Sukh

DELIVERY & CARE FOR DIABETICS IN RURAL COMMUNITIES

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1. Abstract

‘*Sukh*’ is a home-based care, medication and diagnosis delivery system that is aimed at elderly diabetic patients. Through our field research we identified a significant number of elderly people in Kumuzhi and Karanai Puthuchery villages who have diabetes and are not able to access proper follow up care.

To give you an idea, Kumuzhi and Karanai Puthuchery are 2 out of 7 villages in a district with 42000 people and only 1 nurse. With a high prevalence of 5 % , we are looking at a population of 2100 diabetic patients needing regular care. Our system will employ and equip specially trained field workers to provide this specialized care, thereby bridging the economic, geographic, and health related gap that these patients face.

2. Context

A. Background
B. Community Description
C. Problem Framing Statement

2A. Background

Diabetes and high blood pressure are diseases that are exploding throughout India. Although treatment is available at local clinics and hospitals, many patients are unable to visit such facilities on a regular enough basis to receive adequate care. When they do go, they have to travel by public transport or by foot, and then may face lines as long as 3-4 hours to receive their medication and checkups. This makes patients lose faith in the efficiency of the process. These circumstances often result in irregular follow-up medication and in discontinuity in treatment.

Our project aims to help this significant number of elderly people (approximately 5% - 2100 people) in Kumuzhi and Karanai Puthuchery who have diabetes and high blood pressure problems by bringing the medicine and care to their doorstep.

2B. Community Description

Karanai Puthuchery, with a population of 12000, is one of the seven villages under the Karanai Puthucherry Panchayat. The major health care services are delivered through Guduvanchery Primary Health Centre (9.8 km) and Tagore Medical College (10.6 km). Certain areas in Karanai Puthuchery, such as Annanagar & Katur, are suffering from healthcare access issues due to their remote location.

Kumuzhi, another village with a population of 5000. The village is approximately 11 - 15 km from both Kandigai and Guduvanchery PHC and about 13.4 km from Tagore Medical College.

Both villages are part of Urrupakkam, Chennai, Tamilnadu, INDIA.

2B. Community Description: Socio-Economic Observations

1. Steady employment provided by the manufacturing industry in close vicinity has made the younger generation trransition to nonfarm based employment.
2. With the aggressive influx of real estate into these areas, an opportunity for daily wage workers like carpenters, plumbers, masons etc. has been created.
3. The migration of younger generation to industrial areas which are located nearby has also left the elderly isolated in the families. With minimal social and economic support, most elderly are self dependent in these villages.
4. There appeared an invisible cast devide in the communities, with specific ares belonging to specific casts within the villages.

2B. Community Description: Community Health Facilities

Primary Health Centre (Govt) Guruvancherry (9.8 km)

- Daily OPD (no specialty care for diabetes)
- Staffed with doctors & nurses
- Offers free medicine
- High waiting time

Private Small Clinics within the village (2 km)

- No medical expertise for diabetes
- Staffed with nurse
- Acts as referral point for private hospital
- Stocked with general supplies

Private Hospital : SRM Hospital (13.4 km)

- Daily OPD (20 counters) and weekly specialty care OPD (for diabetes)
- Staffed with doctors, medical students
- Provides health insurance and cover
- Offers free transit to hospital via bus

2B. Community Description: Point of Care

Public health services are delivered through 1 village health worker. She works for 1 day a week in each village and concentrates her work around maternal and neonatal care.

Worksites under the National Rural Employment Guarantee Scheme are also located between these villages and far from any healthcare facility. A lot of middle aged (40-50 years) and elderly (> 50 years) diabetic patients are employed here. They earn 180 Rs/day and are guaranteed 100 days of employment in a year. This is a potential point of care for delivering care, medicine, and diagnostic services.

2C. Problem Framing Statement

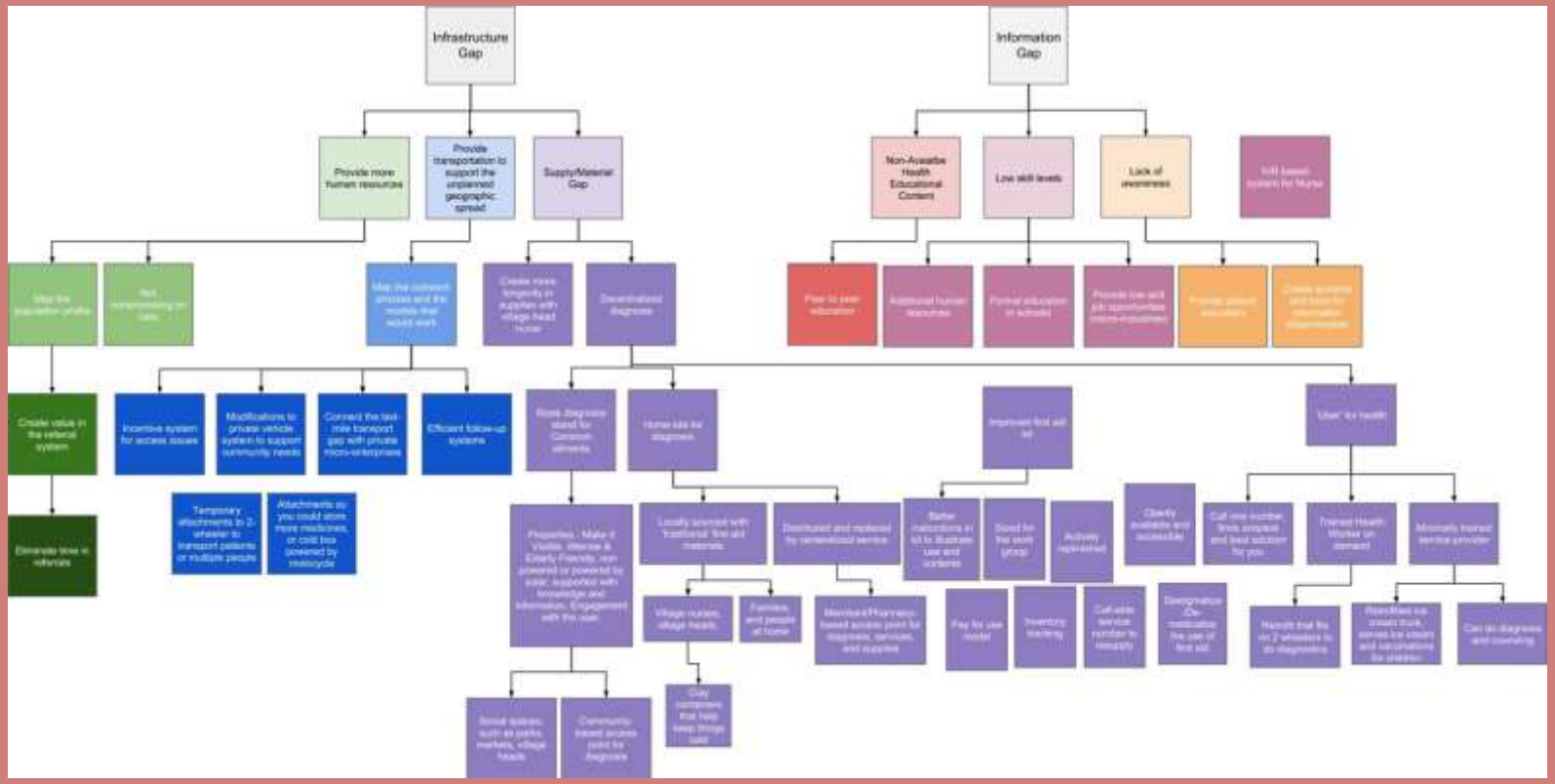
Elderly people in Karanai Puthuchery and Kumuzhi struggle with **chronic diseases** like diabetes because of the amount of time required and complexity inherent in **accessing medical care.**

