Final Report

MedEasy Team

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1. Background

1.1. Situation description

Our MedEasy system is intended to directly serve the needs of our partner in Cambodia, the One-2-One Charitable Trust. This organisation focuses on improving the lives of the most unprivileged groups in Phnom Penh, and one of the ways it does this is by providing free healthcare services directly in the slums.

In these mobile clinics, medical team from One-2-One travel in between a number of slums providing regular health consultations to people in need. These mobile clinics follow a regular set-up, regardless of the slum or location the staff may be working on. The clinic uses a 3-station arrangement formed by triage, consultation and pharmacy. Patients flow through these stations respectively. In triage, the nurse identifies the patient, retrieves the patient's medical history and carries out the initial physical examination. Furthermore, the patient's chief complaints are recorded at this stage. Later, in consultation, the patient's disease history is examined, and medicines are prescribed. Finally, the patients go through the pharmacy station to receive specialised care (like physiotherapy) and the prescribed medicine.

The goal for MedEasy team is to improve the efficiency of the healthcare service, enhance the effectiveness of patients data transaction and data usage and explore the possibility of data analysis with applying our designed solutions.

1.2 Problems

One-2-One is still using paper form to record patient's main information and diseases history. This paper archive, however, has proved itself to be very troublesome for the medical staff. This is because One-2-One commonly deals with patients that have chronic diseases and require frequent medical attention. This means that the archive soon grew to a size that was both too big

and too heavy to carry comfortably into the slums. When noting this, it is important to bear in mind that the slums are located in the suburbs, in zones with difficult access; as such, minimising the material needed to bring into the mobile clinic is, and has always been, a top priority.

Furthermore, the usage of these paper files has become an obstruction to a smooth workflow in the clinic. In order to provide an adequate treatment, the doctors must be able to quickly refer to the patient's history and past diagnosis, something which is quite difficult to achieve with a paper-based database. The retrieval of information from these records is time-consuming (on average 2 minutes) and prone to failure: the records may get damaged by human miskept and during transportation; these may also be misplaced or damaged in the Cambodian unpredictable rainstorms, which ultimately leading to a potential misdiagnosis. These shortcomings are critical, for the consequences of such mistakes have the potential to be life-threatening.

1.3 System's development

To tackle with this issue, MedEasy team decided to launch the Electronic Medical Record system (EMRs) which aims to replace the paper-format patient archive with three-fold deployments: EMRs software apps development, EMRs hardware support and biometrics identification iris scanner. So far, SIGHT has been collaborating with One-2-One for four years, which has allowed the MedEasy teams to develop the project significantly. The EMRs proposed has undergone several, thorough improvements in the form of yearly iterations.

On the first iteration, deployed during June of 2015, the record system developed was laptop based, with the aim to replace the paper file completely. During this first run-through, the information storage and organisation procedure proved to be quite effective, demonstrating a significant improvement from the paper version. Nevertheless, the progress of the deployment was hindered by both technical and social issues. The computers used in the system were obtained through donations, and the units received happened to be slow, heavy and bulky, and their battery life failed to meet the clinic's needs. Furthermore, when the laptop and paper

version were tested on a side-by-side comparison, the computer system was characterised by a longer set-up time, and could not be confidently relied upon due to the extremely unreliable network connection in the rural areas. On the social side, the people in Cambodia, as observed from the volunteers working with One-2-One, encountered difficulties when handling computers, but felt more comfortable with the operation of smartphones, thus clearly portraying that the hypothesised acceptance and adaptability rate for the laptop solution was slower than initially expected.

Additionally, the 2015 team made use of a fingerprint scanner connected to the laptop as means to identify the patients. Due to cultural factors and other customs, the people in Cambodian slums do not have ID cards of any sort, and as a result of their low educational level, they also struggle in remembering personal information such as, but not limited to, the spelling of their names or their date of birth. This proved an additional challenge for the doctors, considering that without such identifying elements, they would be unable to tell whether a particular patient had visited the clinic before or not, and if he/she had, it would be impossible to identify which record corresponded to the patient. The fingerprint scanner was the method chosen to tackle this issue. Nevertheless, it was unsuccessful for the team failed to realise one of the key characteristics of the people living in the slums: due to their jobs being manual in nature, their fingerprints were damaged, making them unreadable to the fingerprint scanner. As such, the fingerprint scanner was eliminated from the design.

On the second iteration, implemented during the summer of 2016, the team developed a mobile version of the software, which was in itself an adaptation from the earlier laptop version. This year's team also developed a mobile kit composed of a Raspberry Pi computer unit, a router and a power bank to power the mobile clinic on a local server, thus eliminating the reliability issues associated with an unstable internet connection. This mobile system made use of Android app that worked in the same way as the clinic, following the triage - consultation - pharmacy workflow. Moreover, a medicine inventory tracking function was implemented into this version, for this was one of the major problems identified by the team. Even though the team had

designed a very thorough implementation plan, the app had been developed too quickly and was too unstable. After several months of operation, One-2-One's staff decided to revert back to the paper system, for the software was still in early stages and could not be relied upon.

On the third iteration, improved during the summer of 2017, the team further enhanced last year's mobile version software and also refined the portable kit. The apps worked pretty smooth during the first month of application. Unfortunately, the synchronization failure in the cloud server and the apps repeatable bugs stopped the medical team use the apps and the team reverted back to the paper system.

1.4 Progress of the project

After the first three iterations, and further basing on the feedback from April trip, the MedEasy team has made significant strides in improving the EMRs for One-2-One. This year MedEasy team redesigned the structure of the mobile apps with assistance from our software expert, Mr. Kristopher Lam since the app from last year was beyond repair. At this current stage of time, our mobile app is more intuitive with high consistency and better user interface. In the new version app, we strive to make it flawless, which mean no bugs and have implemented many desired features, such as easy data synchronization and a seamless data input experience. Later on in the report, detailed information regarding such renovation is further specified.

Furthermore, during the time we stayed in Cambodia, and with the help of the medical staff's suggestions, we further expanded this list of the user needs, which include the following:

- Create a sustainable and stable mobile software platform
- Create a system capable of working reliably in rural areas (being protected against high temperatures and exposure to potentially damaging factors)
- Create a system that is both lightweight and integrated

- Create a system that is both easy in the input of data and efficient in its review and future analysis
- Create a system that is capable of recognising the identity of patients with an extremely high accuracy (99.5%) immediately
- Create a flexible system that can grow and change as the needs change

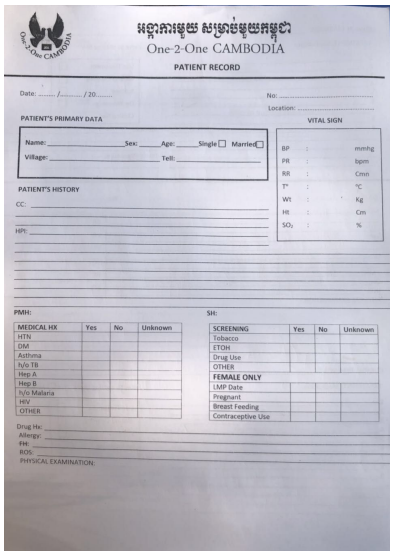
1.5 Objectives

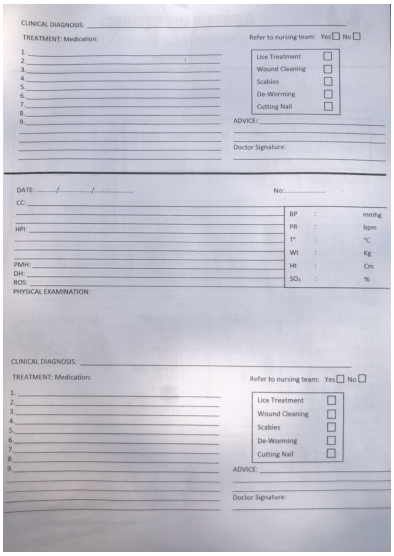
The aim of this project is to develop an effective and precise EMRs able to transmit the patient's information among stations and record them in the database securely. These will result in eliminating the staying time for individual patients, smoothing the communication among the medical teams and speeding the data abstraction and data analysis process. User-friendliness will be achieved by satisfying a few areas:

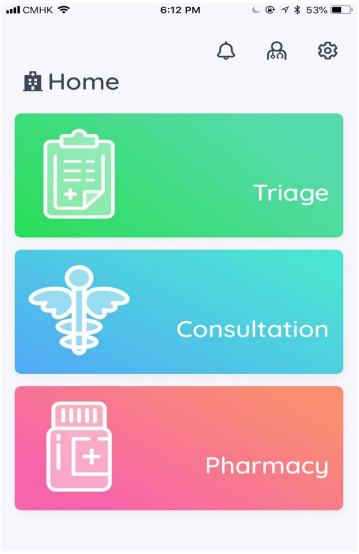
- The app must always work as expected, without crashes or shutdowns under any circumstance
- The app must be user-friendly, being both easily understood and managed by non-IT staff
- The hardware Kit must be very portable, lightweight, integrated, being able to be carried single-handedly
- The hardware Kit must be able to run for at least four hours (continuously)
- The hardware Kit must be easily troubleshot by non-IT staff (provided with relevant guides and information)
- The hardware Kit (with iris scanner) must be able to identify each patient's identity and retrieve the corresponding file immediately afterwards

2. Solutions and prototyping - Electronic Medical Record system

2.1 Software development: MedEasy Mobile App







2.1.1 Data flow

In the slum:

After medical staff user login, home page displays three stations block, namely Triage, Consultation and Pharmacy. User presses his own working desk correspondingly.

* (H) Human behaviour

* (S) System behaviour

The list present information collection in individual station:

Triage
Step 1: (H) Nurse writes tag number on patient's hand Step 2: (H) Nurse scans patient's iris with iris scanner

If the patient is identified as New Patient, nurse presses *Create Patient Profile*	If the patient is identified as Existing Patient, system pops up the patient's record.
Step 3: (H) Nurse takes picture of patient (optional) Step 4: (H) Nurse inputs patient's tag number	
Step 5: (H) Input personal information: Name, Sex, Age, Marital Status, Nationality	
Step 6: (H) Input *Vitals*: Weight, height, body temperature, blood pressure,pulse rate, respiration rate, SpO2, blood sugar,deworming	
Step 7: (H) Input *Chief Complaints*	
Step 8: (H) Input *Previous Medical History*: HTN, diabetes, TB, asthma, HEPA, HEPB, malaria, HIV	
Step 9: (H) Input *Screening*: Tobacco, alcohol, drug, others	
Step 10: (H) Input *Miscellaneous*: Drug history, family history, allergies, ROS	
Step 11: (H) Input Maternal (Female only): Pregnant, LMP, breastfeeding, contraceptive use	
Step 12: (S) System stores patient's information in local server and adds the patient into the queue for consultation room.	

