

Perceptions and experiences with District Health Information System software to collect and utilize health data in Bangladesh: A qualitative exploratory study

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Abstract

Background: Accurate and high-quality data are important for improving program effectiveness and informing policy. Bangladesh's health management information system adopted the District Health Information Software, Version 2 (DHIS2) in 2009 to capture real-time health service utilization data. However, routinely collected data are being underused because of poor data quality. We aimed to understand the facilitators and barriers of implementing DHIS2 as a way to retrieve meaningful and accurate data for reproductive, maternal and child health (RMCAH) services. **Methods:** This qualitative study was conducted in two districts of Bangladesh from September 2017 to 2018. Data collection included key informant interviews (n=11), in-depth interviews (n=23), and focus group discussions (n=2). The study participants were individuals involved with DHIS2 implementation from the community level to the national level. The data were analyzed thematically. **Results:** DHIS2 could improve the timeliness and completeness of data reporting over time. The reported facilitating factors were strong government commitment, extensive donor support, and positive attitudes toward the technology among staffs. Quality checks and feedback loops at multiple levels of data gathering points were helpful to minimize data errors. Introducing a dashboard makes DHIS2 compatible to use as monitoring tool. However, the barriers to effective DHIS2 implementation were lack of human resources, slow Internet connectivity, frequent changes to of DHIS2 versions, and maintaining both manual and electronic system side-by-side. Data in DHIS2 remains incomplete because it does not capture data from private health facilities. Having two parallel management information systems reporting the same RMNCAH indicators threatens data quality and increases the reporting workload. **Conclusion:** The overall insights from this study are expected to contribute to the development of effective strategies for successful DHIS2 implementation and building responsive health management information system. Focused strategic direction is needed to sustain the achievements of digital data culture. Periodic refresher trainings, incentives for increased performance, and an automated single reporting system for multiple stakeholders could make the system more user-friendly. A national electronic health strategy and implementation framework can facilitate creating a culture of DHIS2 use for planning, setting priorities, and decision making among stakeholder groups.

Background

A management information system (MIS), one of the six building blocks of a health system, is essential for strategic planning, priority setting, and decision making⁽¹⁾ In contrast to a paper-based system, electronic-health (e-health) provides timely and accurate collection of health data leading to better health care planning and improved diagnosis⁽²⁾. Electronic health records are often classified into two main categories: individual (i.e., client) records and the records used for information management and decision making. The District Health Information System (DHIS), which fell under the latter category of e-health, was an innovation of the University of Oslo back in 1994⁽³⁾. A significant initiative under the umbrella of DHIS was the introduction of DHIS Version 2 software⁽⁴⁾. The DHIS2 is an integrated, open-source and web-based platform for health data collection, validation, analysis, and presentation of aggregated

and individual data ^(5, 6). It aims to improve health service delivery by strengthening the health management information system (HMIS) ⁽⁷⁾.

Currently, DHIS2 has been translated into multiple languages and 46 countries are using the platform for their HMIS ⁽³⁾. Easy aggregation of reproductive, maternal, neonatal, child and adolescent Health (RMNCAH) data in DHIS2 is a supportive factor for effective strategic planning, priority setting, and decision making ^(8, 9). The system is particularly helpful for developing countries to facilitate using their limited resources to make evidence-based decisions ⁽¹⁰⁾. Evidence from Uganda and Kenya shows that implementation of DHIS2 has improved reporting of immunization coverage, antenatal care (ANC) visits, and facility delivery rate ^(11, 12). In Laos, the effective implementation of DHIS2 on maternal and child health (MNCH) surveillance data could improve service delivery through identification of service coverage, barriers to access to services, and causes of maternal death ⁽¹³⁾. In Sri Lanka, using DHIS2 data for MNCH information management has also improved quality of care ⁽⁵⁾.

Bangladesh's HMIS is considered an active contributor in the global DHIS2 implementation strategy ⁽¹⁴⁾. Currently, about 75 percent of public health facilities are covered under the DHIS2 network ⁽¹⁵⁾. As of February 2019, the data reporting rate through DHIS2 was averaging 98 percent. It collects aggregated data on health indicators, logistic supplies, procurement, and human resources. Particular attention is placed on MNCH data in DHIS2. A comprehensive list of RMNCAH indicators are collected in the system to track progress. (The common RMNCAH indicators retrieved through DHIS2 are listed under additional Table1). The RMNCAH services in Bangladesh are offered by two directorates under the Ministry of Health and Family Welfare (MOHFW): Directorate General of Health Services (DGHS) and Directorate General of Family Planning (DGFP) ⁽¹⁴⁾. The two directorates use different HMISs and only DGHS uses DHIS2. The vast majority of private facilities do not report to the national HMIS ⁽¹⁵⁾ because the private health system in Bangladesh is not obligated to do so. The data flow system under the DGHS and DGFP is presented as additional Figure 1 and 2, respectively. Moreover, the quality of the DHIS2 data in general is considered poor and incomplete ⁽¹⁶⁾. Data from peripheral-level health facilities takes an average of three months to reach the central office ⁽¹⁶⁾. For this reason, policy-makers and health programme planners still rely on periodic surveys instead of DHIS2 data ⁽¹⁶⁾.