3. Design Process

A. Problem Framing Tree
B. Value Proposition
C. Summary of Design Process
D. Analysis and Experimentation

3A. Problem Framing Tree

This problem framing tree was created based on broad, upper level issues that we discovered and explored through our field work. The broad issues were then brainstormed and further broken down into more specific issues. Though this chart flows vertically downwards, issues were also horizontally cross-connected to form problem statements.



3B. Primary Stakeholder

Typical User Persona:

- **Name : Lalitha**
- **Age 67 years old**
- **Unemployed, Widowed**
- **Lives in Kumuzhi with her son, daughter-in-law, and two grandchildren.**
- **Her daily routine involves taking her grandchildren to school, cooking, and other household work.**
- **Suffers from Type 2 Diabetes. She visited a healthcare facility one year ago and has not been regularly following up since then due to distance and economic issues.**

3B. Value Proposition: Primary Stakeholder

Avoiding major medical and travel expenses

- Reduces the need for traveling to healthcare facilities for follow up
- Controlled and safe transportation of drugs to the doorstep
- Care, medication, and diagnosis provided under one roof

Adhering to care and medication regimens

- Individual care plan through pill box
- Assigned care provider per patient
- High frequency of follow up and flexibility in delivery location
- Prior intimation about delivery

Helping her understand her medical condition

- Easy to understand health records (use plain language)
- Pillbox calendar for follow up
- Feedback mechanism to report any grievances
- Adoption of teach-back methods by care provider

3B. Value Proposition: Secondary Stakeholders

Care Provider (Care Delivery Person)

- Local community based employment opportunity
- Skill enhancement: Receives basic training in care provision, general medication, insulin delivery and administration, etc.

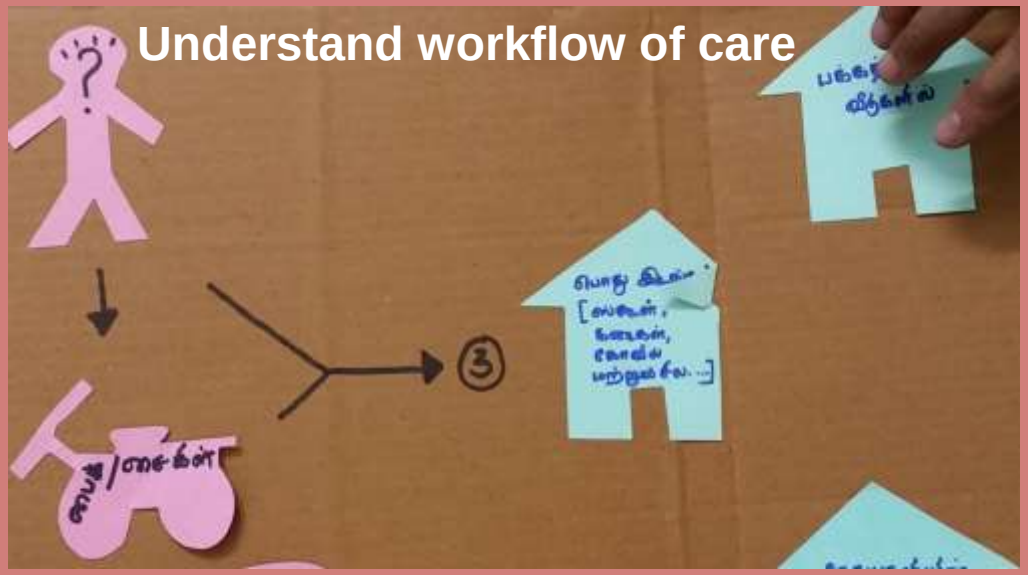
Public Hospital

- Enables outreach of government welfare-oriented scheme which improves hospital follow up after a patient visit
- Load on doctors, nurses, village health workers, etc. is reduced

Private Hospital

- Increased continuity in medicine sales
- Improved follow up of patients

3C. Design process : Tools used



List of Prototyping Materials (sketch models)

TEST 1

Cycle

Box/Freezer Box

Make Dividers (cardboard pieces)

Meds

WHERE: in the community, meeting place, evening, Bora community kitchen (BCK)

