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EVALUATION OF THE NATIONAL COMMUNITY AND FACILITY REPRODUCTIVE, MATERNAL, NEWBORN, AND CHILD HEALTH E-REGISTERS IN BANGLADESH

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Executive Summary

Background: The Directorate General of Family Planning (DGFP) and Directorate General of Health Services, with technical support from four United States Agency for International Development (USAID)-supported partners (MEASURE Evaluation, International Centre for Diarrheal Disease Research, Bangladesh, MaMoni Health Systems Strengthening and SIAPS) have been working on automating the service delivery data systems for community workers and first-line service providers through the design, development and implementation of eMIS applications. The eMIS applications were designed based on existing paper registers and fellow community workers' and service providers' current business processes. The implementation of reproductive, maternal, newborn and child health (RMNCH) e-registers (family welfare assistant [FWA] and family welfare visitor [FWV] e-registers) was ongoing in two districts of Bangladesh, Tangail and Habiganj.

To understand the service delivery mechanism and smooth scale-up in all 62 districts, USAID's Research for Decision Makers project conducted an evaluation of the national community and facility RMNCH eMIS in Bangladesh. The study focused on whether or not the RMNCH eMIS that digitalised the business process of the DGFP could make any changes in primary health service delivery at community- and first-level facilities compared to paper-based data management practices.

Objective: To assess the benefits of using RMNCH eMIS for clients, health care providers (HCPs) and the health system and explore barriers and challenges to the implementation of eMIS.

Results: All HCPs (100%) were found to use tablet PCs and e-registers in the intervention areas. For both antenatal care (ANC) and family planning (FP) services, FWVs and FWAs initially began with using the paper register and gradually shifted to a combination of both e-register and paper register. There was no significant difference between the mean service provision time for ANC services in the intervention and comparison areas. However, for FP services, the FWVs in the intervention areas had a higher mean service provision time than the comparison areas (10 minutes vs 6 minutes, respectively). Monthly report preparation time was substantially reduced while using e-registers compared to paper registers. For FWVs, the mean preparation time was reduced from 304 to 16 minutes. There was no significant difference in client search time by HCPs in the intervention and comparison areas. No record-keeping redundancy was found among HCPs for FP and ANC services in the intervention areas, whereas about 43% of providers had to fill in 10+ data fields in the comparison areas. Data retrieval time also reduced in the intervention areas. For FWVs, the mean data retrieval time was one minute in intervention areas versus four minutes in comparison areas.

The HCPs felt their workload increased, as they had to maintain both electronic and paper registers. Also, supervisors still demanded both hard and soft copies of reports, which meant HCPs had to invest more time creating reports in both formats. Dual practices persisted due to the delays caused

while using TAB during service delivery. However, they reported using a paper register or diary only when they had difficulty working with TAB. As mentioned by the service providers, they kept the paper register next to them because it could be used to tackle any emergency situation.

The data recording validity significantly increased for ANC services among e-register users (90%) versus paper register users (71%). The same scenario was observed for data recording completeness. For FWVs providing ANC services, it was 64% among e-register users compared to 9% among paper register users. All HCPs who used e-registers had >75% accuracy in monthly report matching, compared to only 2% of paper register users achieving such accuracy. Among FWVs who used e-registers, 36% showed at least 75% adherence to FP protocol compared to only 2% of paper register users. All HCPs (both FWVs and FWAs) submitted report on time at the end of the month. Progress in real-time monitoring by managers was also observed, as they required only three minutes on average to track HCPs using electronic platform in intervention areas, compared to 67 minutes in comparison areas.

The quality of ANC services provided by FWVs who used e-registers was excelled compared to that of paper register users (30% vs 5%, respectively). All FWVs in the intervention areas were able to identify risk pregnancies through technology-guided medical intelligence. Also, all FWAs in the intervention areas were able to choose a suitable FP method using the e-registers.

Conclusion: This evaluation provided insight into areas to be capitalised or demanding serious attention. The findings of this study could be used as a baseline for future comparisons to determine progress towards eMIS performance improvement.

Contents

Acronyms

ANC	Antenatal Care
CBHC	Community-Based Health Care
CHW	Community Health Worker
DDFP	Directorate General of Family Planning Services
DDHS	Directorate General of Health Services
DHIS2	District Health Information Software Version 2
eMIS	Electronic Management Information System
FP	Family Planning
FPI	Family Planning Inspector
FWA	Family Welfare Assistant
FWV	Family Welfare Visitor
GIS	Geographic Information Systems
GoB	Government of Bangladesh
HA	Health Assistant
HID	Health Identification
HPNSP	Health Population and Nutrition Sector Program
HIS	Health Information System
HSS	Health Systems Strengthening
ICT	Information Communication Tools
KII	Key Informant Interview
LMICs	Low- and Middle-Income Countries
MDG	Millennium Development Goal
MEL	Monitoring, Evaluation and Learning
MH	Maternal Health
MIS	Management Information Systems
MNH	Maternal and Newborn Health
NGO	Non-Governmental Organisation
PE/E	Preeclampsia/Eclampsia
PRS	Population Registration System
SDGs	Sustainable Development Goals
UH&FWC	Union Health and Family Welfare Center
UHFPO	Upazila Health and Family Planning Officer
USAID	United States Agency for International Development

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1. Introduction

1.1 Background

The overall improvements in maternal and child mortality during the Millennium Development Goals era between 1990 and 2015 were remarkable; however, the agenda remains unfinished. Over the last two decades, child mortality has declined by 53%, along with a 45% reduction in maternal mortality worldwide (1–3). To address the remaining mortality burdens, the world has set new targets, or Sustainable Development Goals (SDGs), for maternal and child health improvements within the next 15 years. Achieving the SDGs for health will require strengthening the country's capacity for measurement and accountability through robust health information systems (HISs) (5, 6). However, HISs in many low- and middle-income countries (LMICs) rarely function systematically (7) and are not yet ready to meet data requirements for tracking progress towards achieving national goals as well as SDGs (4). The use of mobile technologies in health, or mHealth, has great potential for capturing, storing and processing health data and making it easily available and accessible (8, 9). In recent years, many LMICs have shown interest in rapidly adopting mHealth solutions to improve their HISs (8, 10–13). Bangladesh is also adopting various digital innovations and gradually building up its HISs (14).

1.2 Existing health information systems under the Ministry of Health and Family Welfare in Bangladesh

The health service delivery structure of Bangladesh is bifurcated into two directorates: the Directorate General of Health Services (DGHS) and the Directorate General of Family Planning (DGFP), with parallel HISs.

Under the DGHS, both community- and facility-level health data is collected in paper-based registers. At the community level, each community health worker, or health assistant (HA), covers approximately 10,000 populations. Their primary responsibility is to carry out immunisation activities. In addition, they collect data on pregnancy, births, deaths and vaccine adverse effects. Periodic aggregated paper reports are submitted for compilation at the Upazila level. At the Upazila level, medical technologists responsible for EPI activities again compile all paper reports and enter the aggregated data into District Health Information Software version 2 (DHIS2), an online reporting portal. Facility-based service delivery starts at the community clinic. Community health care providers (CHCPs) are the primary service providers at community clinics and are responsible for 6,000 populations. They are supported by both HAs and family welfare assistants (FWAs), who work under the DGFP, to provide basic curative and preventive services. Service data at a community clinic is captured on paper-based registers. However, monthly aggregated reports are prepared and submitted to an online reporting portal using DHIS2 (14). Additionally, there is a DHIS2-based standalone individual tracking system for pregnant women and under-five children that is used by CHCPs to submit all service data received from HAs and FWAs (15).

At the union-level facilities – the Union Sub-Center (USC), Rural Dispensary (RD), Union Health and Family Welfare Center (UH&FWC) – there are medical officers and sub-assistant community medical officers (SACMOs) to provide general patient services. At this level, all service records are entirely collected via a paper-based system. At the end of the month, compiled paper reports are generated and sent to the Upazila level, where online reporting is done using DHIS2. The DGHS is currently piloting an OpenMRS-based hospital automation system in select Upazila- and district-level hospitals. This system enables automated data capturing and management across all sections of a hospital. In other Upazila hospitals where OpenMRS is non-functional, a DHIS2-based individual service recording system for inpatients only is operational. The statistical persons at the Upazila hospitals are responsible for entering inpatient data from paper registers into the system. All other units still use paper registers for reporting and recording data. However, the aggregated reports from the Upazila hospitals are entered online through DHIS2.

Under the DGFP, the community workers, known as FWAs, use a paper-based register for capturing their service data on family planning (FP) methods, maternal and newborn health, child health, immunisation, adolescent health services and so on. From this paper register, they generate an aggregated paper report called MIS 1 every month and send it to an FP inspector (FPI), who compiles all MIS 1 reports under their catchment areas in the MIS 2 report and submits them to the Upazila level. At the union-level facility, known as the UH&FWC, the family welfare visitors (FWVs) and SACMOs provide FP, maternal and child health, and basic patient care services. All service data recording at this level is done on paper registers. Using data from all service registers, an aggregated paper report called MIS 3 is generated monthly and submitted to the Upazila level, at which MIS 2 and MIS 3 reports are compiled into another paper report called MIS 4 and sent to district level electronically.

1.3 Gaps and challenges in existing health information systems in Bangladesh

Over the last decade, the HISs in Bangladesh have changed rapidly through improvements in infrastructure, capacity, and promotion of information and communication technology–based information culture. However, the pace of development differs between the two directorates, the DGHS and DGFP. Under the DGHS, all community health workers (CHWs) and health facilities are equipped with electronic devices and internet connectivity. Although both directorates have embraced digital solutions for their HISs over time, paper-based systems predominate in the DGFP. Partial and fragmented automation of the HISs is impeding the full potential of the digital technologies. Primary emphasis is placed on the availability of online periodic reports, without streamlining paper-based tools or standardising the contents. This still places a heavy paperwork burden on service providers and health managers. Due to the static nature of paper-based systems, data retrieval, activity prioritisation, notification of pending/immediate tasks and tour planning become challenging to perform and adversely affect the data quality. Furthermore, fragmented and partial digitisation of recording and reporting systems limits data portability across and between community workers and facility-based service providers under both directorates. Manual compilation of reports from various sources at multiple levels increases the chance of human error.

Moreover, lack of access to individual-level real-time data in the paper-based system leads to poor monitoring and insufficient data use for decision-making. Thus, a robust electronic-based system that not only provides real-time access to population data but also tracks each individual is the desired solution to address these gaps.

1.4 Automation of reproductive, maternal, newborn and child health service deliveries at the community and union level facilities under the Directorate General of Health Services and the Directorate General of Family Planning

The DGFP and DGHS, with technical support from four United States Agency for International Development–supported partners (i.e. MEASURE Evaluation, International Centre for Diarrheal Disease Research, Bangladesh [icddr,b], MaMoni HSS and SIAPS), have been working on automating the service delivery data systems for community workers and first-line service providers through the design, development and implementation of mHealth applications. The mHealth applications are designed based on the existing paper registers and follow community workers' and service providers' current business processes.

Automation of reproductive, maternal, newborn and child health (RMNCH) services is layered into three levels. The first layer is the Population Registration System (PRS), which is used to register all households in the catchment area of a CHW. Service modules (FWA and FWV e-registers) constitute the second layer. Management modules comprise the third layer. The e-registers are interlinked and allow tracking of every individual at different service delivery points, both in the community and in the health facilities, to ensure continuum of care using a unique identifier.