All the information collected from triage will be synchronized in the local server Pi and transmitted to the consultation station once it is submitted.

Consultation
Step 1: (H) Doctor selects corresponding patient from the queue.
Step 2: (S) System displays all the information from triage.

Step 3: (H) Input *Patient's HPI*
Step 4: (H) Input *Physical Examination* or scratch it with *scratch pad*
Step 5: (H) Input *Prescription*
Step 6: (H) Input *Advice*
Step 7: (H) Input *Further Treatment*
Step 8: (S) System stores patient's information in local server and adds the patient into the queue for pharmacy.

All the information collected from consultation will be synchronized in the local server Pi and some of the important features will be transmitted to the consultation station once it is submitted, they are Prescription, Advice, and Further Treatment.

Pharmacy
Step 1: (H) Pharmacist selects corresponding patient from the queue.
Step 2: (S) System displays the prescription, advice, and further treatment information from consultation.
Step 3: (H) Checkout the individual medicine once collected
Step 4: (H) Delivered the message of advice
Step 5: (H) Carried out the further treatment
Step 6: (S) System stores patient's information in local server and check the patient out of the queue.

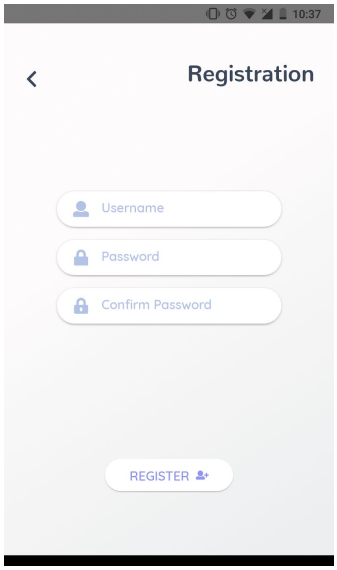
In the headquarter, medical team runs the synchronization function under the Wifi zone to synchronize the data in Pi to the cloud server.

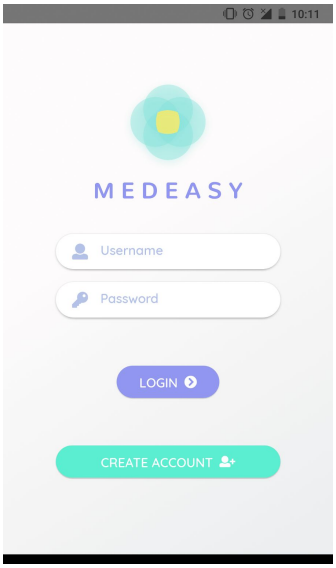
2.1.2 UI Design

As the implementation team of MedEasy, it was vital for us this year to create a flawless UI design that would improve the user experience by leaps and bounds, and so that the tasks should be easy and understandable by the users without additional trainings. Through numerous trials and errors, we reached our final prototype. One important element we kept in mind while design is that it should reuse internal and external components and behaviors, maintaining consistency with purpose.

Firstly, we identified the key attributes and the types of input in each station. Then we ordered the attributes into correct flows. We later designed the user interface with researching on the similar products/apps. After presenting to our end users and collecting their feedbacks, we revised the design and delivered to our programmer for coding the apps. Here we will present our journey of UI design:

A. Login and Landing Page:





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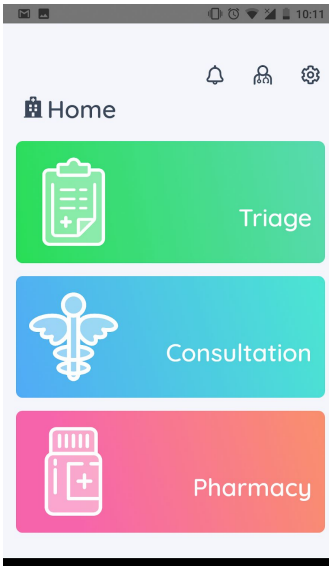
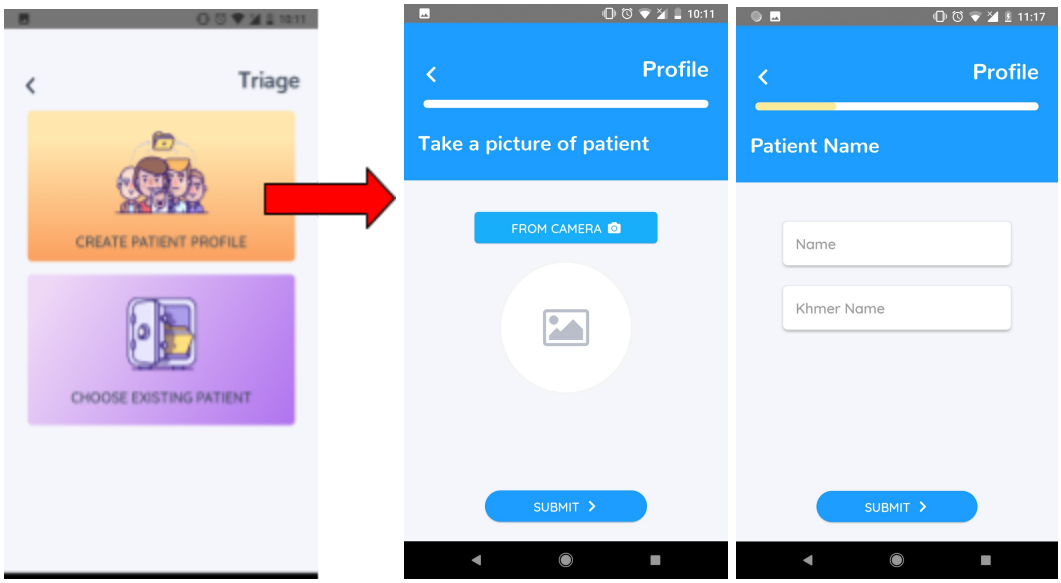


Starting with a very simple registration/login page, the app prompts the user to put in their credentials or create a new user account so as to access the app. This feature has been included to provide an extra layer of security to the sensitive data of patients.

One of the most important objectives of this year's app was to make the workflow more intuitive and basic than the one from last year. Although the app made by MedEasy '17 had already replaced the swipe and touch approach with a very user-friendly landing app, the landing page this year is more self-explanatory insofar it does not require any instructions on what to press to navigate to the required page. Starting from here to the whole app, the same approach was undertaken so that any user can open the app and be comfortable using it.

B. Triage:

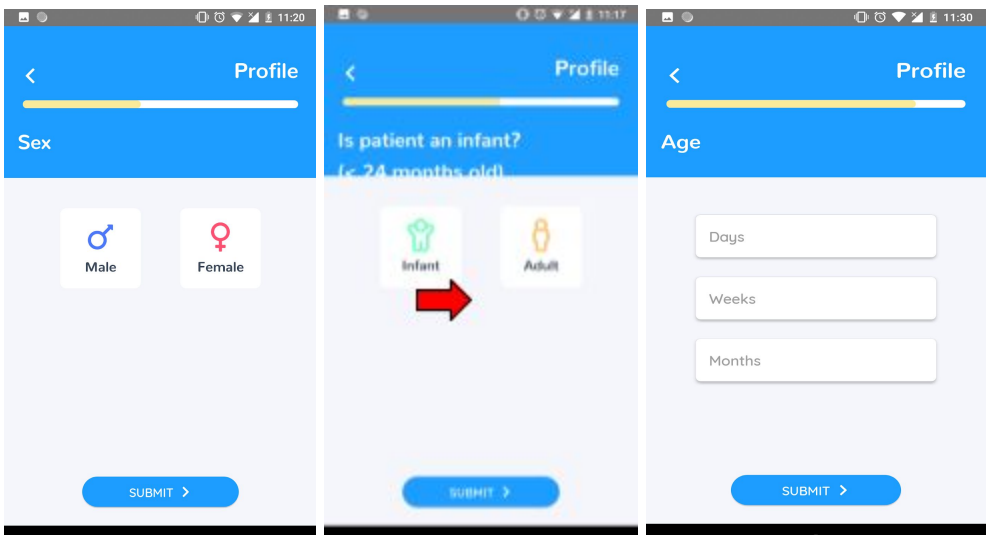


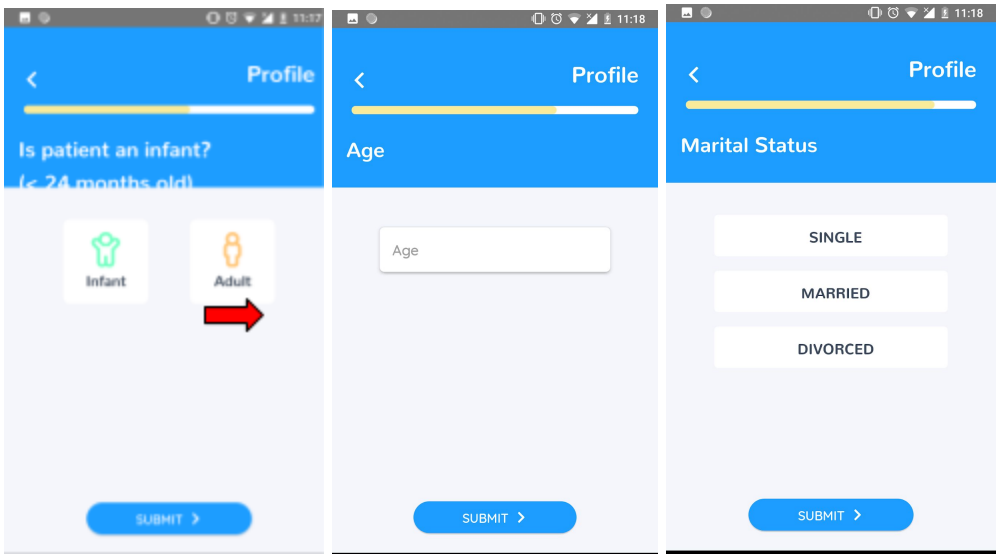
The triage being a vital part of the clinic, it was much required on our part to keep its workflow as simple and efficient as possible. Keeping that in mind, once the user is redirected to proceed from the iris scanner identification page, they will be prompted with two options- 1) Create a new patient, 2) Choose an existing patient.

B1. Create a new patient

For this option, the user would have to input information about the patient from the very beginning. The photo taking option has been included in this year's app so as to improve communication regarding a particular patient between each station during a clinic's session, as well as to have a backing option along with iris recognition for patient identification. However, this menu has been made optional for the user because some patients might refuse to have their picture taken. We also added the option of Khmer name because from the field reports we took during our trip in Cambodia in April, we noticed that doctors like to use both languages to input patients' names-this option is also meant to remove the discrepancy concern that last year's team had regarding the confusions in the language of the name.

