Real-time Regular Routine Reporting for Health (R4Health): Lessons from the Implementation of a Large Scale Mobile Health System for Routine Health Services in the Philippines

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ABSTRACT

Background. The Philippine government aims for a modern information system to enhance data quality and provide more rational evidence to support timely and efficient delivery of health care, management of health systems, programs and policy. Hence, the Real-time Regular Routine Reporting for Health (R4Health) mHealth application was developed and field tested in 246 isolated and disadvantaged municipalities to support the campaign for Universal Health Care and the achievement of the Millennium Development Goals. The R4Health collected point-of-care-specific data on services routinely provided at the rural health facilities, aggregated them and presented in a dashboard for use by program managers and policy makers.

Objective. This paper describes the use of R4Health, a mobile technology-based health reporting system. It will discuss the context of the R4Health implementation, its development and deployment to 246 municipalities in the Philippines. Furthermore, the paper sought to determine enablers and challenges to the adoption of R4Health in routine health care.

Methods. Data was collected through surveys, focus group discussions, participant-observation and review of project reports. Quantitative data was summarized using descriptive statistical methods; qualitative data underwent content analysis.

Results and Conclusion. A total of 515,855 R4Health reports equivalent to 48,856 patient transactions were received from 246 municipalities within a nine-month observation period, supporting the viability of the R4Health as an alternative option to the existing manual and paper based health information management to improve the quality of data. R4Health utilizes a tool that everyone is familiar with, can easily be incorporated in their workflow, can be brought and used anywhere and has an application that is clear, understandable, and easy to learn and use. R4Health data elements, however, have overlaps with other government health reporting systems and is already misconstrued to further duplicate work. More discussions are warranted to coordinate and integrate systems. Given the general positive perspectives, integration of this alternative system to the RHU workflow, an improved R4Health, has a high potential of being accepted and adopted by the first-line health workers across the country.

Key Words: Mobile health, data reporting, text messaging, routine health information system, technology adoption, community health worker

Introduction

Patient care generates a large amount of data that needs to be collected, collated and reported – tasks that consume a significant amount of time of health workers. A typical urban government health center in the Philippines devotes up to fourteen (14) person-hours to prepare a monthly report on maternal health services alone.[1] This monthly report is just one among the many other forms required for submission as part of the Department of Health (DOH) – Field Health Surveillance and Information System (FHSIS),[1] which reflects the major health services rendered in about 3000 primary care public health facilities nationwide. Recognizing the need for a more efficient health information system, DOH initiated the move towards a paperless scheme with the introduction of the electronic FHSIS (eFHSIS). However, despite the latter, health information management in the country continues to be predominantly manual and paper-based, making data aggregation susceptible to human error, alterations, and loss (due to misplacement and/or physical destruction). Consolidation is also prone to inaccuracies, and submission of these reports become liable to delay, making information outdated and irrelevant.[2]

In 2010, Universal Health Care (UHC) was launched as the health policy direction of the newly-inaugurated Aquino administration to address persistent inequities in health across the Philippine archipelago. The Department of Health, mandated as the overall technical authority on health, recognized that in order to achieve UHC for all Filipinos, a modern information system should be established so as to "provide evidence for policy and

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program development, support for immediate and efficient provision of health care, and management of province-wide health systems".[3] Among the strategies was to systematically move towards eHealth and use information and communication technology (ICT). Specifically identified were the use of telemedicine and mobile health (or mHealth) to provide better health services to geographically isolated and disadvantaged areas (GIDA) and to serve as means to improve health information management in the country in support of the Millennium Development Goals (MDGs).[3] This paved way to the development of the National Telehealth Service Program (NTSP), a strategy embedded in the National Health Objectives 2010-2016.

NTSP's Real-time Regular Routine Reporting for Health (R4Health)

The NTSP, a collaborative and developmental project of the DOH with the University of the Philippines Manila – National Telehealth Center (UP NTHC), was implemented in 2011 in all 259 municipalities of six provinces in the Cordillera Administrative Region (CAR), six provinces in Eastern Visayas (Region VIII), and three other provinces – Romblon, Masbate, and Tawi-Tawi – identified by the DOH as priority sites for NTSP implementation because of their high maternal deaths. The program aims to (1) expand the reach of telemedicine to more GIDA municipalities and (2) establish an mHealth-based real-time reporting system on needed health data from the frontline rural health units (RHU) nationwide. The second objective resulted to the development of the R4Health or the Real-time Regular Routine Reporting for Health.

R4Health is a mobile phone application developed on the Android Operating System (Android OS), which gathers and transmits data elements through Short Messaging Service (SMS). The mobile phone is the ICT of choice for compelling reasons: it is a familiar instrument to the majority of the Filipino people even those in remote areas; the gadget is handy and portable; it is generally more affordable to acquire and maintain its services than a computer-based modality; and, mobile phone network infrastructure across the country is largely available, providing 85.7 mobile-phone subscriptions per 100 Filipinos as opposed to only 10% of Philippine homes with internet access.[4]

Data on nine key UHC-related indicators at the RHU front-lines of care are collected using the said mobile health application. These nine indicators, as reflected in Figure 1, were sought by the DOH Secretary in February 2011 to provide the DOH with fresh and real-time or almost instantaneous data as opposed to the two-year delay of paper-based FHSIS reports.

Among the indicators, one monitors use of RHU services by the beneficiaries of the government's Conditional Cash Transfer (CCT) program, seven are related to the reduction of child/infant mortality and improvement of maternal health (MDGs 4 and 5), and the last reflects the availability of essential drugs at the RHU front lines. Data on these indicators are received and automatically aggregated in the UP NTHC R4Health server, and displayed in a web-based R4Health Dashboard. Figure 2 shows how patient health data is encoded and processed using the R4Health application.

Deployed in 246 of 259 targeted towns, the R4Health has the largest footprint in the Philippines of an mHealth-based reporting system on routine services delivered at the peripheral health centers in the country.

Using ICTs as a solution is often met with problems beyond the technology. eHealth is considered disruptive of the status quo for health workers long used to document using pen and paper, and manually manage data and reports. This paper recounts the R4Health implementation and explored the perspectives of RHU health staff in using it as an alternative mode of data management. It presents operational and policy concerns as lessons in integrating eHealth or mHealth-based modalities in the Philippine health information system (HIS). Envisioned was, if R4Health proved to be an operable alternative mHealth-based reporting, it can be mainstreamed into the DOH information systems.

Objectives

This paper describes the use of R4Health as a mobile technology-based health reporting system, the context of its implementation among the trained rural health professionals, and the R4Health development and implementation. The study also seeks to determine enablers and challenges to adoption of R4Health in routine health care.

Methods

This is a case study on the R4Health, sourced mainly from UP NTHC technical reports throughout the project lifetime (from situational analysis to conclusion of the R4Health).

Theoretical Framework

R4Health is envisioned to be continuously used by health workers as a viable methodology to replace the manual and paper-based reporting system. Green's Precede–Proceed Model[5] of health program planning and evaluation, specifically its three factors that encourage practice of the desired behavior (in this case, use of the alternative mode of health data documentation and reporting), was adapted to explain R4Health use (the desired behavior) by RHU workers. Table 1 shows the three factors influencing technology adoption and how data on these factors were collected.

Sources of Data and Data Management

Figure 3 shows the project phases, their descriptions and data sources; the last phase is the main focus of this paper. UP NTHC technical reports on R4Health, presented periodically

and submitted to the DOH, were obtained for review. Both quantitative and qualitative data were collected and analyzed to meet the objectives of the paper. These include electronic data from the 246 participating RHUs, R4Health sites◎ and users◎characteristics, field notes/reports, interview results and observation data on the actual use of the innovation.