When a CHW visits a household, they register the household and household members using the integrated PRS in the FWA e-register. In the subsequent visit, the respective CHW provides printed health identification (HID) cards with unique HID numbers generated from a national system (Shared Health Record). Data from the PRS is stored in a central database. When the CHWs belonging to the DGHS and DGFP provide services to eligible individuals, they retrieve the data of the respective individuals from this database using different search parameters and record service data against the individuals. Due to their use of the same population database, data recorded against an individual by a service provider is accessible to other providers working in the same catchment area.
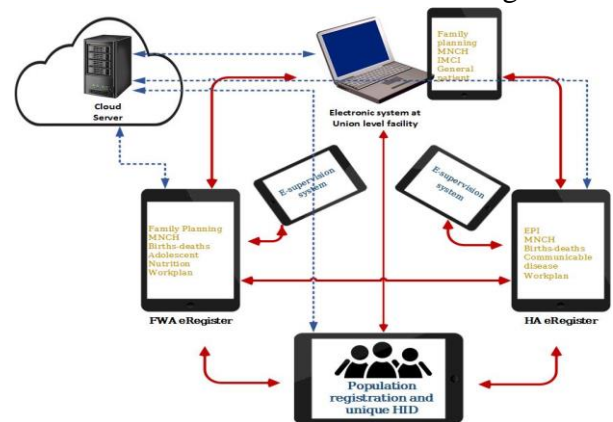
E-supervision systems have been designed for supervisors and Upazila-level managers of the DGHS and DGFP, by which these actors can access real-time data for monitoring CHWs' performance and provide feedback to them accordingly. Interactive web-based monitoring tools provide the opportunity to easily access and view data, based on which local-level decisions are made.

The e-registers have been designed fit for purpose for both tabloids and laptops using open-source mobile and web-based applications. In online mode, data is saved instantly in the devices and uploaded to the central database. The systems also work offline, save data locally and sync the data later if an internet connection is unavailable at the time of data entry.

The implementation of RMNCH e-registers (for FWAs and FWVs) is ongoing in two districts of Bangladesh, Tangail and Habiganj. All FWAs and FWVs have been given training on use of the e-registers and provided with handheld devices (tablet PCs) with internet connectivity. Using the e-registers, they can record all service and related data electronically, both online or offline, at the time of service delivery.

1.5 Study objectives

A review of available literature on digital health initiatives in different countries showed that evaluations of digital health solutions in terms of performance, health outcomes and cost, particularly in low- and middle-income countries, are limited (11, 16). Robust and credible evidence about digital solutions are crucial for the government to adopt suitable solutions alongside interventions to strengthen essential health services delivery (11). This study focused on whether RMNCH e-registers that digitalise the business process of the DGFP could make any changes in primary health service delivery at community- and first-level facilities compared to paper-based data management practices.

The hypothesis was compared with paper-based data management practices, RMNCH e-registers were beneficial to the clients, HCPs and the health system resulted from improved primary health service delivery at community and union level facilities.

The objectives of the study included the following:

- To assess the benefits of e-registers for HCPs, health systems and clients
- To explore the challenges and barriers to e-register interventions

2. Methods

The RMNCH e-register evaluation followed a non-randomised concurrent comparison design. This study included intervention and comparison areas, and the results were compared between both area types to explore the differences in primary health service delivery. In intervention areas, the CHWs (FWAs and FWVs) as well as their supervisors (FPIs and UFPOs) used RMNCH e-registers for service delivery and supervision, respectively. On the contrary, in comparison areas, all activities were done using pre-existing paper registers.

Table 1: Differential inputs between intervention and comparison Upazilas.

Inputs	Intervention Upazila	Comparison Upazila
Data capturing and recording tools for family welfare assistants (FWAs), family welfare visitors (FWVs), family planning inspectors	Tablet PC-based apps for respective e-registers	Existing paper registers/unstructured formats/notebooks, etc.
Users of the tools	FWAs, FWVs	FWAs, FWVs
Training on how to use the data capturing and reporting tools	Yes (recently trained on tablet PC-based e-registers)	Yes (received on-the-job training on paper-based tools)
Onsite support by project staff	Yes - Follow-up support to make sure the users are skilled in using the e-registers - Troubleshooting support related to e-registers	No
Monitoring and supervision by Government of Bangladesh (GoB) supervisors/managers	Yes (using e-supervision system and monitoring tools for GoB supervisors and managers)	Yes (usual GoB practice)
Troubleshooting and feedback by GoB supervisors/managers	Yes (e-register and e-supervision system-related troubleshooting)	Yes (usual GoB practice)

The potential benefits of the e-registers included efficiency in health service delivery and data collection as well as the ability to exchange data among health providers and systems. Efficiency improvement eventually surges service utilisation and quality. **Figure 1** shows the intervention areas of the digital health platform at each level of health service delivery that were used to develop the indicators at each stage.
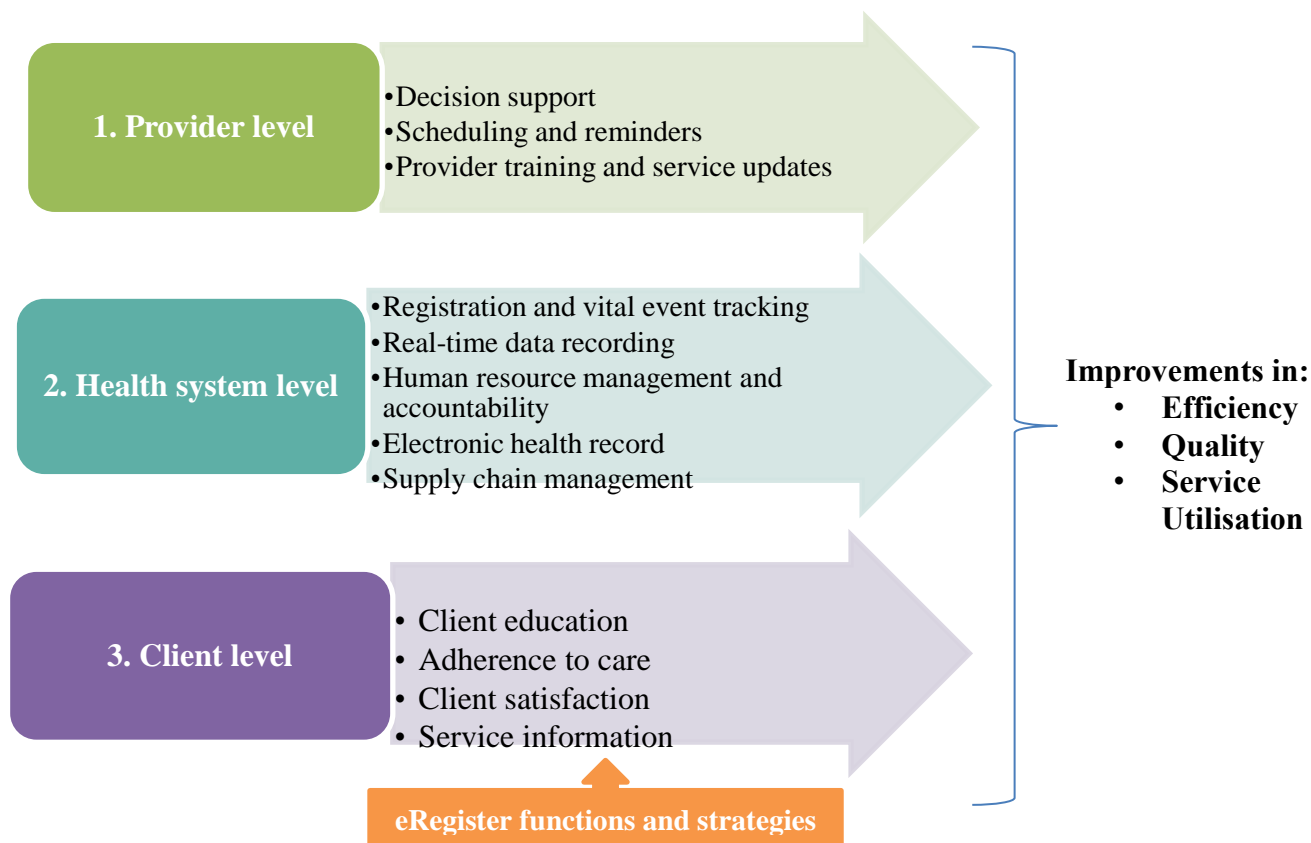
Figure 1: How technology improves the service delivery process at each level.

2.1 Evaluation design

Both qualitative and quantitative methodologies were used for collecting and analysing the data and interpreting the results. To assess the community-level e-registers, the study sample was drawn from FWAs (CHWs under the DGFP) and FWVs (first-line facility service providers under the DGFP). Their respective immediate supervisors, i.e. FPIs and UFPOs, were also included for relevant data collection and in-depth interviews. Qualitative data was collected through interviews and desk reviews. All interviews were conducted according to the guidelines. **Table 2** below summarises the evaluation matrix comprising the domains, activities and indicators at three levels (HCPs, health system and clients).

Table 2: Indicator matrix.

Objectives/domains	Indicators	Method
	• Time required to deliver service • Redundant data fields	Case observation Record review

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Benefits to health care providers (HCPs)	• Time required to prepare monthly report	Observation
Benefits to health system	• Data recording validity and completeness • Adherence to protocol	Case observation
	• Improved quality of monthly report	Record review
	• Real-time monitoring of HCPs	Observation
Benefits to clients	• Quality of care	Observation
	• Risk pregnancy identification and family planning method selection	Observation

Implementation-related barriers	• Perception of
	  ➢ HCPs on using registers to perform monthly job responsibilities and obtain information from previous service contact
	  ➢ Real-time identification of available trained health workforce and service gap areas
	• Barriers and challenges regarding eMIS functionality and implementation
		Key informant interview

2.2 Sampling and sample size

Figure 2: Intervention Upazilas of Tangail and Habiganj Districts
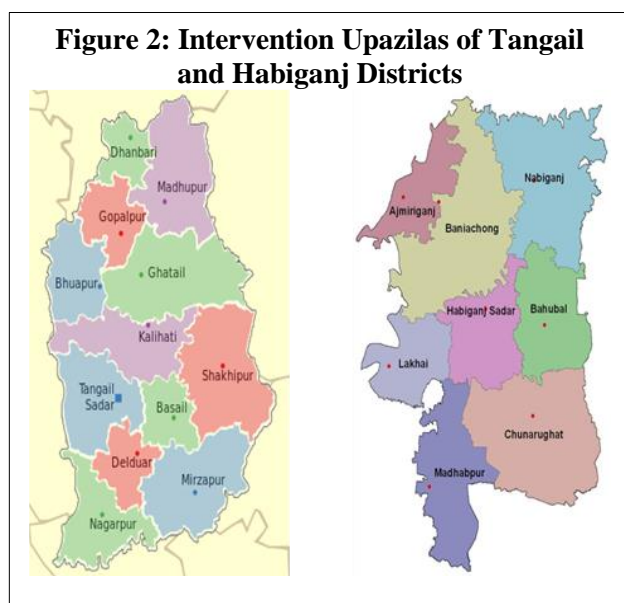
Figure 2: Intervention Upazilas of Tangail and Habiganj districts.

This study had two arms, intervention and comparison. We purposively selected 12 Upazilas (sub-districts) from the Tangail and Habiganj districts (5 and 7, respectively) as intervention areas wherein the service providers had been using the RMNCH e-registers for service delivery at both the community and facility levels for more than six months. These Upazilas were as follows: Tangail Sadar Upazila, Shakhipur Upazila, Mirzapur Upazila, Delduar Upazila and Nagarpur Upazila from the Tangail district; and Habiganj Sadar Upazila, Madhobpur Upazila, Bahubal Upazila, Chunarughat Upazila, Lakhai Upazila, Nabiganj Upazila and Baniachong Upazila from the Habiganj district. The implementation of e-registers in these Upazilas was relatively mature.

For each of the intervention Upazilas, a comparison Upazila was selected from adjacent districts where RMNC e-registers had not been implemented (Mymensing was the comparison district for Tangail, while Kishoreganj was the comparison for Habiganj). Both the intervention and comparison areas had similar sociocultural characteristics. We also ensured that the comparison Upazilas were similar to the intervention Upazilas in terms of demographic characteristics and the status of key maternal and child health indicators.

In total, 106 FWVs from 24 Upazilas of four districts were interviewed, and 506 ANC cases and 507 FP services were observed during this period (**Table 3**). Additionally, from community, 150 FWAs, 103 FPIs and 10 UFPOs were interviewed from 18 Upazilas of four districts. Finally, 1,503 FP services were observed to assess the validity and completeness of service delivery data, monthly reports, advance work plans and timeliness. We conducted 37 key informant interviews (KIIs) of service providers, that is, 18 in Tangail and 19 in Habiganj.

Table 3: Sample size for facility module.