TEST 2

Identify 5 disabled/chronic (bed) elderly people

How many get administered

How many go to the health centre

Would they want delivery & diagnosis

Would they agree to call the person or have to measure

Every week

WHERE: At the home of the patient

TEST 3

Salt

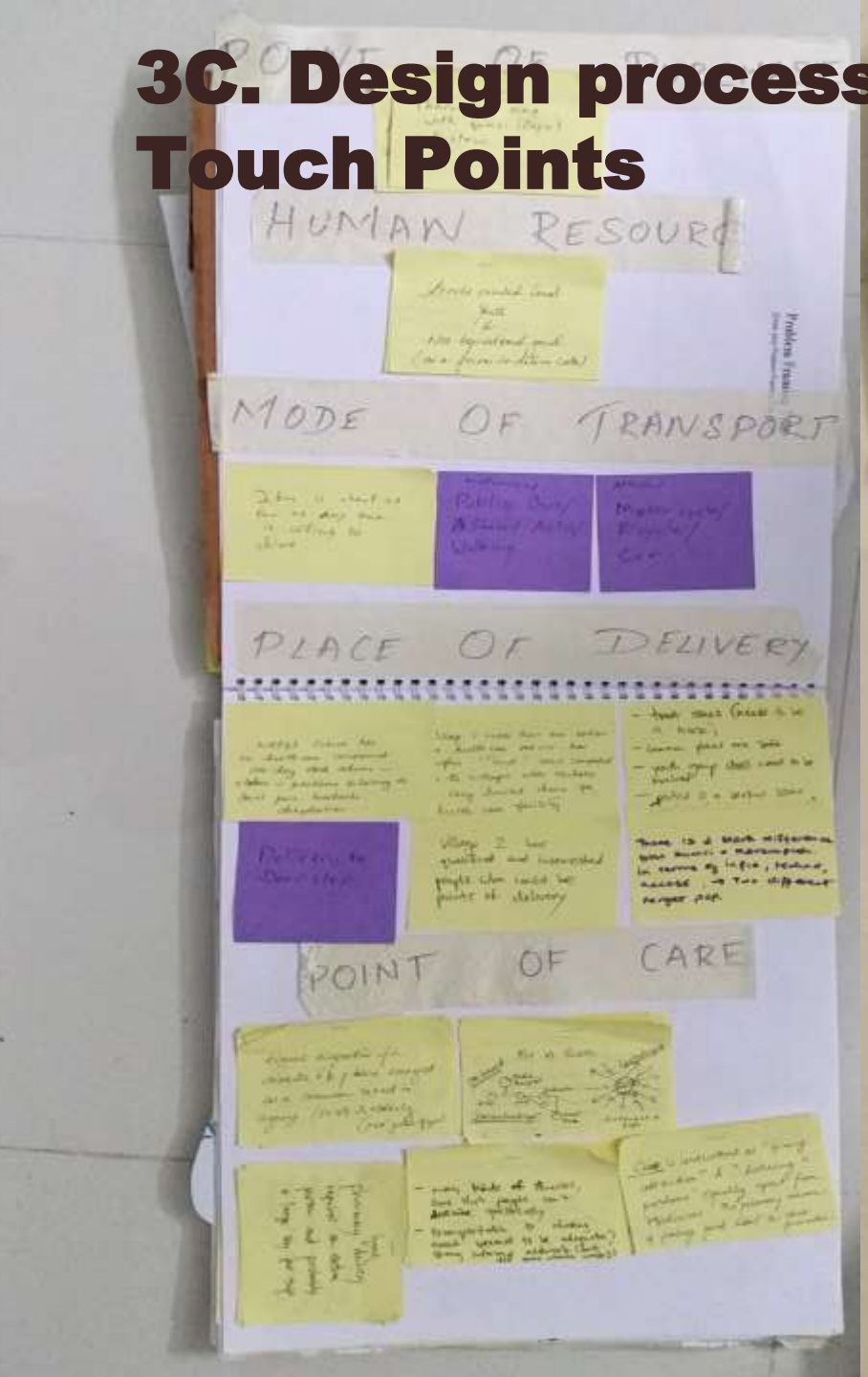
Sugar

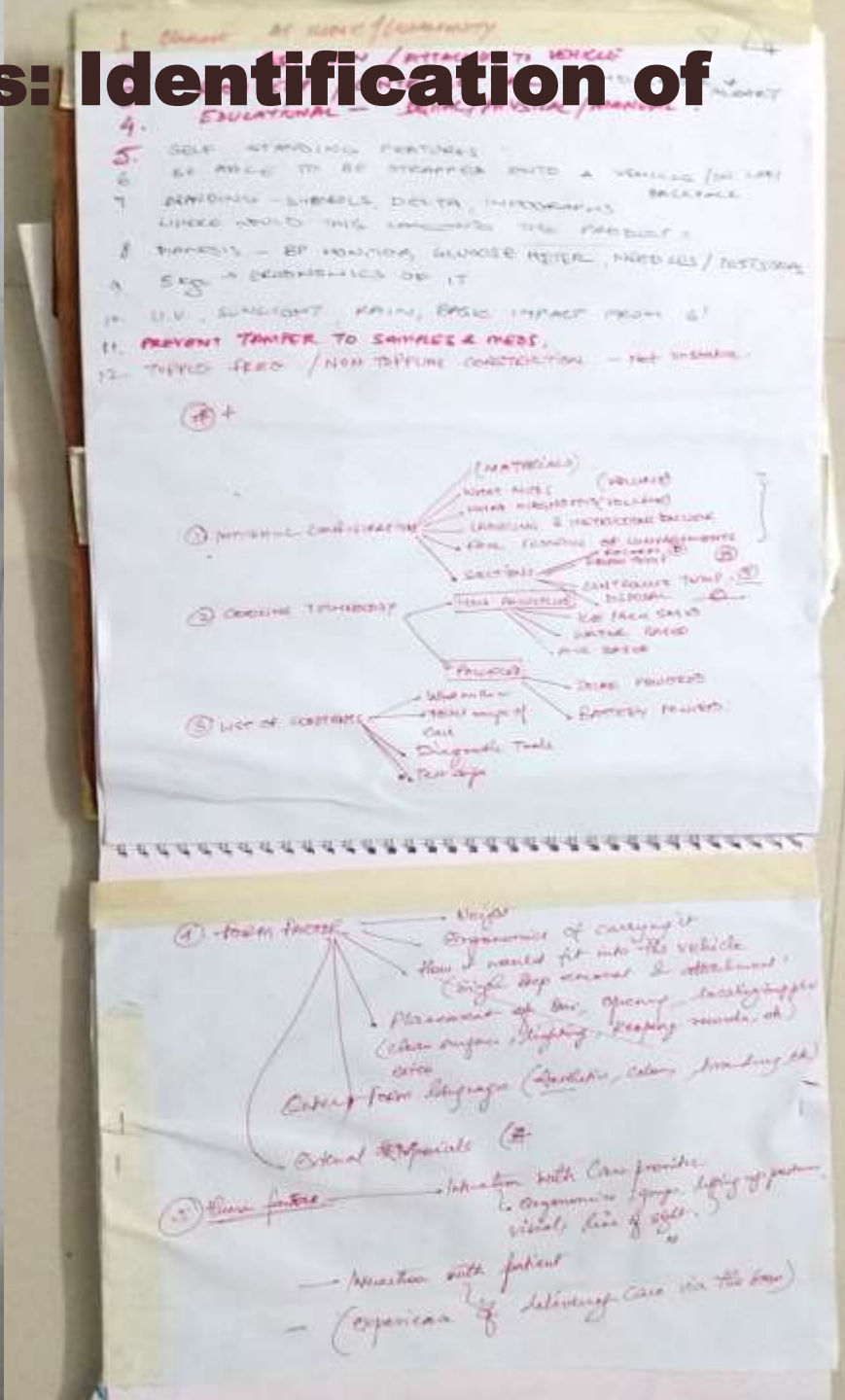
Bowl/Plastic Buckets

TEST 4

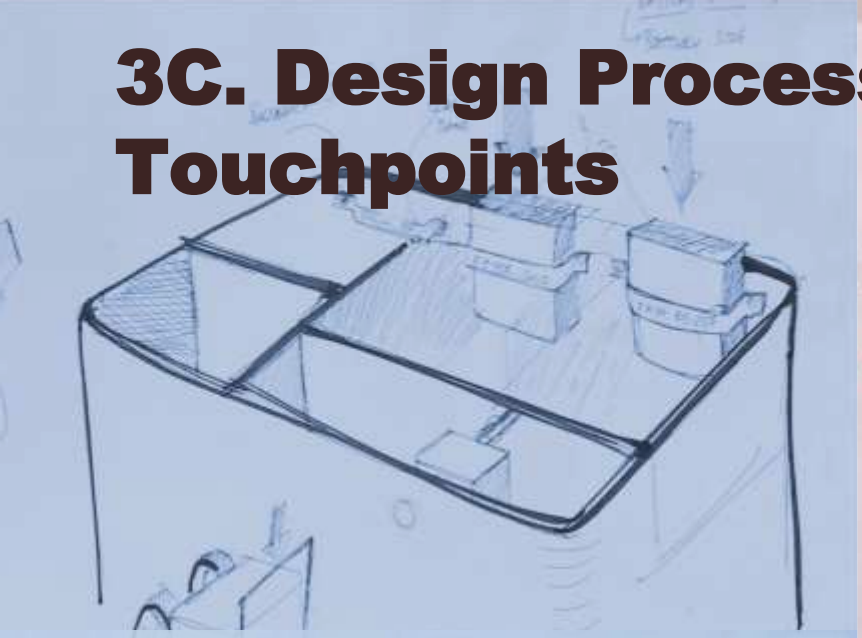
