

DELIVER THE FUTURE PHASE II PREPARATION

Technical Report on Data
Research

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TABLE OF CONTENTS

Table of Contents 0

Acronym List 1

Background 2

The Data Collection for Drone X Phase 2 pilot..... 4

Laboratory diagnostic samples and specimens. 5

 Cost assumptions:..... 6

 Current mechanism (funding): 6

Blood for Transfusion..... 7

 The Blood Samples from Ukerewe to NBTS testing Lab in Mwanza..... 7

 Emergency Blood for Transfusion (Blood Sent from NBTS in Mwanza to Ukerewe Islands).. 7

Vaccine Supply Chains 8

 Cost centers for vaccine supply chain in Ukerewe. 8

 From Regional Vaccine Store to District Vaccine Store (RIVO to DIVO)..... 8

 From District Vaccine Store to Health Facilities (last mile delivery)..... 8

 Cost for Emergency Needs: 9

Normal MSD Supplies for ILS, ARV, TB and Laboratory system 9

 Sources of Fund:..... 9

 Distribution: 9

Emergency MSD Supplies for ILS, ARV, TB and Laboratory system..... 11

 Costs involved in Emergency Orders..... 12

Discussion and Recommendations. 12

Conclusion. 14

ACRONYM LIST

AAV	Autonomous aerial vehicle
AGPAHI	Ariel Glaser Pediatric AIDS Healthcare Initiative
ART	Antiretroviral therapy
CDC	Centers for Disease Control
CHF	Community Health Fund
CHMT	Council Health Management Team
DC	District Council
DH	District hospital
DIVO	District Immunization and Vaccine Officer
DMO	District Medical Officer
eLMIS	electronic Logistics Management Information System
HCW	healthcare worker
ILS	Integrated Logistics System
MDH	Management and Development for Health
MOHCDGEC	Ministry of Health, Community Development, Gender, Elderly, and Children
MSD	Medical Stores Department
NHIF	National Health Insurance Fund
PORALG	President's Office of Regional and Local Government
RIVO	Regional Immunization and Vaccine Officer
THIS	Tanzania HIV Impact Survey

BACKGROUND.

Ukerewe is an island within Lake Victoria and is administratively among 8 districts of Mwanza region, Tanzania. Ukerewe has 25 Wards and 76 Villages (PORALG Village Data) with a total population of 412,621 out of which 210,249 are women and 202,372 men (Census 2012 projections for 2018). With an area of 6,400 square meters, only 10% is dry land. Ukerewe has 38 small Islands, out of which 34 are inhabited and 15 have permanent settlements while 6 islands have health facilities.

Figure 1: A Map Showing Distribution of Health Facilities in Ukerewe district council (DC).