District	Habiganj	Kishoreganj	Tangail	Mymensingh
Upazila [N = 26]	7	7	6	6
#Family welfare visitor (FWV) [N = 106]	32	33	20	21
#Antenatal care (ANC) observation [N = 506]	134	160	102	110
#ANC exit interview [N = 506]	134	160	102	110

#Family planning (FP) observation [N = 507]	146	162	101	100
#FP exit interview [N = 507]	146	162	100	99
Assessed monthly report [N = 106]	32	33	20	21
Re-assessment of ANC services [N = 506]	134	160	102	110
Re-assessment of FP services [N=507]	146	162	100	99

Table 4: Sample size for community module.

District	Habiganj	Kishoreganj	Tangail	Mymensingh
Upazila [N = 10]	4	4	5	5
#Family welfare assistant (FWA) [N = 150]	25	25	50	50
#Family planning inspector (FPI) [N = 103]	19	18	29	37
#FWA interview [N = 150]	25	25	50	50
#FP data quality check [N = 1503]	250	250	503	500
#Record-keeping redundancy [N = 750]	125	125	250	250
#Assessed monthly advance work plan [N = 267]	47	45	89	86
#Assessed MIS1 [N = 150]	25	25	50	50
#Re-assessment of FP services [N = 507]	146	162	100	99
#Timeliness of monthly reporting (UFPO) [N = 10]	2	2	3	3
#Timeliness of monthly reporting (FPI) [N = 121]	22	20	40	39
#UFPO interview [N = 10]	2	2	3	3

2.3 Data collection tools and process

All tools were developed in English and then transcribed into Bangla. The quantitative tools included case scenario/checklist-based observations, structured interview questionnaires, case extraction, community case tracking and review forms. Qualitative data was collected through KIIs. Interview guidelines and questions were developed, and all interviews were conducted according to these guidelines. The list of tools used is summarised in **Annex Table 1**.

Case observation of ELCOs receiving FP services: A data collector accompanied an FWA to observe her service provision in the community. During the time of observation, for each case, the data collector recorded in the case observation form the duration of service delivery and data recorded by the FWA. Trained field assistants (FAs) were responsible for conducting case observation in the community.

Case observation at the first-level health facility: Service provision instances of ANC and FP services delivered by the FWVs at the UH&FWC were observed. Relevant observation checklists were filled out by the observer through direct observation of the service encounter. The observation included recording whether the FWV followed the recommended steps of service delivery. Trained project research physicians (PRPs) were responsible for conducting ANC and FP case observation in study health facilities.

Client exit interview: The ANC and FP clients whose service reception instances were observed upon their exit from the UH&FWC were interviewed by a trained PRP to assess their level of satisfaction regarding the service received.

Client re-assessment: To evaluate whether the FWVs could correctly list risk pregnancies and screen FP clients, ANC and FP clients were re-examined by a trained female PRP in a room arranged for that purpose at the UH&FWC.

Face-to-face interviews: Here, FWAs and FWVs were interviewed on the time required to perform each of their job responsibilities. A Likert scale was used to assess how much the e-registers aided them in performing their job responsibilities and the reasons behind that perception. Their sociodemographic and job demographic history, training history, supervision status and experience with using the e-registers were also explored. Trained FAs conducted these interviews in the community settings, and PRPs did so in the health facility settings.

Record review: Data was extracted from the FWV and FWA registers. Information regarding the number of pregnant women, list of risk pregnancy mothers, number of redundant fields in a register and FP client records was collected using a data extraction form. This data collection helped to understand the data recording validity, redundant data, completeness of recorded data, and completeness and correctness of advance work plans and monthly reports. Trained FAs conducted the interviews in the community settings, and PRPs did so in the health facility settings.

Qualitative interviews: Local- and national-level DGFP managers participated in the KIIs, which were conducted by trained field research officers (FROs) supervised by a research investigator.

2.4 Data collection procedures

2.4.1 Team compositions

Quantitative data collection was done by five PRPs, 10 FAs and one FRA. The PRPs, who were qualified doctors, observed ANC and FP services in the health facilities and interviewed FWVs. The FAs conducted exit interviews with pregnant mothers and FP clients to assess their satisfaction

with the services they received at the health facility. Moreover, they also assessed the quality of FP services in the community and interviewed FWAs. The FRA conducted interviews of supervisors (FPIs and UFPOs) and coordinated with the field team. In total, seven data collectors were recruited for the qualitative data collection, comprising six RAs and one RO. The central team for this assessment consisted of a principal investigator, two research investigators and a research trainee.

2.4.2 Training and pretesting the questionnaire

The training was provided online; Skype and Microsoft teams. Both teams received training for six days. The training sessions included a lecture demonstration of the data collection tools, question–answer sessions, and role-play and simulation-based practice sessions. Apart from data collection tools, the data collectors also received training on novel coronavirus 2019 safety guidelines. Two days of pretesting was conducted in the field before real-time data collection was initiated.

2.4.3 Data collection

Data collection was conducted in three phases to evaluate the effect of digitalised service delivery. In phase I, HCPs in the facilities were interviewed, and ANC and FP service delivery was observed. In phase II, CHWs (FWAs) were interviewed and their services observed. In phase III, qualitative data was collected. The first phase of data collection was conducted from 23 January 2021 to 27 May 2021. There were four teams in total, each consisting of one PRP and one FA. The PRPs were involved in case observation, and the FAs conducted exit interviews of pregnant mothers and FP clients. The PRPs also reviewed the validity and completeness of FP and ANC data recording of the FWVs between the intervention and comparison areas. Moreover, they also conducted re-assessment to identify the risk of pregnancy and FP client segmentation. The validity and completeness of the monthly report and advance work plan were reviewed by the FAs, who stayed at least 1 day at each health facility, occasionally extending this by 2–3 days to obtain the desired sample size. Data was collected on a paper-based form.

The second phase of data collection was conducted from 30 August 2021 to 29 October 2021. Six teams were assigned in this phase, each consisting of one FA. The FAs conducted interviews of supervisors. They stayed at least 2 days at each union, occasionally extending this by 2–3 days to obtain the desired sample size. Data was collected on a paper-based form.

To further explore the experiences of RMNCH e-register users, we also conducted KIIs in the intervention areas in the third phase. Direct supervisors of the CHWs (FPIs) and service providers (FWAs and FWVs) as well as Upazila-level managers (UFPOs) participated in the KIIs. Additionally, 15 IDIs were performed in each district, where the respondents were mothers who received services in the intervention areas.

2.4.4 Data processing and analysis

Consistency checks were conducted on all collected data before it was transferred into the Stata® v15.0 statistical software for analysis. The analysis was performed using descriptive statistics. We used proportions for reporting categorical variables and mean and standard deviations for reporting continuous variables. The data was presented using appropriate numerical, tabular and graphical methods.

2.4.5 Quality assurance

Data quality assurance was of critical importance for this assessment. The research team ensured appropriate quality was maintained across the data collection, data analysis and report writing. Potential sources of biases were checked, and a structured questionnaire and checklist were extensively pretested to keep the responses aligned with the true context and standardised in all arms. All PRPs and FAs were trained based on standard operating procedures to keep the interobserver variability to a minimum. Fortnightly meetings were held with the research team under the guidance of study coordinators. The central investigators conducted frequent field supervision, monitoring and quality checking of the data collection process.

3. Results

3.1 Historical trajectory of eMIS initiative

The eMIS tool has undergone a gradual expansion across various regions of Bangladesh since 2012, when the DGFP embarked on preparatory efforts for eMIS initiatives, which involved reviewing and streamlining paper registers. By 2015, the implementation of e-registers started for the first time in the Tangail and Habiganj districts, within the PRS, covering the catchment area of community health and FP workers. From 2016 to 2019, the development of eMIS applications for community and facility systems continued, resulting in the expansion of e-registers to encompass 32 districts, including Natore, Jhenaidah, Madaripur, Maulvibazar, Lakshmipur, Noakhali, Jhalokathi, Cox's Bazar, Bandarban, Brahmanbaria, Chandpur, Chattogram Cumilla, Dinajpur, Faridpur, Feni, Gaibandha, Khagrachhari, Kurigram, Kushtia, Lalmonirhat, Manikganj, Nilphamari, Panchagarh, Rajshahi, Rangamati, Rangpur, Sunamganj, Sylhet and Thakurga. The year 2020 marked a significant milestone in that the Tangail and Habiganj districts were declared paperless for the first time. Subsequently, on 26 June 2021, an additional four districts (Natore, Jhinaidah, Noakhali and Lakshmipur) achieved paperless status. By 2022, e-registers had been successfully implemented in 40 districts, with the inclusion of the Bhola, Kishoreganj and Khulna districts during that same year. As of 2023, a total of 44 districts are now actively participating in the eMIS initiatives.

Figure 3: Historical trajectory of eMIS initiatives.
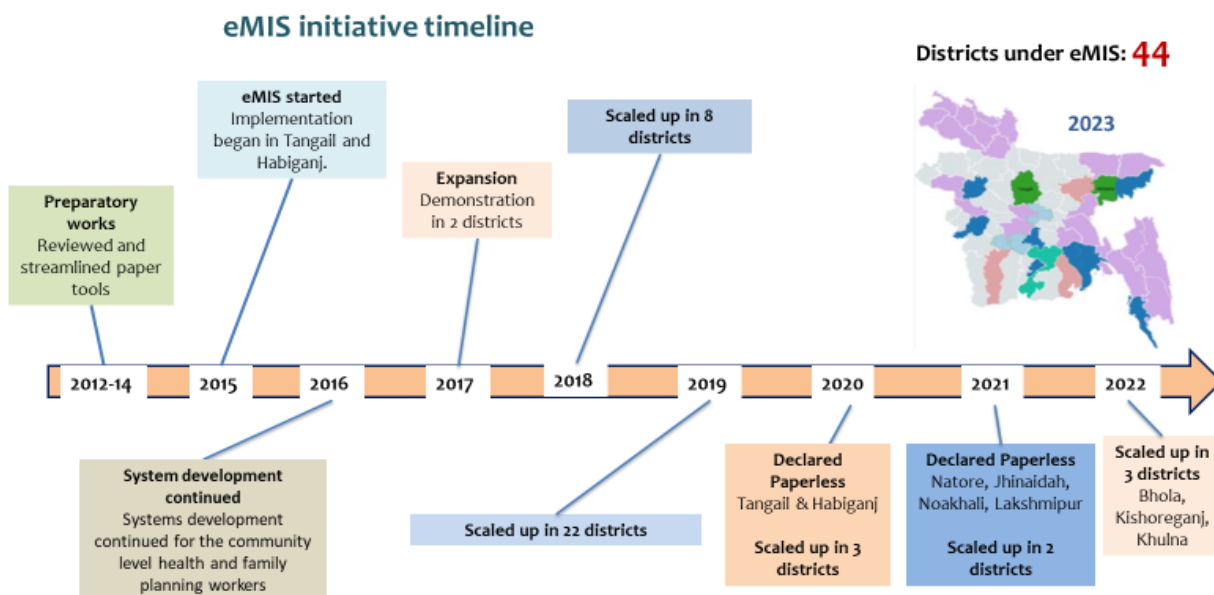
3.2 Benefits and challenges of eMIS at the health care provider level

Key findings

- Almost 42% of FWVs and 70% of FWAs exclusively used the e-registers during service delivery
- Report preparation time for exclusively e-register users: significantly lower
- Decision support for exclusively e-register users: significantly higher
- Record-keeping redundancy for exclusively e-register users: significantly lower
- Service delivery time, client search time and data retrieval time for exclusively e-register users: No difference

3.2.1 Register uses during routine service delivery in the intervention area

During the data collection, we observed which registers were used during service delivery by the FWVs and FWAs in the intervention areas. Since eMIS was being implemented in these areas, the providers there were expected to use only e-registers during service delivery. However, in the comparison areas where eMIS had not yet been initiated, all providers continued to use paper registers.