To date, more emphasis has been given to the technical issues related to DHIS2 implementation and less on the practical experiences of the users. Thus, we lack a clear understanding of the deterrents and enablers of DHIS2 utilization, which are important for a robust implementation process ⁽¹⁴⁾. This information gap has been observed across the Southeast Asian region ⁽¹⁰⁾. To shed light on this information gap, this qualitative study was conducted to explore the perception of different levels of DHIS2 users on the success or failure of this system to meet their everyday job's demands. The additional objective of this study was to identify the facilitators and barriers to utilizing RMNCAH data with DHIS2 at different levels under DGHS. We also aimed to generate evidence for recommendations to strengthen

HMIS operations aiming to ameliorate RMNCAH health outcomes in Bangladesh. This subjective knowledge can guide policy planners to plan for future modification to make the DHIS2 functional.

Methods

Study Design & Setting

This qualitative research followed a grounded theory approach at every step, from sample selection to data collection and analysis⁽¹⁷⁾. The study sites were selected based on the variation in indicator performance among districts according to data retrieved from DHIS2. To choose the study districts, we considered ten different data sets related to RMNCAH services for the last one-year period over all the administrative districts. We used the reporting time indicator to track how timely districts report their data. We assessed the DHIS2 timeliness report, first across the division and then districts. Data from the last 12 months' performance showed that Khulna was the highest-performing division and Chittagong was the lowest-performing division. Consequently, Jessore district was the highest performing in the Khulna division and Brahmanbaria district was the lowest performing in the Chittagong division. We also assumed that certain local-level factors like management structures, human resource availability, staff skills, and training might impact workers' perceptions and experiences with using DHIS2. Keeping this in mind, from each district two upazilas (an administrative unit) were purposely selected. This enable us to capture differences in perceptions and experiences with using DHIS2 as a result of differences in management and DHIS2 operations at the local level.

Study Participants

Forty-seven stakeholders from all levels of the health system were selected to gather details about experiences with using DHIS2 at each level. The participants at the community level were community healthcare providers (CHCPs), nurses, health inspectors, upazila statisticians, and upazila health and family planning officers (UHFPOs). At the district level, participants were civil surgeons and district statisticians. The assistant chief of MIS was involved at the division level, and from the national level, system analysts and program managers under MIS directorates and some donor representatives (e.g., monitoring officers, IT programmers) were interrogated. The inclusion criterion was willingness to participate in the study. The exclusion criteria were unwillingness to participate, and those who had been working in the specified sector for fewer than six months.

Data Collection Methods

The data collection methods were directed by the research objective. Primary data collection methods were in-depth interviews (IDIs), focus group discussions (FGDs), and key informant interviews (KIIs). We collected data since September 2017 through September 2018.

Before initiating data collection, we pretested the interview and FGD guides several times to establish tool validity and reliability. The final guidelines for data collection are added as additional file 4. The IDIs were

conducted with multi-level field staffs: CHCPs, upazila statisticians, nurses, and health inspectors. Study participants for IDIs were selected based on convenient sampling. Emergent questions and reflections from the IDIs were also discussed during the FGDs. Each FGD was comprised of six to seven purposively selected participants. The key informants were categorized into three subgroups at three different levels: health managers (UHFPOs and civil surgeons), HMIS experts (system analysts, IT programmers), and key decision makers (assistant chief MIS-DGHS, program managers from MIS directorates, and divisional focal persons from development partners). A purposive sampling strategy was followed to ensure participation from each stakeholder group. The snowball sampling technique was also used to identify key personal to be interviewed and to ensure collection of rich data. An interview time was selected according to participant's convenience mostly during afterhours of office period. A relatively quiet room within the office premises was selected for interview. Only the interviewer, interviewee, and note taker were present during all face to face interview sessions. Interview time lasted from minimum 45 mints to maximum two hours. All interviews started with the brief introduction of study objectives, introduction of interviewer, and reading out of privacy declaration form. None of the interviewers were previously known to the interviewees and the reason of interrogation was stated as general interest in the research topics. Written informed consent was taken from all the participants in an anonymous privacy declaration form (added as additional file 5). The interviews were audio recorded with the participants' consent. Field notes were taken during the interviews to back-up the audio recorded data in case of equipment failure. The interview was stopped when data saturation achieved. The table 1 details out data collection methods, purpose and quantities

Table 1: Data collection methods

Data collection method	Study respondents	Number of interviews	Sampling technique	Purpose/Main issues explored
IDI	CHCPs, nurses, health inspectors, upazila statisticians	23	Convenient	Efficiency of record keeping using DHIS2; staff attitudes; reporting status; factors hampering data entry and processing
FGD	District statisticians	2	Purposive	Multiplicative information and knowledge of using DHIS2; Cross checking reflections that emerged during the IDIs
KII	Health managers (UHFPOs, civil surgeons)	5	Purposive, Snowball	Role of DHIS 2 technology on improving RMNCAH service delivery; Constraining and facilitating factors faced during DHIS 2 implementation; Other implementation challenges; scope of improvement of servers and software
	HMIS experts (system analysts and IT programmers)	3		
	Key decision makers (assistant chief MIS-DGHS, program managers from MIS directorates and divisional focal persons from development partners)	3		
Total sample size (N)		N= 36		

Data Analysis

The collected data was analyzed by content using a thematic approach. The recommended six staged thematic approach was followed that consisted of data familiarization, coding, identification, review and naming of the major themes and writing of the final report ⁽¹⁸⁾. Interview transcription, translation, and

coding were all an iterative process. As part of data familiarization, the research team met regularly during data transcription and cross-checked confusing data against the recordings. For content analysis, we followed a “directed content analysis” approach, where codes were selected both before and after analysis⁽¹⁹⁾. A-priori codes were prepared using ATLAS.ti. software based on previous research findings and theory⁽²⁰⁾. Coding was done independently by two researchers. Intra-coder reliability was checked before listing it in the final codebook.

