Meghalaya's Drone Delivery Network

Impact of a New Mechanism for Medical Supply Logistics

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Executive Summary

In December 2022, the Government of Meghalaya partnered with Tech Eagle to launch the first drone delivery network in Northeast India to improve universal access to healthcare. Meghalaya Drug Delivery Network's (MDDN) mission is to deliver vital supplies such as drugs, diagnostic samples, vaccines, blood, and blood components quickly and safely to rural and remote health centres. The first phase of the program tested the feasibility of delivering medicines and medical supplies by drone from a Sub-divisional Hospital to Community Health Centres (CHCs) and Primary Health Centres (PHCs).

In this study, we evaluated drone flight records; analyzed the Tech Eagle operating model; and interviewed medical personnel at the PHC/CHC and community leaders in the surrounding villages. Our assessment found that the capability has become more resilient and positively impacted the community. However, there are still hurdles to overcome and opportunities to achieve scale.

MDDN capabilities have improved in the two years of operation:

- **Operating days**: 131% increase in days with flights from 13% of days in 2023 to 30% of days in 2024.
- **Demand**: 16% increase in average flight per day.
- **150% increase in total flights**

However, there are three key hurdles:

1. **Weather:** Rain accounts for ½ of drone downtime.
2. **Costs**: The drone program costs far exceed alternative shipment methods
3. **Deliveries are not fully automated** and require designated landing zones and technicians to land the drones

Moreover, the rural communities view the drone network favorably:

- Medical officers at several PHCs/CHCs confirmed that some of the drugs delivered by drones helped save lives.
- Community leaders have seen improvement in drug availability over the past two years (an outcome we believe is driven more by other changes to Meghalaya's drug delivery network).

Opportunities to achieve scale:

1. Adding Sub-centres to the networks: Given their remote location, Sub-centres are the most difficult to access by road and smaller amounts of drugs are needed to replenish these centers. (MMDSL can adequately service the larger PHCs/CHCs).
2. Expanding the products and services that drones enable: blood, vaccines and lab specimens

These findings have been used to inform Phase 2 of developing the MDDN's drone capabilities: increased payloads, longer ranges to reach Sub-centres, and fully autonomous delivery.

Background - Overview of the Drone Delivery Program

The public health supply chain in Meghalaya faces significant logistical challenges due to its mountainous terrain and numerous unpaved roads, making many villages difficult to access by vehicle. Some areas are even non-motorable, requiring travel on foot. These areas can become completely cut off during heavy rain and underscore the need for a mode of delivering critical supplies that is capable of overcoming these physical barriers.

In November 2021, the Smart Village Movement and the Government of Meghalaya piloted a project with a drone startup, Tech Eagle. The District Hospital in Nongstoin sent medicine to the PHC in Maweit via drone - **covering the 25km journey within 25 minutes**. The State used this successful pilot to craft a model for a new medicine transportation system.

In December 2022, the government of Meghalaya commissioned Northeast India's first Drone Delivery Hub and Network (called as the Meghalaya Drone Delivery Network - MDDN) under the Meghalaya Health System Strengthening Project (MHSSP) funded by the World Bank. MDDN is a hub-and-spoke model. A well-performing sub-divisional hospital at Jengjal, in West Garo Hills District, served as the Hub. Five PHCs in surrounding remote areas (up to 45 km away) served as the spokes/nodes. This hub-and-spoke model allows the Government to evaluate different drone operators, as the government does not own the drones.

By October 2024, the program had been expanded to serve thirteen PHCs (nodes) from one hub (in Jengjal SDH) and more than 240 round-trip flights, with drug deliveries, had been completed. However, there remain several limitations:

1. **Manually controlled landing**. Drones need to land at the PHC and require a trained person to manually land the drone. Because most PHCs do not have trained personnel, a pilot team has to drive to the PHC to land the drone.
2. **Rain** - Tech Eagle's drones cannot fly in the rain.
3. **Drones are not allowed to fly in Red Zones** along the international border between Meghalaya, India and Bangladesh, where many underserved PHCs and Sub-centers are located.