Users require a simple swipe to navigate to the next page.

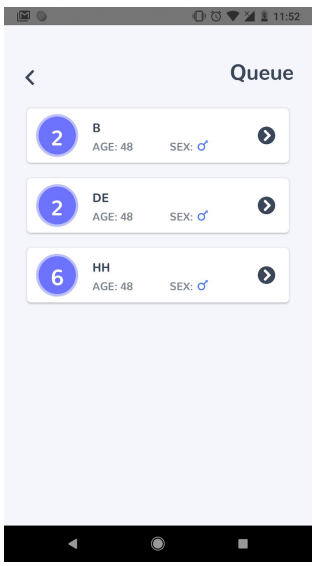


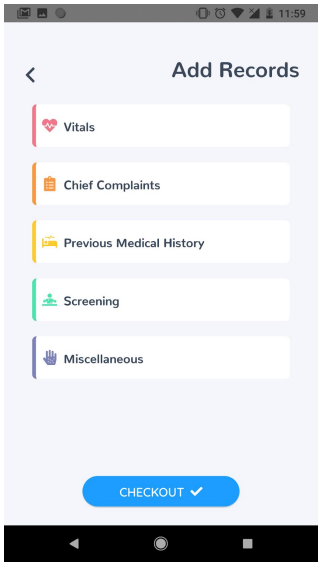


One of the issues that the doctors have at the clinic is to input the age of children under 2 years. This is why, the app this year has an option for the user to select whether the patient is an infant or not. The system will prompt the user to provide the age information in the format of Days-Weeks-Months if the patient is an infant, whereas for adults, only their age is required- thus making it much more easier for the doctors to get used to the app.
Pressing the "Submit" button on each page will make sure that the data is saved.

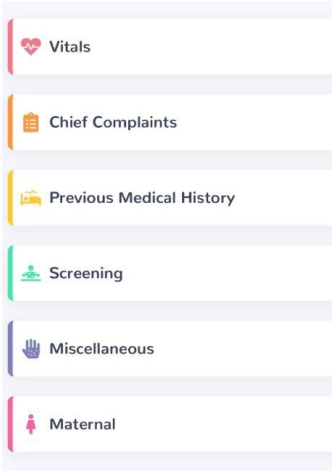
B2. Choose Existing Patient

On the other hand, choosing an existing patient will lead the user to a queue of patients waiting in line.

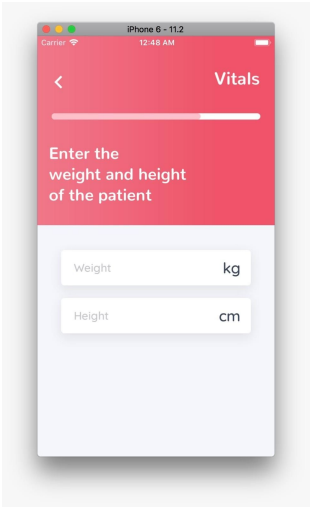


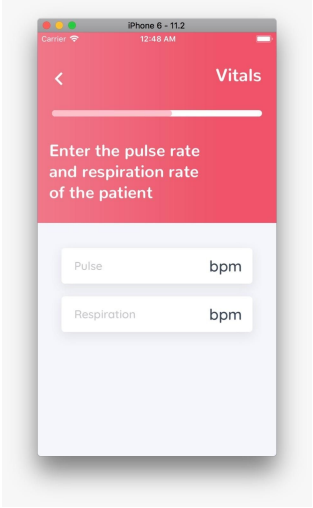


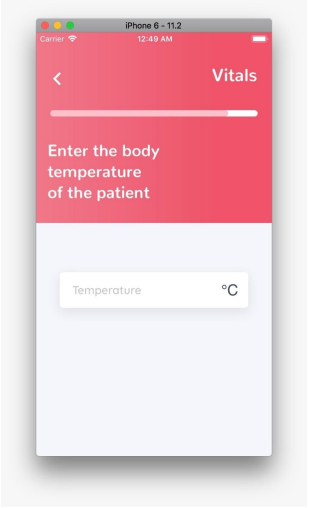
OR



Once a patient is clicked on, the system will show a list of options for the user to input in. The "Maternal" menu will only appear if the patient is female- since it contains information about gynecology and pregnancy.



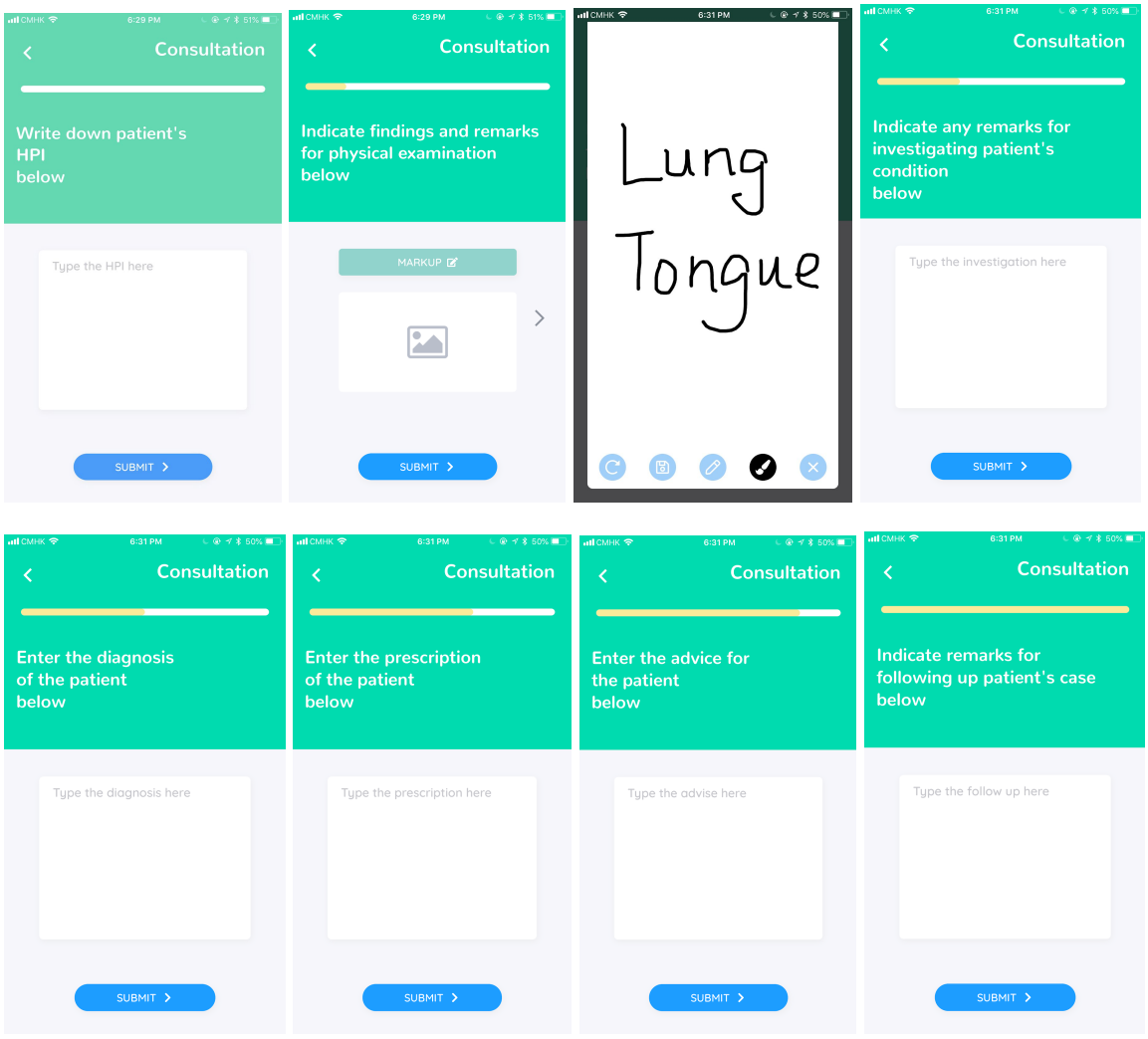




Compared to last year's app, each input option on the app has been made in a way that it takes minimum time for the medical staff to fill in, as this was one of the requirements of our partner. Like the previous pages, Vitals - CC - PMH - Screening - Miscellaneous - Maternal → has all been made keeping in mind the paper form the clinics were using so as to make it very convenient for them to switch from paper to the app.

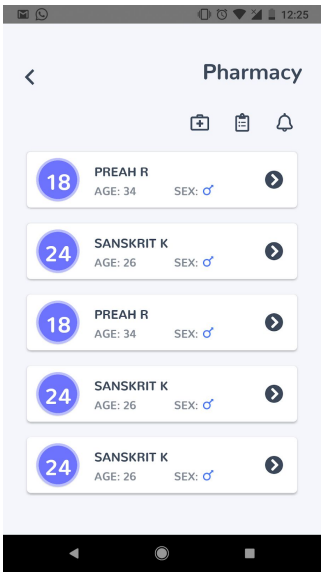
C. Consultation

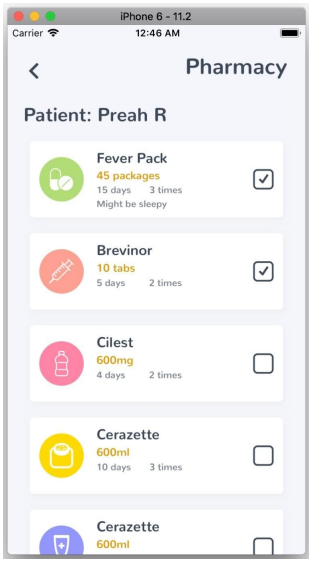
Current prototype:



Apart from the process indicating bar on the upper part, we offer the scratch pad for drawing the physical examination after feedback from April trip. The scratch pad provides full screen area and the pen with two colors which help doctors to mark down any special issues with physical examination.