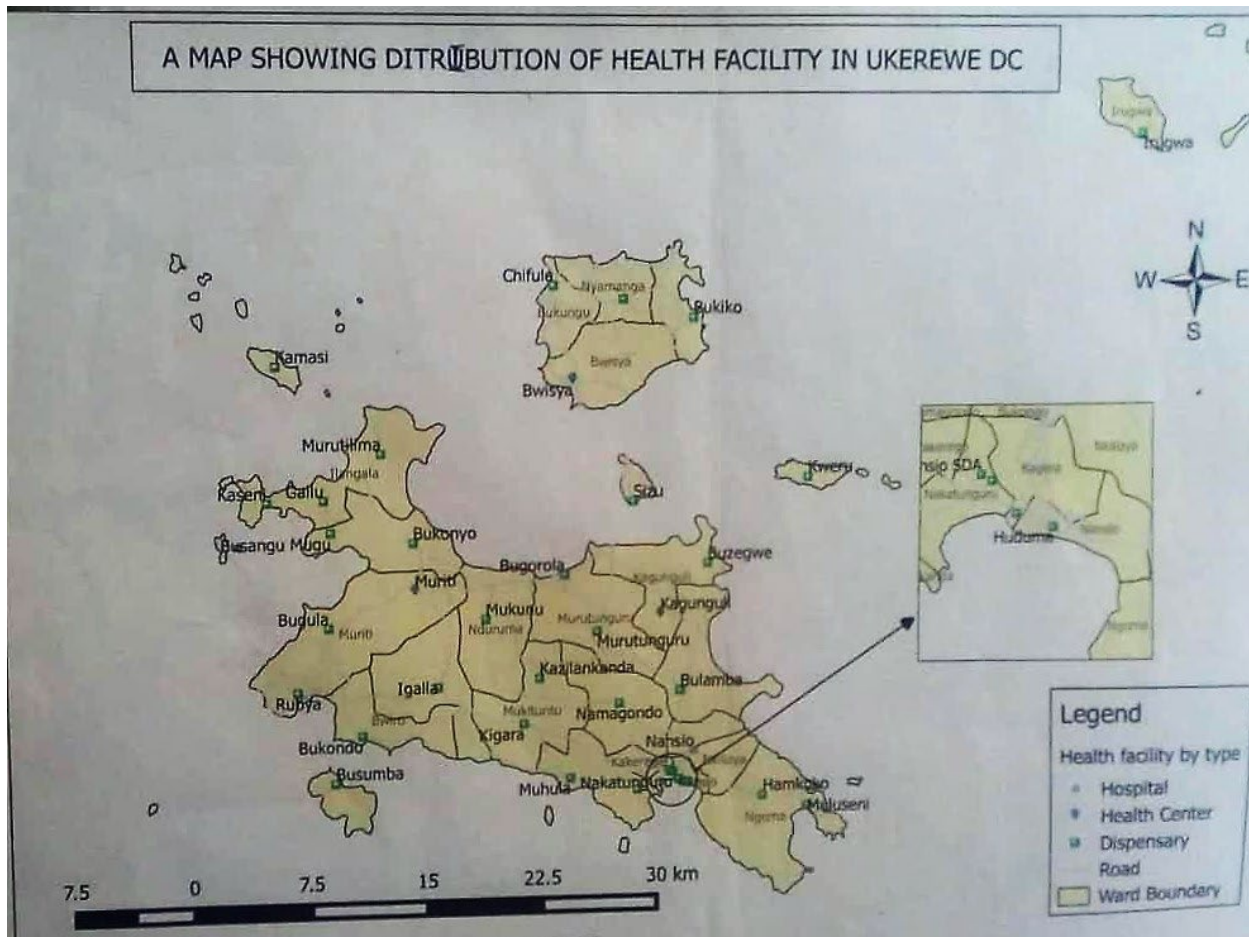


Table I: Health Facilities & Catchment Population (as per Ministry of Health, Community Development, Gender, Elderly, and Children [MOHCDGEC] – Pharmaceutical Services Unit: 2017)

S N	Facility Name	Type	Notional Service Population - 2017(MOH)
1	Bugorola	Disp	20,000
2	Bugula	Disp	20,000
3	Bukiko	Disp	20,000
4	Nakitunguru	Health Centre	20,000
5	Hamuyebe	Disp	20,000
6	Nabweko	Disp	20,000
7	Kurazu	Disp	20,000
8	Bukondo	Disp	20,000
9	Bukonyo	Disp	20,000
10	Bulamba	Disp	20,000
11	Busangu - Mugu	Disp	20,000
12	Busumba	Disp	20,000
13	Buzegwe	Disp	20,000
14	Bwisya	Health Centre	89,217
15	Chifule	Disp	20,000
16	Gallu	Disp	20,000
17	Hamkoko	Disp	20,000
18	Igalla	Disp	20,000
19	Irugwa	Disp	20,000
20	Kagunguli	Health Centre	22,100
21	Kamasi	Disp	20,000
22	Kaseni	Disp	20,000
23	Kigara	Disp	20,000
24	Kweru	Disp	20,000
25	Magereza Ukerewe	Disp	4,000
26	Muhula	Disp	20,000
27	Mukunu	Disp	20,000
28	Muriti	Health Centre	31,544
29	Muruseni	Disp	20,000
30	Murutilima	Disp	20,000
31	Murutunguru	Disp	20,000
32	Namagondo	Disp	20,000
33	Nyamanga	Disp	20,000
34	Nyang'ombe	Disp	20,000
35	Rubya	Disp	20,000
36	Sizu	Disp	20,000
37	Nansio, Ukerewe	Hospital	345,147

In addition to the data outlined above on facilities, JSI consulted the District Medical Officer (DMO) and the members of the Council Health Management Team (CHMT) to identify five (5) representative health facilities in Ukerewe District in terms of **geographical spread** over the district and favorably weighted with **population**. The DMO and the team selected the following;

- Igala Dispensary, located within the main island, 24.2 km from Nansio, (*Notional Service Population; 20,000*)
- Muriti Health Centre – located within the main island, 48 km from Nansio (*Notional Service Population; 31,544*).
- Bwisya Health Centre – located in Ukara island, 1-2 hours long journey from Bugorola shoreline (*Notional Service Population: 89,217*).
- Irugwa Dispensary – located in Irugwa island, 6 hours journey on Lake Victoria from Nansio or via Bunda district (4 hours on road and 2 hours on ferry); *the Notional Service Population is 20,000*.
- Nansio District Hospital – located in the main island, 2 km drive from the Nansio Port, Ukerewe; *Notional Service Population is 345,147*

The Annex 1 – Ukerewe Stocked out Facilities 2018 –eLMIS data provides the stock out reports for all the 37 facilities in Ukerewe from March to August 2018 as reported in the electronic Logistics Management Information System (*eLMIS*).

It is important to note that patient referrals within and from the Ukerewe facilities is not driven by stock outs at one level (lower level of care) but rather is triggered by the need for specialized medical care. Within Ukerewe, doctors refer patients to high levels (such as Nansio District Hospital) mainly for delivery through Caesarian Section. The referrals to Mwanza are due to lack of Medical Specialists in Ukerewe DC and specialized diagnostic laboratory.

This report covers the supply chains for health commodities in Ukerewe considering all 37 health facilities.

THE DATA COLLECTION FOR DRONE X PHASE 2 PILOT.

JSI did the field data collection from 29 October to 2 November, 2018. The data collection involved both quantitative and qualitative methods.

The following programs' supply chains were studied.