In parallel to the drone program, in November 2022, the State of Meghalaya also created a new company to consolidate and improve the drug supply chain logistics, Meghalayan Medical Drugs and Services Limited (MMDSL). To streamline routine drug replenishment. Prior to MMDSL, the process of indenting and procuring medicines was duplicated through efforts of different verticals within the Health Department. Also, it required medical personnel to drive to the district warehouse to procure the medicines for their centre. Today, MMDSL oversees all deliveries. This capability includes a fleet of vehicles; a route of 241 delivery points; warehouse inventory management; and an online portal for indenting medicines. These changes have eliminated the need for PHC personnel to travel to the warehouse to acquire supplies and have dramatically

reduced medicine out of stocks at the PHCs/CHCs. See Appendix for more detail.

Analysis

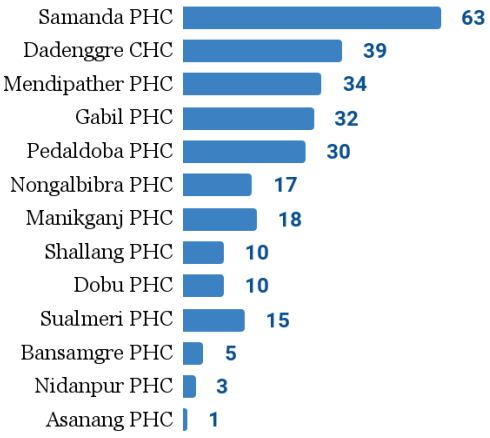
We evaluated the impact of Phase 1 by analyzing drone flight data and operating costs. We also collected learnings from Tech Eagle and conducted a qualitative assessment by surveying medical personnel and by coordinating with the WISH Foundation to survey community leaders.

1. Flight Data

277 deliveries were made from December 1st, 2022, to October 31st, 2024 (Fig. 1),

Figure 1: 277 Flights to 13 PHCs

Round-trip flights, Dec 2022 to Oct 2024



and 62% of these flights were to four PHCs: Samanda, Mendipathar, Dadenggre, and Gabil (Fig. 1).

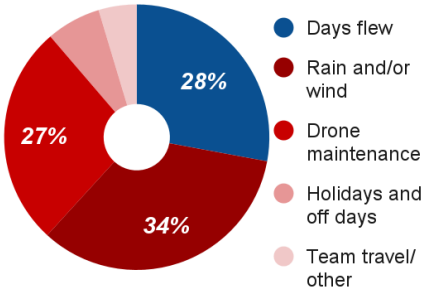
In the past six months ending September 2024, there were on average **2 deliveries per centre per month.** However, there is a high level of variability among the centres: Gabil had the highest rate of monthly deliveries, averaging 3.6 deliveries per month; while four centres had none (Asanang, Nidanpur, Shallang, and Nongalbibra.)

Uptime, measured as the percentage of days that had flights in a month, has increased since 2023 but still remains less than 50% (Appendix), limited by three factors (fig. 2):

- Weather (drones cannot fly when it is raining)
- Training & maintenance
- Lack of demand.

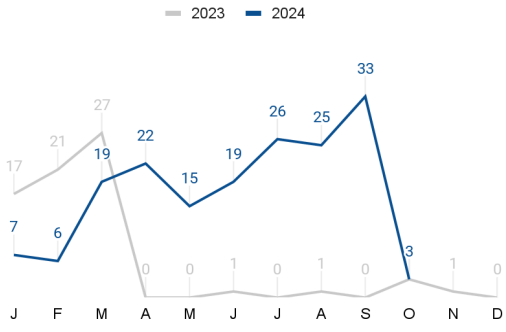
Fig. 2: Drones flew 28% of days from Jan 1st - Oct 31st., 2024

However, rain and wind ground drones 3 of every 10 days.



Overall, flights steadily increased in 2024, from 7 flights in January to 33 flights in September (Fig. 3). Notably, the program continued to operate flights in June through August. October flights were paused for drone maintenance and tech upgrades.