After coding, the research team translated the coded data into English. Data from the IDIs, FGDs, and KIIs were analyzed separately and we drew collective inferences from the findings collectively under identified themes⁽²¹⁾. The findings were shared and discussed in a consultative workshop with relevant stakeholders for data interpretation and validation (including study participants). The suggestions came during workshop were also incorporated into the final reports under respective study theme.

There were eight initial codes consist of; Knowledge, experience, expectation, acceptability, cost incurred, supportive factors, challenges and suggestions. These codes were condensed to six clusters or subthemes; Individual, institutional, infrastructural, financial, technical and suggestions. Later on, we arranged our findings under four key themes that related to the core objectives of our research: The flow of coding to emergent theme is presented in **Figure1**. The subtheme “individual” capture user’s knowledge, experience, expectation and their overall acceptability towards electronic system against paper based system. This subtheme lead us to the “ key theme 1: Perception” . The code Supportive factors and Challenges was applied when informants talks about positive and negative determinants of DHIS2 use respectively. Both the factors could range from “Individual capacity”; “institutional support” to “technical issues related to DHIS2 software”. Similarly the code suggestions applied when informant mentioned their opinion on overcoming challenges or any new suggestions to make the system more functional. So this recommendation theme pull data from rest of the themes too.

Fig 1: Data structure detailing code plan and core themes of this study

A 32 item checklist to report qualitative research findings known as “Consolidated criteria for reporting qualitative studies (COREQ)” has been followed with this research and added as additional file 6.

Results

This study identified a set of interrelated concepts across the study informants that influences the grounded phenomenon, “the overall use of DHIS2”. Consequently, the study findings were organized under four main key themes:

Key theme 1: Perception of the respondents towards DHIS2. This came from capturing users’ knowledge, experience, expectation, and their overall acceptability towards an electronic HMIS versus a paper-based HMIS.

Key theme 2: Perceived barriers to implementing DHIS2. These were drawn from the study participants discussion of positive determinants of DHIS2 use related to individual capacity, institutional support, or technical issues related to DHIS2 software.

Key theme 3: Perceived facilitators to implementing DHIS2. These were drawn from the study informant's discussion of negative determinants of DHIS2 use related to individual capacity, institutional support, or technical issues related to DHIS2 software.

Key theme 4: Recommendations to improve DHIS2 functionality. The study participants shared their suggestions for overcoming challenges or how to make the system more functional.

Key theme 1: Perception of the respondents towards DHIS2

The majority of study participants expressed a strong, positive preference toward using DHIS2 for RMNCAH data collection. They described DHIS2 as a dynamic system that has improved overall medical record keeping and accountability of data reporting from community clinics at the periphery to district-level hospitals.

Online is a perfect system. Previously I used to collect data in papers, and at the end of the year my office gets full of papers. It was also very difficult to retrieve data from thousands of piled up paper forms. Now, in online, by clicking the date or by name or phone number of the patients, I can easily check the data. I am getting the data collection form even in my mobile, by which I can fill up the form, from any place and any time! So, it is easier.” – Community health care provider, IDI

The supervisory team perceived that initiating such technology has contributed to instant monitoring, cross-checking of collected data, setting priorities, and making decisions, which was time-consuming with the previous paper-based system. With DHIS2, statisticians are assigned to tabulate the data and share the generated summary reports with district and divisional health managers. Managers observe and flag the gaps in service delivery and note achievements. Findings are discussed at monthly review meetings in the presence of field staff. At these meetings, which are held in each sub-district, district, and divisional health manager's office, comparisons are made with the previous month, present month, and yearly national targets to track improvements in performance and identify any hindrances to achieving targets. Most respondents, from the community to the national level, identified this review meeting as a platform for RMNCAH-related data observation, monitoring, and instant planning for the coming weeks.

From DHIS 2, along with [the] national scenario, we can see the status of districts and sub-districts, even unions and wards. All the field staff are forwarding data on rate of using contraceptives, maternal death, amount of IUD [intrauterine device] delivered, and number of oral contraceptives supplied. – Information communication technology focal person, IDI

Additional factors also strongly influenced users' perception of DHIS2. These were both individual and at the institutional level. DHIS2 users who were more frequent users and had sufficient training perceived

the true need for it. Availability of sufficient technical equipment like laptops, desktops, and tablets at the field level made them more enthusiastic.