On the day of the visit, in the intervention areas, all HCPs had functional tablet PCs and used an e-register. However, about 58% of the FWVs and 30% of the FWAs were observed to use both paper-based and e-registers.
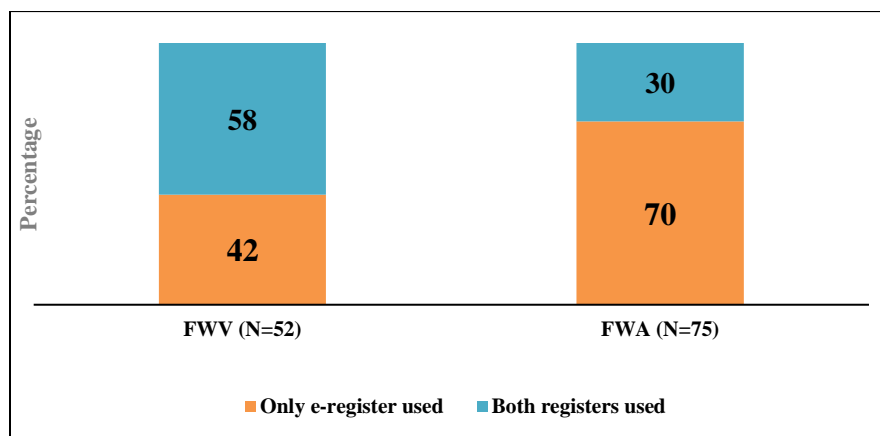

Figure 4: Percentage of use of e-registers and both paper-based and e-registers by providers.

For ANC services, 98% of the FWVs who used both paper and e-registers initially started using the paper register for each client. For FP services, all FWVs and 74% of FWAs began using the paper register first and, subsequently, transitioned to a combination of e-register and paper register.
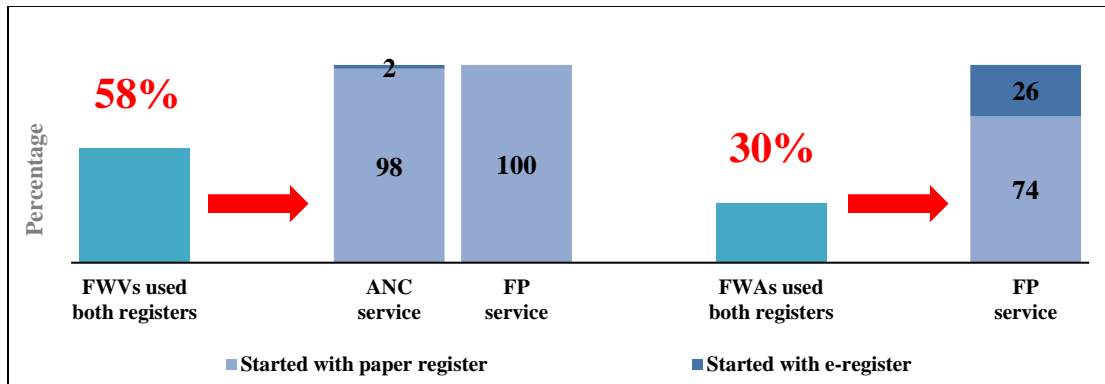
Figure 5: Percentage of register use (paper/e-register) at initiation of service delivery.

We explored the cause behind the use of both registers in the intervention areas. The majority of service providers informed that they used both registers due to low-performing devices, poor PRS data base, lack of internet coverage and slow data streaming hindering the use of TAB while providing services. Low-performing devices were reported to be the most prominent factor forcing users to choose hard copies as alternatives to provide services nearly every day. An FWV who used both registers said,

> My first tab was a Lenovo; after using it for a few days, some issues appeared. Then, another company's tab was provided. There are still a lot of problems, such as characters not showing while writing, the TAB's display flickering, server issues, incorrect data synchronisation, slow performance and prolonged searching times. There is a pregnancy register book, and I use the book and put the information into the ANC register book when I see the TAB is down or there is a server issue. (ID-5)

There were two levels of delays mentioned by the providers while using TAB offline. First, they had to wait a long time to log in to the system, and second, moving from one page to another took time, as the TAB would buffer. In such cases, for prompt service delivery, they were compelled to use a separate paper to document service data. As a result, they had to bundle together increasing pages of paper at the end of the month for reporting. An FWV narrated,

> We work in health centre, so we do not face internet problem. But those who work at satellite clinic, most of them have internet problem. When they work at satellite, they cannot work with the TAB; they write down the information in a page, [and] then, they put the information into TAB later. (ID-35)

They reported using a paper register or diary only when they had difficulty working with TAB. As mentioned by the service providers, they kept the paper register alongside them because it could be used to tackle any emergency situation. Sometimes, due to server problems or poor internet

connectivity, it took longer to insert information into TAB. In addition, the service recipients were often in a rush. In such situations, recording the information in the paper register became necessary. One FWV said,

> Usually, I provide services with TAB, but sometimes, we write information in the paper, and then, again, we insert the information into TAB. Isn't it [an] additional task for me? Net connection is very poor here. If we want to insert one piece of information, it takes [a] long time. The internet starts buffering while the patients want to leave. That is why paper register is used for alternative; then after going back home, we again inset information into TAB from paper register. (ID-15)

3.2.2 Time required to provide routine service delivery

During the data collection, we observed how much time was required for the FWVs and FWAs to provide service delivery in both the intervention and comparison areas, using a stopwatch to measure the service delivery time. The expected benefits of using the MNC and FP e-registers were as follows:

- New service seekers or clients could be instantly registered using a tablet PC.
- A client's details could be retrieved from the PRS database using a unique ID if they had already been registered.
- Client service histories and FP method usage were accessible from the relevant database as well.

As information was recorded through e-registers and there was no need to write anything in a hard copy in the intervention areas, it was expected that there should be less time required to serve the clients than in the comparison areas.

As shown in **Figure 6,** no significant difference was found in the mean service time for ANC services provided by FWVs between the intervention and comparison areas (15 vs 13 minutes, respectively). For FP services, the FWVs in the intervention areas had a higher mean service time compared to those in the comparison areas (10 vs 6 minutes, respectively). The mean service time for FP services among FWAs was the same in both the intervention and comparison areas (10 minutes).
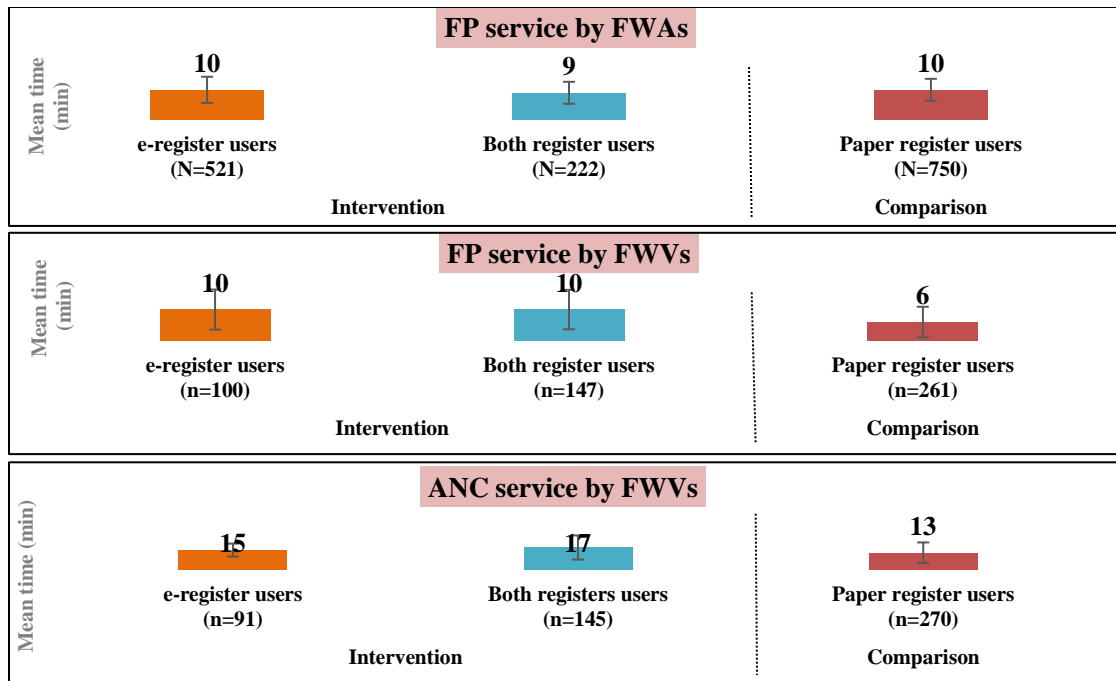
Figure 6: Mean service time for e-register and paper register users while providing antenatal (ANC) and family planning (FP) services.

In the intervention areas, most service providers mentioned that the time required for service delivery remained consistent due to several factors. These included extended waiting times to log in to the system, the increased time taken when moving between different sections, the limitations of low-performing devices, slow data streaming, instances where clients did not have their HID, national ID (NID) or non-registered client ID (NRC ID), and discrepancies in name spelling and date of birth for the same individuals. Additionally, service providers in both intervention areas noted that the use of TABs had increased their workload, as they were required to manage both TAB and paper registers simultaneously. One FWV said,

> We face internet problem both in health centre and at the satellite clinic. The TAB doesn't work properly. We need to wait [a] long time to log in to the system, and moving from one page to another takes more time, as the TAB buffers. So, when we work at the health centre or satellite, we cannot work with the TAB. We write down the information in a page; then, we put the information into TAB later. (ID-23)

They mentioned their workload would be reduced if they could use only one register. During office hour, they could not use both due to the large number of patients. Therefore, they used a paper register while seeing patients and inserted the information into TAB later. One service provider said,

> While logging, TAB shows that stop internet and try again to log in; then, I disconnected my internet and tried and succeeded. After that, I got all the data synced, but the office

informed me that you have not logged [in] since last two to three days. That means if I work stopping my internet, I remain invisible. (ID-10)

Another said,

Sometimes, we cannot find out the ID of the mothers. Firstly, we try to search for her in different ways; still, if we cannot find her, then we do NRC, and after that, we also insert the information into the paper register. (ID-39)

3.2.3 Time required for report preparation

We explored the e-registers' benefits regarding the time required to prepare monthly reports in the intervention and comparison areas. As before, we used a stopwatch to measure the report preparation time. We considered tablet log-in time, server connection establishment, system navigation and report preparation during the time count. With the e-registers,

- monthly report forms could be generated automatically at any point in time, and
- it was expected to reduce the workload and save time for the FWVs and FWAs, who used to spend 1–2 days each month compiling the report by extracting relevant data from multiple paper registers.

As **Figure 7** shows, exclusively e-register users required significantly less time, on average, to compile the report compared to paper register users. The mean report preparation time for both electronic and paper register users was considerably higher than that for exclusively e-register users.

For FWVs, the mean report preparation time was only 16 minutes in the intervention areas compared to 304 minutes in the comparison areas, and for FWAs, it was only 18 minutes versus 291 minutes, respectively. The time increased for users of both registers.
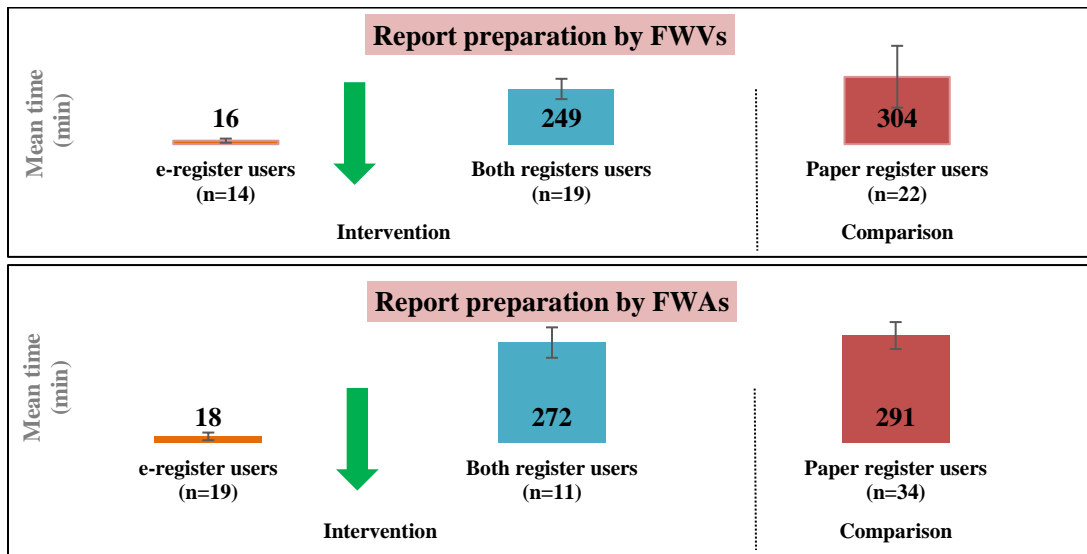

Figure 7: Mean report preparation time by health care providers.