D. Pharmacy

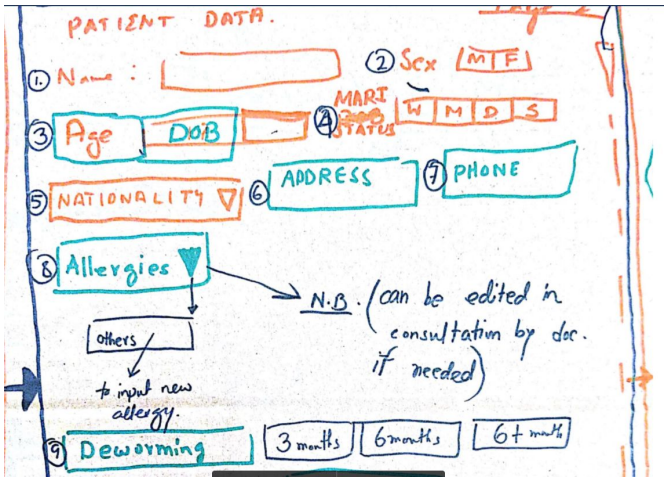


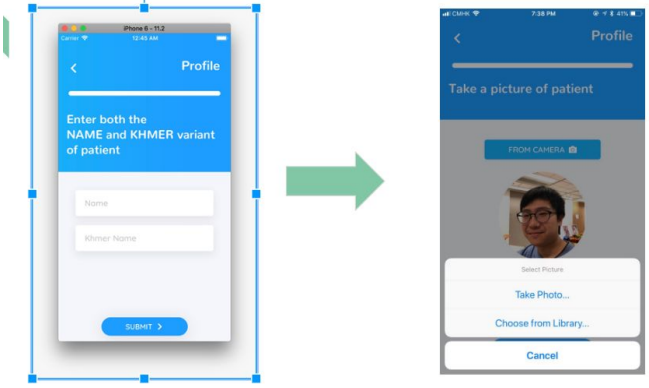
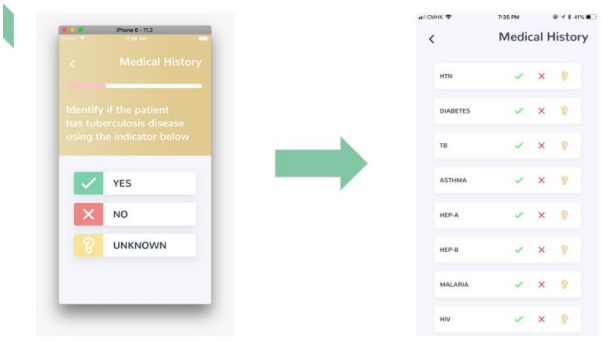


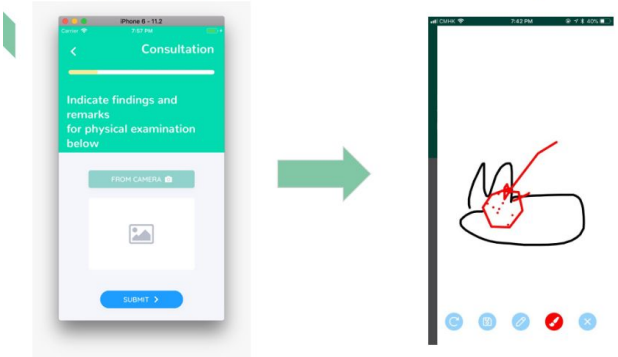
One of our aim in application design is that we aim to provide our partners a more focused design. Take pharmacy as an instance, in this context it means nurses in pharmacy station can trace which kind of medicine has already been distributed to the patient. In the previous year's model, the doctors as well as the nurses in the pharmacy had to input the medicines names manually, but in this year's app, we created individual identities of each medicine along with its quantity, time of intake, process of intake and more- so as to save time efficiently. The nurses at pharmacy can make use of a checklist to keep in mind which medicine they distributed already and which is yet to be distributed.

E. Gradual Prototyping and Journey of UI design

Using the previous year's app as a landmark of what we should change and what we should keep, we spoke to the doctors of One-2-One from February to April to gradually create a working app with features suggested by them, some ideated by us. After the trip in April, however, we decided to change a lot of the features. Here's an overview of the journey we had while designing the UI:

February 2018 onwards	 Created dummy designs on paper after several conversations with the One-2-One team. Having sent these to our software team, we received the app just before our trip to Cambodia in April. MEDEASY Because we felt the need of adding a very fundamental human factor to the design of our app that would some integrate the identity of Cambodia as well as the purpose of this app, we redesigned the

	logo of MedEasy keeping in mind the national flower of Cambodia- Rumdul. The four petals of the logo also means the three stations of the clinic added to the synergy that exists among them.
April 2018 onwards	After the trip, having received numerous direct and indirect feedback from the medical staff, we made a few major changes to the app: **Change 1: Add picture taking as first info**  **Change 2: Present the medical history in 1 page** 

	Change 3: Replace camera with Scratch pad  Other than these, we added the new "maternal" option. Because we think it was an important part for us to invoice all the necessary feedback between the software team and the users continuously, we made sure both stakeholders were aware of every change and requirement. This helped us make our design journey much more flexible and easier for everyone.

2.1.3 Server and database

In order to fulfil the objectives, various software frontend and backend technologies were used to create a simple and easy to use, yet powerful application for the staff at One-2-One.

Cloud database and server

The cloud database provides a reliable storage system in which to save the patients' files. Should the slum be placed in a location with good cellular receptivity, it may also act as the direct server of the system - when this is the case, the MedEasy kit is fully dispensable.

Local database and server

The Raspberry Pi 3 acts as a local server, embedded with a 32GB SD card used to store the patients' files. Similar in fashion to the cloud database, it both stores the data and provides a

communication linkage between the mobile devices at each of the stations - the Pi is powerful enough to handle quick data transmissions between the devices, and is power efficient enough to run the local server for more than four hours (the standard duration of a clinic session).

2.2 Hardware support: MedEasy Kit

A. Raspberry Pi

The Raspberry Pi 3 is a type of computer board and it works as a temporary server for the MedEasy. When One-2-One doctors go to slums, the phone cannot connect to the internet and synchronize the data to the cloud, so MedEasy team provide the portable server kit to One-2-One doctor and one of the main component of the kit is the Raspberry PI 3. The smartphone can connect to WiFi that emitted by the Raspberry Pi 3 and send all the data to the Raspberry Pi 3 to let the Raspberry Pi 3 store the data while doctors are working in the slums. Also, after the phone connect to the server, the Raspberry will also send the patient data to all the phone, for example, when the phone in triage station record the patient data, the Raspberry Pi 3 will receive the data record in triage station then the phone in consultation station can receive the data in triage station.

The hardware design of 2018 MedEasy team mainly follow 2017 MedEasy team's design. For 2017 Medeasy team, they are also using the Raspberry Pi 3 for the computer board in the MedEasy kit. This year, 2018 MedEasy tried to compare different computer board like ODROID-UX4, Undo x86 Ultra, ASUS Tinker board with Raspberry Pi 3, but 2018 MedEasy still decide keep using Raspberry Pi 3 this year. Since Raspberry Pi 3 is powerful and not too expensive, also the size of Raspberry PI 3 is acceptable, there are lots of open source for Raspberry Pi 3 in the internet, so we finally choose to use Raspberry Pi 3 for this year computer board. Also, Raspberry Pi 3 include router function so it is possible to remove the router in the kit in the future. The Raspberry Pi has the following specifications: 1.2GHz 64-bit quad-core

ARMv8 CPU, 1GB RAM, 4 USB ports, Ethernet port and a 32GB SD card used for storing data. After conducting field test with the Raspberry Pi 3, the Raspberry Pi believed can holds up to the standards and requirements.

B. Router

The router is an essential piece of the hardware set because it allows the different smartphones at each clinic station to communicate with the server and among each other. The most important parameters for selecting a router are then bandwidth (or “speed”) and range, which is how far away can a device connect to the router. While not affecting the bandwidth much, a router's antennas are important when it comes to range. External antennas (outside the main casing) allow for a better range, but make the router bulkier. However, given the fact that the clinic stations are close to each other and are not separated by any walls, the router doesn’t need such a large range, and weaker, smaller internal antenna routers could also be used. The team decided to opt for a mini travel router TL WR802n with internal antennas for its affordability and its size. This router has the same nominal bandwidth (300 Mbps) as the router used in the previous year, but to verify it had enough bandwidth to support several phones and enough range to provide a stable connection clinic wide, a range test was conducted in the lab,. Router range test For this test, 6 mobile phones were connected to the server simultaneously and the signal strength was measured at 3m distance intervals. No phone disconnected throughout the test, and connection was strong within the 0-6 m range which corresponds to the spread of doctors at a clinic.

C. Powerbank

A few considerations were taken when choosing an appropriate power bank. The power banks must:

- Allow 2A current load to support the Raspberry Pi at full CPU usage; and
- Have at least 12000mAh to support the clinic through its entire operation.

Given these requirements as well as budget constraints, last year’s team chose the Xiaomi 20000mAh power bank. However, although this particular power bank was good enough to serve the purpose, we realized we need a power bank with a digital screen so that the users can see the

remaining battery level in it without having to open the box and charge accordingly. For this, we switched to Pineng 20000mAh power bank.

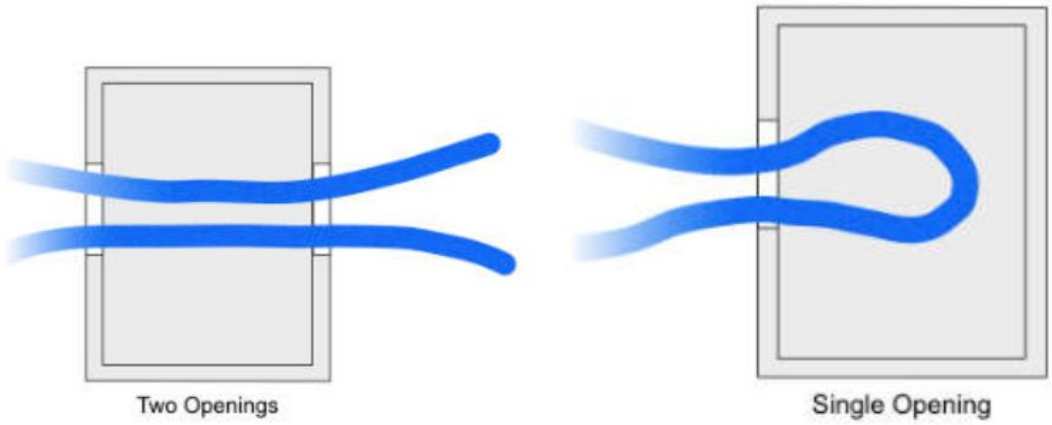
D. Thermal considerations (cooling system)

Overheating of the Raspberry Pi 3 is one of the most serious problem MedEasy team need to concern. The Raspberry Pi will stop responding when it meet or over 80 degree C and the chip dictated by both the level of activity as well as the ambient temperature so our target is to control the temperature of the chip under 50 degree C. There are mainly 2 cooling part in the MedEasy kit, one is cooling fan and one is heatsink and 2018 MedEasy team tried to improve last year cooling system design.