The demand for using DHIS2 is going beyond RMNCAH. Key informants who had been involved with DHIS2 since its inception explained that the software is maturing continually. In 2009, when DHIS2 was launched, it was not used for data visualization and decision making because accessing the system was challenging. As soon as DHIS2 has introduced the dashboard concept in 2012, it has drawn the attention of directors working at the national level, who demanded the platform be used for their own reporting. As a result, the online data entry forms increased from 12 in 2012 to 32 in 2013. The perceived need of DHIS2 can be better explained from the below quote:

In 2013, the DHIS 2 log in dashboard became much popular, all users could access it. At that time, 5,000 to 6,000 graphs were made using DHIS 2, which eventually increased to 15,000 to 16,000. It means, people were trying to use it. To justify my argument I must say, these much of graphs were prepared by users from 64 districts not by a single use,, that means people are using it!— HMIS expert, KII

A few health managers expressed a contrasting view, arguing that staff orientation and adaptation to technology sometimes works as a major obstacle to electronic HMIS implementation.

In some places . . . a complex device, [like a] computer has been handed over to the hand of an old community health worker, hence she cannot use it.—Upazila health manger KII

DHIS2 has been used to report aggregated data on a monthly basis. CHCPs need to maintain both paper and electronic forms as automated data reporting is not possible within the current system. This makes the data entry process time-consuming and complicated, hence less data use and more misreporting at the end. Moreover, insufficient understanding on the RMNCAH indicators sometimes leads to unintentional errors in data entry.

Key theme 2: Perceived barriers to implementing DHIS2

Technical

Several technical challenges with the DHIS2 platform were highlighted during the KIIs. There is no provision of automated calculation for aggregated data, and key informants expressed that its absence increased the possibility of data disparity and generating errors.

DHIS2 has a problem. . . . There are [boxes] for entering aggregated data. But, now, it is needed to use the formula. Many of the staff do not understand these formulas. In training sessions, I provide them the formula, explain this using multimedia presentation. Many [field staffs] do not understand it. In several cases, they put the value of one indicator in boxes designated for other indicator. — IT expert for MIS, KII

In addition, DHIS2 has the provision to “SKIP” for all indicators, which contributes to data incompleteness. With incomplete data, it is difficult to retrieve valid results from DHIS2.

Respondents also pointed out some technical issues with the data collection forms that should be checked to decrease misreporting and improve efficiency.

In [the] individual server, first, I put mother's name, her EDD [estimated date of delivery], date of enrolment, and then a box will pop up for gender. There is male, female and transgender. The data is on a pregnant mother, which is clear from this information, I don't understand what the need of gender then? There should be a system that [the] computer would recognize the gender automatically when pregnant women has been marked. We should not put it manually. Here our field workers are making mistake[s].— District statistician, FGD

Instead of using unique health identification numbers to track patients, patients' cell phone numbers are used. However, it is difficult and time-consuming to search the database with a cell phone number. To get around this, CHCPs prefer to enroll follow-up patients as new ones. This raises a data quality issue since repeat clients are identified in the system as new clients. According to the key informants, this has created a gap in the system, as it is not possible to track the health status of a single patient in the existing system during data analysis and visualization. It was suggested that the system could be linked to Bangladesh's National Identification Database. It was also noted that the platform design makes data validation challenging.

Updating the data entry forms to facilitate comparisons among data variables is challenging. DHIS2 started with version 2.6 on 2009, which was upgraded, version-by-version, to 2.13 at the end of 2013 to make the system faster. Each time the data entry forms are changed it becomes more difficult to compare the old and new data because the software cannot match the data variables, resulting in invalid findings.

For those, who are computer literate, for them, version change is an "attraction." "Let us explore, what are the new features?" But, our CHCPs do not perceive it in this way. They think, there was a box here in the older version, where did the box goes now with the newer version? They don't understand, we are trying to make their work easier! It will take some time, to change the culture. — HMIS expert, KII

Several informants reported that in the existing system, searching for sub-districts is a time-consuming process.

Institutional:

At the supervisory level, district and sub-district health managers could not find the time to use DHIS 2 on a daily basis because they were involved in other activities. Sometimes they can escape the use of DHIS2 too.

A health manager knows clearly about his district's targets on immunization coverage, or ANC coverage, or even for facility births from their years of experience. So they do not need to open the computer and get into the DHIS 2. The mechanism is such; you cannot trap him for this reason — Senior programmer, KII

The DHIS2 is an additional task for the statisticians with other regular administrative duties (e.g., preparing salary sheets, drafting letters). They need to do extra hour work for that. National-level key personnel acknowledged the shortage of statisticians or other staff trained in data analysis. They admit that in many areas, qualified statisticians have not been recruited. Even so, many statisticians are not efficient in using computer software and do not understand health indicators and data compilation. In many areas, statisticians do not even attend trainings.

The job description and responsibilities of statistician should be separate. But, in many districts there is no designated statistician. . . . In area “YY,” a ward boy does all the work of statistician; you cannot expect anything better from him! There should be an assigned person, who will do research [with data]. – District health manager, KII

The RMNCAH data collected by the MIS Division of DGHS have also been used by the RMNCAH line directorate of DGHS. However, data retrieval from the DHIS 2 platform is not the regular practice for the RMNCAH line directorates; like all other directorates they rely on their own reporting format.

Statisticians reported not receiving any specific training on DHIS 2; rather it was a part of computer literacy training. Participants received DHIS 2 training manuals, though these were not updated to reflect changes in newer versions of the software and forms. Since DHIS 2 was introduced, all the line directorates want to incorporate their relevant indicators to be collected and analyzed through DHIS2 using same workforce.