We explored the challenges in preparing reports in the intervention areas. Almost all service providers stated that due to technical glitches, sometimes, reports were not auto-generated, forcing them to use both hard- and soft-copy report submissions. Most of the service providers and their supervisors reported that they used to submit the report as a hard copy in the past, but now, they had to submit reports in both formats, which they regarded as an additional task. Moreover, the supervisors mentioned that they officially instructed the union-level health workers to submit the report in both the e-register and paper register. However, before submission of the report, they were instructed to match the hard-copy report with the TAB report. One FPI said that FWAs were instructed to submit a report through TAB only, and along with it, the hard-copy report was preserved, narrating,

> We were not given [a] paper register; we were asked to use only TAB, though sir (UFPO) instructed us to use [a] photocopy of [the] register side by side. We mainly submit report[s] using TAB. As we were not supplied [a] hard-copy register; we use paper to generate and submit report[s] and also preserve the reports. (ID-16)

Slow data streaming was a major cause of delays in monthly report preparation and submission. Providers reported that sometimes it took 48 hours to complete this task. One FWA explained this delay, saying,

> Sometimes, [a] report is not auto-generated. Last month, I submitted the monthly report using TAB, but it took two days to complete the submission. Initially, I thought it was my fault, so the report was not being sent. I called my other colleagues and found out that they had the same problem with TAB. So, we don't wait for TAB report to be sent. Instead, we sent the hard-copy report as the original document along with the TAB report. (ID-15)

When service providers faced a problem, they usually contacted their immediate supervisors. One provider said,

> I was having a problem to submit a monthly report; then, I talked to my supervisor about it, and he resolved it. (ID-14)

Another narrated,

> I contacted FPI about the report submission. I was trying, but I could not submit the report. After that, I informed FPI, and FPI informed the troubleshooter, and then, the trouble shooter contacted icddr,b people. However, finally, it was resolved. (ID-10)

A few service providers stated that their supervisors did not have training on TAB; hence, they could not solve technical TAB-related issues. One service provider reported that her supervisor was not keen to solve problems made while working with TAB, saying,

> When I ask my supervisor (FPI) to correct the mistakes I made in TAB while working, he replies that 'the problem will be solved', but in reality, it does not happen. (ID-10)

3.2.4 Time required to search registered clients

We explored the e-registers' benefits regarding the time required to search for registered clients in the intervention and comparison areas. As before, we used a stopwatch to measure the search time. The e-registers were installed to retrieve case information using unique HIDs. In the absence of HID, the client's name/NID/non-registered client ID (NRC ID)/birth registration number/mobile number would be utilised for the client search. The whole process should not take more than a few seconds.

As shown in **Figure 8**, no significant difference was observed in search time for clients. The mean client search time by FWVs using only the e-register was two minutes in both the intervention and comparison areas, whereas it was three minutes for those using both registers. The mean client search time by FWAs in both the intervention and comparison areas was one minute.
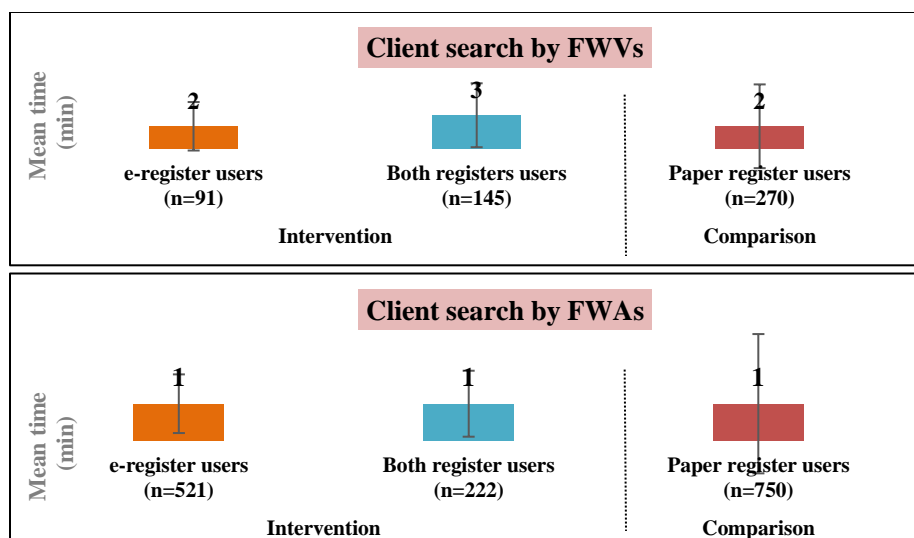
Figure 8: Mean search time for client search by health care providers.

In the intervention areas, most of the service providers informed that it became easier to find data or clients using the TAB due to its multiple search options. However, they did not bring their HID card, which was provided during PRS. Sometimes, the spelling of the name did not match, making it challenging to find a client in the TAB. As reported by the HCPs, clients were not used to using this health card. They did not bring it with them because they were unable to understand its importance and lacked motivation. Thus, the HCPs urged the clients to carry it while receiving services. If service providers could not find the name of a client, then they newly registered the service recipient. A service provider from an intervention area said,

> I think using TAB has many benefits in my work because if any patient comes to me, I can find all her information if I just search her name using her HID or phone number. I do not have to write all the information again, as FWAs had done PRS beforehand. So, I just need to insert the registration to find the client. I can provide services to the clients. But she

didn't bring HID or her mobile number didn't match, so I gave her service with a paper register and put the information in my free time. (ID-41)

3.2.5 Record-keeping redundancy

Through the use of e-registers for ANC and FP services, essential information about registered pregnant mothers was recorded in relevant database tables. With the elimination of redundant/duplicate data entries, time was saved.

Looking at **Figure 9**, no record-keeping redundancy was observed for registered clients in the intervention areas. However, 57% of the providers had to fill in 1–10 data fields and the remaining 43% of the providers 10+ data fields in the comparison areas.
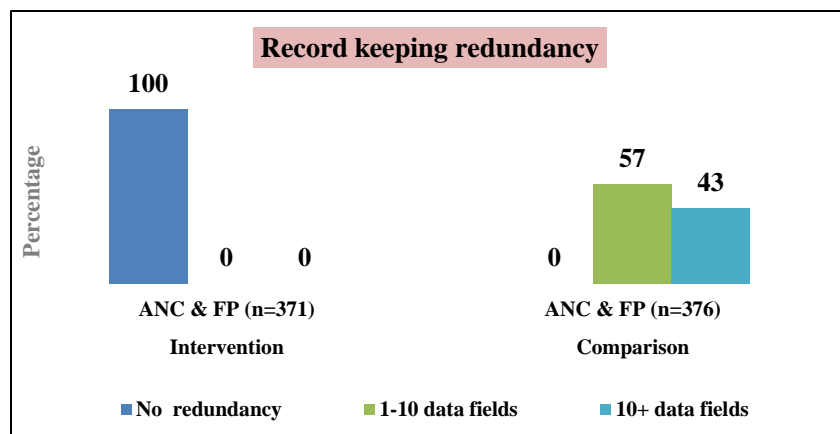
Figure 9: Record-keeping redundancy for antenatal care (ANC) and family planning (FP) services.

According to feedback from the service providers, in the past, they had to complete 20 or more information columns for each pregnant woman, which was a time-consuming process. However, now, they no longer had to fill out as many columns because the information was already stored on the tablet. Using the tablet to retrieve client information was much quicker than flipping through pages of paper registers. A service provider from an intervention area opined,

> Previously, we had to fill up 21 columns of information for a pregnant woman, which used to take [a] long time. But now, no need to fill up so many columns as the information were there inside the TAB already. (ID-28)

3.2.6 Retrieving data for service delivery planning

Notification and job aid tools were new features added to the digital e-registers, made possible by the capabilities of digital technologies. Notifications were generated to alert HCPs about their pending tasks. For instance, an FWA could review the list of pregnant women who had passed their expected date of delivery and decide to visit their households to collect data. This eliminated the need for manual searching, saving time and improving the quality of care.

We asked the FWVs and FWAs to demonstrate how to identify clients who missed their latest scheduled ANC and FP visits. In the comparison areas, 60% of FWVs could not retrieve the list of these clients, whereas only 38% in the intervention areas faced the same issue.

Among those who could retrieve the list (**Figure 10**), no significant difference was found. The FWVs using only e-registers required less time to retrieve the list compared to paper register users. However, no significant difference in mean retrieval time was observed for FWAs. For FWVs, the mean data retrieval time was one minute in the intervention areas versus four minutes in the comparison areas, while for FWAs, it was three minutes versus four minutes, respectively. The mean data retrieval time increased for FWVs and FWAs using both registers.
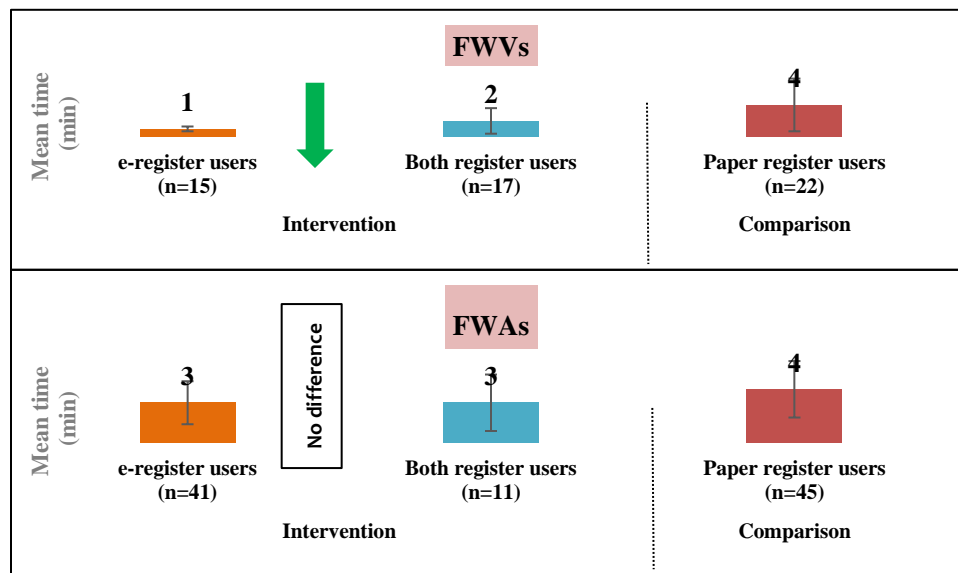
Figure 10: Mean time required for data retrieval by health care providers.

The service providers stated that they received notifications from TAB about which clients to serve and when and which medicines were to be provided for a particular health problem. If they missed providing services to any clients, they were reminded with a notification from TAB to reach out to them. Moreover, TAB helped to identify pregnant mothers who needed ANC immediately and was also helpful in identifying mothers with complications who needed to be served on a priority basis. One FWV said,

Regarding ANC, the TAB guides us when to give the next ANC; the date of next ANC is automatically calculated in the TAB. When we insert information of the pregnant mother, the TAB shows the EDD. [The] TAB prioritises the pregnant mothers about their services they will have to receive, who will get which services and the next visit date, including the delivery date. (ID-28)

3.3 Benefits and challenges of eMIS at the health system level

Key findings

- Data recording validity for exclusively e-register users: Higher

- Data recording completeness for FP services among the e-register user FWAs: Higher

- Accuracy of monthly reports of exclusively e-register users (paper report matched with the online report): Higher

- Adherence to protocol for FP service among the e-register user: Higher

- Searching time to monitor HCPs by managers in the intervention areas: Lower

3.3.1 More than 75% data recording validity by study sites and providers

The ANC and FP e-registers replicated the CHWs' paper-based registers and forms, ensuring familiarity. Consequently, data collection was simplified, and reporting became both high-quality and effortless. We observed the ANC and FP services provided by the FWVs and FWAs and assessed the data recording validity by comparing their findings during service provision with what they recorded in the registers. We defined recording validity as at least 75% of the information recorded in the register for each client being correct.