Show people (community kitchen) of a freezer/fridge and ask if it would work

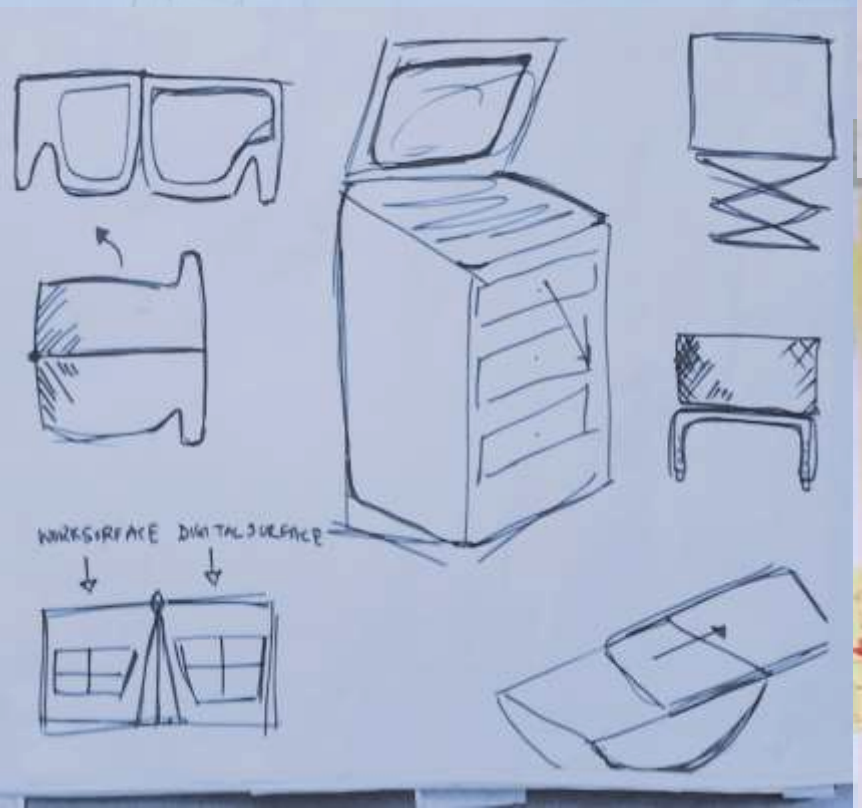
3C. Design process: Identification of Touch Points

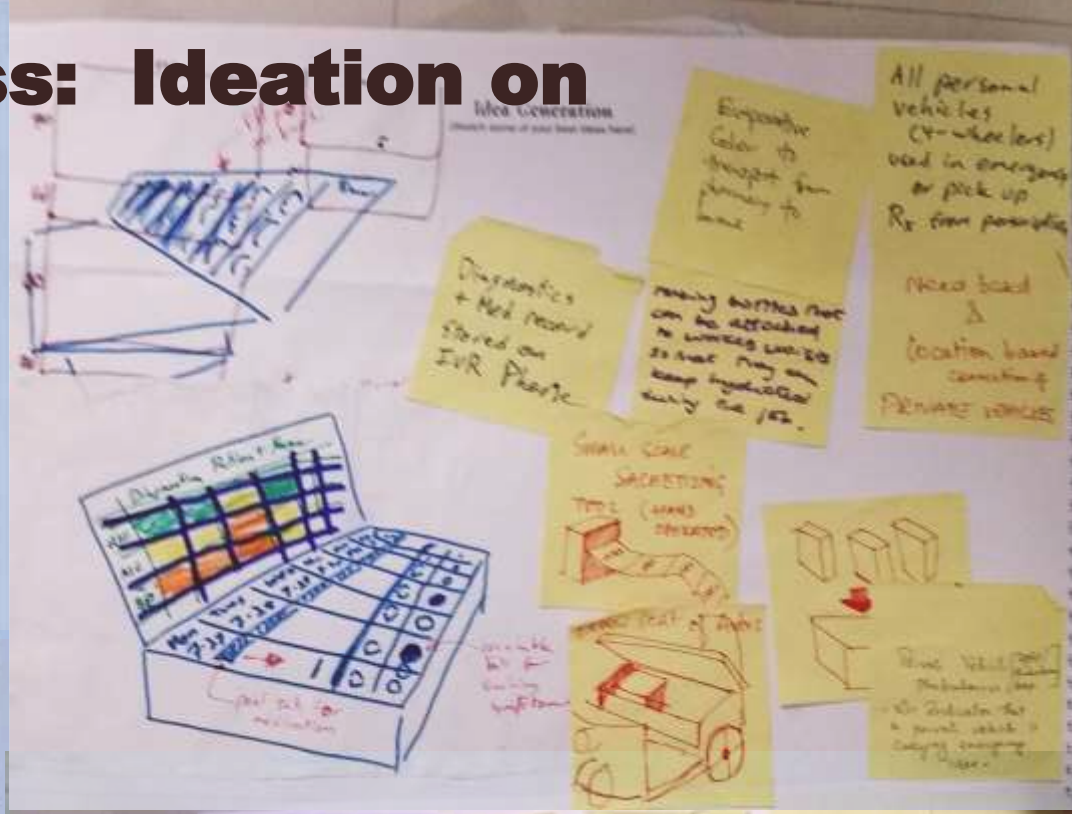




3C. Design Process: Ideation on Touchpoints







3C. Design Process: Prototypes

4. Final Prototype

A. Design requirements
B. How it works
C. Performance
D. List of prototyping materials

4A. Design Requirements: Service Design

The patient care process should be/have:

1. Localized
- **Use local, long-term human resources**
- **Leverage existing local supply chains**

2. Individualized
- **Care, attention, and detailed communication**

3. Transparent
- **Allow examining of care provider credentials**
- **Allow examining of product quality**

4. User-centric communication
- **General information provided via public announcement, camps, etc.**
- **Personalized information suited for neo-literates and illiterates**

5. Centralized reporting and data collection
- **For tracking patient medical conditions**
- **For ensuring successful patient transfer between health facilities**

4A. Design Requirements: Product Design

The Delivery Box should meet the following requirements:

1. **Store medication for 15-20 patients**
2. **Cold storage compartment (15-25 ℃) with cooling that lasts for an entire workday (10 hours)**
3. **Light-weight (5 kg overall weight)**
4. **Low-powered (e.g. can be powered by a regular bike battery)**
5. **Provide clean work surface for administering care**
6. **Have adequate disposal chamber for medical waste**
7. **Modular to meet different delivery requirements**
8. **Be ergonomic to wear on the shoulders and take off the shoulders**

Proposed Concept

Our proposed concept has two aspects:

Service concept

for delivery of last mile care, medicine and diagnostics.

This includes design of -

- **Patient engagement initiation process**
- **Medicine procurement process**
- **Patient care process**
- **Reporting & Data collection process**

Product concept

technologies/tools that enable the service concept

This includes design of -

- **Pillbox for patient compliance**
- **Informational templates for patients**
- **Delivery Box (for care provider)**

Service Concept

4B. How it Works: Service Concept

SUKH aims to bridge the access issues relating to chronic disease by providing specialized care through the following:

Tracking prescriptions by partnering with public and private healthcare facilities

Identifying the local human resource and training them to provide follow-up care in villages

Providing a technology for safe transport of drugs and diagnosis at the door-step

Providing a neo-literate and illiterate friendly healthcare service

4B. How it Works: Service Concept

Sukh partners with

- **Private Healthcare Facility**
- **Public Healthcare Facility**

Sukh → ✚ Sukh sets up Patient Prescription Sheet process for elderly patients in facility

 Facility intimates Sukh when elderly patient has not come for follow up appointments

✚ → **Sukh** Facility gives Sukh respective Patient Prescription Sheet

Sukh →  Sukh passes this on to Care Provider located in the area of the patient

- A. The Care Process for the patient initiates
- B. Sukh charges the facility a sum/ patient/ month

Sukh

4B. How it Works: Service Concept Partnership Model

Grass-root Entrepreneurships
Sukh will empower grass root entrepreneurs to bridge the last mile care and delivery gap in each community.

Sukh

Private Hospital

Patients get free delivery and pay MRP for their medications bought from the respective private center

Public Hospital

Patients get free delivery and medications given by the respective public facility

Unorganized Sector

Patients get free delivery and pay MRP for their medications bought from the respective private center