Now everybody wants their data from DHIS 2. Non-communicable Disease division add some indicator[s], RMNCAH add some too. In some cases, the reporting format is also different than the one used by DHIS 2. For example, if [the] EmNOC [emergency newborn and obstetric care] reporting format for [the] MIS division and RMNCAH would be same, I can get the report by clicking on DHIS 2 data. But [the] EmNOC report for RMNCAH directorates have 27 indicators while it is 25 in DHIS 2 database. – Sub district statistician,IDI

Infrastructure

Although the participants said the number of electronics provided for data collection is sufficient, slow Internet connectivity makes real-time data entry difficult. As one CHCP described,

At dawn, sometimes the Internet speed is better. In most cases, I enter the data at this time. It happened, I could not report for one week, two weeks, as the speed was slow. With a weak connection, I cannot even log in into the system..... CHCP, IDI

The provision of offline data entry could make the things little easier. The process of sending broken tablets to capital city for repairs and transporting them back to the community took a long time. The majority of respondents reported internet modem shortages as well. In many areas, sub-district and district health managers personally obtain a modem and Wi-Fi router.

Section 3: Facilitators of data Collection and analysis with DHIS 2

Mandatory quality checks at different tiers have played a significant role in improving data quality. At data entry level, the system does not allow to put wrong data there. The system ensure self-validation of data by adopting three approaches; input validation, adding appropriate range and validation rules. When data operator add any value that is out of expected range they got error messages. Moreover DHIS2 allows local level data access and correction before it has been reported at the national warehouse. IT focal person with medical background has been assigned at sub-district hospital and at district civil surgeon office to check the data errors. Consequently regular monthly feedback meetings are organized at the sub-district level in presence of field level workers from both health and family planning wing to minimize duplication of RMCAH data. The similar monthly feedback meeting also organized at the district and national level. The national core MIS committee chaired by MIS directorates meet once monthly to get feedback on technical issues and for monitoring data coming from all the districts. Our key informants greatly appreciate this national level meeting where both the government officials, donors and technical person participate.

A national-level expert shared his experience with checking data validity:

For example, when we check MMR [maternal mortality ratio], we locate where the ratio is high. Then we review the ratio of that particular district for consecutive months to explore the consistency of data and reporting status, either it was low or high for the previous months. We check all these. Then we send an e-mail, to respective authority, to look into the matter. – HMIS expert, KII

So far, DHIS2's performance has been measured from the perspective of timeliness and completeness. The sub-district and districts are evaluated according to their overall reporting rate. A positive competition for service improvement has been nurtured. The best-performing district or division receives recognition from the national level.

In our monthly meeting we discuss our shortfall; we plan how to improve the reporting rate. We always analyze the data, hence our performance is better!! We have a silent competition with other districts of this division and we do better always and got national award as model district – District health manager, KII

International donors strongly support strengthening Bangladesh's HMIS. They share financial costs with the government for national- and international-level training for the staff, IT equipment purchases, and other needs. In collaboration with other NGOs, like icddr,b, they are providing technical support to the IT programmer for online platform improvement and organizing a training on the DHIS 2 manual for staff working at different tiers of health system. Donor organizations have demonstrated a strong commitment to the successful implementation of DHIS 2 by deploying their staff as monitoring officers at each administrative division and ensuring their physical presence and participation during monthly coordination meetings at the divisional and central levels.

The government has limited capacity and could not develop that capability till now. From the side of development partners, we are giving them that support. If development partners withdraw their support, how will the system run? But the DHIS 2 dashboard is already sustainable, and its automatic; staff have training and they can handle it. The government is cordial, and they have sufficient resources, training arrangement, hardware. In this context, strict monitoring and defined role of staffs are important. In addition, ownership of data is a major concern, many health managers do not own the data. – HMIS expert from donor, KII

The measure evaluation suggested monitoring and evaluation framework is used to identify DHIS2 related facilitating factors at all steps ranged from input, process and outcome (Figure 2)

Figure 2. Analytic framework on strengthened DHIS 2 in Bangladesh

Section 4. Recommendations for Strengthening the HMIS to improve RMNCAH Outcomes

Based on the study findings, the participants' major recommendations for strengthening the HMIS to ameliorate RMNCAH outcomes in Bangladesh are elaborated below.

The DHIS2 platform should be programmed to generate automated data for specific RMNCAH indicators. A pop-up box with the indicator definition, calculation (if applicable), and any possible disaggregation should be included. This will provide instant help to the CHCPs and standardize data collection. The software should be translated into Bangla (the local language) to help create a clear understanding of instructions and RMNCAH indicators. An online dashboard should be installed in the platform where instant RMNCAH-related reporting and performance status updates should be exhibited automatically at the sub-district and district levels. Statisticians should be informed in advance about software updates and notified of specific changes so they can prepare the CHCPs.

Data collection forms should be simplified to ease the data collection process and data reporting. Creating unique health identification numbers for patients and issuing individual health cards will decrease the time spent on data entry and help mitigate data duplication. Since the system will contain clients' contact information, statisticians can verify the collected data through random phone calls. A geographic information system should be installed in CHCPs' electronic devices used for data collection to track the providers' movement. Users should be able to enter data into DHIS 2 daily, as aggregated data increase the risk of errors, thus compromising data quality.