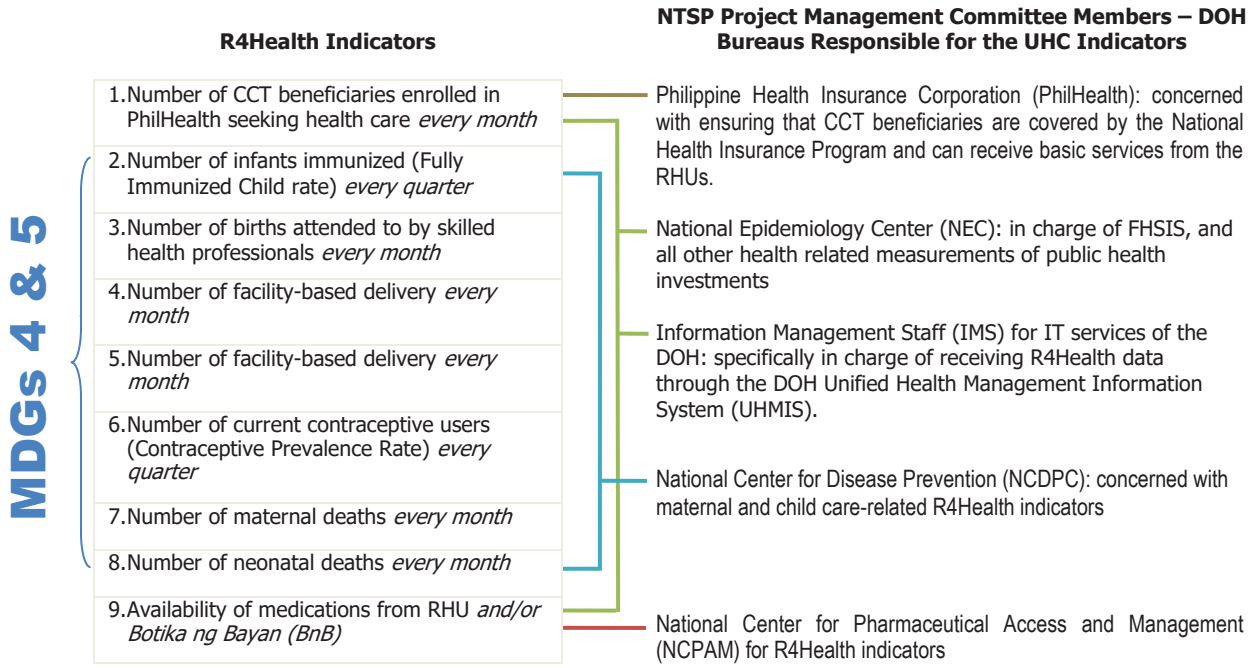

Figure 1. Universal Health Care (UHC) or Kalusugang Pangkahalatan (KP) Indicators Captured by R4Health and monitored by NTSP Project Committee Members – DOH Bureaus.

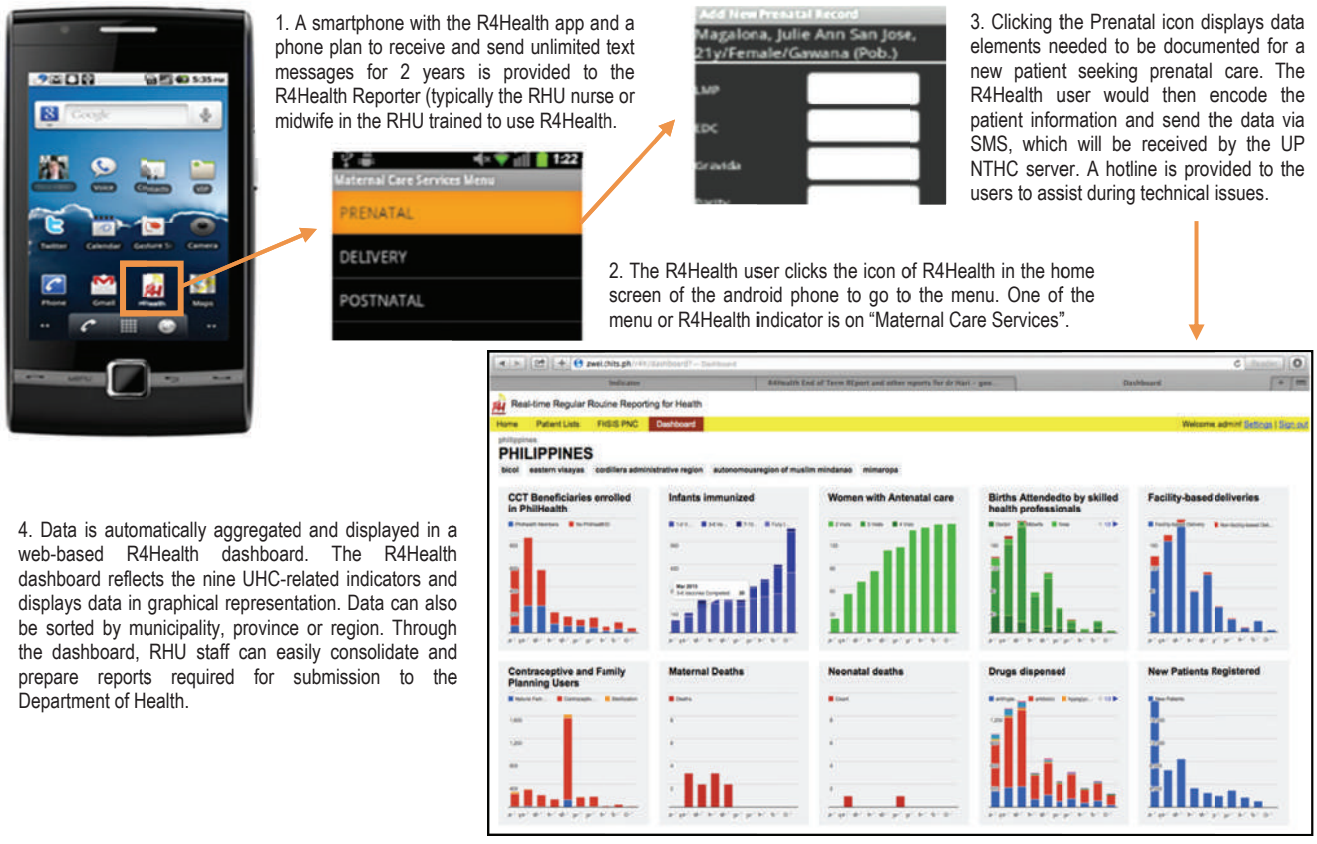

Figure 2. The R4Health Process Flow (from Application to Dashboard).