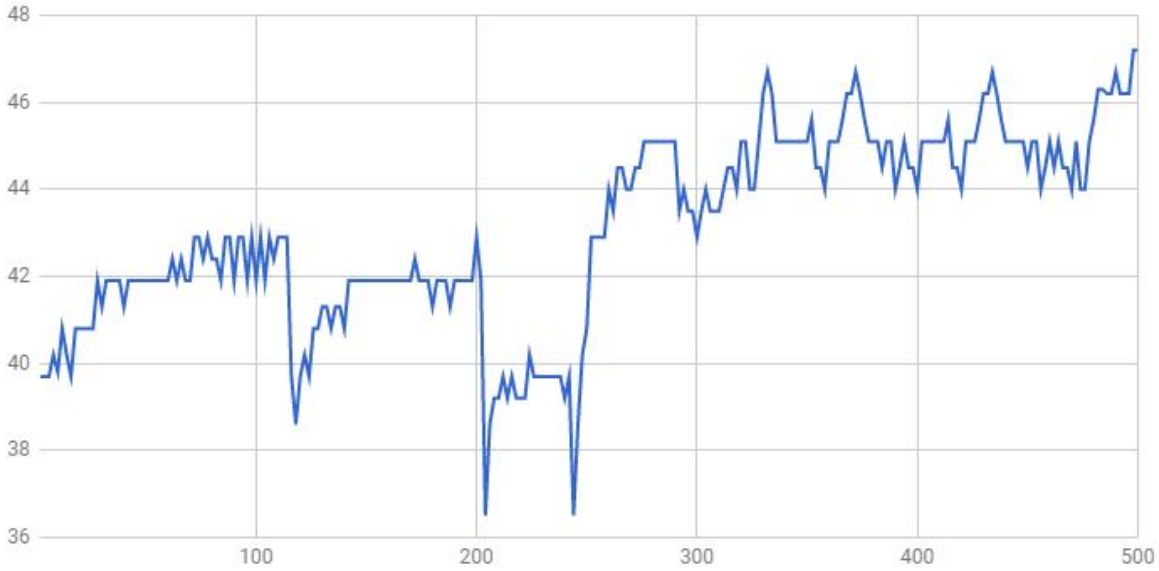
Using heatsink for cooling is kind of passive cooling method which don't spend energy and only depends on the surface area contact with the air of heatsink. It means using a larger heatsink can have a larger efficiency. The most important of using heat sink is choose an appropriate heat sink. Last year MedEasy team done a test on different material and size of the heat sink and they find out the big (28x28x20mm) aluminium performed the best on the long run. This year MedEasy team also have tried smaller heat sink, although it can control the temperature under 50 degree C, the heatsink last year used performed better than that, so the last year heat sink still chosen for this year.

For the cooling fan part which a type of active cooling method mainly include 2 components, one is cooling fan one is ventilation hole. The cooling fan connect to the Raspberry Pi 3 and get electricity from the Raspberry Pi 3. The cooling fan can force cool the chip on the Raspberry Pi 3

and let the cooler air get into the kit. Last MedEasy kit only have one ventilation hole on it but this year MedEasy team design to have 2 ventilation hole to have a better ventilation effect.



During the April trip, a temperature field test is done in the slum to check the cooling system can or cannot control the temperature under 50 degree C and the result is the kit haven't meet 50 degree C in whole work period and 2018 MedEasy team think the whole cooling system using now can meet our requirement and decide to use this system for the coming june trip.



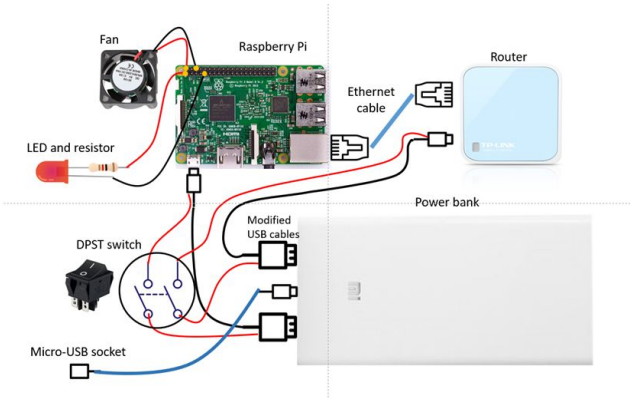
E. Power circuit design

For the circuit design, MedEasy team tried to design a circuit that the doctor don't need to open the kit unless there is problem. They can use the local server kit without connect the wire or need

to open each component separately.This year, 2018MedEasy team follow last year one-button design which the doctor only need to press one button to open all the component in the server kit and without open the box. The user never need to rewire the wire or take out the component.

Since the server kit have 3 main component, power bank, router and Raspberry Pi 3, we need to use a power bank that provide steady power output and 2 usb plug for Raspberry Pi 3 and router. This year, MedEasy team change the power bank from Xiaomi 20000mAh power bank to Pineng 20000mAh power bank and the reason is the Pineng 20000mAh power have the digital display which is one of the doctor requirement and when the doctor want to check the battery level, the server kit will not be shut down.

For the one-button design, there should be a switch connect the power line of the router and the Raspberry Pi 3, since the power bank should connect to 2 devices, a DPST switch is chosen for the circuit. It can connect to 2 devices and turn both devices on by only turn on the switch.



F. Pouch design

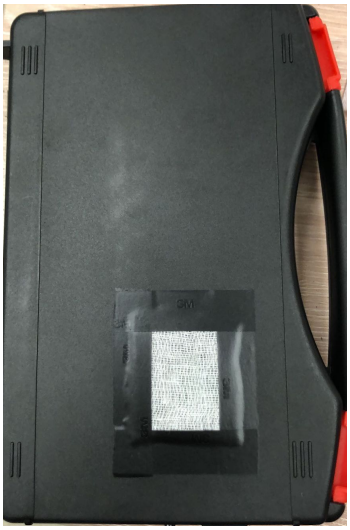
Because holes had to be made for ventilation on the case, the kit and its inner components became more susceptible to rain and dust damage. A water shielding pouch was designed to minimise such effects, and to facilitate the transportation of the other MedEasy accessories such as the iris scanner. Previously, the pouch was made of thin waterproof cloth which allowed heat to easily dissipate away from the box. This year, we changed the design using the double layers

of the same material- adding to it elastic bands and zippers to provide extra protection. However, later on, we decided to move on to a completely new design made of 100% polyester and polyethylene made bag with more ventilation and space so that the staff can store all their phones, iris scanner, keyboard the kit together.

Pouch from last year	 The problem with this was the minimum space to keep the scanner as well as zero protection on top of the box.
Our initial pouch design	 The problem with this was that the zipper on the side, although provided an extra layer of protection to the box, would accidentally cause the switch to turn due to being very fitting on the box

Final pouch design	 Finalized because of its size, compact style and fitting to our requirements for the box. The material itself is splash proof- thus making it safer to be used in adverse weather.

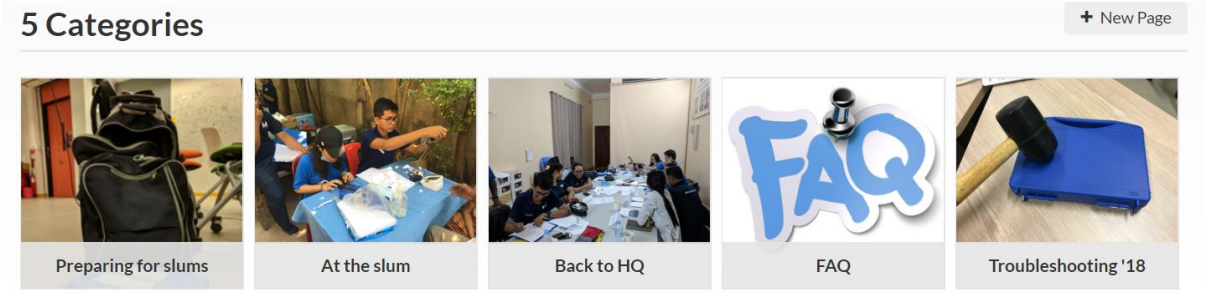
G. Journey of box design

Box design before April Trip		
		Problems: 1. Unstable network with Raspberry Pi emitting wifi 2. User cannot see battery level

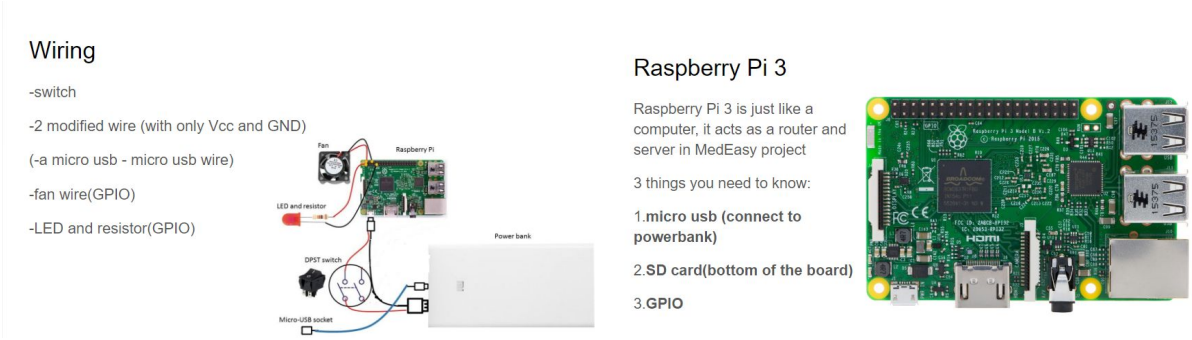
Box design after April Trip		
		Improvements: 1. Add back router for network provision 2. Use the power bank with digital display 3. Open a "window" to display the battery level directly

H. Contingency plan

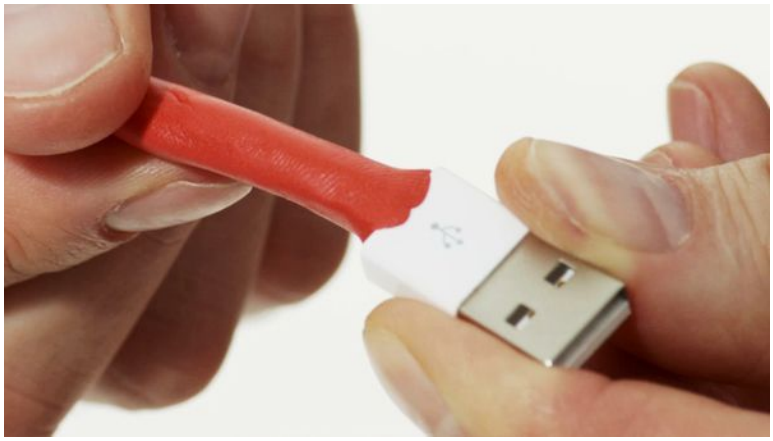
During the June trip, 2018 MedEasy team will give the final prototype which with the digital display of the battery level and teach the One-2-One IT nurse the method to fix the box and show the online manual to them. The online manual include FAQ and all basic information of each component



Apart from the online manual, MedEasy will also hold a basic tutorial class with the nurses and the doctors and teach them the basic contingency plan to plan. MedEasy team hope the nurse and the doctors can fix the whole kit themselves when there are problems.