Fig.4: Roundtrip Flights by Month - 2023 and 2024

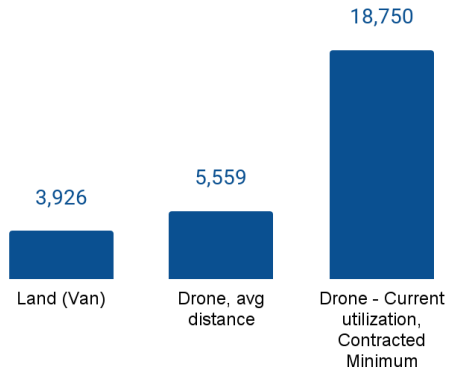


2. Payload and Costs

The billable cost per flight is based on a rate per distance. However, the vendor is paid a minimum amount per day of operation, regardless of whether there are flights that day. For each day of operation, the State pays the vendor the greater of (1) the costs of the flights or (2) a contracted minimum daily rate. If the drones were flying at full capacity, but not exceeding the daily minimum rate, the cost per drone delivery would be approximately 5,600 INR. However, given the low number of flights, the costs of the flights have not exceeded 25% of the contracted monthly minimum rate (Appendix). **At current levels of utilization, the actual cost per drone delivery exceeds 19,000 INR.**

The cost *per trip (agnostic of payload) is five times higher by drone than by land.* (Figure 5).

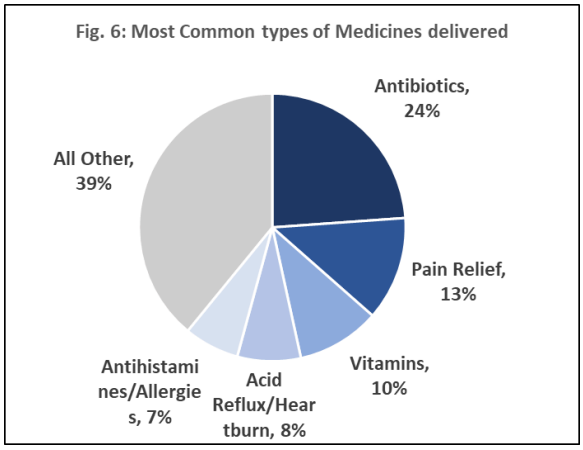
Fig. 5: Current Drone cost per delivery (agnostic of payload) is 5xs greater than by Van



3. Analysis of the Medicines Delivered

Analyzing the manifests of 182 flights December 2022 thru August 2024, yielded the following insights:

- The median payload contains 5 items per flight.
- The most common types of items were antibiotics, pain relievers, and vitamins (Fig. 6).
- Moreover, there were only 9 units of time-sensitive medication: Antivenom for snake bites (6 units) and rabies vaccine (3 units).
- We estimate <20% of flights carried medicines needed for same-day delivery.
- **On average it costs 15,000 INR, ~ $180USD, to deliver each item over 20 months of operation.**



Finally, there is still excess payload capacity per flight. Payloads averaged 1.73 kg/flight in 2024, about 60% of the 3 kg payload capacity for the drone.

4. Voice of TECHEAGLE

Vikram Singh, the CEO of Tech Eagle, shared his experience operating

drone-based healthcare logistics in Meghalaya, one of India's most geographically challenging regions for Drone operations. He highlighted key operational challenges, including heavy rainfall, high wind speeds, limited GPS connectivity, complex terrain, and the absence of secure landing zones. These factors initially contributed to high costs and logistical inefficiencies. In response, Tech Eagle developed and tested weather-resistant drones with improved wind tolerance of 50% and waterproofing; offline navigation systems and AI-powered flight corrections to fly in areas with limited GPS; AI-based terrain mapping and smart weather scheduling to adapt to complex topography and unpredictable weather; and winch-based delivery mechanisms that eliminated the need for landing in remote areas. These improvements are planned to be implemented in PHASE 2 of MDDN. Tech Eagle also implemented automated scheduling and predictive flight pathing, reportedly reducing operational costs by 40%.

Vikram believes these adaptations have created a scalable, autonomous drone logistics model with expanded coverage across 25 healthcare centers. And planned advancements include AI-driven inventory management, expanded hubs, and higher payload drones.

5. Voice of the Medical Officers

Medical Officers and Pharmacists at 12 PHCs/CHCs confirmed instances where the Drone Delivery Program helped save lives, but impact is limited.