Product Concept

4B. How it Works: Delivery Box

Diagnosis and first aid unit

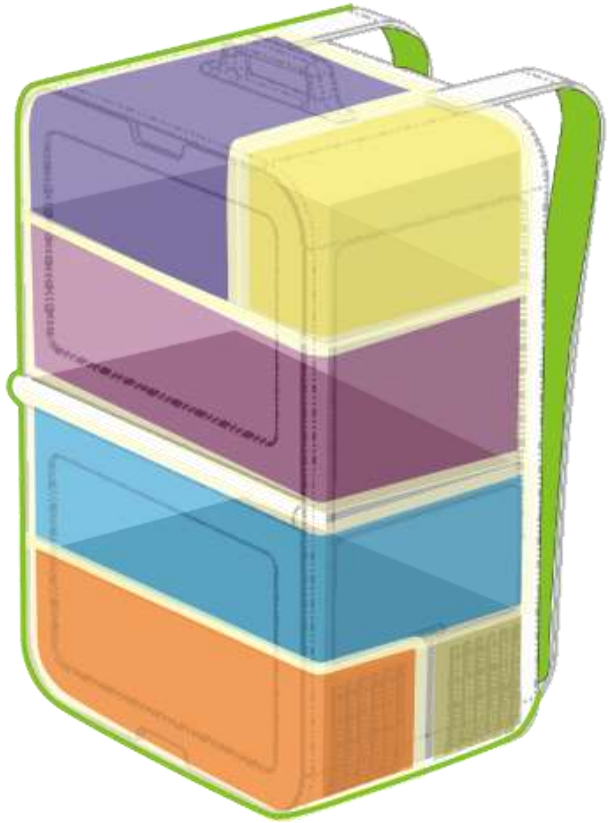
Disposal Chamber

Pillbox unit with pills, patient details, and prescription

Cold storage for insulin and blood samples

Thermoelectric cooling unit

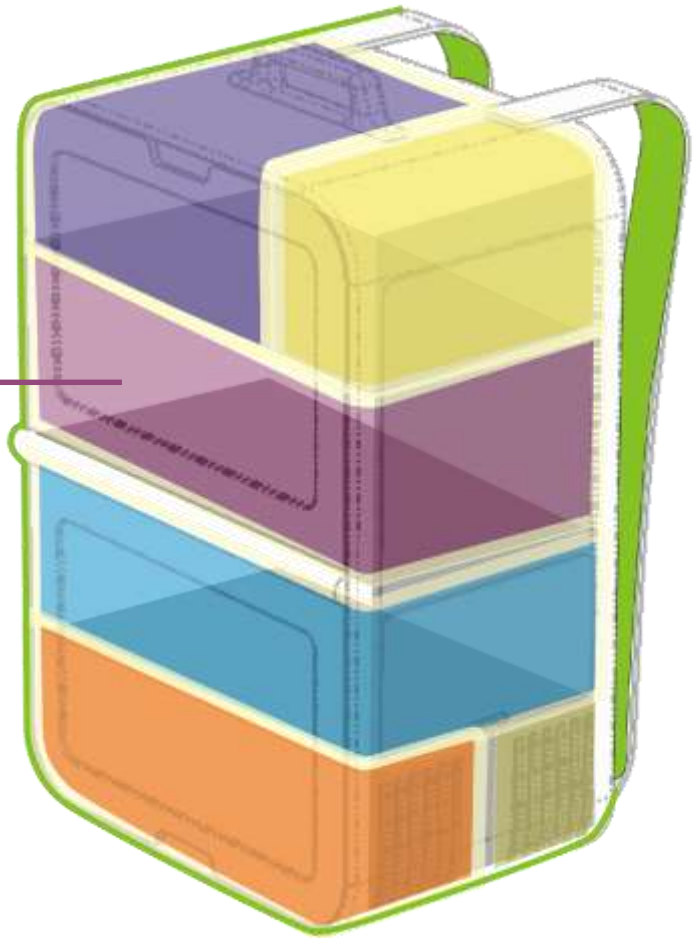
Battery Pack



4B. How it Works: Patient Pill Box

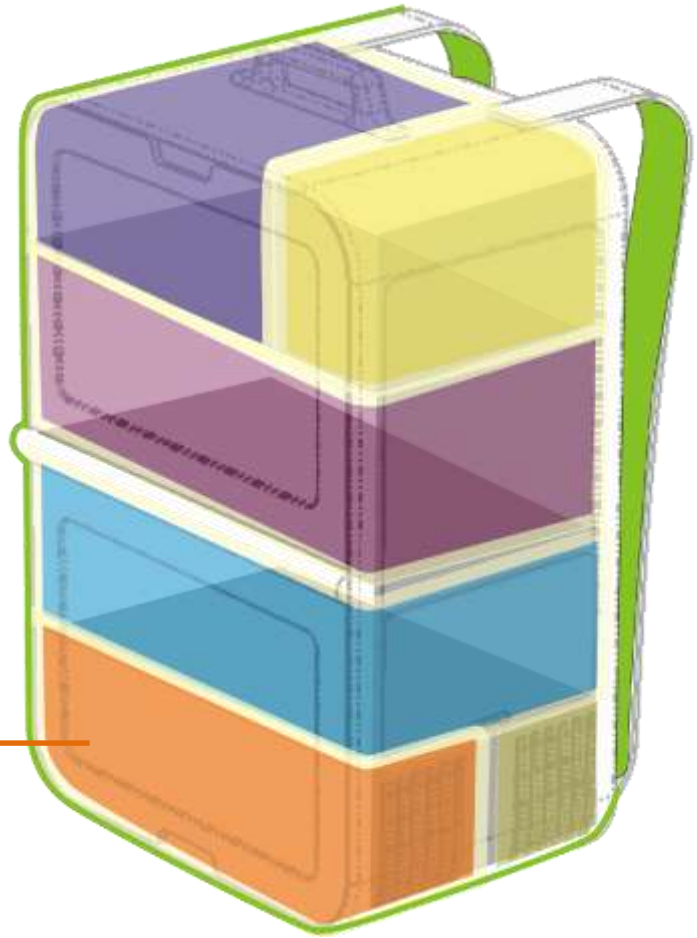
G31 M **Metformin** 500mg
Twice daily. Take with food.

TEST	2/2015	5/2015	8/2015	11/2015
FBS	142	122	127	
PPBS	173	152	158	
BP	152/95	140/80	140/90	



Sukh Pill Box and Pill Calendar is a personalized medication system for illiterates and neoliterates. Sukh Pill Box provides patients with daily dosage forms. Sukh Pill Calendar keeps track of the diagnosis (BP and Diabetes), medication supply, and other related health care information.

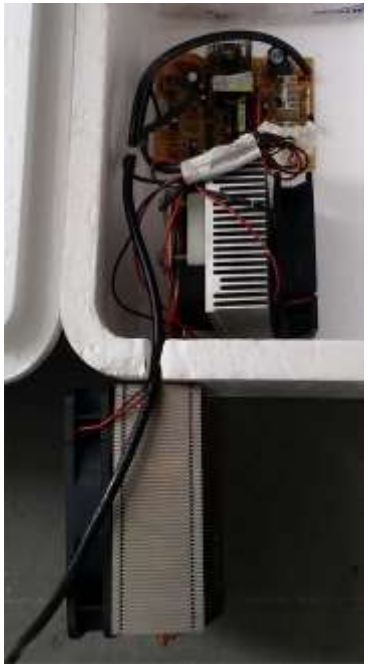
4B. How it Works: Cold Storage Unit

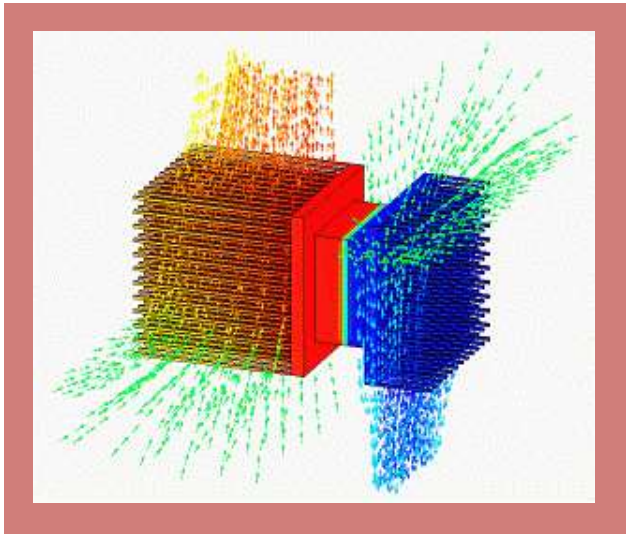


Uses both the thermoelectric system and gel/ice packs for optimal temperature management.

4B. How it Works: Cold Storage Unit

Thermoelectric devices operate by the Peltier effect. When DC current flows through the device, a HOT junction and a COLD junction are created. The hot junction is attached to a heat sink, often with a fan to blow hot air away from the device as exhaust. The cold junction may have a fan to re-circulate the cold air in an insulated container, thereby steadily reducing the temperature in the container.





Thermoelectric cooling. (2015, July 21). In Wikipedia, The Free Encyclopedia. Retrieved 16:45, August 15, 2015, from https://en.wikipedia.org/w/index.php?title=Thermoelectric_cooling&oldid=672411940