1. Laboratory diagnostic specimens sent from HFs in Ukerewe to Nansio district hospital (DH) and Bugando Medical Centre or Sekou Toure Hospital in Mwanza
2. Blood for transfusion, divided into
 - Samples being sent from Ukerewe to National Blood Transfusion Services (NBTS) in Mwanza for testing)
 - Emergency Blood for Transfusion (whole blood sent from NBTS in Mwanza to Ukerewe Islands)
3. Vaccine Supply Chains
4. Normal Medical Stores Department (MSD) Supplies for Integrated Logistics System (ILS), ARV, tuberculosis (TB) and Laboratory systems
5. Emergency MSD Supplies for ILS, ARV, TB, and Laboratory systems.

The summary of results is presented below:

Table 2: Supply Cost for health products and laboratory samples in Ukerewe DC

Supply Chain Type	Supply Chain Cost Per Year in TZS	Supply Chain Cost Per Year in USD(1\$-2270TZS)	Funding Source(s)
Lab Diagnostics	104,694,000	\$ 46,120.70	Ariel Glaser Pediatric AIDS Healthcare Initiative (AGPAHI), DED Ukerewe
Blood for Transfusion	8,496,000	\$ 3,742.73	NBTS, DED Ukerewe
Vaccine Supply Chains	38,332,000	\$ 16,886.34	MOHCDGEC, DED Ukerewe

Emergency MSD Supplies	141,024,000	\$ 62,125.11	DED UKEREWE, Basket Fund
Regular MSD Supplies	5,752,000	\$ 2,533.92	MOHCDGEC
	298,298,000	\$ 131,408.81	

The calculations of cost is summarized in Annex 2 – *Supply Chain Cost and Journey Log Ukerewe* and Annex 3 – *Ukerewe Distribution Cost MSD*.

Below is the short description of each supply chain and the respective cost aspects.

LABORATORY DIAGNOSTIC SAMPLES AND SPECIMENS.

Laboratory samples require good sample management practice to ensure integrity of results. Most false outcomes are due to sample integrity being jeopardized during transportation process.

Ukerewe district has organized the lab samples collection in such a way that facilities with no capacity to process samples (termed as “spokes”) ships the samples daily for initial processing at facilities with such capacity, called HUBS. HUBS have infrastructure such as fridges, cold chain, and centrifuges.

Lab samples need to be processed (centrifuges) not more than five hours after collection and must later be under cold chain (8 Celsius degrees). Some samples require to be frozen at -20 Celsius degrees within 24 hours (e.g whole blood plasma).

In both cases the samples need to reach the main lab within five days after collection, maintaining the cold chain throughout the chain.

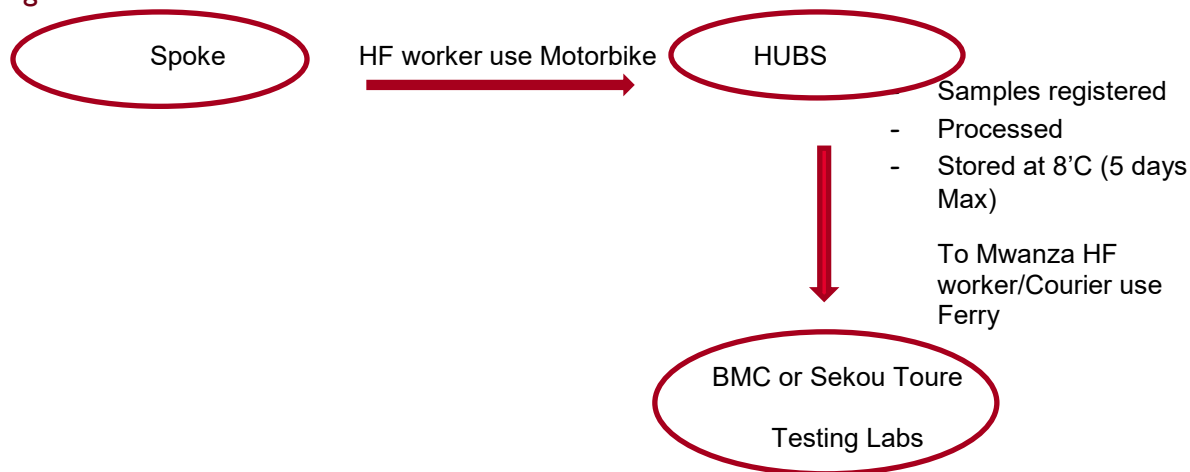
In Ukerewe, there are three HUBS:

Muriti Health Centre – located within the main Ukerewe Island Nansio

Bwisya Health Centre – located in UKARA Island

Nansio District Hospital.

Diagram I: LAB SAMPLES MOVEMENT



The two hubs Muriti and Bwisya submit their samples to the main HUB - Nansio District Hospital - which are transported to Mwanza (Bugando Medical Centre or Sekou Toure) at least **TWICE** a week.

*One hub collects an estimate of 50 – 100 Samples a week.