- 8 of 12 respondents said "Yes" the drone delivery program has helped save a life.
- And 5 of 12 respondents affirmed that delivered medicines helped save a life within the last 3 months.

Pharmacists/MOs mentioned following critical life-saving medicines:

- **Antirabies:** 1.2% of total deliveries YTD, 0% last three months.
- Ceftriaxone **(Typhoid):** 1.3% total deliveries YTD, 2.8% last three months.
- **Diabetes** medication: <1% of total deliveries YTD, 0% last three months.

Out of stocks were minimal. 9 of 12 PHCs had no out-of-stock issues in the past three months and two PHCs had a single incident. One PHC, Samanda, struggled with significant out-of-stocks (30-50 out-of-stocks in the last 3 months).

Respondents also provided statistics for patient footfall and the percentage of visits that required prescriptions. Drone-delivered medicines covered 2% of patient footfall (assuming one medicine per patient). From our analysis of this survey information and the flight data, **we estimate that 0.5% of total patient footfall use drone-delivered medicines the same day.**

Overall, there was a high level of support for MDDN within the medical community. Dr. Paul Francis, Senior Consultant at Jengjal Sub divisional hospital (Hub of MDDN), shared strong support of the drone delivery network as a key capability and believes drones would be valuable in other situations, such as delivering specific drugs to patients with noncommunicable diseases, delivering medicines to stabilize heart attack patients prior to reaching a district hospital, and improving availability of vaccines.

In the long run, the comparative advantage of drone delivery will diminish as logistics improve and the systemic problem of limited space for drug storage at the PHCs is addressed. However, the drone program can strengthen its unique value proposition by focusing on a subset of medicines that the health centers routinely run short of.

To do this, the doctors recommended the following improvement areas:

- GPS coordinates for drones to deliver to where there is not a spoke, and ability to land drones at any time.
- Automate operation of drone delivery & return flight.
- Increase payload capacity to deliver blood, blood products, and vaccines.
- Standardize delivery schedules and communications

6. Voice of the Community Leader

A survey of twelve Headmen/Village Health Council leaders in the villages serviced by PHCs in the drones program (see appendix for results) yielded insights into the communities' perception of MDDN's impact on community health.

Lack of medicines is no longer the most pressing concern - Respondents mentioned needs for improving staffing and equipment 12x more frequently than improving medicine availability. Only five respondents said that they sometimes hear the PHC has run out of medicines and four believed that lack of medicines may have played a role in some patients being transferred to other hospitals.

The drone program is perceived to have added value by most. 80%, or 10 of the 12 participants, agreed that the drone delivery added "slight" or "significant" value to the PHCs and that there had been "slight" to "significant" improvement in the availability of drugs in the past 2 years.
The PHCs also scored well in relative quality. Eight respondents rated PHC quality of care as "much better" or "slightly better" than alternatives (District Hospital, Private Hospitals and Traditional Healers.) However, only 5 of 10 were either "satisfied" or "very satisfied" with the quality of care at their PHC.

However, two communities (served by Pedaldoba PHC and Asanang PHC) did not believe the drones added value. The headmen in these villages have not seen improvement in availability of medicines. They also said they "often/very often" hear about these PHCs running out of medicines and believe the quality of care at the PHCs is worse than the alternatives.

CONCLUSION & RECOMMENDATIONS

Our analysis indicates that the drones program is viewed favorably by the public and perceived as a valuable service by health professionals. However, demand is still low; autonomous deliveries and higher payloads are not yet feasible; and the program is operating significantly below its capacity, resulting in an unsustainably high delivery cost.

The success of the program will depend on the long-term commitment to support the scalability of the technology, with clear milestones of success:

1. **Payload:** Payload needs to increase from 3 kg to 25 kg to support the transportation of

other medical supplies, such as blood and vaccines.

2. **Autonomous delivery** - The requirement of a ground team to control the landing at the PHC is not scalable. Techniques to obviate a ground team at the delivery point, such as winching down consignment, is vital to achieving scale.

3. **Delivery based on GPS coordinates** - the ability to have a drone deliver to a specific latitude and longitude will allow deliveries to Sub-centers and other remote facilities.