Since DHIS 2 is used at different levels of the health system, the DHIS 2 training curriculum should be tailored to the needs of health professionals working at different levels. The IDIs and FGDs revealed a need for separate training sessions on medical terminology for community and sub-district level staff. After every update to the software or data collection forms refresher trainings should be organized to improve staff knowledge and efficiency. A standardized training curriculum and tools are also needed. Furthermore, soft copies of training manuals should be shared with staff via e-mail so they can be easily updated and disseminated.

Along with a statistician, another staff member should be trained in data compilation and analysis to complement the statistician's work and support the statistician in his/her absence. A separate MIS unit can be formed comprising, at a minimum, a statistician and a supporting staff member who will be assigned to perform all MIS-related tasks only. Sub-district and district health managers should be more involved in data reporting and analysis to develop ownership and a regular practice of using DHIS2.

Computers and other electronic devices for data collection should be repaired at the local level to save money and time. Providing CHCPs with an Internet data subscription can ensure timely reporting. The number of modems at the subdistrict and district levels should be increased, and each municipality should have its own dedicated laptop for the statisticians to use to ensure timely reporting.

The country would benefit from a national e-health strategy and implementation framework to facilitate a culture of DHIS 2 use for planning, setting priorities, and decision making among different stakeholder groups. This strategy should include how the country intends to provide the resources to fund DHIS 2's long-term sustainability when donor support is no longer available.

Discussion

Digital Information Technology (IT) is a complex intervention in the health sector⁽²²⁾. The success of Health IT depends on interdisciplinary co-ordination ranged from IT setup to the health care service delivery points⁽²²⁾. When appropriately designed this digital health technology has proven benefit to improve quality of health care through data driven decision⁽²²⁾. However, inappropriate IT adversely affect the health system from poor human-computer interaction and potential time loss with demoralization of staff towards system⁽²²⁾. Thus, health system experts emphasize more on the maintenance and evaluation⁽²³⁾. Currently, more research has been done to know the user acceptance and use of IT across the world as the key component of health IT lifecycle^(24, 25). The latest model "Unified Theory of Acceptance and Use of Technology (UTAUT)" proposed by the researchers included all the possible determinants of user acceptance. The key themes of our research correctly addressed all the elements of "UTAUT model" that suggested to cover; "Performance expectancy, effort expectancy, social influence, facilitating conditions"⁽²⁶⁾. In our research, we focused on the acceptance of DHIS2 among all level of users along with the challenges and facilitators of DHIS2 implementation in Bangladesh health system. The recommendations received from the study informants are compared with other research findings to confirm it's feasibility.

We observed a strong, positive attitude toward a digitized e-health system among our study informants. The corresponding actions taken from the directorates could make nationwide implementation of DHIS 2 possible in Bangladesh. As a facilitating factors, informants highlighted some of the unique initiatives taken by the Bangladesh health system. Among them presence of IT focal person at the peripheral level health facilities, option of both online and offline data entry, adding DHIS2 dashboard in the online platform were the commonly mentioned issues. The health mangers mentioned that dashboard make the system more user friendly for local level planning. Similar to that, the DHIS 2 users from other countries

opine that data collected through DHIS2 need to be analyzed and used at more frequent intervals. DHIS2 dashboard was introduced for data visualization on everyday basis. They further mentioned that this graphical output helped them to identify the required input to overcome the service gap ⁽²⁷⁻²⁹⁾.

Mandatory data quality checks and regular monthly coordination meeting at different tiers of the health system with active participation from all levels of key stakeholders were another positive influencing factors in our study. The importance of data review meetings to strengthen the HIS has been highlighted in other studies too ^(12, 30) On the contrary, some informants mentioned that quality still compromised due to problem with data collection tools. Moreover, in absence of automated system some errors happen while summing up monthly report. The importance of automated system in the DHIS2 has been mentioned by the other African studies. According to those studies, the automated reporting system could minimize the reporting time and also increased the completeness and accuracy of MNCH data in their context ^(31, 32)

Although data accuracy and completeness remain an issue, users were encouraged to use DHIS2. To increase the use of DHIS2, MIS division of Bangladesh has started to announce and reward best performing district on annual basis. While measuring the district performance, timeliness to provide monthly report get priority. This is expected to enhance positive competition among DHIS 2 users. The other studies also highlighted the importance of incentive in increasing DHIS2 use . Researchers mentioned that by adding incentives for accurate and timely reporting could bring a positive mind set change among field-level health workers in their settings ^(9, 30, 33).

The barriers to implementing an electronic HMIS mentioned under this study are similar to those reported by other developing countries: inadequate human resources, frequent power outages, low internet connectivity, and a poor culture of using data for decision making ^(28, 34-37). Some field staff are still struggling with the mindset change; moving from paper-based to electronic data collection and appreciating the usefulness of collected data. In this regard, another study highlighted that time is needed to allow community health workers to adapt and increase their computer literacy. Their suggestion to overcome this barrier was to organize onsite supportive supervision and providing trouble shooting at the district level ^(11, 38). The other suggestion from successful DHIS2 implementer country was to ensure data ownership. Data ownership enabled the field-level workers to understand the purpose of data collection and how the information would be used rather than considering it an administrative burden ⁽¹¹⁾

The data collected under DHIS2 was considered comprehensive in our study. In addition to collecting RMNCAH health indicators, it captures human resources, medicine and logistics data. This data availability allows the health system to address broader contextual factors like human resource shortages or stock outs, which can act as hindrances to achieving high-quality RMNCAH data. ^(15, 32).