Figure 11 shows that among the FWVs, for ANC services, exclusively e-register users recorded at least 75% of the data correctly in 90% of cases, whereas paper register users exhibited the same level of accuracy in only 71% of cases. For FP services, exclusively e-register users exhibited 84% and paper register users 81% data recording validity. However, the data recording validity was poorer, at only 48%, among those who used both registers. Among the FWAs, the data recording validity was high for e-register and paper register users: in nearly all cases, both groups correctly recorded more than 75% of the information.
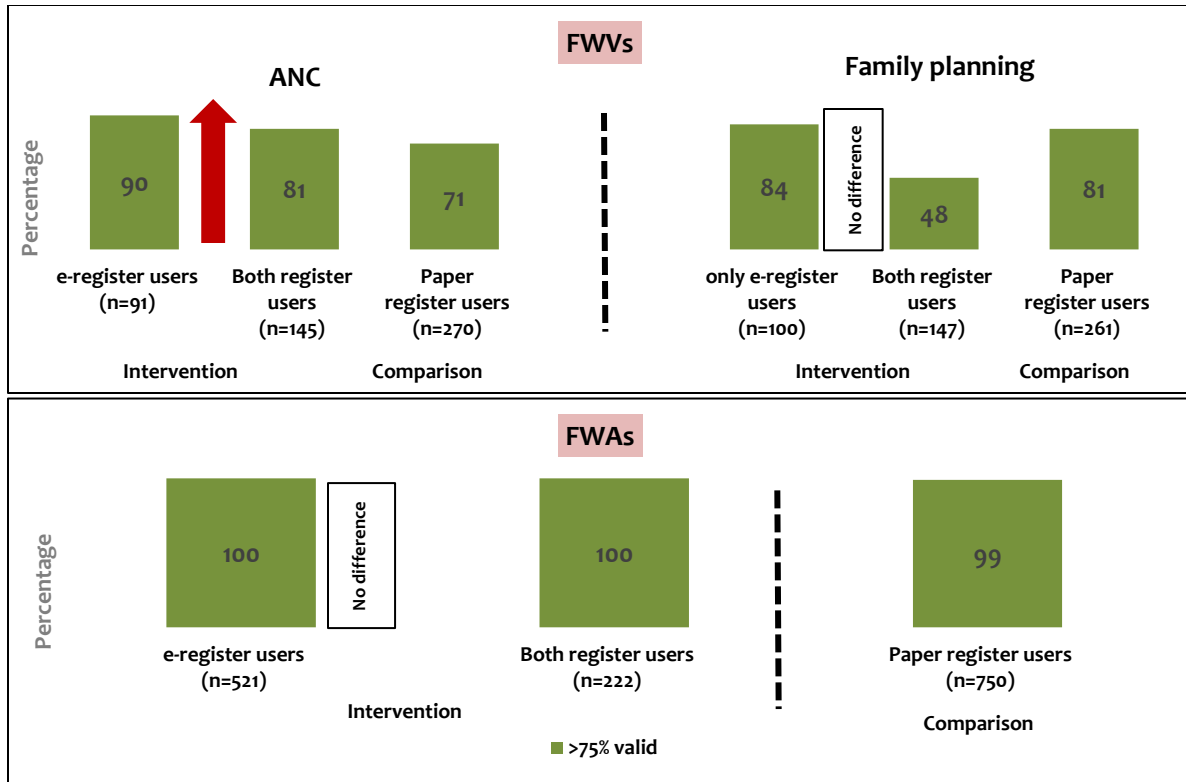
Figure 11: Data recording validity (>75%) by study sites and providers.

3.3.2 More than 75% of data recording completeness by study sites and providers

It was expected that with the elimination of manual paperwork, complete data recording should reach 100%. We defined record completeness as at least 75% of all relevant data cells having been filled out in a client service record form.

Figure 12 shows that among the FWVs who exclusively used e-registers, in 64% of ANC cases, at least 75% of the information cells on the recording forms were filled. In contrast, among paper register users in the comparison areas, the data recording completeness was notably low, at only 9%. However, for FP services, recording completeness was lower among e-register users.

Among the FWAs, exclusively e-register users demonstrated significantly higher recording completeness compared to users of both registers and paper register users.
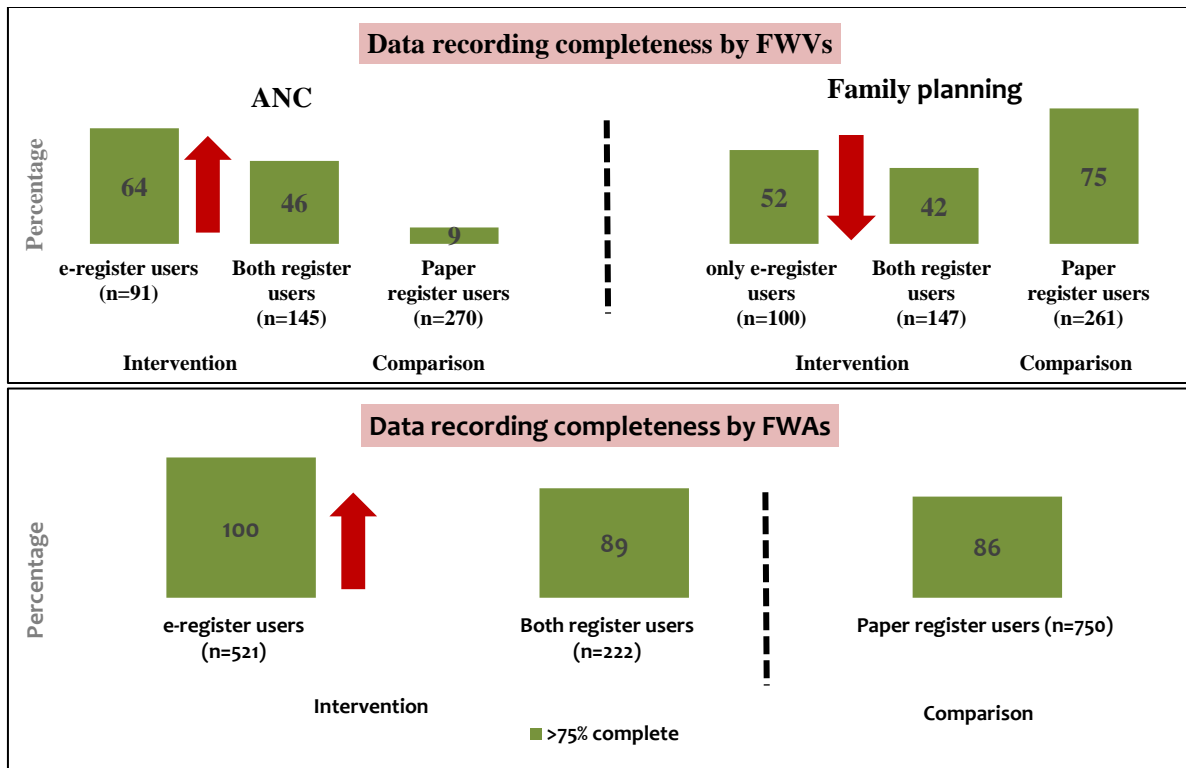
Figure 12: Data recording completeness (>75%) by study sites and providers.

3.3.3. More than 75% of online reports matched with paper reports by study sites and providers / accuracy of monthly data reporting

We explored the accuracy of monthly data reporting in both the intervention and comparison areas. Since eMIS generated the end-of-month report automatically via the app, we expected the report submitted through eMIS to contain 100% correct and complete data. We employed various relevant approaches to assess the accuracy of the monthly data reporting. In the intervention areas, all HCPs submitted both electronic and paper reports, and we compared the two formats to verify whether the figures matched. In the comparison areas, we compared monthly paper reports with paper register records.

We found that in the intervention areas, among HCPs who exclusively used eMIS during service delivery, more than 75% of data fields in all monthly reports matched with the paper reports (**Figure 13**). However, none of the users of both registers had electronic and monthly reports matching 75% or more data fields. In the comparison areas, a maximum of 2% of HCPs had 75% or more data fields in their monthly report matching with the paper register records.
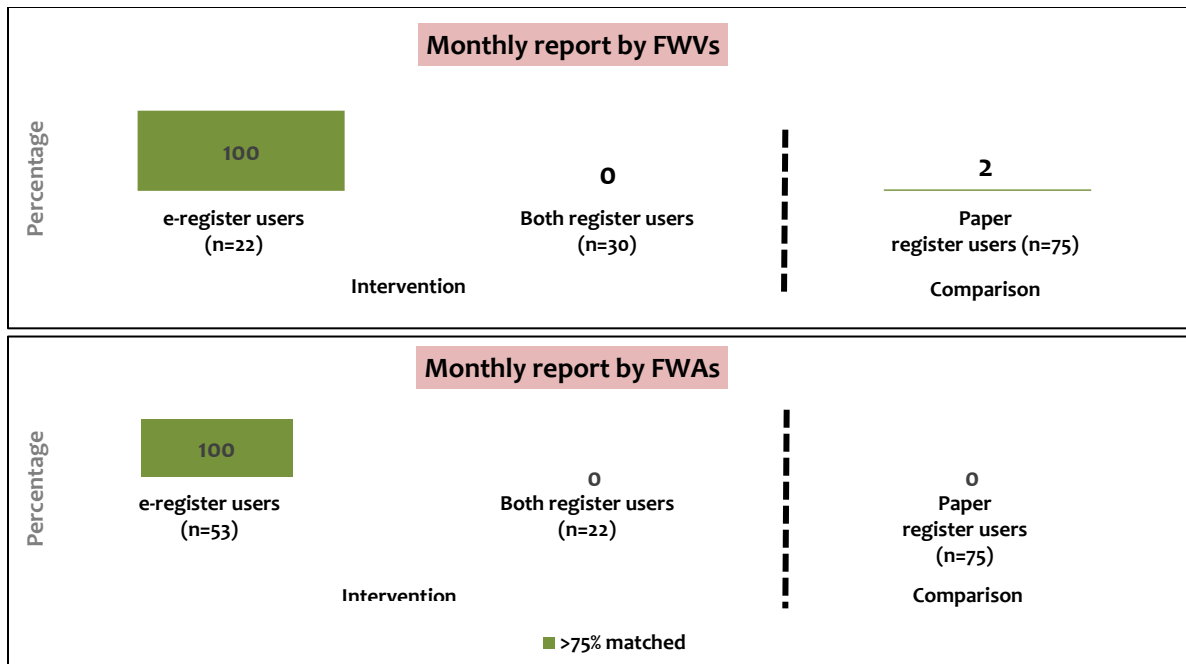
Figure 13: Accuracy of monthly data reporting (>75% matched) by study sites and providers.

Most of the service providers in both study sites opined that with the help of TAB, monthly report generation had become much easier and quicker. If all data was inserted into TAB properly, the report was automatically generated at the end of the month. However, TAB often showed wrong information in the notifications. This inconvenience created mistrust among the providers concerning TAB. An FWA said,

> Sometimes, the TAB shows wrong information in the notification. For example, I entered 120 eligible couples, but [the] notification shows 100 couples. In [a] few cases, I did not find recorded data of an entire month in TAB. Another example was a woman's husband died, and it was inserted into TAB accordingly, but still, her name was showing in the list of eligible couples. (ID-11)

Qualitative data illustrated that most of the young HCPs had early exposure to smartphones, which helped them fill out all data forms correctly in the e-registers. They reported greater familiarity with and efficacy in using various mobile applications. Although the older HCPs had difficulty using the e-registers, their younger colleagues helped them complete the data entry in TAB. By receiving such support from colleagues, the older HCPs learned to use the e-register more thoroughly and correctly. One FWA narrated how her previous experience of using smartphones helped her learn the e-register handling, saying,

> When I was a college student, my parents bought me a smartphone. I used the phone for many things; especially, I used to apply online for job circulars. Applying for jobs online requires filling [out] a few forms using the mobile app. In some cases, those forms were in Bengali and sometimes in English. I understood all this and completed the application.