4. **Flying in Red Zones** - most Sub-centers are located within 50 km of an international border, known as a red zone. Securing the permissions and process to deliver to locations closest in this area will have the greater impact on last-mile delivery.

5. **Reduced the cost per flight via cost efficiencies and increased flights.** Demand needs to increase to more than 10 flights per day, without an increase to the network operating costs, to make drone deliveries more cost effective.

6. **Drones capable of flying in rain.** We have learned that there are drones capable of doing so, that should be evaluated.

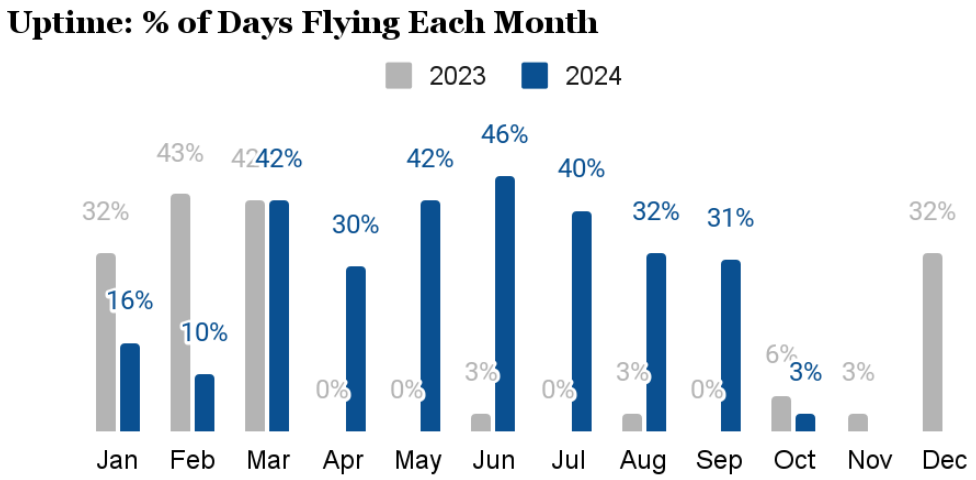
Appendix

1. **Background on MMDSL:** MMDSL contracts with a third-party logistics company to deliver medicines to 241 delivery points. Currently, MMDSL utilizes 10 delivery vehicles to deliver medicines to the 12 districts, with inventory held in 11 district headquarters (with one vehicle shared between the smaller districts). An online portal was created for indenting medicines, tracking inventory and deliveries. These changes eliminated the need for PHC staff to call the district warehouse to indent medicines and use their own means of transportation to travel to the warehouse to acquire supplies. Continuous improvements are underway to reduce out-of-stocks by implementing best practices for safety stock management and routine deliveries.

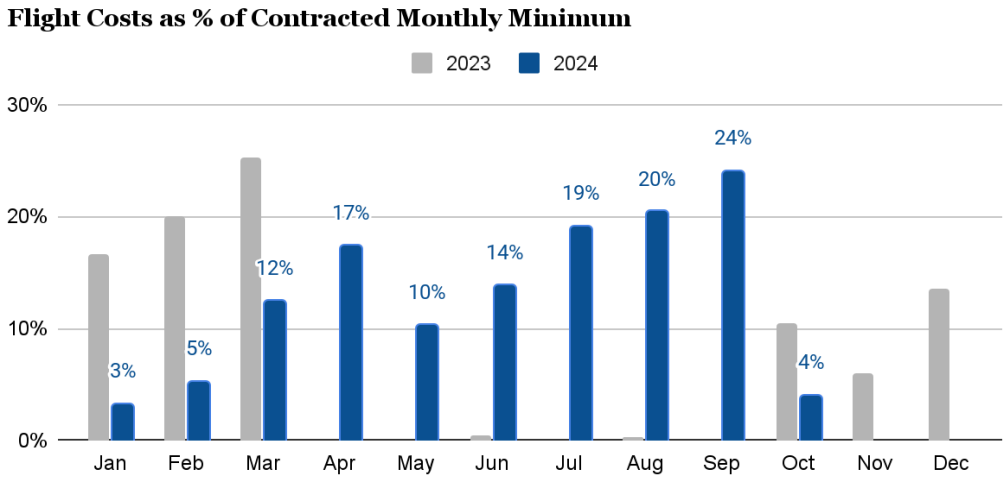
   The cost of this new ground transportation is determined at the cost to operate each vehicle: 1.06 lakhs INR per month. This includes the driver, a helper, vehicle maintenance, insurance, GPS, and 2,000km of fuel. Additional mileage is calculated at a cost of Rs. 20/km for the small vans and Rs. 30/km for the trucks. This has been operational since July 2024. Due to limited storage space in health facilities for one-month supplies, MMDSL decided to deliver drugs to lower-level facilities (e.g., CHC, PHC) twice a month and increase the consignment volume for larger facilities (e.g., District Hospitals). Consequently, MMDSL added 10 vehicles to its fleet.