2017 MedEasy also put a coloured tape on each wire to let the user can easier to fix the kit. However the tapes are easily to get off of the surface of the wire and the tapes are hard to see. This year MedEasy team tried to use sugru to colour the wire and cover the inner copper wire to prevent shortage. The sugru can protect the wire from bending and different colour of sugru can help the user to recognize the use of each wire and the user can reconnect wires by connect the wire to the plug with the same colour of sugru.



2.3 Patient identification: Biometric Iris Scanner

Having considered last year's solutions for patient identification, we ventured out to new possible products that might serve the purpose and perhaps be more efficient. One of the most viable solutions was a finger vein reader. This reader solves the issue of patient identification by capturing images of the vein patterns inside their fingers. These patterns (like other biometric patterns) are unique and, finger vein patterns are virtually impossible to reverse engineer and replicate.

However, this particular identification tool had two major problems:

1. Babies need to re-enrolled into the system every few months as their bodies keep changing, and so does something as internal as vein patterns
2. The app that comes with this device can only be run on a windows OS, whereas our app is on Android.

Hence, after much calculations, we decided to stick to the iris scanner from previous year:

Figure 7 Iris scanner working in slum

Considering the social context issues mentioned earlier, a biometric identification system had to be implemented to recognise the visiting patients. Biometrics refers to the unique physical characteristics that can be used for automated recognition, such as fingerprints. As the fingerprint scanner proved unsuccessful in the Cambodian context, the team chose iris recognition for the 2017 implementation trip.

Many doubts had been raised regarding the validity of iris recognition on cataract and pterygium eyes, as well as the eyes of infants and elderly. Fortunately, the team had the honour to consult an expert in biometric systems regarding the scope of validity of the iris technology. The team learned that, given the nature of the human iris and of the diseases that can affect it, the technology is applicable to people of all ages, and is guaranteed to work on pterygium eyes and cataract eyes that have an opacity of more than 50% (if opacity is less than 50%, the patient is considered blind, and One-2-One have notified of no blind patients in the slums).

Figure 8 Iris scanner and ergonomic goggle

After an extensive research on the available iris recognition technology in the market, the team decided to use the company IriTech's iris scanner of model IriShield USB MK2120U, which had been used for a widespread healthcare project in collaboration with the Government of India.

The field tests with the iris scanner proved remarkably successful. A vast amount of positive feedback was collected from both the medical staff and the patients, which greatly enjoyed the simplicity of the system. To further enhance the friendliness of the scanner towards the patients, the team developed a goggle which would allow the scanner to rest more stably on the patient's face, and which would, too, allow for a better alignment.

3. Implementation plan and Deployment Analysis

PHASE 1: APRIL

From the 2nd to the 5th of April, 2018, the MedEasy team travelled to Cambodia in its first implementation trip. The goals for the trip were set prior to the team's departure, and included the following undertakings,

1. understand the context and underlying factors that trigger the difficulties faced by One-2-One's medical staff;
2. collect vast amounts of information and feedback from the end users through focus groups and job shadowing;

3. comprehend the clinic's workflow and modify the system's software accordingly, and
4. test the reliability and resilience of the system and assess its long-term sustainability.

These tasks would enable the team to fine-tune the system to perfectly match the medical staff's needs and surpass their expectations.

The trip's main objective was dual in nature: the team would be able to both provide the medical staff an insight into the changes made and collect relevant feedback on the system's functionality and performance. This would allow the team to ensure an effective deployment of MedEasy when the team returns on the next implementation trip. Over the span of four days, the team planned the following activities:

· Observation of the workflow in the slums and in the clinic.
· On-field trial of system by MedEasy members.
· Training session designated for One-2-One medical staff.

Figure 1: MedEasy team with the One-2-One staff

DAY ZERO (02/04/18)

The team arrived to Phnom Penh in the evening. The next day's itinerary was finalised, and a small simulation of the medical staff's training session was rehearsed at the hotel.

DAY ONE (03/04/18)

The MedEasy team met up with the One-2-One medical staff for the first time in the main clinic. Some of our observations at the HQ are summarized below:

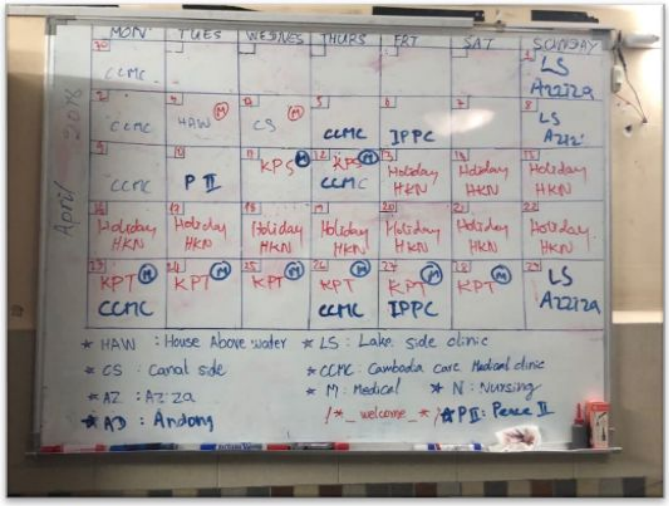


Figure 2: One-2-One's visiting schedule

One-2-One slum visiting team is composed of two full-time doctors, two to three nurses and one driver. The team goes to each of the seven service slums[1] twice a month. Each slum visit serves anywhere from 30 to 50 patients ranging in age from newborn babies to the elderly. Every slum visit involves the transportation of three folded desks, ten chairs, three large pieces of luggage (one for medicine, one for triage equipment and one for consultation equipment), two to five files of patient profiles and other medical items as need be; the items are transported with a van.

Figure 3: One-2-One slum arrangement

On day one, the MedEasy team met up with the One-2-One medical staff for the first time at the main clinic in downtown Phnom Penh. From there, the team was taken to the House Above Water (HAW) slum where they shadowed the medical staff in all the three mobile clinic stages

i.e. Triage, Consultation, and Pharmacy. While the medical staff used their paper forms to collect the patients' information, the MedEasy team replicated their annotations on the app. At the consultation stage, the team shadowed both Dr. Soursdey and Dr. Sokchan simultaneously.

With regards to the MedEasy system, while the server wasn't up and running, most features were functional. Despite the fact that the patients' data could not be stored, it was an adequate initial trial in a real-life setting, with an unquestionable didactic function. This initial visit allowed the team to gain a deeper understanding of the workflow through the ethnographic technique of participant observation. This, too, provided an excellent opportunity to collect valuable field-notes and make important observations regarding the functionality of the MedEasy EMRS when assessed on a side-by-side basis with the existing paper file. The following observations were made:

TRIAGE:

- Total time taken by medical staff to record a new patient's information on paper: 2 minutes, 35 seconds. Total time taken by MedEasy team to record the same information on the app: 1 minute, 59 seconds.
- It is important to note that the Chief Complaints section was placed in the consultation menu, the staff inputs this information in Triage. This is a fundamental difference that will be corrected.

CONSULTATION:

- Dr. Soursdey, like other doctors, sometimes likes to draw pictures of the affected body part when completing the Physical Condition section; these drawings provide a further explanation to accompany the written comments.
- It is important to note that the Sugar Level section was placed in the Triage menu, yet, when the number of patients is high, the staff tends to add this information in Consultation. This is a fundamental difference that will be corrected.

- Both doctors revisited the Patient Medical History and Social History sections as recorded in Triage, and rechecked with the patient if required.

PHARMACY:

- Medical staff at Pharmacy takes the prescription as written by the doctor and prepares the medicines for the patient.
- Each doctor uses a slightly different prescription format from each other.

Figure 4: Triage and Consultation session at House Above Water

Once the slum session concluded, the team returned to the One-2-One headquarters to carry out the training session for the medical staff. This training was designed to equip the team with the knowledge and skills necessary to be able to handle the MedEasy system proficiently.

The training session integrated both a formal presentation and a hands-on simulation phase. The workshop begun with the formal presentation, which focused on the technical details of the system. Nevertheless, and to make the whole session more interactive, two rounds of didactic games were played with the staff members:

The first game took the format of a quiz - both the MedEasy team and the medical staff participated by answering short questions about the MedEasy system. This game helped the doctors learn more about the brief history of MedEasy, but also served as an ice-breaker to become more comfortable with the 2018 team.

After the ice-breaking round, the team reviewed the hardware box and showed the staff how to operate the hardware kit in its entirety: how to switch it on, how to connect to WiFi on the phones and showed them how one of the newest features of the hardware kit of this year is how we were able to remove the router from the kit and emit the WiFi instead through the Raspberry Pi. Then, each medical staff from One-2-One were assisted by MedEasy members to use the app, and understand the complete workflow. Due to the app being very intuitive, it took them a short while to understand and get used to the new features. As they got their hands on the app, the immediate feedback from them was very positive, along with a lot of suggestions- like moving the CC to Triage. Once they showed they were ready to use the app, we played another game.

In round 2, two members from the MedEasy team acted out as patients and the medical staff were broken down into two groups- one who would use the app and the other who would use the tradition paper forms and go through the whole process from Triage to Consultation. The main aim of this game was to both help them practically get equipped with the app and also evidently show them that in a practical setting it takes less time to use the app than the paper when consulting the same paper. The app team won by a margin of 20 seconds and the training session turned out to be successful for both ends. After the slum trip and training session, MedEasy team went back to hotel and had a meeting with our SIGHT leaders and Malinda for the daily debriefing session and consolidated all the notes and feedback from both during clinic operations and during training/feedback session.

Figure 6: Training at the One-2-One HQ

Figure 5: Medical staff testing the app

DAY TWO (04/04/18)-

After the workshop in day one and introduction of Medeasy, the doctors and nurses will try to use the app in real situation on the second day. In day two, Medeasy team visited a slum named "Canal Side" with One-to-One. Canal Side is next to a river and the mobile clinic set in a wooden house next to the river. After MedEasy team arrived the wooden house, the nurse can turn the hardware kit and connect the smartphone to WiFi which emitted by the hardware kit less than 2 minutes. The hardware kit is user-friendly and they can understand how to use the hardware kit after yesterday's workshop.

During testing time, MedEasy team members again sat next to doctors and nurse in 3 stages, triage, consultation and pharmacy, to help them to use the app and take feedback by asking questions and observe.

In the triage stage, the app could help nurses to take all the record include chief complaints which we change from consultation stage to triage stage on Day 1. The nurses could use the app in triage stage themselves and think the app is good for them to take record and find the patient record faster. There were a few issues with the user interface of the app that we will be discussing below.