Common samples are:

- *HIV viral load*
- *DBS*
- *Haematology*
- *Chemistry*
- *Sputum samples for TB testing*

-
- *Histology samples (biopsy)*

There are at least three cost centers in this system

- From Spokes to Hubs : healthcare worker (HCW) uses Motorbike or Motorbike + Boat
- From Two Hubs to Main Hub Nansio District Hospital: Muriti can use Ambulance or Motorbike, Bwisya being in Ukara, use both boat and public transport to Nansio DH.
- From Nansio DH to testing Lab in Mwanza: Ferry (4-5 hrs) and Taxi

Cost assumptions:

A. From spokes to Hubs

Assumption:

2 trips a day for 5 days: average 4000/- return fare per worker * 34 spokes

No per diem.

B. From Two Hubs to Main Hub:

Muriti to Nansio District Hospital (31km apart, 51 minute drive)

- *Option 1 – using Muriti Ambulance:*
 - Driver's fuel 6litres/km return trip : estimated 12 litres @ 2500 each
 - No Per diem
 - Two trips per week
- *Option 2 – using Public Transport:*
 - Fare for HCW – 6,000/- per trip (6,000/- x 2)
 - No Per diem
 - Two trips per week

Bwisya (Ukara Island) to Nansio DH:

- Cost 1: HCW Transport using Ferry + Public Transport (return trip): (10,000/- x 2)
- Cost 2: 1 night per diem (60,000/-)
- Two trips per week

C. From Nansio DH to Mwanza (Bugando Medical Center + Sekou Toure)

A health care worker packs all samples in special packs for transportation (triple packs with cold chain). Uses the Nansio to Mwanza Ferry, then taxi to Bugando or Sekou Toure

Costs:

Ferry fares: 7,000 /- per trip (round trip is 7,000 x 2)

Taxi in Mwanza: 5,000/ -

Per Diem: one night at 100,000/- per night.

Luggage is treated as hand luggage and hence no separate payment in the ferry.

Current mechanism (funding):

Funding for transport of lab samples (related to HIV Care and Treatment) come from the Centers for Disease Control (CDC) Implementing Partner in Mwanza region AGPAHI for 9 CTC sites in Ukerewe. AGPAHI also uses the courier SKYNET to transport the samples in some sites and in others the healthcare workers are used. The remaining facilities (which offer option B+), the Ukerewe DC uses own funds to transport the samples.

BLOOD FOR TRANSFUSION.

This involves the following

- Samples sent from Ukerewe to NBTS Lab in Mwanza for testing and
- Whole blood for transfusion sent from NBTS Office in Mwanza to Ukerewe

The Blood Samples from Ukerewe to NBTS testing Lab in Mwanza.

Diagram 2: Movement of Samples for testing from Ukerewe to NBTS Mwanza



- Packaging and barcoding of samples is done at Ukerewe District Hospital.
- Samples are transported once a week to NBTS Lab Mwanza, results come back via email.
- Quantities transported to NBTS Lab Mwanza are around 30 – 50 per week during normal seasons (as reported by Ukerewe Lab personnel); though official data at Mwanza NBTS shows from January to October, 325 samples were received from Ukerewe where by 91 samples (28%) were haemolyzed due to poor transport.
- During the blood donation campaigns, samples are above 150 (*Campaigns happen quarterly or any time fund is available*)

The cost for this mechanism mainly involves a district staff fare to Mwanza and one night per diem once a week. Per diem rate is 100,000/-, fare is 7,000/- (x2), and Taxi in Mwanza 5,000/.

Emergency Blood for Transfusion (Blood Sent from NBTS in Mwanza to Ukerewe Islands)

This mainly happens when in cases of postpartum hemorrhage (excessive bleeding due to child birth) or when there is rare blood group patient such as Group 0 negative.

From January to October 2018, the NBTS issued 30 units of blood to Ukerewe on emergency cases. It is more convenient to send blood to Ukerewe than to refer patients to Sekou Toure or Bugando due to challenging geography of Ukerewe and transportation mode via motor bicycles and later ferry.

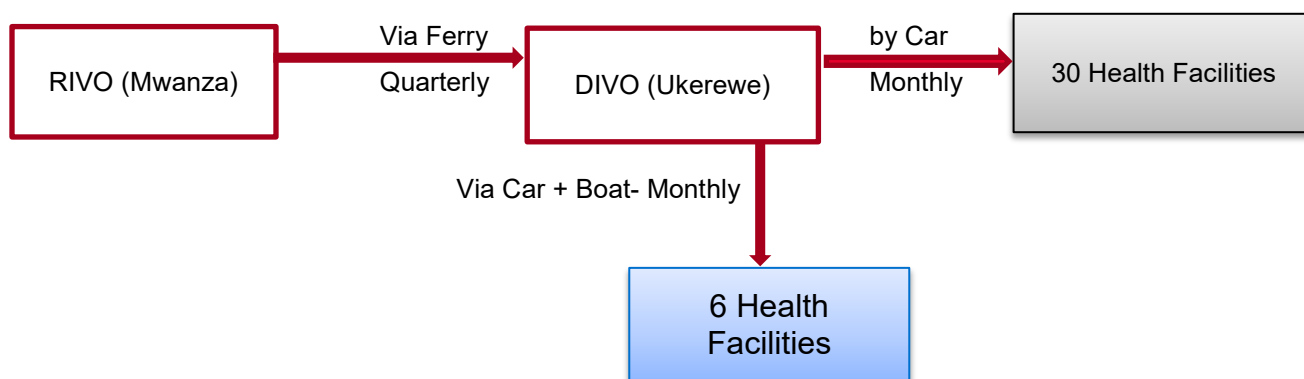
Once sent, blood is used in three Transfusion sites in Ukerewe (where patients are referred to); namely Muriti Health Centre, Kagunguri Health Centre, and Ukerewe DH; Bwisya Health Centre which is in Ukara district is set to start transfusion services in near future to make a total of 4 transfusing sites in Ukerewe District.