   We analyzed MMDSL's cost of delivering medicines by land. Two districts, South Garo Hills and South West Garo Hills were selected. Accounting for 27 delivery points, monthly replenishment, and the cost to operate each delivery vehicle, the average cost per delivery by truck is 3,926 INR.

2. Uptime:



3. Flight Costs as a percentage of the contracted monthly minimum payments to Tech Eagle.



4. Business Model Canvas - Drone Delivery Program

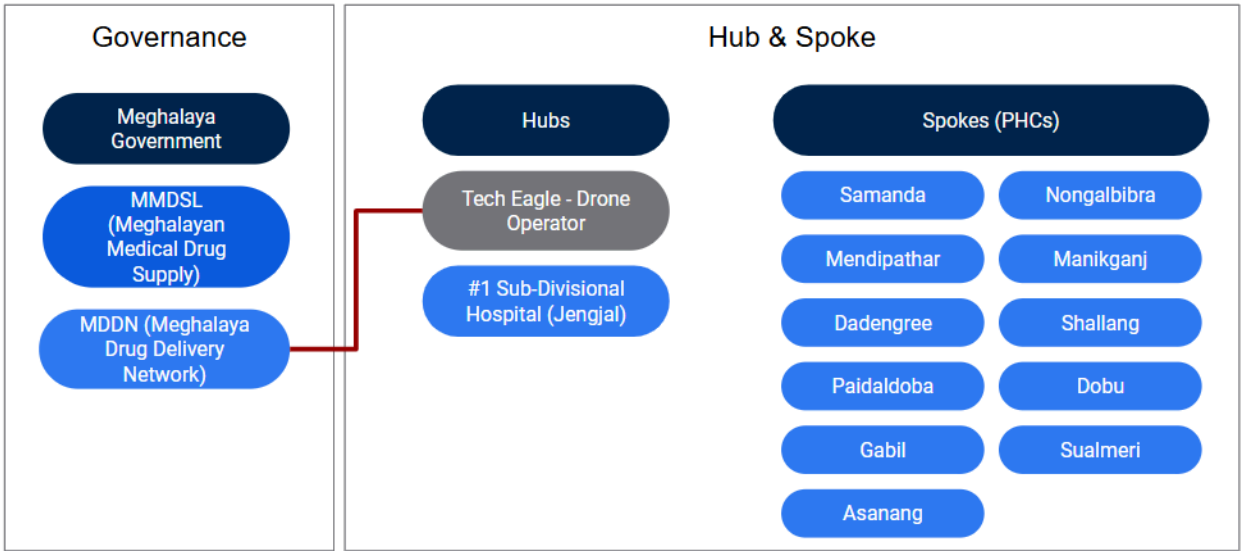
KEY PARTNERS	KEY ACTIVITIES	VALUE PROPOSITIONS	CUSTOMER RELATIONSHIPS	CUSTOMER SEGMENTS
Meghalaya Government Tech Eagle Team Smart Village Movement Meghalaya Drone Delivery Network MMDSL Drug warehouse/ Pharmacies/pharmacists	1. Receive request for medicine or testing 2. Round-trip Drone flight (including reverse logistics) 3. Record keeping & analytics 4. Drone delivery/pickup training **KEY RESOURCES** 1. Drone-essential Drug list 2. 3. Inventory of drugs	Rapid delivery of critical medicines for PHCs in Rural villages. Reduce time of delivery from X to Y Provide diagnostic services Reduce need for patients to travel to District Hospitals	Education of PHC Medical Officer Relationship with pharmacists **CHANNELS** Primary Health Centers (PHCs) in X Villages.	B2B Key Customer: - Medical Officer in charge of PHC Consumer: Residents in Rural Villages in Meghalaya (District X) served by local PHCs Consumer Segment 1: Patients in need of time-sensitive medication Consumer Segment 2: Patients in need of diagnostics not available at PHCs