In the consultation stage, the doctors felt the app was good. They could elaborately enter all the HPI details in the app and look back at the vitals sent from triage. However, they couldn't edit the information input during triage stage, which they really needed. They suggested us to add a page for doctors on consultation stage to edit information in triage stage. Since the functionalities of pharmacy were not built for this trip, they could not give any comment about the app about the pharmacy stage but we still observed the workflow in pharmacy stage to improve the app for the June trip.

After the testing time, MedEasy went to One-2-One headquarter and had a meeting with all the doctors and nurse to focus on the design of the whole app and ensure the app include all the things they need. MedEasy team also proposed some new ideas based on doctors' comment or request. Doctors gave us some good comments that help us to improve the app and rethink. Some notable feedback were:

Content/Flow of events:

1. Switched the Chief Complaint from Consultation to Triage.
2. Added one more events named HPI (History of present illness) in Consultation as the first event of Consultation.
3. Add month and week option for new-borns for the Age input in Triage.
4. Replaced the swiping action with scrolling down action for the PMH and Screening page in triage (since the swiping action design takes up too many pages).

Function requirement:

1. Add Search button in "ALL" and "QUEUE"
2. Add Notification once any info is submitted

Debugging:

1. Users can't view their text after the length is over the fixed provided spaces.

User Interface:

1. The background colour is similar with the text colour, it is hard to see the text
    1. Replaced the swiping action with scrolling down action for the PMH and Screening page in triage (since the swiping action design takes up too many pages).

Improvements:

1. The name in triage stage should include both the Khmer name and English name

1. The pregnancy should include more information
2. The name of “pregnancy” in triage stage should change to “maternal”
3. The hepatitis should separate into hepatitis A and B instead of group them together into one statement in the screening
4. Progress bar for Triage menu

-And many more that have already been delivered to the software team.

Fig 4(a) : Canal Side demo day

Fig 4(b) : Consultation with Dr.Soursdey

We also got feedback on what the app should flow like. So at the HQ, we drew decision trees for the app’s workflow and got more feedback from the doctors, as well as the software team’s comments on each of them. The software team + the full MedEasy team helped the doctors pinpoint the areas of concern and confusion and that helped us get very specific, detailed comments on the app.

We returned back to the hotel after dinner, and had another meeting at night so as to discuss and go over all the info we had collected, consolidated and understood.

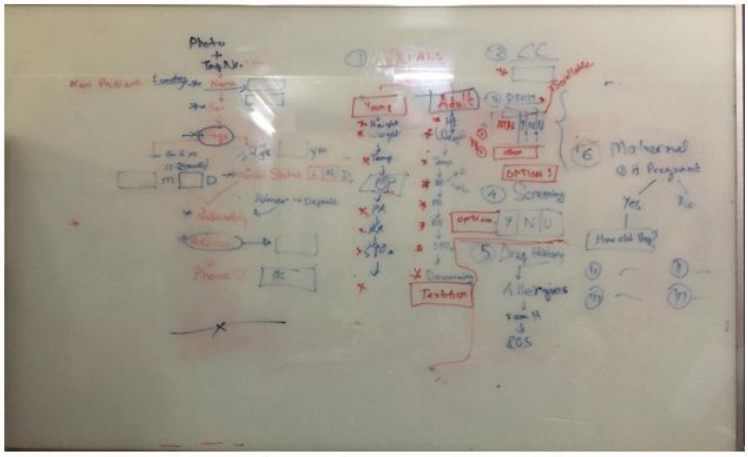


Fig 5: Brainstorming on app UI workflow

DAY THREE (05/04/18)

On the third day, we went back to House Above Water (HAW), and continued the app and paper progression like day 2. The doctors on this day were more efficient in using the app, and that helped them point out even the minutest details that they might like in the app to be changed. We also recorded a lot of previous medical reports from their files, so as to:

1. Collect all possible diagnoses so that we can create a database of preset diagnoses
2. To understand and note down if the forms are different from each other and in what ways- to explore all possible functionalities that we might need to add in the app

Finally, after the field trial, we went back to the headquarters for a final brief meeting with the staff team to come to a conclusion about all the data we had collected throughout the trip. We got a lot of insights on the Data Analysis Reports and how it would be beneficial for them as well. We collected 3 phones from them as provided by the previous MedEasy team, and also the hardware kits of 2017.

This last meeting was also used to brainstorm in-depth and consolidate remaining feedback about UI design, bug troubleshoots and potential future outlook of the project.

Eventually, the MedEasy Team and One-2-One bid a fond farewell with each other as MedEasy left for Hong Kong in the evening, with a lot of great photographs and inspiration to go back with a better, final product in June.

Fig 6: Final meeting at the headquarters

PHASE 2: JUNE

SIGHT & ONE-2-ONE

ACCREDITED CERTIFICATION

This certificate is awarded to

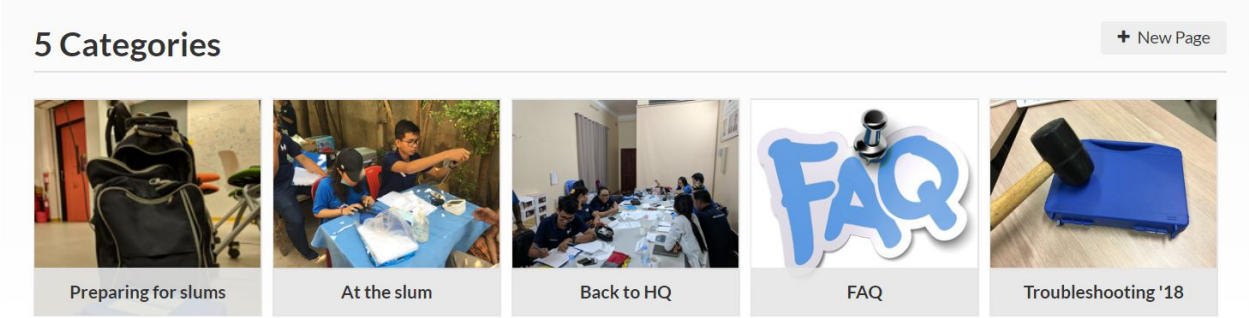
Tem Soursdey

In testimony thereof, after formal evaluations we acknowledge demonstrated knowledge and outstanding competence in using, debugging and further imparting knowledge about the system

Awarded this 27th day of March, 2019 at the One-2-One Headquarters.

SUPERVISOR

For June implementation, along with the training process we imparted successfully in April, we would also like to introduce a Technical Certification for the medical staff to encourage them to be an efficient user of the MedEasy system. This certification can be used by them to authorize them as users of the system- in case MedEasy expands on a wider level in the near future; it can also provide them motivation in their careers.



Along with the complete deployment of the system, we also plan on providing a very detailed manual, both online and offline so that all sorts of documentation is available to them, to equip them in case of any contingency arises. For the online version, we are using Dozuki which provide step-by-step manual guides which can help anyone to understand the platform easily.

4. Future outlook

Funding Strategy

We would demonstrate the project financial viability by providing the financial estimate on target market, revenue model and sustainability of the project.

Target Market and Customer

Our target customers are the healthcare service provided Non-Government Organizations, the small clinics and the mobile clinics in the developing countries, especially those with poor internet connection. Cooperating with a Cambodian NGO for some years, we would like to further expand our system to other Cambodian clinics, and other Asian countries, such as Laos, Vietnam, Malaysia, and some urban areas in China.

Revenue model

The revenue will be generated from two product lines.

Product Line One: MedEasy Electronic Medical Record system(EMRs) Package selling

This package contains the mutually support Network Provision Kit and MedEasy EMRs mobile application. We will introduce two paid versions of the package at the initial state, which are Fundamental Version and Expert Version. Meanwhile, a free trial version will be published on our website.

The Fundamental Version is a standard universal version for all customers. This version provides a complete circle of all functions, including triage, consultation and pharmacy. The functions can meet most of the requirements for the electronic medical record system, while the customized elements are neglected.

The Expert Version is a tailor-made version for individual project/customer. This version provides a customized complete circle of all functions in terms of the capacity of the database, performance of the mobile apps, variety of data format and other corresponding requirements. The consulting team will analyse the project underlining issues and modify the apps design catering to the needs of end users. MedEasy customer service team will follow up the technical problems and system updating.

The Free Version provides limited try out functions of the apps, i.e. triage and consultation station only. The Free Version apps provides a way for potential buyers to test drive the apps, get to see some of their features and make the purchasing decision. As a social enterprise, we call on more specialists join in the healthcare industry, especially the electronic medical system industry by publishing our MedEasy Kit assembling manual on our website and share the programming codes of some basic functions.

We have been built our MedEasy Kit prototype and our mobile apps is at the testing stage. While we still need the financial support for making the professional hardware and the mobile apps.

The Cost for one project per year ranges from $3,650 to $5,650 HKD (depends on the version). For hardware part, the raw material costs $650 per kit. For software part, the system UI/UX customization costs $2,000 to $3,000 each time, the system maintenance and upgrading costs $1,000 to $2,000 each time.

In order to support our administrative expenses and have further investment benefit to the R&D of our company, a profit margin of 15% is required. We will charge our customer for $4,200 (Fundamental Version) and $6,500 (Expert Version) for the first year for system installation, and $1,200 to $2,300 for second year onwards for system upgrading.

Product Line Two: MedEasy Electronic Medical Record system(EMRs) Data Analysis Tool
MedEasy Team will conduct data mining based on the information collected from MedEasy mobile apps and find out the intrinsic patterns for further illness prevention related report and illustration. The data analysis service will be executed by our EMRs Data Analysis Tool. The data analysis will benefit back to the data provider, which means our EMRs customer. Thanks to the data analysis tool, the physicians can visualize the correlation of certain illness with the demographics, lifestyle, and other attributes, which help them better understand the causation and prevention of specific diseases.

Apart from the NGO clinics, we can approach the state-owned clinics and national healthcare think tanks. Illness elimination creates huge marginal benefits for the personal health and society healthcare, which also addresses the Good Health and Well-being UN sustainable development goal.

Since the Data Analysis Tool is still in its infancy, we estimate an R&D cost up to $10,000 for this approach. The cost covers the consultation fees from related specialists and the data analysis tool computer programming.

As an additional advanced function of MedEasy EMRs, this Data Analysis Tool can be sold together with Product Line One either version. The additional price for each project is $3,000 per year.

Investments and Use of Funds

The investment will be used for R&D and hardware productions. Established in 2014 by a group of HKUST students, we now have solid engineering hardware and systematic apps content. In the future, we will focus on constructing the Data Analysis Tool with other specialists from healthcare and computer science industries. Simultaneously, a few sets of MedEasy Kit will be

produced and promoted to other NGOs in Hong Kong and China, which can benefit more people.