When I joined here as [an] FWA, I was trained to use TAB, and I found that all forms are easy. (ID-28)

3.3.4 More than 75% adherence to the protocol by study sites and providers

We explored the benefits of eMIS in improving adherence to ANC and FP service protocols, as it guided real-time service delivery, which was not possible with a paper register. It was expected that with the assistance of medical intelligence, adherence to the protocol should be enhanced. We defined adherence to the service protocol as 75% or more of the service components or steps being performed correctly.

For ANC services, no FWVs in the intervention or comparison areas demonstrated at least 75% adherence to the protocol (**Figure 14**). However, for FP services, 36% of exclusively e-register users adhered to the protocol compared to only 1% of paper register users in the comparison areas. Adherence to the protocol was lower among users of both registers in the intervention areas. Among the FWAs who used e-registers exclusively, 55% exhibited at least 75% adherence to the protocol for FP services, compared to 45% of paper register users in the comparison areas.
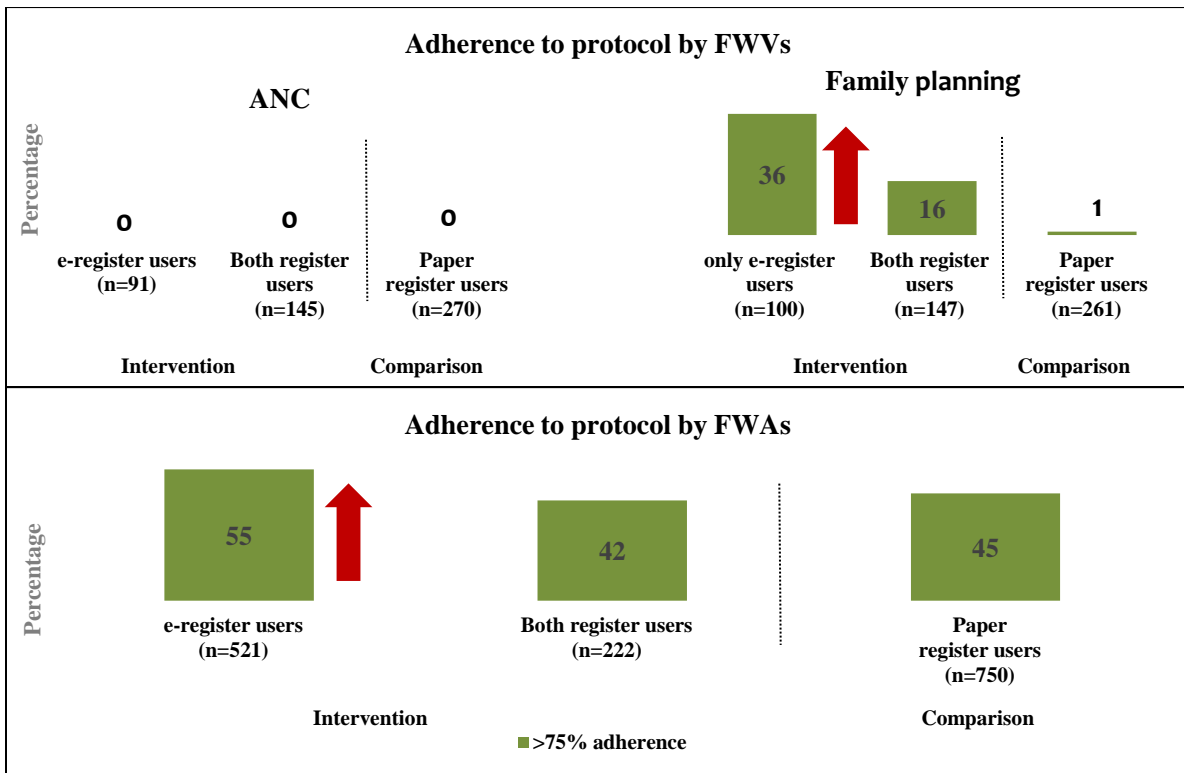
Figure 14: Adherence to the protocol (>75%) by study sites and providers.

We explored the reasons behind the persistently low adherence to the protocol in the intervention areas despite the guidance provided by eMIS. Many HCPs cited frequent use of both registers, primarily due to issues such as underperforming devices, extended wait times to access the system

and the time-consuming process of transitioning between different sections. An FWA using an e-register said,

> I encountered various problems when using TAB during service delivery. Working on the tablet can be challenging and boring due to its electrical nature. Sometimes, pages don't open, and waiting time increases. (ID-09)

3.3.5 Timeliness of report submission

As MIS-3 and MIS-1 forms were now generated automatically at any point in time through the use of e-registers, manual paperwork was eliminated. Thus, timely report submission should be increased. In our study, we also found that all HCPs (both FWVs and FWAs) submitted reports on time at the end of the moth (**Figure 15**).
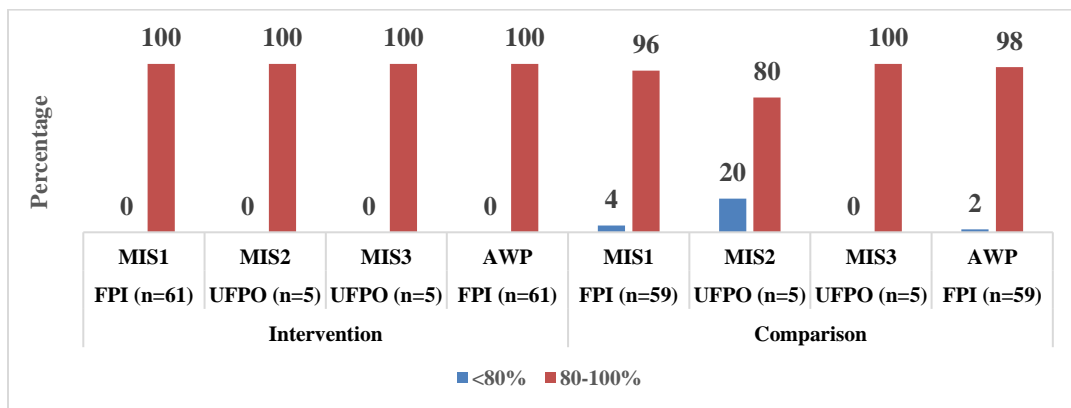
Figure 15: Timeliness of report submission.

Most of the service providers in both study areas mentioned that they submitted their monthly report on time. Sometimes, they wrote down information to keep the data consistent in both hard copies and TAB. Like report generation, report submission was also significantly faster. A service provider informed,

> In the past, we used to take a long time to prepare and submit the report; since the report is auto-generated now, we do not have to write anything with our hand; all we need to do is to check the report and submit it. It takes less time now as opposed to hard-copy register.
> （ID-13）

One of the supervisors narrated,

> [The] FWAs fill MIS-1 and submit it to FPI, and FPI submits MIS-2 to UFPO, and then UFPO approves it. On the other hand, clinical staff submit MIS-3 to UFPO for approval. Once UFPO approves it, the report is auto-generated in MIS-4 and subsequently approved at district level. (ID-8)

3.3.6 Real-time monitoring by managers

We explored the potential for real-time managerial monitoring using e-registers, as supervisory apps are readily available on mobile devices to assist managers in overseeing their workforce's performance. We inquired with the supervisors about their ability to remotely monitor, in real time, the attendance of their staff. Our findings revealed that three out of the five supervisors utilised the eMIS platform as their primary method for checking whether an HCP was working on a given day, while the remaining two relied on both phone calls and the eMIS platform. In the comparison areas, phone calls were the sole means of determining which HCPs were on duty for the day. Notably, the search time was significantly shorter in the intervention areas, with an average of only 3 minutes required compared to 67 minutes in the comparison areas.

The supervisors opined that TAB played a vital role in supervising and monitoring the service providers and their work. The providers could be supervised from anywhere, without supervisors going to the field. In TAB, in addition to real-time monitoring, there was also an option to give feedback on providers' work. A supervisor said,

> In the past, we had moved to the field to supervise the service providers, but now we can supervise them from anywhere without going to [the] field. (ID-11)

If an FPI could not visit the field, they could log in to the monitoring tool using TAB and check what the FWAs were doing that day and whether they were performing their routine work properly. However, we found some supervisors primarily monitored and supervised service providers over the phone. One service provider said,

> If [an] FPI wants, he can monitor using TAB; if he wants, he goes to FWC, or he can monitor service providers directly going to the field. It absolutely depends on the FPI and how he wants to monitor it. In the past, he (FPI) used to monitor in the field; now, he can monitor with TAB what his service providers are doing. He is monitoring both offline and online. (ID-13)

The supervisors could also easily track the types and quantity of methods being provided to clients with the help of TAB. The use of TAB made the service providers more active and accountable to their supervisors. The providers opined that with the introduction of TAB, no one could skip their assigned tasks because their supervisors continuously monitored their work online. A service provider from the intervention areas said,

> We (HCPs) are now more careful about the timely completion of our work. Now, there is no way to deceive our supervisor; we do our work timely. (ID-09)

3.4 Benefits and challenges at the client level

Key findings

- Better quality of ANC in the intervention areas among exclusively e-register users

- Providers in intervention areas could use eMIS to identify risk pregnancies and FP method selection

3.4.1 Quality of care by study sites and providers

One of the primary benefits we explored for clients was enhancement of the quality of care, made possible by eMIS guiding service delivery, which was not achievable with paper registers.
As shown in **Figure 16,** among the FWVs who exclusively relied on e-registers, there were higher rates of weight and blood pressure measurements being taken than the paper register users (weight measurement: 99% vs 83%; blood pressure measurement: 95% vs 87%). Additionally, haemoglobin levels were assessed in 32% of ANC cases among exclusively e-register users (compared to only 9% among paper register users), and urine albumin was tested in 41% of ANC cases (compared to just 7% among paper register users). Overall, the quality of ANC services provided by the FWVs using e-registers exceeded that of those using paper registers (30% vs 5%, respectively). Furthermore, each individual component of ANC and the overall quality of ANC service provision were lower among FWVs who utilised both registers in comparison to those who exclusively used e-registers.
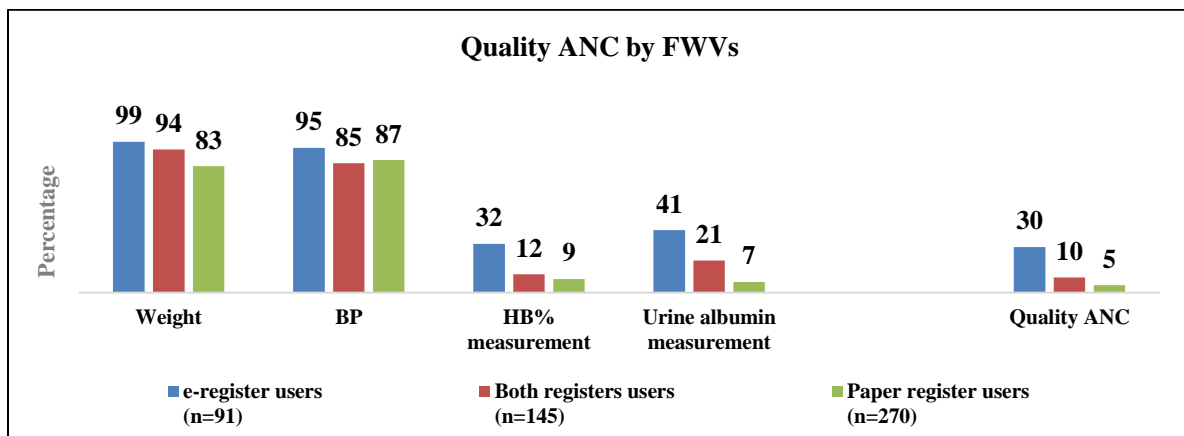

Figure 16: Quality antenatal care (ANC) by family welfare visitors (FWVs) using e-registers, paper registers and both registers.

3.4.2 Identification of high-risk pregnancies

The MNC e-register was designed to identify high-risk pregnancies while recording pregnancy information for each case as well as instantly notify the provider if a client required referral to a higher-level facility. With the assistance of such technology-guided medical intelligence, the quality of care should be improved. In our study, we found that all FWVs in the intervention areas were able to identify high-risk pregnancies using the e-registers.