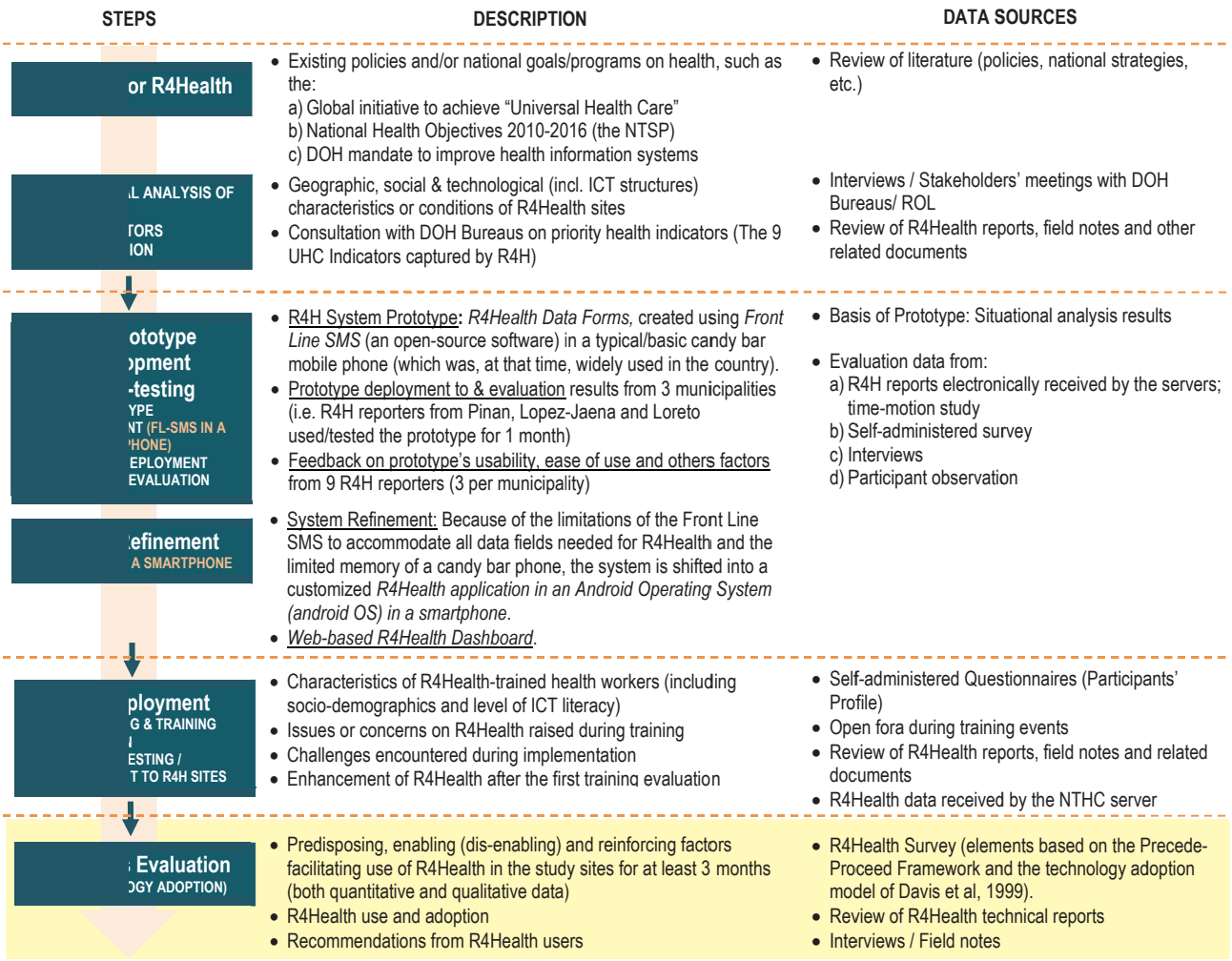

Figure 3. R4Health Project Phases.

Table 1. Predisposing, enabling & reinforcing factors of the precede-proceed model adapted to R4Health use

Factor / Operational Definition	Measurement and Methods of Analysis
Predisposing factors Characteristics of a targeted RHU worker that encourages the desired behavior (of using the R4Health application) prior to or during the occurrence of that behavior. These include an individual's knowledge, beliefs, values, and attitudes towards use of ICTs in their profession.	Measured through a self-administered survey (the R4Health Survey) and qualitative methods (e.g. focus group discussions / FGDs, interviews and review of NTHC documents) using four parameters associated with technology adoption: 1. Perceived usefulness (PU): degree to which the Reporter believes that using R4Health would enhance his or her job performance 2. *Perceived Ease-of-Use (PEU):* degree to which the Reporter believes that using R4Health would be free from effort[6] 3. Relative advantage (RA): degree to which the R4Health innovation is considered by the Reporter to be an improvement of the technology it replaced (paper based reporting).[7] 4. Compatibility (C): degree to which innovation is regarded as being consistent with the R4Health Reporter's existing work values, prior experiences with using phones for professional needs and functions.[8]
Enabling factors Characteristics of the environment that facilitate action and any skill or resource required to attain specific behavior. These include programs, services, availability and accessibility of resources, or new skills required to enable behavior change.	Measured through content analysis of reports, interviews with R4Health end-users, participant observation and focus group discussions. These include the ICT infrastructure in the R4Health communities, training and availability of post-training technical support, policy and program factors (conformity of the R4Health objectives with those of the RHU and its administration), and RHU/local government and DOH rules and regulations that are needed for the implementation and sustainability of the program.[9,10]
Reinforcing factors Rewards or punishments following or anticipated as a result of R4Health use, which serve to strengthen the inclination for R4Health use.	Measured through content analysis of reports, interviews with R4Health end-users, participant observation and focus group discussions. These include social support by peers (co-workers in their RHUs as well as other RHUs) as well as encouragement and modeling by champions, role models or supervisors from organizational hierarchical structures (such as the municipal physician, local government leaders and DOH leaders the R4Health-reporters encounter through the course of the project).[9,10]

Table 2. Characteristics of NTSP municipalities, 2012

Region / *Province*	INCOME CLASS					With CCT Beneficiaries		TYPE		Total Towns in Region / Province	Total Towns Trained, 2012-2013	Towns trained per region/ province over 246 total towns trained	% of Towns Trained per Region / Province
	4th	5th	6th	1st to 3rd	Unknown category	CCT	(No Data)	Rural	Partially Urban				
Eastern Visayas (Region 8)	22	35	3	25	52	96	41	9	127	136	129	52%	95%
CAR	17	31	1	16	10	42	33	25	45	75	69	28%	92%
Romblon	3	9	2	2	1	16	1	1	16	17	17	7%	100%
Masbate	1	1	0	17	1	20	0	0	20	20	20	8%	100%
Tawi-Tawi	2	1	0	8	0	11	0	1	10	11	11	4%	100%
TOTAL	45	77	6	68	64	185	75	35	225	259	246	100%	95%

Data were also collected from the results of a self-administered survey (i.e. the R4Health survey conducted from March to May 2013) answered by 137 R4Health end-users from 50 health facilities. The R4Health survey is consisted of 18 questions, measuring four parameters of *predisposing* factors to R4Health use: perceived usability, perceived ease of use, relative advantage and compatibility. In the survey, the respondents agreement with each question is measured through a four-point Likert scale with a score of "1" as *strongly disagree* to a rating of "4" for *strongly agree*. Respondents' answers were collated and the average score for each item was determined and interpreted. The survey questionnaire was pretested by 15 pioneer R4Health reporters from municipalities in Romblon and Masbate provinces (they were among the first trained, and have been using the tool for about two months already when the pre-test was conducted).

Open ended questions were included in the survey to allow respondents to freely express their thoughts; 91 health workers were interviewed further to clarify their comments. Focused group discussions were also done to explore further ideas and concerns among the RHU staff; up to 115 health personnel were engaged for these. Observations of R4Health users during data collection and reporting are made throughout the 50 field visits, and more in-depth participant observation was conducted in one town each in CAR and Region VIII (Kibungan, Benguet and Abuyog, Leyte, respectively).

Quantitative data is analyzed using standard descriptive statistical methods and qualitative data is evaluated through identification of common themes.

Limitations. This case report does not include systematic study of perceptions of other stakeholders – the DOH NTSP Project Management Committee, DOH Regional Offices, Municipal Mayors, among others. Furthermore, impact on health outcomes is not expected as R4Health implementation was at its early stages at the time of the study.

Results

Characteristics of the R4Health Sites

R4Health was implemented in 246 out of the 259 (or 95% of) municipalities chosen by the DOH as priority pilot sites for the NTSP. Selected were GIDA towns, with high Maternal Mortality Ratios and sizable beneficiary populations of the Conditional Cash Transfer (CCT) program. The latter is the national government's human development and anti-poverty strategy, patterned after the CCT schemes in Latin American and African countries.[11] Table 2 summarizes social characteristics of these target communities.

A. Geographic and social characteristics that contribute to health inequity

Of the 259 target towns, 87% is considered partially urban, 71% have CCT beneficiaries, and about half (49% of towns) are considered poor (i.e. considered 4th to 6th economic income class type of municipalities).

Geographically, Cordillera Administrative Region (CAR) has a mountainous terrain and many of its towns become especially isolated in inclement weather, making health service delivery difficult in the area. The Eastern Visayas Region (Region VIII), on the other hand, lies on the eastern side of the country and faces the Pacific Ocean. It is subject to the numerous annual typhoons that hit the Philippines, many of which are devastating to the poor who typically live in homes made of light materials. Several municipalities are also inland – accessible only through long river rides. Romblon, Masbate and Tawi Tawi, the other three sites for R4Health implementation, are island provinces, whose health and social concerns are due, to a large extent, to their geographic isolation. Insurgency is also a social-political problem in most of the R4Health sites, specifically in CAR, Eastern Visayas and Masbate.

B. Available infrastructures

A rapid assessment of telecommunications status and ICT capacities in the selected implementation sites was

undertaken through (phone) interviews with municipal health officers referred by the DOH Regional Office Provincial Health Team Leaders. A total of 181 respondents out of the targeted 259 Municipal Health Officers or RHU physicians (70%) were reached for this rapid assessment.