The cost for this mode is mainly one night of per diem (100,000/-) and fare for a health worker from Mwanza to Ukerewe (not more than 30,000/- including Taxi). On average six emergencies occur per year. However, there are some transportation costs incurred to get certain blood types from other places if such type is not available at NBTS Mwanza zone. Sometimes if they do not have sufficient funds, they would ask the transporters to transport for free and certain transporters (Nyhunge, Bunda and Zakaria buses) have agreed to transport for free as their donation to NBTS Mwanza.

VACCINE SUPPLY CHAINS

The vaccines supply chains are working parallel to the MSD system. The Regional Immunization and Vaccine Officer (RIVO), who is a custodian of Regional Vaccine Store, is responsible for supplying vaccines and related supplies to District Immunization and Vaccine Officers (DIVOs) quarterly. In turn the DIVO is responsible for monthly delivery to health facilities (last mile).

Diagram 3: Vaccine Supply Chains – Ukerewe DC



Cost centers for vaccine supply chain in Ukerewe.

From Regional Vaccine Store to District Vaccine Store (RIVO to DIVO)

There are two options for this distribution;

Option 1: The vehicle with vaccine consignment uses ferry to cross over to Ukerewe

Costs:

- Land cruiser with Vaccine is charged 70,000/- in the ferry (round trip)
- Per Diem for driver (1 night) is 60,000/-
- Per Diem for officer (1 night) is 100,000/-
- Ferry fare for officer is 14,000/-
- Fuel for vehicle 100,000/-

Option 2: To load the ferry with vaccine consignment

Costs:

- Cargo fees in the Ferry: 100,000/- to 200,000/- (including loading and offloading)
- Per Diem for officer (1 night) is 100,000/-
- Fare for officer (return) is 14,000
- Ferry fare for officer is 14,000/-
- Taxi – 20,000/-

From District Vaccine Store to Health Facilities (last mile delivery)

The distribution at this level is challenging to the council as it only relies on the council's own source of funds. Distribution happens on a monthly basis since lower health facilities cannot keep three months of stock of vaccines on cold chain, they depend on gas refrigerators and not electric refrigerators available at District level.

Distribution happens in 36 health facilities using the District vehicle transport. In six facilities the DIVO uses boats to carry vaccines since they are located in small islands within Lake Victoria.

In addition to monthly delivery by DIVO, there are an estimated four emergency orders per year from high population sites. In those cases the HF health worker travels to DIVO with a cold box to pick the vaccines.

Costs involved:

Transportation

Fuel: based on 690km per distribution cycle per month

Total fuel (1litre – 6km) 115 litres

1 litre – 2500 TZS

Boat: Fare for officer (5000/=) and Cold Boxes load (5000/= per box)

Estimated cost is 30,000/- .

Some rare cases may require hiring the boat at 100,000/-

Per Diem:

For Officer

Rate: 20,000/- per day within Ukerewe (estimated. 4 days)

60,000/- per day within Islands (estimated 4 days)

For Driver: 20,000/- per day within Ukerewe (est. 4 days a month)

Cost for Emergency Needs:

Health Facility workers from four high population sites travel to Nansio DH to pick supplies:

The cost of round trip is not more than 20,000/- per facility

Emergency supplies from Regional Vaccine Store to District are estimated to take place once per quarter (four times a year). In such cases the DIVO travels to Mwanza using public transport and cost involves one night per diem, paying for cargo at the ferry, and the DIVO's fare (ferry and taxi).

NORMAL MSD SUPPLIES FOR ILS, ARV, TB AND LABORATORY SYSTEM

Ukerewe District has health commodity needs worth 1.2BN TZS (\$552,552) per year (source: 2017/18 CCHP Budget for Ukerewe DC)

Sources of Fund:

Basket Fund (Direct Facility Financing): 300,000,000/-

Receipt in Kind (MoHCDGEC/ MSD account): 761,000,000/-

National Health Insurance Fund (NHIF) collections: 61,000,000/-

User Fees: 51,000,000/-

Community Health Fund (CHF) collections: 32,000,000/-

Distribution:

MSD Mwanza Zone is distributing ILS packages up to the last mile on a quarterly basis, the average number of ILS boxes per facility is 15 per quarter (source MSD data). MSD also performs parallel deliveries for the TB System, Lab System, and ARVs in every quarter up to the District Hospital.

Commodities for ARV and TB are picked from the District Hospital by the respective HF staff.