We identified training need for the field level staff. Moreover the training was found inappropriate to meet the demand of all level of DHIS2 users. Our study informants perceived that DHIS2 training curriculum should be tailored to the needs of health professionals working at different levels. A separate training

sessions on medical terminology for the community and sub-district level staff has also been suggested by them. They also demand refresher trainings particularly after every update to the DHIS2 software or any changes made in the data collection forms.

Although the study participants felt the data collected under DHIS 2 were comprehensive, the system lacks critical information, such as family planning statistics. Because the DGFP MIS is not connected to DHIS2, data collected under the DGFP cannot be accessed and analyzed with DHIS2. This lack of synchronization creates parallel reporting systems⁽³⁹⁾. The study participants highlighted this duplicity in reporting and mentioned the difficulty of managing multiple forms and needing to report the same RMNCAH indicators in different formats for different stakeholders. However, to mitigate this data duplication issue, a pilot project funded by USAID has launched at the 20 sub-districts of Tangail and Habiganj in Bangladesh . Every eligible mother and under-five child at the community level has received a health card with a unique identification number that allows the system to retrieve and monitor their MNCH service uptake data at any service delivery point⁽⁴⁰⁾ The outcome of that pilot project will be supportive to understand the feasibility of HMIS's unification of the DGHS and DGFP

The other challenge of getting comprehensive RMCAH data was that majority of the urban health facilities are not reported in DHIS2 in Bangladesh. The urban health system is dominated by the private sector, which is not accountable for monthly reporting to DHIS2. The similar situation has been observed in African countries where private health facilities are not reporting through routine DHIS2 reporting ⁽³⁸⁾.

The national-level key informants of our study mentioned that DHIS2 implementation in Bangladesh is largely dependent on international donors. To ensure sustainability, they suggest the country should adopt its own strategy to self-finance the HIS. They also suggest the need of national e-health strategy for better interdisciplinary actions. Likewise, the evidence from other successful DHIS2 implementing countries has shown that capacity building of IT staff and funding generated through public-private partnerships were successful strategies for ameliorating donor dependency in their context ^(3, 30).

Conclusion

Our study found that most study participants exhibited a positive attitude toward an electronic HIS. Although DHIS 2 has become the data repository for different health data, multiple reporting formats for different stakeholders, in addition to the ongoing reporting requirements, negatively impact the workload of field-level health workers. The exclusion of data from large private health sector is a hindrance to getting a complete picture of the country's RMNCAH status. Slow Internet connectivity, some health workers' defensive attitude toward an electronic system, and limited use of data for local-level decision making prevent the successful implementation of DHIS2. We recommend periodic refresher trainings to increase staff confidence in computer literacy. A national e-health strategy and implementation framework, as recommended by key stakeholders, will outline how the country will fund the sustainability of DHIS 2 and facilitate a culture of data use for planning, setting priorities, and decision making.

List Of Abbreviations

ANC antenatal care; CHCP community healthcare provider; DGHS Directorate General of Health Services; DGFP Directorate General of Family Planning; e-health electronic health; FGD focus group discussion; HIS health information system(s) HMIS health management information system(s) IDI in-depth interview IT information technology; KII key informant interview; MIS management information system(s) MOHFW Ministry of Health and Family Welfare; MNCH maternal, newborn, and child health; PNC postnatal care; RMNCAH reproductive, maternal, newborn, child, and adolescent health; UHFPO upazila health and family planning officer; WHO World Health Organization

Declarations

Ethics Approval and Consent to Participate:

The study protocol was reviewed and approved by the Institutional Review Board (IRB) of international centre for Diarrhoeal research (icddr,b), Dhaka. The IRB comprises of two independent research and ethics review committee. The IRB provided approval for research after reviewing full proposal, informed consent form and data collection guideline against the protocol number PR-17086. Informed written consent were taken from all the study participants.

Consent for publication

Not applicable

Availability of data and material:

Data supporting this study findings will be available from the Research administration of icddr,b with reasonable request of anonymous data. Please email to director research administration of icddr,b for further data request

Competing interests: All authors declare they have no competing interests.

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Authors' contributions

All authors have read and approved the manuscript. The role of researchers in different aspect of research are as follows; Conception and research design: TB, SMK,IA,AK,JF,MPSI; Data analysis: TB,SMK,FAK; Data interpretation: TB,SMK,FAK,IA; Drafting the manuscript: TB,SMK, AB, IA,FAK,AR,JF,MPSI

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Additional Files

Additional file: Interview guidelines

Additional file: Privacy declaration forms

Additional file: study quality assessment checklist (COREQ checklist)