Like in any technology, availability of electricity is a major factor to consider in the implementation of R4Health. Majority of the targeted towns have round the clock electricity; although, some use gas-operated generator when there is power outage. Limited electricity supply (e.g. available only for six to 12 hours at night when RHUs are closed) due to isolation and distance from the main power lines is reported in some island and inland municipalities. Despite the reported variable availability of electricity, all 181 phone interview respondents report that they are able to regularly charge their personal mobile phones. Training participants also affirmed these accounts.

As for ICT availability and use, ICT gadgets, such as laptops, desktop computers, printers and mobile phones, are largely available for use by RHU staff. All towns, except one in Tawi Tawi, have at least one of these gadgets. Majority (120 of 246) of these towns have at least three or four gadgets for official use. However, none of the sites have an official written policy on ICT use for health; although the presence of ICT tools for use of the RHUs in majority can signify support by RHU and/or the local government leadership.

Majority of the health workers also own personal mobile phones for communication needs (i.e. used for texting and calling). Though many towns reported inadequate coverage by cellular towers due to their remoteness (such as in the case of island and mountain communities), the difficult terrain (i.e. mountains, inland rivers), and sporadic presence of armed groups who threaten to destroy cellular towers, all municipalities covered by R4Health have at least one strong mobile phone signal in the town proper, where the RHU is located. Designated R4Health Reporters are able to send mobile reports in these areas during the study period, affirming R4Health use despite unfavourable technology, social and geographic circumstances.

Use of the R4Health: Reports Received from August 2012 to May 2013

The total volume of reports received from the 246 R4Health municipalities trained on the R4Health was 515,855 within a nine-month period (August 2012 to May 2013). This is approximately 1,725 reports per day from all the RHUs or seven reports per RHU per day. Each patient transaction is equivalent to a registration (where a patient's demographic information is entered) with the specific health service rendered, corresponding to any of the nine UHC indicators. A single patient transaction is about four to twelve SMS reports, depending on the type of service reported. Figure 4 shows the cumulative total of reports received from the frontline health facilities on services delivered from August 23, 2012 to May 31, 2013 while Figure 5 reflects the distribution of these received reports per province.

Characteristics of R4Health Trainees, August 2012 to March 2013[12]

From August 2012 to May 2013, 269 participants joined 11 training events on R4Health: 166 nurses (62% of 269 participants), 44 doctors (16%) and 45 midwives (17%). In terms of ICT readiness, a modest majority (55%) consider themselves to have *intermediate ICT skills* – i.e. own or have used a smart phone, can type text files using a computer at an average of 20 words per minute, and can send and open an email. Table 3 describes the characteristics of these R4Health trainees.

Table 3. Characteristics of R4Health trainees: type of health worker, ICT literacy and distribution per R4Health site

		R4Health Regions / *Provinces*												
		Region VIII		**CAR**		*Romblon*		*Masbate*		*Tawi-Tawi*		**TOTAL (%)**		
	Year Trained	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	Total (%)
TYPE OF HEALTH WORKER[A]	MHO/ RHP	19	2	14	0	2	2	5	0	0	0	40	4	44 (16)
	RN (PHN, Nurse I-III)	71	16	32	13	11	1	13	0	9	0	136	30	166 (62)
	RM (Midwife I to III)	27	5	5	4	1	0	3	0	0	0	36	9	45 (17)
	Others (RMT, Sanitary Inspector, DOH representative)	6	0	2	5	0	0	0	0	1	0	9	5	14 (5)
	Subtotal	123	23	53	22	14	3	21	0	10	0	221 (82)	48 (18)	269 (100)
	Total (%)	146 (54)		75 (28)		17 (6)		21 (8)		10 (4)		269 (100)		
ICT LITERACY[B]	Beginner	22		7		3		4		3		39 (21)		
	Intermediate	51		26		9		7		8		101 (55)		
	Advanced	16		4		6		6		1		33 (18)		
	No Answer	2		6		4		0		0		12 (6)		
	Total (%)	91		43		22		17		12		185 (100)		

[A] Health Worker Positions: MHO-Municipal Health Officer, RHP-Rural Health Physician, RN-Registered Nurse, PHN-Public Health Nurse, RM-Registered Midwife, RMT-Registered Medical Technologist

[B] ICT Literacy is based on the collated User Profile forms filled up by 185 R4Health Trainees.

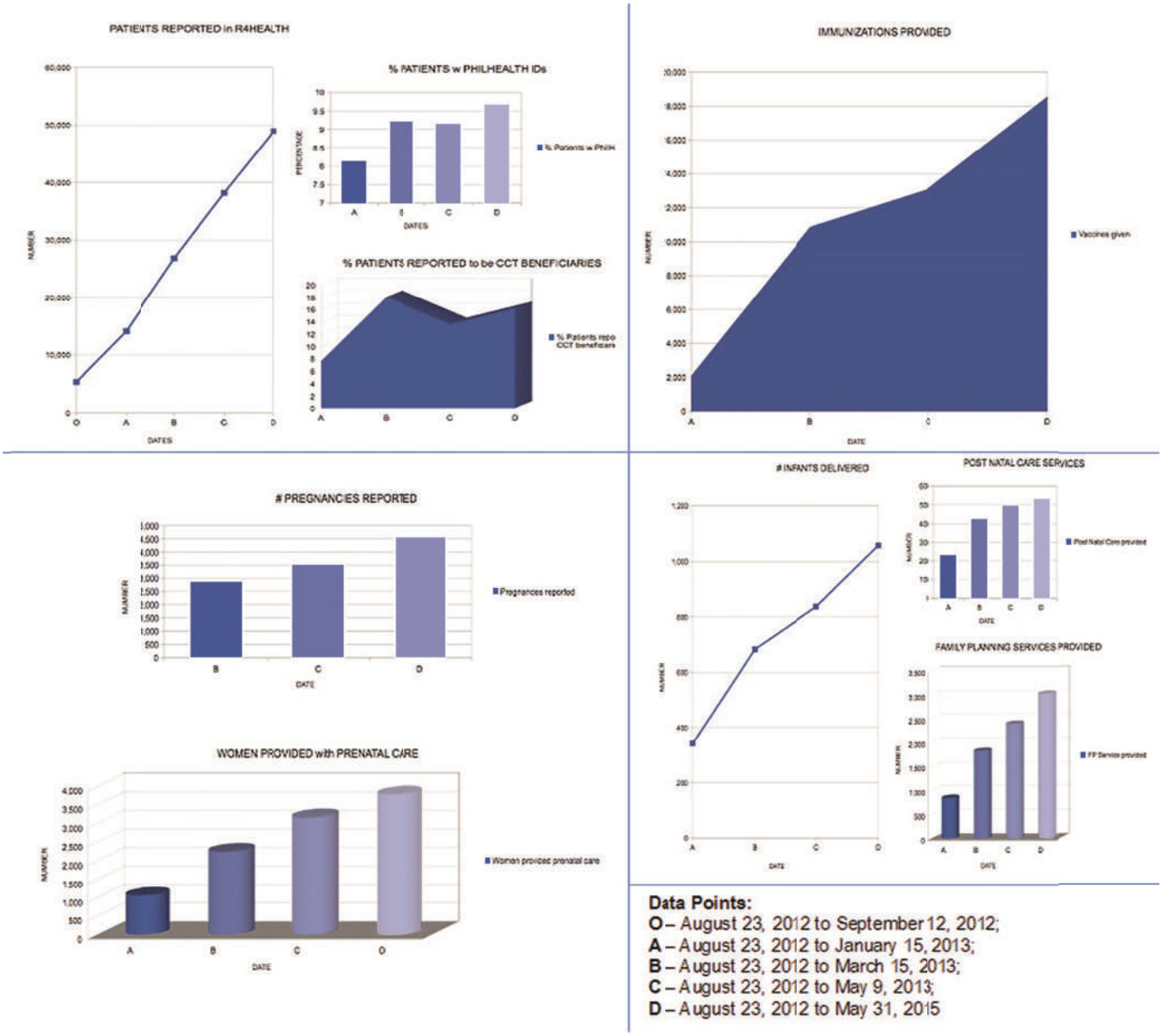

Figure 4. Cumulative data reported through R4Health on services provided by 246 RHUs (August 2012-May 2013).