4C. Performance: Cold Storage Unit

Thermoelectric System

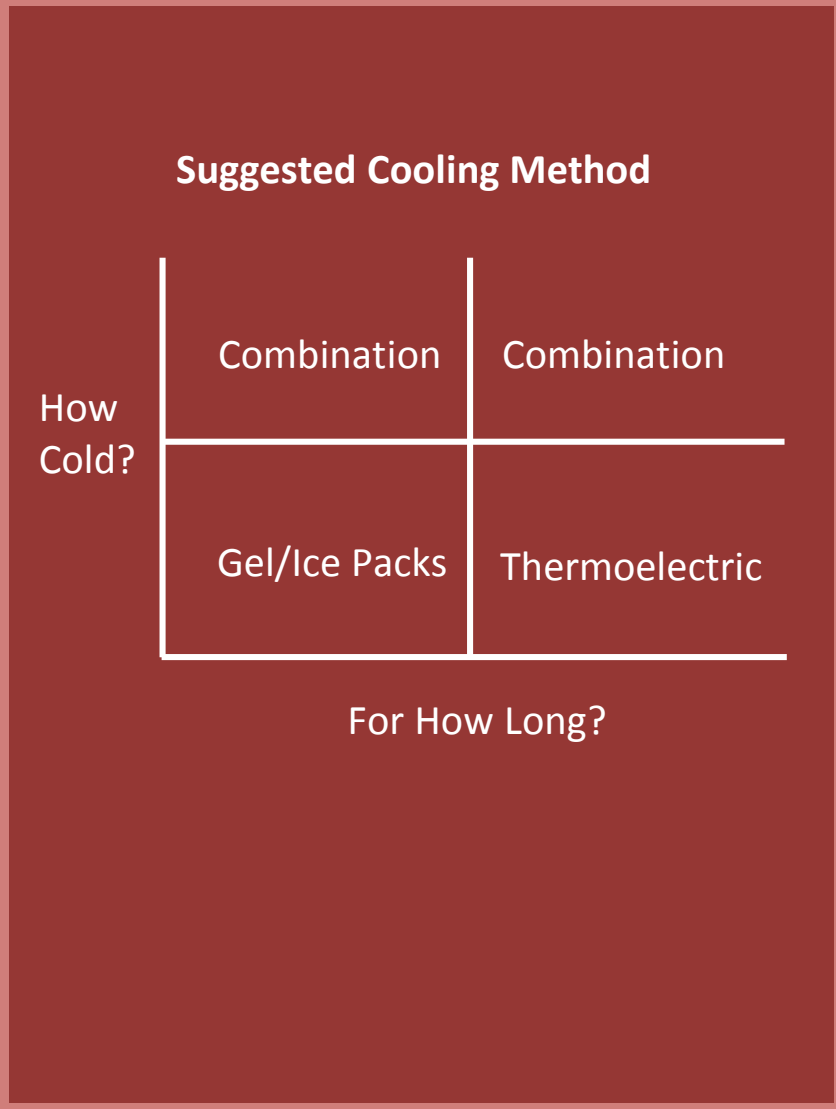
- Easily maintains 15-25 ºC temperatures when powered by battery
- Simpler, cheaper, and lighter than other electric-powered solutions
- Slower and requires more power than gel/ice packs

Gel/Ice Packs

- Easily available and usable
- Do not last long enough for certain use profiles

Combination

- Uses both the thermoelectric system and gel/ice packs for optimal temperature management



4D. List of prototyping Materials

- 1 Suitcase
- 2 Foam Shoulder Straps
- 3 Thermoelectric Cooling Unit
  - 1 Thermoelectric Cooler
  - 2 Heat Sinks
  - 2 Fans
- 15 Medical Tablet Containers
- (cardboard)
- 5 Medical Liquid Containers
- 6 Wall partitions (PU foam)
- 2 Inch thick PU foam insulation
- First aid kit
- 8 rivets for strap mounting on bag

4E. Analysis and Experimentation

We performed a variety of experiments, some of which included testing to determine what cooling method would be best, what delivery box strap positions were most comfortable, and what size delivery box was needed for our idea to make financial sense.

Regarding the size of our delivery box, we obtained samples of the relevant medication that our target patients needed, and then calculated the dimensions that would be required for a patient Pill Box. We multiplied this out by the number of patients that needed to be visited for our idea to be viable, and were able to determine a rough minimal size for our delivery box.

Regarding the strap position, we simply used push pins to place the straps at different locations, and then wore the delivery box to see how it felt.

4E. Analysis and Experimentation

Within our delivery box, there was a need for a temperature controlled storage space (for insulin vials, blood samples, etc.). For this, some of our preliminary analysis revolved around what type of cooling system to use. We considered gel/ice packs, evaporative cooling, solar-powered cooling, standard condenser refrigeration, and thermoelectric cooling.

Gel/ice packs function well if the container has good insulation and if the care provider has the habit of closing the lid properly after each delivery. However, the required insulation would have made our delivery box much more bulky, and we knew that care providers often left their cold storage containers unsealed, thereby greatly reducing the amount of time that the cooling effect would last for.

Evaporative cooling was dismissed fairly quickly as it required water and particular environmental conditions, which would make the unit less effective and less mobile.

4E. Analysis and Experimentation

Solar-powered cooling was also dismissed fairly quickly, as we expected our delivery boxes to be transported by two-wheelers, and thought that solar was not durable enough. Cost was also a concern.

Condenser refrigeration was dismissed due to the size and weight that such a refrigeration unit would require. Our goal was to make a small and safe cold storage unit. Cost was also a concern.

Thermoelectric cooling seemed to be the best option because it was simple technology that was solid state, light-weight, low-power, and comparatively cheap. It was also readily available for testing, as we were able to source a unit fairly quickly.

4E. Analysis and Experimentation

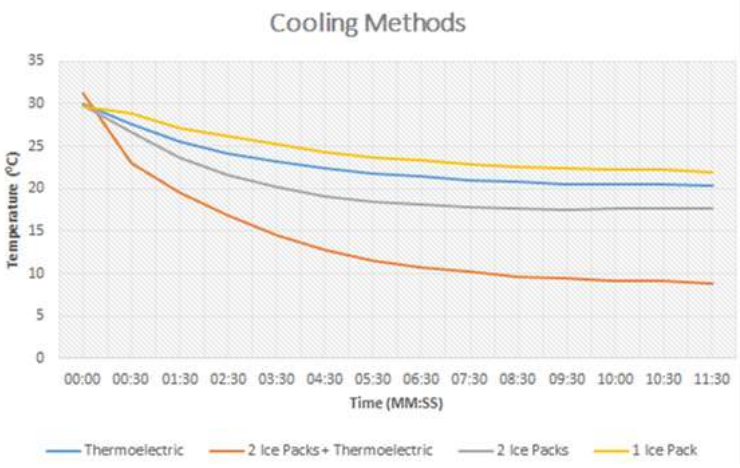
Most of our experimentation revolved around the thermoelectric unit. Our ideal temperature range was 15-25 ºC, which was cold enough for storing insulin and blood samples.

We found that two ice packs could maintain the temperature at ~11 ℃. However, it took a long time to reach this temperature, especially if the container was opened on a regular basis. Our experiments included the container being opened every 30-60 seconds for a temperature check, which actually caused brief temperature rises because cold air escaped the container. This resulted in a stable temperature of ~17.5 ℃. One ice pack could maintain the temperature at ~19 ℃, but due to regular opening, had a stable temperature of ~22 ℃. Thermoelectric cooling had a similar stable temperature of ~20 ℃.

Although these results were satisfactory for short deliveries, we recognized that gel/ice packs lose efficacy over time. This loss was important to consider for long delivery times of 6-8 hours.

4E. Analysis and Experimentation

Consequently, it was important for us to have a cooling system to supplement the gel/ice pack solution. Thermoelectric cooling was the answer, since it could also be used alone for short deliveries, but was especially useful for long deliveries because it was electric-powered and did not lose efficacy over time. In combination, the thermoelectric unit could take over the loss in efficacy of gel/ice packs, and also make up for the cooling loss each time the cold storage unit was opened. This could easily result in temperatures of ~9 ℃, which are actually not too cold. Still, the thermoelectric unit could be turned on and off (automatically or manually) as needed to maintain an ideal temperature.



5. Lessons Learned

A. Community Engagement
B. User Feedback
C. Troubleshooting

5A. Community Engagement

To engage people in Kumuzhi and Karanai Puthuchery, we relied on an established community contact, who introduced us to community leaders and other stakeholders. We were able to interview these people and make contextual observations.