3.4.3 Selection of family planning method

The tablet PC used for the MNC e-register was equipped with a system algorithm that established the criteria/biomarkers for selecting an FP method. Consequently, when the necessary information was input, the tablet automatically suggested appropriate FP methods. In our study, we found that all FWAs in the intervention areas were able to choose a suitable FP method using the e-registers.

4. Study Recommendations

Suggestions to improve eMIS for registering mothers and providing services

- **A good-quality tablet is required:** To facilitate a paperless system, it is essential to provide high-quality tablets so that service providers can work comfortably and efficiently.
- **A robust server is essential:** Server-related issues can lead to delays in report submission. Therefore, strong server infrastructure is necessary to ensure smoother and faster report submissions.
- **Simplify the eMIS system:** The eMIS operating system should be made more user-friendly. Data entry for ANC, PNC and FP services can be complex and should be simplified.
- **Provide training for FPIs:** Many service providers suggested arranging training for family planning inspector (FPIs) to enable them to become proficient trouble-shooters and effectively resolve technical issues with tablets.
- **Regular refresher training is necessary:** Service providers emphasised the need for frequent refresher training sessions, which could provide a platform for learning, discussion, issue resolution and skill improvement.
- **Increase the number of trouble-shooters or tablet technicians:** The current ratio of one technician to many service providers makes it challenging to address all technical issues faced by FWAs. Therefore, the number of trouble-shooters should be increased based on the number of service providers in an area.
- **Implement alphabetical order for names:** Organising names alphabetically would facilitate easier name search. For instance, if users search for names starting with 'M', the tablet should display all names that begin with the letter 'M'.

- **Include an edit option:** It is important to have an option to edit data. Currently, the system restricts data editing after 72 hours from initial insertion.

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Annex:

Annex Table 1: List of data collection tools.

Types of data collection tools	Assessment domain
Quantitative tools	
Case scenario–based observation tool	Retrieval of selected ELCO and pregnant women data for family welfare assistants (FWAs) and family welfare visitors (FWVs)
Observation using checklist	Provision of selected service encounters by FWAs and FWVs
	Observation of ease/difficulty of ELCO data retrieval for FWVs and of pregnant women data retrieval for FWAs
	Adherence to service delivery protocols by FWAs and FWVs
Structured interview questionnaire	Assessment of workload in a given month
Case extraction sheet for individual records and community case tracking	Extraction of selected individual service data recorded by FWAs and FWVs and checking of those with the actual service recipients
Case extraction and review form (for aggregated and individual data)	Extraction of selected monthly reports of FWAs and FWVs from Upazila offices and checking of the aggregated no. with the respective sources
	Extraction of selected individual records by FWAs and FWVs and review to see data updates
	Extraction of selected records from FWV records and checking of data availability in FWA records
	Extraction of selected individual service records by FWAs and FWVs and review to see data completeness
Monthly reports review form	Review of monthly reports for a given month and checking of timeliness
	Review of monthly reports for a given month and checking of data completeness
	Review of monthly reports for a given month and checking of reporting completeness
Qualitative tools	

Types of data collection tools	Assessment domain
Interview	Perceived ease/difficulty of ELCO data retrieval for FWVs and pregnant women data retrieval for FWAs
	Perceived ease/difficulty of performing the monthly tasks
	Perceived ease/difficulty of data sharing between community and facility
	Use of job aid tools for performing selected functions
	Community health worker (CHW) supervisors to access community-level data for performing selected functions
	Supervision activities by CHW supervisors and the way they manage these
Desk review	Mapping indicators can be reported through reproductive, maternal, newborn and child health e-registers
In-depth interview	RDWs and family planning clients
Key informant interview	Perspective from CHW supervisors and managers • FWVs, FWAs, family planning inspectors, UFPO

Annex Table 2: Percentage of providers using e-register and both registers in the intervention areas.

Indicators	n(%) of providers			
	Family welfare visitor		Family welfare assistant	
	Tangail (n = 20)	Habiganj (n = 32)	Tangail (n = 50)	Habiganj (n = 25)
Only e-register user	7 (35.0)	15 (46.9)	38 (76.0)	14 (56.0)
Both register users	13 (65.0)	17 (53.1)	12 (24.0)	11 (44.0)

Annex Table 3: Guided service delivery for intervention areas.

Indicators	n(%) of providers					
	Family welfare visitor			Family welfare assistant		
	Habiganj	Tangail	Total	Habiganj	Tangail	Total
Guided service	**n=32**	**n=20**	**n=52**	**n=25**	**n=50**	**n=75**
Client search	25(78.1)	14(70.0)	39(75.0)	12(48.0)	26(52.0)	38(50.7)
Service delivery	28(87.5)	14(70.0)	42(80.8)	11(44.0)	28(56.0)	39(52.0)

Risk pregnancy identification/family planning method selection	29(90.6)	17(85.0)	46(88.5)	11(44.0)	24(48.0)	35(46.7)
Counselling	30(93.8)	19(95.0)	49(94.2)	10(40.0)	22(44.0)	32(42.7)
Refer	30(93.8)	15(75.0)	45(86.5)	13(52.0)	34(68.0)	47(62.7)
Prepare and submit MIS report	32(100.0)	19(95.0)	51(98.1)	13(52.0)	33(66.0)	46(61.3)

Annex Table 4: Continuum of information.

Indicators	n(%) of providers	
	Family welfare assistant	
	Intervention	**Comparison**
Continuum of information	**N = 371**	**n = 376**
0%–25%	214(57.7)	204(54.3)
26%–50%	112(30.2)	109(29.0)
51%–75%	32(8.6)	51(13.6)
76%–100%	13(3.5)	12(3.1)
Mean	21.0 ± 25.6	25.1 ± 26.9

Annex Table 5: Instruction on using e-registers.

Indicators	n(%) of providers					
	FWV			**FWA**		
	Habiganj	**Tangail**	**Total**	**Habiganj**	**Tangail**	**Total**
	N = 32	**N = 20**	**N = 52**	**N = 25**	**N = 50**	**N = 75**
Instruction given during supervision						
Advice on using e-register	**12(37.5)**	**4(20.0)**	**16(30.8)**	**5(20.0)**	**15(30.0)**	**20(26.7)**
Matching numbers for both e-register and	**8(25.0)**	**2(10.0)**	**10(19.2)**	0(0.0)	8(16.0)	8(10.7)

paper register						
Monthly progress as per advance work plan	1(3.1)	1(5.0)	2(3.9)	4(16.0)	15(30.0)	19(25.3)
Technical solution regarding TAB usage	15(46.9)	7(35.0)	**22(42.3)**	15(60.0)	27(54.0)	**42(56.0)**
Providing monthly report on time	16(50.0)	8(40.0)	**24(46.2)**	21(84.0)	28(56.0)	**49(65.3)**
Issued discussed in the monthly meeting						
Matching numbers for both e-register and paper register	14(43.8)	6(30.0)	**20(38.5)**	5(20.0)	17(34.0)	**22(29.3)**
Matching reports for both eMIS and paper register	13(40.6)	5(25.0)	**18(34.6)**	4(16.0)	8(16.0)	**12(16.0)**
Advice on using e-register	14(43.8)	5(25.0)	19(36.5)	5(20.0)	30(60.0)	35(46.7)
Technical solution regarding TAB usage	14(43.8)	8(40.0)	22(42.3)	19(76.0)	41(82.0)	60(80.0)
Providing monthly report on time	15(46.9)	6(30.0)	21(40.4)	21(84.0)	30(60.0)	51(68.0)

Annex Table 6: Client satisfaction.

Indicators	n(%) of clients

	Intervention		Comparison	
	Antenatal care (ANC) service	**Family planning (FP) service**	**ANC service**	**FP service**
Client satisfaction	**N = 236**	**N = 246**	**N = 270**	**N = 261**
Provided adequate information	206(87.3)	205(83.3)	221(81.9)	223(85.4)
Respectful attitude	161(68.2)	164(66.7)	151(55.9)	142(54.4)
Health worker busy with e-register/paper register	26(11.0)	34(13.8)	49(18.2)	47(18.0)
Waiting time at reception				
<10 minutes	74(31.4)	79(32.1)	121(44.8)	152(58.2)
10–30 minutes	110(46.6)	124(50.4)	107(39.6)	84(32.2)
>30 minutes	52(22.0)	43(17.5)	42(15.6)	25(9.6)
Mean time	27.3 ± 33.3	24.2 ± 32.0	20.3 ± 30.5	14.6 ± 28.2
Feeling about the time				
Quite a long time	23(9.8)	17(6.9)	4(1.5)	3(1.2)
A long time	64(27.1)	69(28.1)	73(27.0)	47(18.0)
A little while	102(43.2)	110(44.7)	159(58.9)	184(70.5)
Very little time	47(19.9)	50(20.3)	34(12.6)	27(10.3)
Chance to ask questions				
No chance at all	0(0.0)	0(0.0)	4(1.5)	8(3.1)
Not much chance	8(3.4)	25(10.2)	6(2.2)	7(2.7)
Little chance	39(16.5)	37(15.0)	48(17.8)	68(26.1)
Many chances	189(80.1)	184(74.8)	212(78.5)	178(68.2)
Responsiveness				
Full attention	229(97.0)	230(93.5)	259(95.9)	238(91.2)
Low attention	7(3.0)	13(5.3)	7(2.6)	22(8.4)
No scope to ask	0(0.0)	3(1.2)	4(1.5)	1(0.4)
Feeling about the advice				
Worse	0(0.0)	0(0.0)	2(0.7)	4(1.5)
Good	149(63.1)	152(61.8)	219(81.1)	216(82.8)
Very good	75(31.8)	72(29.3)	34(12.6)	21(8.1)
No advice	12(5.1)	22(8.9)	15(5.6)	20(7.6)
Environment of the facility				
Very bad	0(0.0)	0(0.0)	3(1.1)	1(0.4)
Bad	0(0.0)	1(0.4)	247(91.5)	1(0.4)
Good	194(82.2)	184(74.8)	20(7.4)	249(95.4)
Very good	42(17.8)	61(24.8)		10(3.8)
Attitude of health care provider				
Very bad	0(0.0)	0(0.0)	2(0.7)	0(0.0)
Bad	0(0.0)	1(0.4)	1(0.4)	2(0.8)
Good	141(59.8)	148(60.2)	242(89.6)	234(89.6)
Very good	95(40.2)	97(39.4)	25(9.3)	25(9.6)
Attitude of staff				
Very bad	2(0.9)	0(0.0)	0(0.0)	0(0.0)

Bad	0(0.0)	0(0.0)	0(0.0)	3(1.2)
Good	175(74.1)	184(74.8)	248(91.9)	243(93.1)
Very good	59(25.0)	62(25.2)	22(8.1)	15(5.7)
Overall experience				
More comfortable	224(94.9)	232(94.3)	248(91.9)	239(91.5)
Less comfortable	12(5.1)	13(5.3)	17(6.3)	13(5.0)
Not comfortable	0(0.0)	1(0.4)	5(1.8)	9(3.5)

Annex Table 7: Percentage of health care providers receiving training before data collection.

Indicators	n(%) of providers			
	Family welfare visitor		**Family welfare assistant**	
	Intervention	**Comparison**	**Intervention**	**Comparison**
	N = 52	**N = 54**	**N = 75**	**N = 75**
Received training on using paper/e-register	45(86.5)	9(16.7)	75(100.0)	75(100.0)
Received last training on using paper/e-register	**N = 45(%)**	**N = 9(%)**	**N = 75(%)**	**N = 75(%)**
Within 5 years	16(35.6)	3(33.3)	37(49.3)	50(66.7)
More than 5 years	1(2.2)	3(33.3)	14(18.7)	6(8.0)
Don't know	28(62.2)	3(33.3)	24(32.0)	19(25.3)
Duration of current job				
Less than 10 years	23(44.2)	23(42.5)	20(26.6)	22(29.3)
10–24 years	2(3.9)	0(0.0)	11(14.7)	11(14.7)
More than 25 years	27(51.9)	30(55.6)	44(58.7)	41(54.7)
Don't know	0(0.0)	1(1.9)	0(0.0)	1(1.3)