The cost of this system, which is 5,752,000/- per year, is documented in *Annex 1: Ukerewe Distribution Cost MSD*. The details on actual quantities shipped (Jan – Oct, 2018), the estimated weight and volume are attached in *Annex 4- MSD Distribution product volumes and weight*.

The normal distribution routes used by MSD are summarized in the tables below.

Table 3a: MSD Distribution Routes and Distances in Ukerewe

Route 1		
FROM	TO	KM
MSD	UKEREWE	250
NANSIO	BUGOROLA	48

BUGOROLA	NANSIO	49
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Route 2

FROM	TO	KM
NANSIO	MURUSENI	8
MURUSENI	HAMKOKO	3
HAMKOKO	MUHULA	16
MUHULA	KIGARA	5
KIGARA	IGALA	7
IGALA	BUKONDO	9
BUKONDO	BUSUMBA	1
BUSUMBA	RUBYA	9
RUBYA	NANSIO	34

Route 3

FROM	TO	KM
NANSIO	BULAMBA	4
BULAMBA	MAGEREZA	5
MAGEREZA	NANSIO	14
NANSIO	KWERU	18
KWERU	BUZENGWE	4
BUZENGWE	SIZU	14
SIZU	MURITI	18
MURITI	BUGALAMA	7
BUGALAMA	NANSIO	40

Route 4

FROM	TO	KM
NANSIO	MURUTUNGURU	16
MURUTUNGURU	MUKUNU	11
MUKUNU	BUKONYO	9
BUKONYO	MURUTILIMA	7
MURUTILIMA	KAMASI	5
KAMASI	GALLU	3
GALLU	KASENI	8
KASENI	BUSANGU	15
BUSANGU	NANSIO	33

Route 5

FROM	TO	KM
NANSIO	KAGUNGULI	112
KAGUNGULI	BUGULA	9
BUGULA	NANSIO	29
NANSIO	NAMAGONDO	14
NAMAGONDO	BWISYA	19

BWISYA	NYAMANGA	1
NYAMANGA	BUKIKO	8
BUKIKO	CHIFULE	16
CHIFULE	BWISYA	1
BWISYA	NANSIO	47

Route 6

FROM	TO	KM
NANSIO	IRUGWA DISPE	14
NANSIO	MSD	264

To reach six facilities which are located in 6 Islands, MSD uses boat to transport consignments.

Table 3b: Boat Trips used by MSD in last mile delivery- Ukerewe

Boat Trips
Kamasi - ukerewe
Kweru - ukerewe
Irugwa - ukerewe
Busumba - ukerewe
Sizu - ukerewe
Lukuba - ukerewe

EMERGENCY MSD SUPPLIES FOR ILS, ARV, TB AND LABORATORY SYSTEM.

Emergency orders happen mainly for two reasons

- Low fill rate at MSD – causes facilities to re-order when commodity is available at MSD Warehouse
- Fund availability – facilities make purchases (order) to MSD when fund is available especially from other sources such as NHIF, CHF, User Fees and Basket Fund.

On average; lower health facilities (dispensaries and health centers) have 4 emergency orders a year (source: eLMIS).

Analysis of eLMIS dataset for Ukerewe District Hospital (Nansio) indicated that over 68% of all orders from the Hospital to MSD are Emergency.

Table 2: Normal v/s Emergency Orders at Nansio District Hospital, Ukerewe.

Source: eLMIS

Date: 01/01/2017 to 02/11/2018

Program	Total Orders	Normal	Emergency
ARV	10	7	3
Lab System	31	4	27
ILS	26	7	19
TB System	12	7	5
	79	25	54
		32%	68%

From the data above (extracted on 2 November 2018), the Hospital has at least two emergency orders in a month.

Emergency orders are not covered by normal MSD distribution system, the ordering facility (or District) covers the supply chain costs associated with the orders.

Costs involved in Emergency Orders.

Alternative 1: A health care worker uses public transport to pick orders from MSD Mwanza

- i. Transport from MSD Warehouse to Ferry in Mwanza (normally MSD provides free ride)
- ii. Offloading and loading cost (casual workers) : 100/- per box
- iii. Cargo fee in the Ferry: Estimated at 300,000/- for District Hospital Cargo and 50,000/- for lower health facility cargo.
- iv. Transport from Nansio Port to District Hospital or to lower health facility. This is divided into two ways:
 - For facilities in Nansio Island , transport is 5,000/- + 7,000/- (return) ; which is 24,000/- per trip
 - For 6 facilities located in small Islands, the cost increases by at least 15,000 more due to additional boat and fee for cargo.
- v. Per Diem cost for 1-2 nights for District Staff or HCW going to submit order to MSD and pick the cargo back to Ukerewe HF. (rate is normally 100,000/- per night).

Alternative 2. A health care worker uses the district vehicle to pick goods from MSD Mwanza.

This involves the following additional costs:

- Fuel: Estimated 60kms, which is 10 litres @2,500 each : 24,000/- TZS
- Drivers' per Diem for 1 -2 nights ; 80,000/- per night
- No cargo fee but district vehicle is charged 70,000/-(round trip) in the Ferry.