Characteristics of R4Health Survey Respondents

Data was collected from March to May 2013 from the RHU staff of 50 municipalities (Table 4), representing 23% of total eligible towns (i.e. towns with R4Health reporters trained in 2012 and with at least 3 months of R4Health use) and 20% of all 246 towns trained for the project. These towns are purposively chosen due to proximity to each other, accessibility from provincial capitols where catch up training events on the NTSP are conducted, and limitations in project funds.

A total of 137 respondents from the 50 municipalities visited completed the R4Health survey. Whereas only one R4Health Reporter per RHU was trained, other RHU personnel were taught by the R4Health Reporters albeit informally. The former became Reporters themselves and were also enjoined to provide views on R4Health. Hence, though only 50 R4Health Reporters were formally trained by the UP NTHC in these 50 municipalities, 137 identified themselves as R4Health users and performed the same function of documenting and reporting patient care data using the R4Health phone. They were included in the study as respondents.

Majority of the R4Health survey respondents are females, nurses, and served an average of 14 years in government. Respondents are almost equally distributed within all the working age ranges between 20 to 59 years old (Figure 6). All of them are current mobile phone users. Their characteristics essentially reflect the demographics of the R4Health trainees themselves, except that the study involved more RHU staff who are younger than the trainees (20-29-year-old age range) since local governments typically

send the more senior staff (of age 30 to 50 years and with permanent items) for training. RHUs, however, are government deployment sites of the DOH program for young graduates of nursing and midwifery schools who render service but receive salary from the national government. More of these younger health workers were able to participate in the study survey.

Table 4. Distribution of R4Health survey respondents per region / province

Region/ *Province*	Number of eligible towns whose R4Health reporters are qualified to be included in the R4Health Survey*	Survey Participants [f (%)]	
		Number of eligible towns represented by survey respondents	Actual R4Health Survey Respondents
CAR	53	16 (30%)	39 (28% of respondents)
Region 8	120	18 (15%)	64 (47%)
Romblon	14	7 (50%)	11 (8%)
Masbate	20	5 (25%)	18 (13%)
Tawi-Tawi	10	4 (40%)	5 (4%)
TOTAL	217	50 (23% of total eligible towns)	137 (100%)

*Eligibility criteria: Towns from each region/province trained as of 2012 AND have at least 3 months of R4Health use by March 2013. R4Health reporters from these eligible towns were invited to participate in the survey. Legend: f – frequency or number of respondents, % - percentage

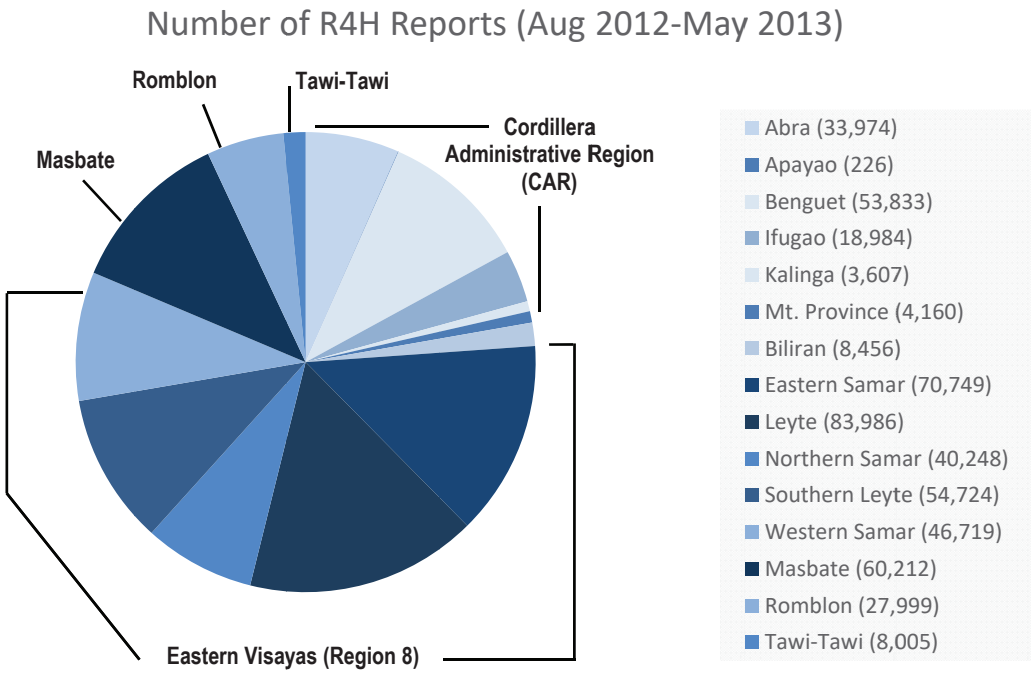

Figure 5. Distribution of R4Health reports per province (2012-2013).

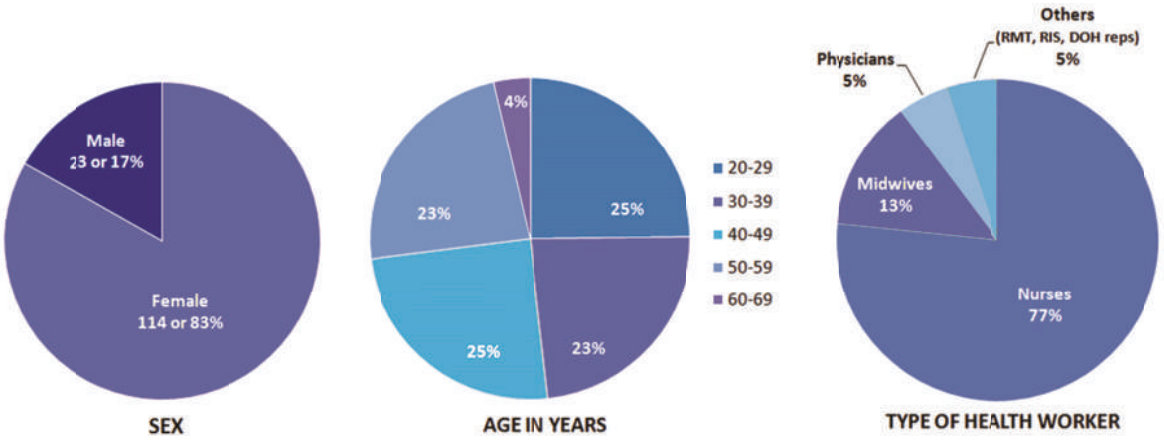

Figure 6. Socio-demographic characteristics of R4Health survey respondents.

R4Health Survey Results: Factors affecting R4Health use

Based on the R4Health Survey, respondents only moderately perceive R4Health as useful, easy to use, compatible with their work tasks and roles, and provides a relative advantage over the current manual and paper-based system. That is, 46% to 69% of respondents agreed with these statements, with a range of scores (or weighted means of) 2.40 to 2.77, where the highest score of 4 means "strongly agree" (Table 5).

Noteworthy is the perceived *relative advantage* of R4Health score of 2.4, which means the R4Health is generally viewed to be better than the existing manual and paper-based data capture and reporting system. On perusal of the two aspects of this parameter, majority (up to 69%) finds the use of phone as a good alternative to the current manual and paper-based reporting but an even bigger majority (up to 86%) still considers R4Health a repetition of other tasks in the health center.