COST STRUCTURE	REVENUE STREAMS
1. Payment to Tech Eagle Team	

ENVIRONMENTAL COSTS	SOCIETAL COSTS	SOCIETAL BENEFITS	ENVIRONMENTAL BENEFITS
		1. Time to Treatment 2. Availability of Medicines 3. Reduced trips to travel to District Hospital 4. Increased reliability and credibility of rural Health system	

6. Governance

Governance and Hub & Spoke Model for the Drone Network



7. Voice of PHC Pharmacist - Patient footfall.

Patient Footfall, and Drone Deliveries, From January to July, 2024							
Row Labels	**Est. Patient footfall (July 2024 YTD)***	**# of Medicines delivered by drone**	**drone medicine/patient**	**# of Flights**	**% used same day***	**Medicines used same day**	**Same Day medicines as % of Footfall**
Gabil PHC	1768	112	6.3%	20	50%	56	3.17%
Samanda PHC	954	198	20.8%	31	10%	20	2.08%
Dadenggre CHC	6970	102	1.5%	18	25%	26	0.37%
Pedaldoba PHC	524	92	17.6%	16	25%	23	4.39%
Manikganj PHC	768	45	5.9%	7	10%	5	0.59%
Sualmeri PHC	1500	18	1.2%	4	25%	5	0.30%
Mendipathar PHC	4586	66	1.4%	11	50%	33	0.72%
Nongalbibra PHC	2952	0	0.0%	0	0%	0	0.00%
Dobu PHC	1320	31	2.3%	5	10%	3	0.23%
Shallang PHC	4500	0	0%	0	N/A		
Tikrikilla PHC	2500	0	0%	0	N/A		
Asanang PHC	4300	0	0%	0	N/A		
Grand Total	**32642**	**664**	**2.0%**	**112**	**25.5%**	**169**	**0.52%**
*Estimate Provided by Pharmacist or MO at the PHC							

(Survey collected August 2024)							

8. Voice of Headman

Nearest PHC/CHC	Village Name	Role of person surveyed	What are things that you feel the PHC lacks or needs to improve?									
			More Staff	Night shifts	X-rays, Ultrasounds	Ambulances	Drinking Water, electricity	maintanence & cleanliness	Road repair to CHC	availability of medicinces	Lack of beds	Other
Pedaldoba PHC	Pedaldoba Garo	Headman, VHC , Others , SHG	1		1							
ASANANG	CHANDIGRE	VHC member	1							1	1	Medicines for ASHA workers
Gabil PHC	Gabil Songmong	Headman. VHC member	1	1		1						
Gabil Songmong	Gabil Songmong	VHC member , Others	1			1						upgrad facitlities in Gabil PHC
Sualmari PHC	Lower Sualmari	Headman, VHC member	1									services and emergency cases
Upper Saulmari	Upper Saulmari	Headman	1	1								improve facilities
Samanda PHC	Samanda Dolwari -A	Headman					1	1		1		
Tikrikilla phc	Williampur	VHC member , Others , SHG	1	1								
Dadenggre CHC	Ajrigre	Headman , VHC member	1	1	1				1			
Nongalbibra PHC	Nengsin Gittim	VHC member	1			1	1					
Mendipathar PHC	Salpara	Headman, VHC member	1		1							ECG technicians, Assistant lab techs,
Dobu PHC	Dobu Dongbing	VHC member	1		1							trained technictions (x-ray, ECG); asst