DISCUSSION AND RECOMMENDATIONS.

Based on the above findings and public health impact, the following are recommended as the priority health products relevant for Drone X business case. Caveats to the recommendations below include:

- We assume that deliveries will be done from the supplier (MSD in most cases) to facilities and not from a potential drone port in Ukerewe. An alternative flow of commodities would influence the recommendations below.
- More nuanced recommendations can be developed given additional time for data gathering and analysis. The segments of the supply chain presented here as recommendations can be further refined, i.e. layered use cases which could include certain percentages of various product groups/segments may be supported by drone delivery while others may be more efficiently delivered by other vehicles. For example, emergency deliveries (or HIV or TB) do not necessarily have to be all delivered by drone or none delivered by drone. Rather, a certain percentage of emergency deliveries (or HIV or TB), may present the most efficient use case. Criteria could be developed on whether a certain delivery (or set of deliveries) make sense for drone delivery.
- We did not consider the number of drones available to support these product groups/segments. For example, if there is one drone, the priority would be a combination of certain use cases; if there are two drones, additional priorities could be identified.
- These recommendations do not consider additional contextual factors. For example, vertical program commodities, particularly vaccines, are traditionally more appealing to donors to fund, while essential medicine commodities are largely financed domestically.
- Finally, recommendations included do not assume a willingness of MSD to pay, or describe a specific business case for implementation.

1st Priority: HIV viral load tests and other laboratory diagnostic samples

Ukerewe DC is among the 81 priority councils for HIV interventions by PEPFAR (TZ-COP 2018). The 81 councils represent approximately 78% of the 1.4 million persons living with HIV (PLHIV). According to Tanzania HIV Impact Survey (THIS) 2016-2017, the prevalence of HIV in Mwanza region (where Ukerewe is located) is 7.2% - way above the national average of 5% - making it rank the 4th highest in prevalence behind Njombe, Iringa and Mbeya. The Viral load suppression is only reaching 49.6% out of the 90% goal by 2020 included in the UNAIDS 90-90-90 strategy. The 90-90-90 strategy aims to diagnose 90% of all HIV-positive persons, provide antiretroviral therapy (ART) for 90% of those diagnosed, and achieve viral suppression for 90% of those treated by 2020.

The number of samples (especially for Viral Load testing) is set to increase in order to reach 90-90-90 strategy goal by 2020. The major setback for viral load samples is “sample integrity” which is jeopardized during transportation using the motorcycles famously known as “BODA BODA”. This results in false outcomes, which complicate clinical management of persons with HIV. For example, a person with viral load of 8,000 copies of HIV tRNA may have his sample read only 1,000 copies of HIV tRNA giving the impression that viral suppression is achieved while actually there is a treatment failure and change of regimen is necessary.

The CDC Implementing partners have started to outsource the sample transportation to private sector players. Our research identified SKYNET in Mwanza Region and TUTUME Worldwide Ltd currently operating in Kagera Region and soon to open operations in Shinyanga region. Our interview with TUTUME’s Head of Marketing identified that they use local BODA BODA drivers after giving them some basic training who help to ship samples between spokes and hubs; from hubs they use cars or flight to testing labs (e.g Kagera samples are flown to MDH Lab in Temeke Dar).We did not get the SKYNET staff for interview, but the Laboratory Technologist from AGPAHI indicated that they still have challenges in sample integrity and false outcomes due to poor transport mode.

In Lake Zone, the active partners are Management and Development for Health (MDH) and AGPAHI. This indicates there is dedicated fund and players to support safe transport of viral load samples which improves treatment outcomes and help Tanzania government reach the 90-90-90 goals by 2020.

2nd Priority: Vaccine delivery from the district level to the health facilities

The delivery to the last mile is the most challenging to the councils and is the third highest cost councils incur. Usually it takes around 10 days to complete. Vaccine availability is the priority of the councils, program, and even at the Ministry level. Vaccine delivery requires cold chain maintenance throughout the supply chain and with the transportation challenges, this is usually put in risk. It is a compelling case to use autonomous aerial vehicles (AAVs) to deliver vaccines when the AAVs go to pick diagnostic samples. Although we have recommended to do last mile delivery of vaccines; the opportunity is also there from regional level store to the Ukerewe district store.

3rd Priority: Blood for transfusion samples and whole blood for emergency transfusion.

This group is prioritized based on its public health importance even if the cost is currently the lowest of all supply chains and can be attributed to the fact that. While blood samples for testing suffers from haemolysis (28% of samples) due to poor transportation, the emergency blood for rare blood groups is vital to save lives of women giving birth in Ukerewe who experience excessive blood loss (Post-Partum Hemorrhage). Due to Ukerewe geography, it is easier to send blood units to Ukerewe than referring such patients to Mwanza (Bugando or Sekou Toure) during emergence.