Table 5. Analysis of R4Health survey

Parameter	Survey Question	Weighted Mean (SD)/ parameter/ Interpretation	Interpretation	Weighted Mean/Item	Results SA (%)	A (%)	D (%)	SD (%)	NA
Perceived Usefulness	1. Using R4Health in my work enabled me to accomplish my tasks more quickly	2.60 (0.11) Agrees at R4Hs usefulness	Agree	2.66	7%	56%	31%	5%	1%
	7. I was able to do more with the use of R4Health		Agree	2.46	0%	46%	42%	4%	8%
	9. R4Health made the preparation of FHSIS reports easier		Agree	2.57	7%	40%	47%	0%	6%
	10. The generated reports from the R4Health submissions I made will be useful for the FHSIS reports that I need to make.		Agree	2.53	0%	47%	41%	0%	12%
	13. Using R4Health enhances my effectiveness as an RHU staff		Agree	2.73	9%	52%	35%	0%	4%
	14. Using R4Health made my work easier		Agree	2.44	0%	46%	46%	4%	4%
	16. I found R4Health useful in my work		Agree	2.71	0%	69%	28%	0%	3%
	18. The phone was useful for other purposes		Agree	2.67	0%	58%	29%	0%	13%
Relative (Perceived) Advantage	2. R4Health is *NOT a repetition* of other tasks in the health center	2.40 (0.70) Agrees at R4Hs relative advantage	Disagree	1.90	0%	12%	64%	22%	2%
	11. Compared to paper-based reporting, the use of cellphone is a good alternative to putting together or aggregating data for requirements of DOH and PhilHealth (some FHSIS reports, ComPack and PCB package)		Agree	2.89	16%	53%	26%	0%	5%
Perceived Ease of Use	3. Operating the R4Health phone is easy	2.77 (0.18) Agrees at R4Hs ease of use	Agree	2.88	17%	51%	29%	0%	3%
	6. I found the R4Health phone application *NOT difficult* to interact with		Agree	2.58	0%	56%	40%	0%	4%
	8. The R4Health phone application is clear and understandable		Agree	2.99	14%	69%	15%	0%	2%
	12. I found R4Health easy to use		Agree	2.83	12%	56%	28%	0%	4%
	15.I found it *NOT difficult (easy)* to get R4Health phone application to do what I want to do		Agree	2.54	0%	51%	44%	0%	5%
	17. It was easy to become skillful at using the R4Health phone application		Agree	2.82	7%	61%	24%	0%	8%
Compatibility	4. Using R4Health made it *NOT difficult (easy)* to perform my work	2.59 (0.11) Agrees at R4Hs compatibility	Agree	2.52	1%	51%	41%	3%	4%
	5. R4Health was easily incorporated in my work		Agree	2.72	5%	58%	32%	0%	5%
	10. The generated reports from the R4Health submissions I made will be useful for the FHSIS reports that I need to make.		Agree	2.53	0%	47%	41%	0%	12%

SD = Standard Deviation; SA = strongly agree, A = agree, D = Disagree, SD = strongly disagree; Scoring System: SA=4, A=3, D=2, SD=1;
A weighted mean of greater than or equal to 2.0 is interpreted as "agreement to the corresponding statement/parameter" while a value of 1.99 and below is interpreted as "disagreement to the corresponding statement/parameter". Highlighted percentages reflect equivocal results (which means that approximately the same number of respondents agreed and disagreed with the statement/s).

Results of other field data: FGD, Interviews and Observations

Recurring themes gathered through qualitative methods (i.e. FGDs, interviews and participant observation) are categorized to factors that predispose or reinforce use of the R4Health.

A. Predisposing Factors

Perceived Usefulness. There is recognition among the RHU staff of the need to provide timely and accurate data. Majority view mobile phone-based reporting (R4Health) as a better alternative to paper-based reporting. They found the R4Health application useful in their work. A modest majority found the system beneficial for reporting FHSIS data and found it easy to integrate with other reporting systems. It was useful for other purposes too as it supplemented RHU, and even personal, communication needs, aside from serving as a tool for reporting the R4Health indicators. Almost all agreed that R4Health should be replicated in other RHUs.

Ease of use. The mobile phone is reported to be easy to use despite some degree of learning required, especially for those who are not used to phones without keypads (note that the R4Health phones have touch screens). However, some respondents shared difficulty in using the R4Health phone because of its small keypad and display screen. One reiterating suggestion is to change the device from mobile phone to laptop or tablet.

Similar to the results of the R4Health survey, R4Health reporters who participated in FGDs and interviews viewed the R4Health application (program) as clear and understandable.

Designated RHU R4Health Reporters also shared that they engage colleagues who also manage health data to use the R4Health phone to report on the services they have rendered to patients.

Relative Advantage and Compatibility with Work. Majority of participants in the FGDs perceive R4Health as beneficial, especially with regard to the convenience in reporting of health data (i.e. documentation of patient care). This perceived advantage is further sharpened when respondents acknowledged their common experiences and difficulties relating to their tasks as field health workers (these experiences include going to distant barangays due to lack of transportation allowance, limited means of transportation and physical barriers such as in cases where motorboats or other means of transport are required to reach the area). Participants reported that R4Health helps them in their reporting since they can do it anytime and anywhere, and allows easy monitoring of patients and retrieval of their records even in times of black outs.

While a potential replacement of the current system, almost all consider R4Health a repetition of other tasks in the health center – a perceived disadvantage of this program. Implementers said that R4Health only captures a segment of the FHSIS, thus manual and paper-based FHSIS reports preparation and then copying tallied totals on the eFHSIS remain to be DOH requirements. The latter have specific administrative orders which health workers try to comply with, in addition to the R4Health report. Despite advantages of R4Health – potential and experienced – most of RHU personnel interviewed agreed that R4Health reporting added onto their workload.

Another challenge reported is the lack of feedback from UP NTHC or from the program on receipt of R4Health reports. One R4Health Reporter from Abuyog, Leyte (Eastern Visayas) stated, *"At times, I am not sure if I already sent a specific set of data, since I do not get a feedback or sometimes the phone hangs... So I repeat the data recording and reporting."* The R4Health application does not have this automatic feedback feature in the deployed beta prototype version.

Familiarity with other electronic health information systems. All respondents in group discussions verbalized familiarity with other DOH electronic health data reporting systems such as the Surveillance in Post Extreme Emergencies and Disasters, Philippine Integrated Disease Surveillance and Response, and the Electronic FHSIS (eFHSIS); the latter two are already deployed web-based reporting systems of aggregated notifiable diseases and FHSIS reports.

B. Enabling and Dis-enabling Factors

The use of "textblasts" from the UP NTHC as information channels was found to be an enabling feature of the R4Health as it provided the reporters with fresh news about varied health topics and reminded the health workers of their link with researchers in Manila, and thus encouraged R4health use. Furthermore, many shared that the "hot line", manned by the UP-NTHC staff which are able to answer their needs regarding the R4Health, is helpful.

In many of the towns visited, LGU and DOH support for modern information systems is seen in the availability of computer systems for the RHUs. However, health workers were quick to point out that only those who are considered proficient use computers were the ones specifically tasked to prepare reports for town, the DOH Regional (and some Provincial) Health Office leaders, and others who might need reports.

Almost all towns report having regular monthly mobile phone budget for most RHU staff if not all.

One reported dis-enabling factor is that there is only "one R4Health phone to be shared by many health workers". The NTSP issued only one phone per RHU, which became a rate limiting step to real-time reporting. In Kibungan (in CAR), rural midwives who render care in distant villages typically report to the main RHUs towards the end of the month. "It takes about two to three days every end of the month when we send the R4Health data. Midwives 'line up'

and take turns to use the cellphone", they reported. The official designated R4Health Reporter (the Nurse) also confirmed this; "When the barangays are distant from the RHUs, I do not immediately get the data from the midwives", she said. In contrast, the R4Health Reporter from Abuyog (Eastern Visayas) send the SMS report as soon as data from rural midwives assigned to villages provide them; in this municipality, field based workers easily travel to the main RHU. Delayed submission of reports by some Rural Midwives causes the delay of these R4Health SMS-based reports. While effort was made to capture services from all barangays, health workers admit missing out reporting at several points over the project period because of the stated issue.

Another dis-enabler is with regard to technical problems with the cell phone type or R4Health application. In almost all towns issued with a cloud phone model, RHU staff raised concerns about the capacity of the phone to process the data: "When we report patients one-after the other and many of us use it, the phone hangs, freezes or becomes unresponsive."

Furthermore, while the DOH Administrative Order on the NTSP (which, include R4Health) was drafted and began to be discussed prior to R4Health training and deployment, it was never promulgated within the project period. Hence, its enabling power was never experienced.

C. Reinforcing Factors

One nurse from CAR and a local chief executive from Eastern Visayas expressed their views that the R4Health can be a tool to "check on" or monitor the attendance of and services rendered by the Rural Midwives deployed to the barangays remote from the RHU. Although these were verbalized, no policy was actually made to impose R4Health use in its pilot implementation phase in these towns.