One community that we engaged with closely was a National Rural Employment Guarantee Scheme workgroup, because we found many people who lacked transportation and previously had trouble accessing the health system. We interviewed many individuals there, sometimes using sketch models to gather more feedback.

5A. Community Engagement

Another community group that we spent time working with was a youth group which consisted of young men in Karanai Puthuchery, who were between the ages of 16 and 30.

Our initial meeting with the group was an unstructured interview with the entire group, which ended with a friendly game of carrom.

In our second meeting with the group, we broke them up into smaller sections and used sketch models to learn how resources in the village could be used in different health scenarios.

5A. Community Engagement

The next day, we ran a community presentation, and took the large group of community members present there as an opportunity to run a focus group. In addition to the focus group, we conducted a group survey to understand the health conditions that were prevalent in the community.

Concurrently, we used a sketch model to assess aspects of trust in the community. We ran this session separately, with two Tamil speakers and two English speakers, so that the interview could move fluidly with one English speaker taking notes and another English speaker facilitating the conversation.

5B. User Feedback

When interviewing and working with people, it was difficult to keep the conversation focused on chronic disease management or delivery services. Most, if not all, of the people we interviewed viewed healthcare episodes as a single interaction or sickness -- which is a big gap between how care is managed and what actually happens.

Additionally, many community members could not imagine receiving care or health education from anyone but a trained medical practitioner. This showed us the trust issues related to healthcare that were prevalent in the communities.

Our team decided to answer this feedback by including an educational component in our system, as well as by providing transparency to the community, and training for the local care providers.

5C. Troubleshooting

For the cold storage unit, we had to troubleshoot the quality of our insulation and the proper air flow for the thermoelectric system. Our initial prototype was built with cut and taped pieces of low-quality insulation. This led to unnecessary loss of cold air, and therefore barely adequate temperatures. We subsequently replaced the initial insulation with a fully formed high-quality insulating container, which produced much better temperature results. As for airflow, it took a few tests to realize that we weren't getting proper airflow for the unit, and had to cut holes in our initial insulating structure to get more accurate results.

Overall, we learned that our system design and product prototype needed field testing to more accurately gauge viability. Although lab tests indicated success for the cold storage unit, there was no way to lab test our system solution (apart from a successful role play of a basic medical encounter). The system solution will require field testing and adjustment going forward.

6. Next Steps

A. Reflections On Project Viability and Other Design Opportunities
B. Continuity/Dissemination Model
C. 6-Month Plan & Team Engagement
D. Anticipated Risks & Challenges

6A. Reflections on Project Viability and Other Design Opportunities

We were able to obtain satisfactory results for the cold storage unit in our preliminary prototype. Depending on the intended use profile (making a few deliveries vs. delivering medicine all day), gel packs and thermoelectric cooling could be used alone or in combination to achieve the required temperatures. However, these temperature results would need to be maintained in further prototypes that integrated a battery, an exhaust interface, and insulating doors. Based on other already-existing products, we are confident that our cooling system could maintain such temperatures in further prototypes.

As for viability of the system in general, it is hard to comment. The system still needs to be tested, and may need to be modified as we observe how the communities adopt and respond to the service. We believe it is important to tackle the information gap related to the targeted diseases, so our system will remain focused on that, but we understand that some flexibility may be required.

6B. Continuity/Dissemination Model

Continuity will be maintained through a continued relationship with BSAU and HIVE InnoSpace, where there are abundant resources to continue the prototyping process. Team members that are not local are also willing to contribute by advising and doing research.

As for dissemination, the plan is to test the system in the communities where we have established relationships and where there is already considerable buy-in. From that point, we will be able to contact other villages and describe the service to them, and should have at least one driver with the ability to deliver medicine and diagnostics to those villages. The crucial step to move into these villages is to find the target population and to teach them about the service. This will require leg-work, but we believe will ultimately be successful with positive recommendations from our first communities.

6C. 6-Month Plan and Team Engagement

Some members of the team are interested and able to continue working on this project. As of this writing, we are expecting to receive a few design reviews and to proceed by making any necessary adjustments.

Our plan is to prototype the exhaust interface of the cold storage unit with the delivery box itself. In parallel, we plan to prototype the battery interface with the cold storage unit, and the doors of the delivery box to make sure that the seal for the cold storage unit functions as required.

After that, it will be a matter of deciding where to source materials and components, to start establishing all relevant processes, and then to launch the system as a business.

We expect that the prototyping will take roughly six months, followed by another six months of setting the stage for a service pilot.

6D. Anticipated Risks and Challenges

One challenge we anticipate is in moving forward with the prototyping, since some of the required skills may need to be learned. However, BSAU and HIVE InnoSpace have many resources to help with this, and we hope to take advantage of those resources and the expertise there.

The biggest challenge that we anticipate, however, is in community adoption and actual use of our system. This is because behavior change is hard to accomplish, especially when there are trust issues involved. Although our system is designed to increase patient knowledge of their condition and to increase trust in the provided medical care, it is unclear how readily such a solution will be adopted.

We believe that the relationships our team established with key stakeholders in both communities will help us overcome this challenge. We hope to have successful launches in these communities that will allow us to test and improve the system as we move forward.

7. Team Members + Points of Contact

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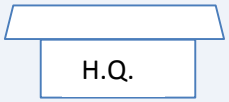
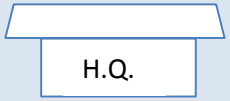
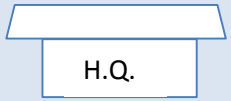
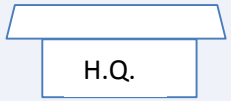
8. Appendix

The Care Process

Stages	Location	Tools
Stage 1: **Patient Initiated Hospital Visit**		Standardized Patient Prescription Sheet
Stage 2: **Care accessed**		Checking of standardized Patient Prescription Sheet
Stage 3: **Identifying Patient**		- Telephone - Checking of standardized Patient Prescription Sheet
Stage 4: **Confirming Identification (Information Verification- Telephonic)**		- Telephone - Location maps
Stage 5: **Location Identification and Visit Planning**		- Checking of standardized Patient Prescription Sheet - Sukh Delivery Box

The Care Process

Stages	Location	Tools
Stage 6: Preparing Box and Pre-visit Prescription Verification		- Checking of standardized Patient Prescription Sheet - Sukh Delivery Box
Stage 7: Confirming Identification and Prescription Verification		- Standardized Patient - Prescription Sheet (Sukh and Patient Copy)
Stage 8: Delivers Care		- Standardized Patient Prescription Sheet (Sukh and Patient Copy) - Sukh Delivery Box
Stage 9: Confirms Follow-up Appointment		- Standardized Patient - Prescription Sheet (Sukh and Patient Copy)