4th Priority: Emergency Supplies for ILS, ARV, TB and Laboratory system from MSD

This is the one of top expenses in the Ukerewe commodity supply chains. The expenses are more pronounced in Nansio District Hospital and DroneX should prioritize this location. In small facilities , this is largely driven by the newly introduced Direct Facility Financing DFF where Basket Funds are disbursed directly to a health facility who then place orders with MSD anytime cash is available even outside the normal schedule. While this effect may subsidize by introduction of bi-monthly ordering for lower facilities; it is not yet clear as to when that system will commence. Moreover, independent purchases robs health

facilities not only the funds which could procure supplies (which now cover for per diem and transport expenses) but also the quality patient care due to low staffing levels at health facilities. The use of AAVs can ensure quick supplies, clinicians spending time at facilities treating patients and can potentially save funds used for per diem and travel expenses.

CONCLUSION.

The four priority commodity types have been recommended based on actual field data, their public health importance and the needs of Ukerewe Council. Engagement and collaboration with key players such as HIV Implementing Partners (MDH, AGPAHI and entire Boresha Afya Project) and local private sector currently involved in supply chains for the priority commodities will help to address issues that may arise. Implementing partners can pay for delivery cost as they are currently do; Councils and health facilities can contribute the same amount they are incurring now for delivery, and we believe that can help recuperate operation costs.

We calculated number of flights per year below based on our analytical tool. Important notes for these figures:

- Blood is not included in the current analytical tool, and would need to be added.
- We were unable to calculate the number of flights for emergency supplies. More analysis of the gathered data is necessary to determine emergency vs non-routine deliveries to get a more accurate estimation of the volumes of emergency delivery.
- Flights for diagnostic samples have been considered separately below since the analytical tool doesn't consider spokes and hubs model.

Product Category	Number of flights per year	Average number of flights per day (excluding weekends)
Essential Medicine including RCH and malaria commodities	8978	35
HIV medicines	1561	6
TB and Leprosy medicines	781	3
Vaccines	195	1

Special consideration for number of flights for diagnostic samples.

To get number of flights for diagnostic samples we have considered only a supply network of high volume sites comprising of 6 spokes and 3 hubs. The high volume sites are those which offer HIV Care and Treatment services and include the following:

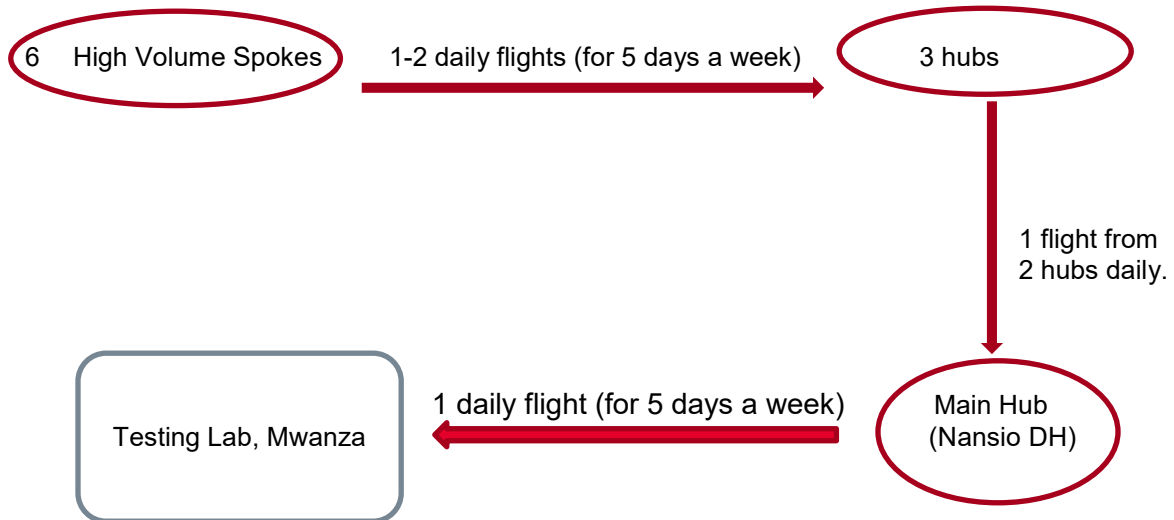
Spokes

- Bugorola dispensary
- Bukondo dispensary
- Kagunguli health centre
- Kamasi dispensary (in Kamasi Island)
- Kigara dispensary
- Muritima dispensary

The hubs are:

- Muriti health centre
- Bwisya health centre (in Ukara Island)
- Nansio district hospital

Diagram IV: Number of flights for Lab diagnostic Samples



- From 6 high volume spokes to 3 hubs: $2 * 6 = 12$ flights a day , 60 a week, 3,120 a year
- From 2 hubs (Bwisya and Muriti) to main hub: $1 * 2 = 2$ flights a day, 10 a week, 520 a year
- From Main hub (Nansio) to Mwanza testing lab: $1 * 1 = 1$ flight a day, 5 a week, 260 a year
- Total flights are: **3,900** a year.

Based on the number of flights per day, a possible use cases is for vaccines delivery and diagnostic samples transportation, and possible inclusion of vertical program commodities (HIV medicines, and TB and leprosy medicines). As mentioned above, additional analysis can be completed for blood delivery and emergency order delivery to determine the appropriateness of inclusion. Further analysis can be conducted to refine the segments/product groups presented here, develop scenarios based on the number of drones that could be utilized, or consider the establishment of a droneport.