project runs at full capacity and starts producing quality on time data, then at that time the value of the data increases, thus making it cost effective.

In a state like Bihar, when the data from all of its corner is coming through mobile phone and on time has many good take ups. First, the efficiency of the mobile-based data will increase, thus making it cost effective. Second, a user at the state level can know in a timely manner the non-reporting units, which will help him take the necessary action.

The paper-based system suffers from data errors as one has to manually check them. This is completely automated in the mobile-based reporting system. As a result of the data more accurate. This data can be used for analysis at state and national level. In mobile-based software's the data validation is embedded in the reporting screen, so when user punches the data the validation rule instantaneously tells him/her, if the data entered is right or wrong.

Real-time data availability increases the usability of the data and preserves it values in time. This is very useful for state and national level analysis. The information generated would be available to the decision makers at the right time. Right time here suggests that window of opportunity



COMPLIANCE WITH ETHICAL STANDARDS

Funding: The study is self-funded

Conflict of Interest: Not applicable

Ethical approval: Ethical approval is obtained for the study. It was obtained from the IIHMR University's IRB under the number – PHD2016/2 for a period of Jun 30, 2014 to Apr 25, 2017. The IRB has the Federalwide Assurance (FWA) for the protection of Human Rights under no. FWA00018806.

Informed consent: Informed consent was obtained from the study participants.

The author acknowledges the support provided by the Care India-Bihar team and Uttar Pradesh Technical Support Unit in completion of the study.

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