Despite the duplication of tasks, the RHU staff followed the "DOH order" to implement R4Health as they deemed it to be implied when they were invited and trained on R4Health use. This reinforced the use of the mobile technology. Furthermore, the DOH Representatives, when possible, monitored the use of the R4Health within the immediate three to six months of its implementation. The DOH Regional (and some Provincial) Health Office leaders also participated in the NTSP – R4Health orientation, training, and results presentation events.

Discussion

R4Health was implemented widely in 246 municipalities out of 1500 rural towns nationwide – the most widespread deployment of a mobile phone application on routine health services. Yet, as an evolving tool, the R4Health would be categorized by the WHO, at best, as a *pilot* implementation of a mobile technology.[13] R4Health, like other mobile health technologies, has the potential to improve healthcare in low-resource environments of developing countries, such as the Philippines.

ICTs, if aligned with the local cultural, environmental, organizational, economic and political conditions as well as properly designed and implemented, can generate favorable health outcomes: improved access for communities in remote areas to health care, support of healthcare professionals, real-time disease surveillance, health data management and sharing.[14] For an archipelago like the Philippines, ICT innovations can serve as the bridge to address the widening inequity of access to quality health services in the country.

Mobile phones are already an integral tool in our society. There is promising evidence to suggest that mHealth can be used to deliver increased and enhanced health care services to individuals and communities, while helping to strengthen health systems.[15] In general, the use of mobile technology in health is still emerging; most projects have only been recently implemented, or are in a pilot stage and their duration is too short to be able to accurately measure their impacts.[16] These have yet to translate into significant mHealth policy investment. The low uptake likely stems from a lack of evidence of the scalable, sustainable impact on health indicators.[17,18]

Along with more sound evidence, another key challenge is moving mHealth approaches from pilot projects to national scalable programs while properly engaging health workers and communities in the process. Adjusting to new systems and technologies is not easy. In a study evaluating Thai electronic information systems,[19] the authors found that more than 40% of information technology projects in various sectors, including the health sector, have failed or abandoned. Among major factors leading to this failure is the inadequate understanding of the socio-technical aspects of the technology, particularly the understanding of how people and organizations adopt information technology.[19]

The R4Health Adoption

Across nine months of R4Health's field test, there were incremental increases observed in reports received from the RHUs, resulting to over half a million reports received by May 2013. The survey, interviews and FGDs also point to the overall positive features and perceived positive effects of the R4Health.

Among the 137 R4Health Survey respondents, only 50 R4Health users were trained formally. The latter then trained the other 87 health workers to share in the work of patient care documentation and reporting. This is a 174% increase in users within three months, which can also imply that teaching and learning how to use the R4Health application is apparently easy enough. This reflects an encouraging trend towards technology diffusion.

A. Factors Influencing Adoption of R4Health: Predisposing Factors

Socio-demographic elements can influence technology adoption. Among R4Health users, majority are college graduates, and all are formally employed as frontline health workers in the RHUs. Schmidt and Stork, in their study, identified completion of secondary and tertiary education as a good indicator of ICT use, regardless of income and employment status.[20]

Predisposing factors, which include perceptions of usefulness, ease of use, relative advantage and compatibility with the RHU work, were also found to affect acceptance and use of the ICT. Perceived ease of use and usefulness of an introduced technology are proven to predict acceptance, adoption and use behavior.[21]

Perceived usefulness. Majority of end-users agree that R4Health enables them to accomplish tasks more quickly and enhances their effectiveness as RHU staff. They found the mobile phone with the R4Health application useful in their work. Furthermore, the R4Health project has instilled beginning realization among the RHU staff of the need to provide better quality data that is legible, complete, and timely. They see the potential of a full electronic system hastening their work – capturing data as soon as patients are attended to in about 45,000 municipalities nationwide. R4Health users also recognized additional uses of R4Health aside from its primary documentation and reporting functions, such as receiving health information updates through the "textblasts" sent by the UP-NTHC.

Despite challenges, almost all agreed that R4Health should be implemented in other RHUs. They also expressed hope that the R4Health would expand to cover more (and even all) data points of the FHSIS to lessen the time of data report generation as it eliminates multiple entries of same reports.

Perceived ease of use. The R4Health application is reportedly easy to learn and use. Many attributed this to their familiarity with mobile phones as all respondents have owned and used mobile phones in one way or another. While the basic candy bar type of phone is ubiquitous, a modest majority of the RHU health professionals have already began using smartphones, which have additional engaging features (e.g. clearer camera) and emerging affordable options. The skills in navigating through their own phones were found to be transferrable, extended to navigate through the R4Health application.

Perceived relative advantage and compatibility. R4Health is found to be relatively compatible with tasks at the RHU. Majority of R4Health users found it easy to perform their work and incorporate R4Health in their work.

Given the general positive perspectives on R4Health's usefulness, ease of use, advantage and compatibility with RHU work, integration of this alternative system to the RHU workflow, an improved-R4Health, has a high potential of being accepted and adopted by the first-line health workers across the country. However, challenges and issues relating to the use of this technology must be addressed to further enable R4Health adoption.

Perceived Challenges in R4Health Adoption. R4Health users acknowledged R4Health as a potential replacement of the current paper-based system. However, one pervading issue raised is that R4Health only captures a segment of the FHSIS, which necessitates the RHU staff to do manual and paper-based preparation of FHSIS segments required by the DOH that are not included in the R4Health system. This is reported as the reason why R4Health is considered by all respondents as a repetition of other tasks in the health center and an addition to their workload. Thus, majority of RHU reporters suggested integration of the R4Health in the current FHSIS.

Further difficulties expressed are on the phones' small display screens, as well as having to use flat touch screens instead of the more tactile keypad, which health workers were used to. These features can be addressed in the near-future as the R4Health government-issued phone can be replaced by tablets or phablets that would allow for larger fonts as these become more affordable equipment options. Concerns similar to this should be regarded closely, especially in the light of the more data input required in this work-related task as opposed to the social nature of the phone.

Though the R4Health project incorporated games and adult learning methodologies as strategies to add value to R4Health, steps to further prime the RHU staff to test and adopt the R4Health innovation are still needed. mHealth use is formally required of them for the first time; adjustments are natural, the health workers should be supported by organization and policy changes. Gadget features can contribute to ease of use and engage people but it can also frustrate the end-user. The added features of the smart phone, such as its clearer camera which Filipinos can use to document and take pictures or videos, and its use as a supplementary communication line for work-related and social functions are technology traits that must be capitalized upon by government to further encourage the use of mHealth like R4Health.

B. Enabling Factors to R4Health Adoption

Presence of ICT infrastructure. The ICT infrastructure is fundamental to the development and successful adoption of electronic health information systems. The R4Health demonstrated the efficacy of an mHealth-based innovation in improving health information management even with infrastructure challenges that characterize the targeted poor GIDA municipalities. Albeit many of these towns are already described to be partly urban, challenges remain such as unstable electricity and intermittent mobile phone signals, difficulties in physical access to deliver services due to the

island or mountainous terrain in component villages, as well as sporadic eruptions of violence between the army and insurgents.

Mobile phone as the medium for R4Health. It helps that the new technology introduced is in the form of a mobile phone, which is a familiar and commonly used ICT. Since mobile phones by nature do not need to be constantly connected to an electrical source or its phone line, data capture or reporting continued even during black outs. Mobile phone signal issues are addressed by providing a SIM card of the network provider identified by the users as having the most coverage in the area.

Use of the R4Health application is further enabled by the project-supplied mobile phone, bundled with unlimited SMS for sending reports (with one-year subscription provided by the Project). The challenge is sustaining its use when project funds dry out. The Project is premised on demonstration of its viability as a cogent alternative to status quo that local or even national government would want to continue to support it. The PhilHealth Primary Care Benefits Package is also an available source for local governments to finance R4Health beyond the field implementation phase. The Project observation period was not long enough to demonstrate issues related to financing, however.