Nearest PHC/CHC	Village Name	Do you think the drone services have added any value to your PHCs?	Have you seen any improvement in the availability of drugs in the last 2 years?	How often do you hear that the PHC has run out of a medicine?	Are you aware of any people whose condition worsened due to lack of the necessary medicine at the PHC?
Pedaldoba PHC	Pedaldoba Garo	No	No, it's the same	Very Often	Yes (*Due to insufficient staff nurses and a lack of medicines, patients have to be transferred to other*
ASANANG	CHANDIGRE	No	No, it's the same	Often	Yes (*When they get malaria or typhoid, sufficient medicines are not available in the PHC.*)
Gabil PHC	Gabil Songmong	Yes, slightly	Yes, slightly	Sometimes	Sometimes in case of jaundice or malaria in that case they use to refer to Tura District Hospital
Gabil Songmong	Gabil Songmong	Yes, slightly	Yes, slightly	Sometimes	No
Sualmari PHC	Lower Sualmari	Yes, slightly	Yes, slightly	Sometimes	Sometimes in some cases
Upper Saulmari	Upper Saulmari	Yes, slightly	Yes, slightly	Sometimes	No from my side but sometimes heard about some cases which they used to refer to
Samanda PHC	Samanda Dolwari -A	Yes, significantly	Yes, slightly	Sometimes	NO
Tikrikilla phc	Williampur	Yes, significantly	Yes, slightly	Rarely	No - (*Have not heard of any worsening of patients conditions due to a lack of medicines in the PHC.*
Dadenggre CHC	Ajrigre	Yes, significantly	Yes, significantly	Rarely	Unsure - not sure about the worst condition due to lack of necessary medicine, but sometimes in
Nongalbibra PHC	Nengsin Gittim	Yes, significantly	Yes, significantly	Rarely	No - Nongalbibra PHC is functioning well.)
Mendipathar PHC	Salpara	Yes, significantly	Yes, significantly	Not at all	No
Dobu PHC	Dobu Dongbing	Yes, significantly	Yes, significantly	Rarely	No (no complaints)

Nearest PHC/CHC	Village Name	Where else will will people go?					How does the quality of care at the PHC compare to these alternatives ?	How satisfied are you with the level of Care that the PHC/CHC provides to your community?	In which areas do you feel the PHC/CHC is doing well?
		District Hospitals	Private Hospitals	Private Clinics	Faith Healers	Traditional			
Pedaldoba PHC	Pedaldoba Garo		■		■	■	much worse	Very unsatisfied	(*Have not heard about the work of other PHC and CHC, except for Pedaldoba PHC.*)
ASANANG	CHANDIGRE	■	■	■	■	■	slightly worse	Neutral	(*In my opinion, it does not seem to be functioning effectively. During my visit , the staffs response was not very good; they do*
Gabil PHC	Gabil Songmong	■	■		■	■	slightly better	Satisfied	Bajengdoba PHC under Resubelpara
Gabil Songmong	Gabil Songmong	■	■		■	■	slightly better	Satisfied	Bajengdoba PHC
Sualmari PHC	Lower Sualmari	■	■			■	slightly better	Neutral	Bajengdoba PHC
Upper Saulmari	Upper Saulmari	■	■		■	■	slightly better	Neutral	Bajengdoba PHC this days
Samanda PHC	Samanda Dolwari -A	■				■	slightly worse	Very Satisfied	*As of today, the sub-centre and PHC have been effectively performing their duties and providing good care.*)
Tikrikilla phc	Williampur		■		■	■	slightly better	Neutral	(*No other PHCs nearby except Tikrikilla so not aware.*)
Dadenggre CHC	Ajrigre	■	■	■		■	the same	Satisfied	Dadenggre CHC is also doing well but don't know about different areas, and under Dadenggre CHC Romgre Sub-centre
Nongalbibra PHC	Nengsin Gittim	■					much better	Satisfied	*Except for Nongalbibra PHC, no other PHC or CHC is availabe, so not aware.*)
Mendipathar PHC	Salpara	■	■	■		■	slightly better	Very unsatisfied	In my opinion, the Manikganj Primary Health Center (PHC) is performing exceptionally well. The Medical Officer's (MO)
Dobu PHC	Dobu Dongbing	■	■	■			slightly better	Very unsatisfied	Dobu PHC is very helpful and satisfactory but the only hardship the face through is during serious condition the shift to district