Figures

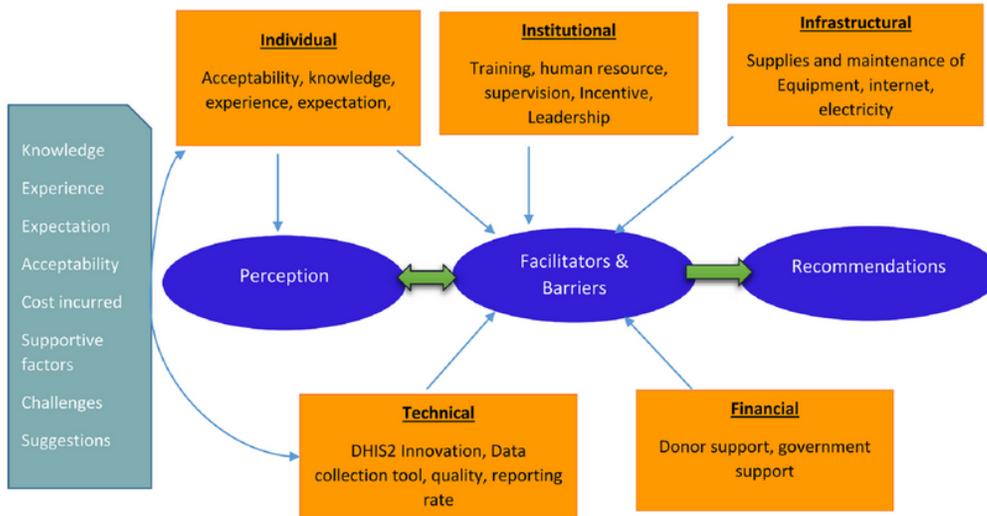


Figure 1

HMIS data flow under Director General of Health, Bangladesh

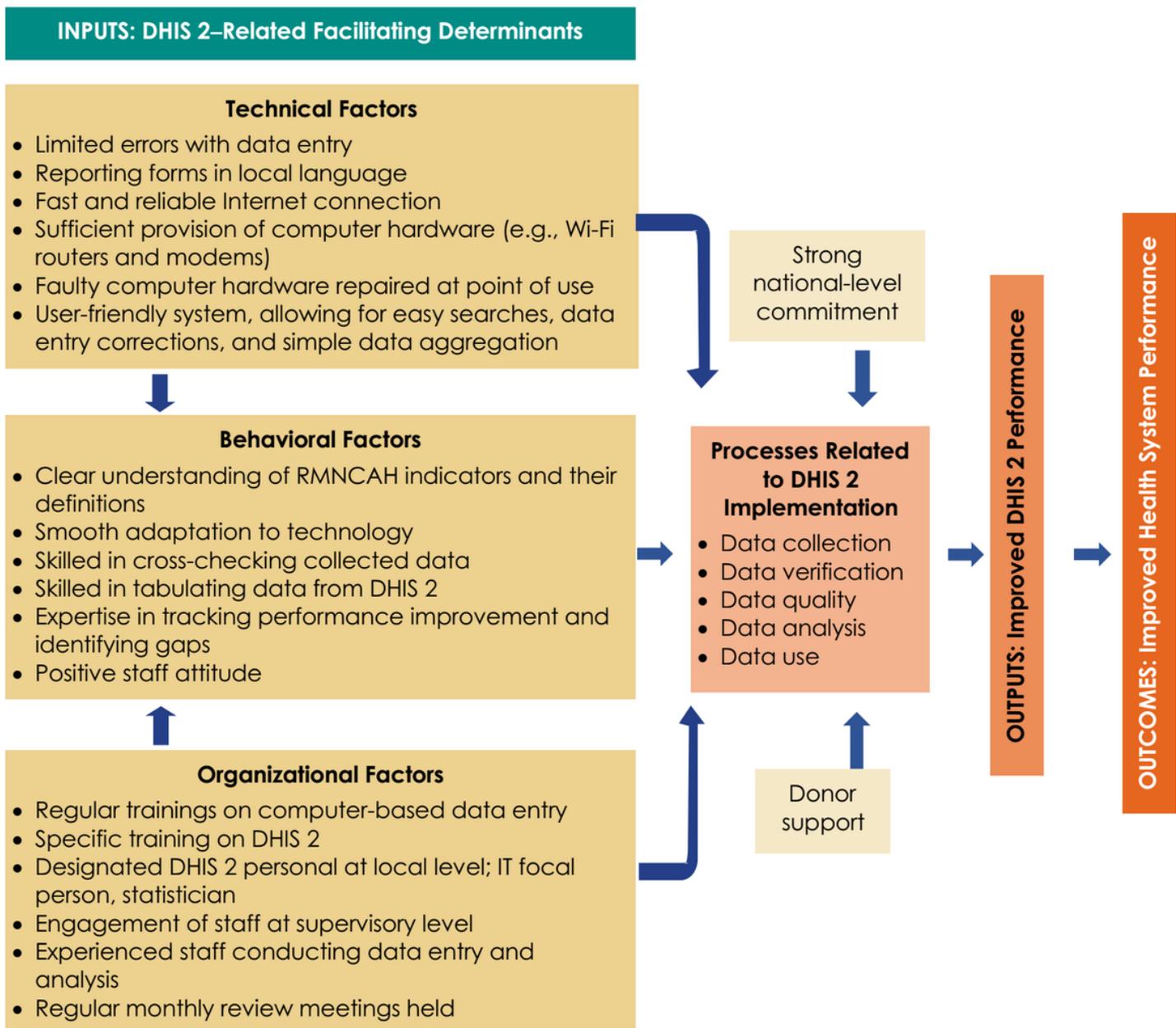


Figure 2

HMIS data flow under Director General of Family Planning, Bangladesh

Supplementary Files

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