Three other contributing factors to the adoption of R4Health are identified: first, the training strategy, which extensively used adult learning participatory strategies and hands-on workshops where trainees were coached closely to build needed skills to navigate effectively through the R4Health application.[12] The second is the presence of the support lines or help lines by the UP NTHC to answer the needs of the end users. The use of "textblasts" (i.e. sending a SMS to a large number of people) as an information channel for reminders and basic information was noted to be helpful in encouraging frontline health workers to continue using the alternative reporting system.

R4Health is a viable and practical tool for health data capture and reporting, a workable alternative to paper-based system, and the medium is also easy to use despite some degree of learning required. In the context of 22.9% internet access by the Filipino populace at the time this Project concluded (in 2013),[22] it also validated that SMS remains the most practical standardized communication protocol for data exchange, especially in GIDAs.

Dis-enabling factors. There are some real and practical concerns regarding the actual mobile phone appliances used. These range from physical features, such as the size of the screen or the lack of a keypad, to the actual capacity of the technology, which is pushed to the limit, "forced closes" when there is apparent "excessive" use within a certain period of time. As previously discussed, the type of gadget can encourage or discourage continuous use of the introduced technology. Future implementation should give equal careful attention to the type of hardware that delivers the innovative application.

Having only one mobile phone per RHU is a major limitation of R4Health in achieving any form of "real-time" reporting. This becomes especially pronounced in GIDA, where access to the main health centers is often limited. The hub-and-spokes model of the Philippine health care delivery system means health personnel are distributed and physically based in remote villages to render care. These remote health workers still use the paper-based documentation system and enter patient records on their return to the main health facility once a week or a month. In that sense, real-time documentation of services at the point of care is only limited to the main R4Health reporter who is usually based in the RHU.

The R4Health application was successful in that it compels the health workers to supply the needed data points that provide proof of the quality of services rendered. Digital documentation allows audit or external evaluation. In that sense, R4Health was able to improve quality of health information management at the front lines. However, some village-based health workers admitted lapses in reporting their patients through the R4Health upon their return to the RHUs. The "one phone, one RHU" arrangement in this Project has thus limited improving completeness of data reported *per RHU facility*. The potential benefits of R4Health, as a true alternative, will further be established if each and all health workers are provided their own R4Health phone as they render care in the remote villages.

Also, another missing significant element is an enabling policy for mHealth – and eHealth for that matter, in the country. The nine-month field test elucidated the need to clarify further and urgently the relationship of the UHC indicators captured by R4Health (and requested by the DOH Secretary) with the FHSIS data collection systems (including the eFHSIS), managed through DOH's bureaucracy. While R4Health is shown to be a viable alternative to managing a subset of the FHSIS, better integration is warranted so as not to address the inadvertent duplication of work R4Health introduced. The Directors of relevant bureaus of the DOH and Regional Offices acknowledged the accomplishments of the field research project, however a review of policy and organizational procedures are needed at this point. At the time the project period concluded, the draft Administrative Order on the NTSP as a policy to boost continuous and institutionalized use of R4Health was still under public discussion.

Another challenge to eHealth adoption is the lack of interoperability among electronic information systems developed within the DOH, as well as with other government agencies. In a study of three countries by an independent consulting group on socio-economic impact of mobile health, they found out that despite having established eGovernment systems in these countries, none

has developed a similar policy toward health that could help drive forward standardization. This is similar to the Philippines, where eGovernment systems have already been started but are only limited to single agency transactions with almost no inter-agency mechanisms. The full impact of ICT benefits in healthcare will only be realized if it is systematically incorporated in the national eGovernment framework. There is also a need to commit to common technical standards.

There is a fundamental need for a clear governance of the eHealth system and its varied actors. There are ongoing talks between the DOH, PhilHealth, the Department of Science and Technology as well as the Department of Budget Management towards this end. The National eHealth Steering Committee is proposed to provide governance and national directions to harness the known potentials to boost health and social development.

C. Reinforcing the use of R4Health

Social influences on the end-user affect use of ICT. Rewarding desired health behaviour – in this case, the use of R4Health – affirms end-users and strengthens desired behaviours among peers and elevates the stature of these health workers in the eyes of their superiors. Although project-funded, public recognition activities should continue as R4Health is improved.

The support of the MHOs, who were NTSP trainees themselves, was also important as this allowed R4Health to be a part of the RHU work, i.e. encouraging the application of new systems and technologies in health care and reporting responsibilities to the national government. Building on the natural management systems of RHUs influence the efficiency of implementing a new technology such as the R4Health. Both the MHOs and the RHU nurses-R4Health Reporters encouraged the rest of the RHU staff to test and use the R4Health system. The supportive role of their respective local governments for health is evident and cited by the RHU staff. They feel there is adequate amount of health human and financial resources allocated for RHU operations. This enables both RHUs to function and make necessary adjustments when new systems are introduced. LGU support for modernization is seen in the availability of computers for use by the RHU, and regular monthly mobile phone allowances for the RHU staff. The capacity of these RHUs (personnel and resources) and the LGU support (funding and ICT infrastructure) are essential factors in the roll-out or upgrade of the NTSP, and the R4Health, in particular.

The Regional DOH Directors/Officers and Provincial Health Officers where R4Health was implemented were especially engaged with the proven ability to collect fresh data at point of care and display this on the R4Health Dashboard (complete with national, regional, provincial and municipal views). The dashboard was developed after all training events have been completed and were demonstrated and shown at length to the NTSP PMC member agencies as well as Regional Directors of CAR DOH, Regions IV and V and Provincial Health Officers of Romblon, Masbate and Tawi Tawi. The 246 R4Health Reporters were notified of the Dashboard, and were given access by UP NTHC through specific usernames and passwords for a designated RHU staff for each municipality.

Unfortunately, the Project did not capitalize on the power of feedback to reinforce R4Health use behaviour. Users already suggested that a feedback notification that the R4Health server received the field reports be incorporated in the next iteration of R4Health. The value of the visual feedback from the R4Health Dashboard was also diminished when the Dashboard was developed and deployed only after the R4Health training occurred. Future mHealth-based routine health information management tools should thus cover the critical steps of data collection, aggregation and display; this should be offered as a complete system that can better reinforce use and provide timely evidence for health program decisions.

As a collaborative and sanctioned Project by the DOH, implemented through the regional offices, the RHU personnel generally adhered to R4Health use within the nine-month observation period. What is strongly suggested however is deeper involvement of the local health leaders in the governance of such large-scale mHealth or eHealth innovations, rather than just the implementation component. In this way, local ownership and leadership over the innovation are fostered. The role of governance at all levels (national and local) and policies to sustain innovations that work and scale its implementation are emphasized.

With the proposed National eHealth Steering Committee that would provide governance, there is reason to be hopeful that the large investments in the large-scale R4Health field implementation will not be for naught, and that lessons will be used to continue and leverage better mHealth systems in the country.

Conclusion

R4Health is a viable tool for data capture and reporting because it utilizes a familiar, widely and commonly used ICT. SMS remains the most practical medium for reporting health data collected at the point-of-care, especially in GIDA. R4Health users perceive the R4Health to be useful, easy to use, compatible with work tasks and roles, and provides a relative advantage over the current manual and paper-based health information management system. Given the general positive perspectives, integration of this alternative system to the RHU workflow, an improved-R4Health, has a high potential of being accepted and adopted by the first-line health workers across the country.

Strategies that encourage adoption of innovations into the clinical workflow should first focus on the RHU staff as

central actors to be equipped with tools that support their needs and are easy to work with. They should be encouraged through participatory adult learning strategies that allow them to value their role in generating health data of better quality and overall national health information management. Enabling and reinforcing organizational and policy strategies must likewise be carefully put in place.

R4Health demonstrated that health information management can be improved using mobile technologies. Personal health care management is enhanced similarly as R4Health facilitate tracking of services rendered to the patients. Data quality, i.e. completeness of personal health data captured at the point of care is enhanced. Real-time reporting, data aggregation and presentation to central offices is made more freshly available for public health decision making.

R4Health data elements, however, have overlaps with other DOH reporting systems and is already misconstrued to further duplicate work. More discussions are warranted to coordinate and integrate systems. The proposed National eHealth Steering Committee tasked to provide governance and over-all direction to the growing eHealth community is a welcome development.

Overall, the National Telehealth Service Program – and its R4Health component – is a forward-looking step in the right direction for attaining health for all.

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