Sustainability

The inefficient internet coverage in the developing countries determines the high demand for the MedEasy hardware kit when using the MedEasy EMRs mobile apps. We forecast that we can build the partnership with three to five clinics for the first year, with product sales volume of $19,500 (three Expert Version packages). For the second year, we estimate mild growth of partnership due to the work-of-mouth promotion and product development, our sales volume can be recorded up to $65,400. For the third year, we estimate accelerate growth of market share due to the maturity of apps production and utilization of data analysis tool, our sales volume can reach to $234,000.

Healthcare issues are globally concerns, MedEasy is designated to assist the clinics in those under developed areas with cost-efficient product. More importantly, we strive to fully utilize the data-driven approach for tackling the global healthcare issue. We are ambitious that MedEasy product will be introduced to more Asian countries, and African countries, and the product fees will be reduced due to the mass consumption.

Conclusion:

As we prepare ourselves for a more sustainable MedEasy system that can last in the slums for a long time, we look back on our experiences in Cambodia from April and can actually understand the impact we might be able to make. There were a lot of things we could not understand or take into consideration about the whole workflow and process while in Hong Kong, but a lot of those details came into limelight when we actually visited the slums and experienced what the doctors work like in real life. We hope the data we collected would help us to improve our system and take it back again in June- this time for full-fledged implementation. In the long run, we hope to make sure MedEasy reaches in other communities such as Hong Kong, as well as other provinces of Cambodia.

5. APPENDICES

Appendix A: Bill of Materials

Item	Description	Unit Price	Unit	Total Price	Shop
USB Micro Socket	Micro-B 4pin	5	4	20	WECL
USB Micro Socket	Micro-B 2pin	5	3	15	
LED	3mm Green	4	2	8	
Resistor	1/4W 1%	0.5	4	2	
Resistor	1W 5%	1	1	1	
Raspberry	Pi 3 Model B	285	1	285	
Thermal Glue	Fujik BAB.900 50ml	58	1	58	
Total				**389**	
Heat Sink	40*40*11	8	1	8	WECL
Heat Sink	37*37*6	8	1	8	
Total				**16**	
Micro USB to Micro USB	Extension	15	1	**15**	Sing Wing Computer

Box	Waterproof	150	1	**150**	Fung Sheng Technology
Switch Button		3	4	**12**	昌記
Fan	2.5cm 5V	1	40	**40**	Best Buy Computer Limited
TP-Link	802N	1	135	**135**	8 Century
Xiaomi	20000mAh	2	180	**360**	MT Technology
TP-Link	802N	1	110	**110**	A Grade Technology

Appendix B: Communication Record

Type of Meeting	Participant	Agenda	Date & Time
Face to Face	Mass Team	Course syllabus, grading, project introduction	1/2/2018
Face to Face Regular Meeting 1	Mass Team	Project introduction	2/2/2018
Face to Face	Mashiat, Oscar, Winifred	Literature review presentation preparation	4/2/2018
Facebook Messenger	Winifred, Doctor Sea, Doctor Soursdey	Users feedback towards previous system	4/2/2018
WhatsApp	Mashiat, Christine	Software upgrades, answers to questions in details	4/2/2018
WhatsApp	Mashiat, Kris	Sofrware	5/2/201

			8
1st Presentation and Feedback	Prof, The team	Literature review presentation & Feedback	8/2/2018
Face to Face Regular Meeting 2	Mass Team	Objectives	9/2/2018
Messenger	Winifred, Doctor Sea, Doctor Soursdey	Medical terms	11/2/2018
Messenger	Winifred, Doctor Sea, Doctor Soursdey	Medical terms	10/2/2018
Email	M2SYS Biometrics	Enquiry about new biometric system	19/2/2018
Skype call	M2SYS Biometrics	Discussing prospects of Bio-SnapOn	20/2/2018
Messenger	Winifred, Mashiat, Oscar, Dr Soursdey	IT Personnel	22/2/2018
Messenger	Winifred, Mashiat, Oscar, Dr Soursdey	Final Report on paper	23/2/2018
Messenger	Winifred, Mashiat, Oscar, Dr Soursdey, Mr Tem	Introduction of Mr Tem: IT Nurse	26/02/2018
Facebook Video Call	Mr Tem, Mashiat	UI Design + Feedback	1/3/2018
Messenger	Mr Tem, Mashiat	List of Medicines	2/3/2018
Messenger	Mr Tem, Mashiat	Diseases list	10/3/2018
Regular Meetings	Team + Interns	Team time + Discussion	Every

			Friday
Group message on Facebook	Winifred, Mashiat, Oscar, Dr. Soursdey, Fernando, Malinda, Dr Neang,Dr Sokchan, Dr Soktom	Feedback and discussion	April 5 onwards

Appendix C:

Meeting minutes with advisors, team and medical staff can be found here:

https://drive.google.com/drive/folders/1R5SaCH8pXOb2H2MeI78BOZeEgY8gjsvE?usp=sharing

Appendix D:

MedEasy Kit Soldering Instructions

A:Components

1.Raspberry Pi 3

2.Power bank with 1 micro-USB input and at least 2 USB output

3.Router and ethernet cable

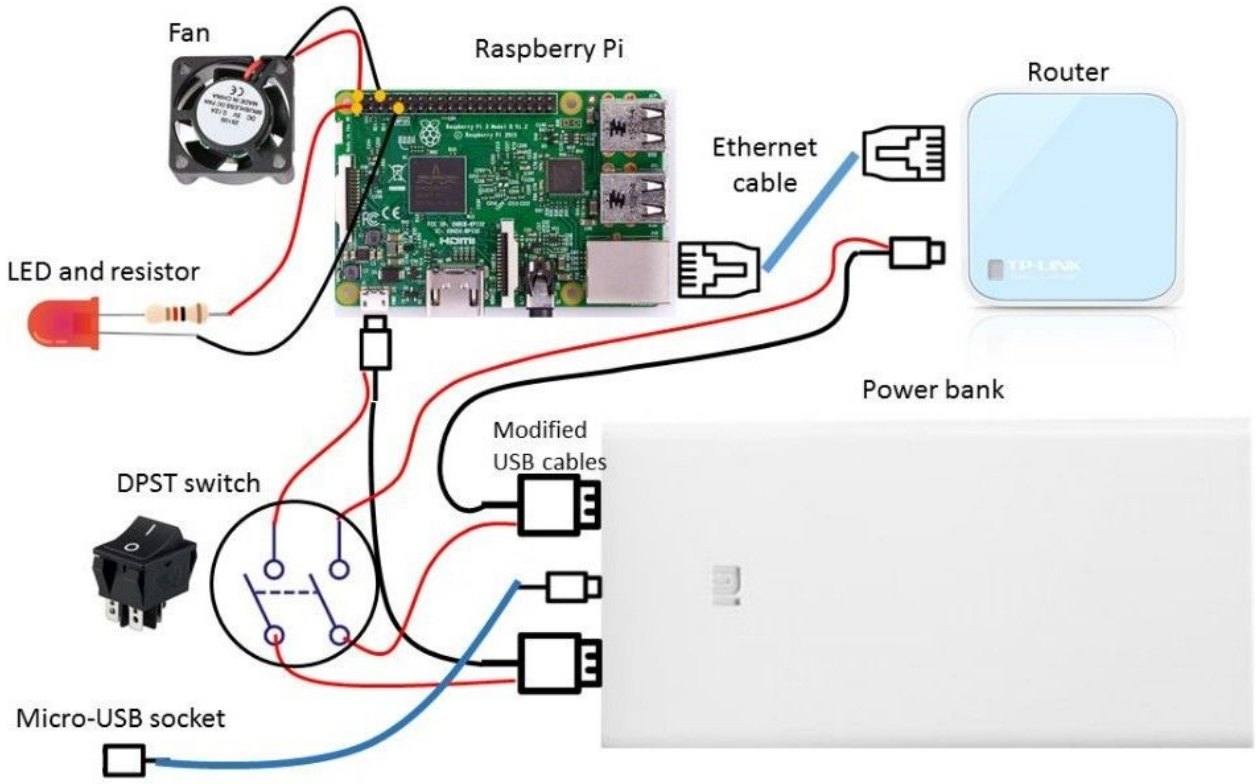
4.LED

5.Fan with 3D-printing mount

6.Window for power bank

7.Box

8.Switch and wiring



B Raspberry Pi 3

The Raspberry Pi 3 ‘s power source is from the power bank,Raspberry Pi 3 provide power to fan and the LED and the ethernet cable on the Raspberry Pi will connect to the router.

1. Connect to power bank

1.1 Find a micro-USB-USB wire

1.2 Connect the micro-USB plug to Raspberry Pi 3

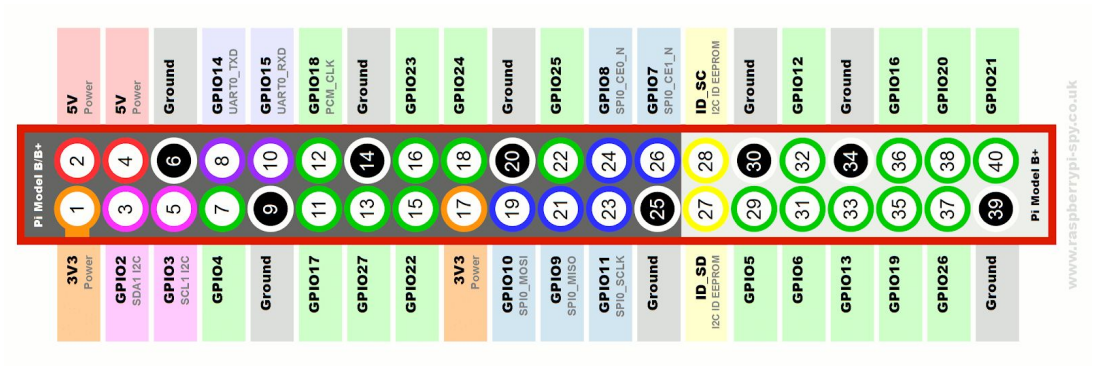
1.3 Cut VCC wire and connect it to the switch (Details in Switch and wiring part)

1.4 Connect the USB plug to the power bank

2. Connect to fan and LED

2.1 Connect fan’s red cable to 5V pin and black cable to Ground(GND) on Raspberry Pi 3

2.2 Connect LED’s red cable to 3.3V pin and black cable to Ground(GND) on Raspberry Pi 3



3.Connect to router.

3.1 Connect the ethernet cable to the router

4. Heatsink

4.1 make sure the Pi's CPU surface and the heatsink surface are both clean

4.2 put a little thermal glue onto the CPU

4.3 place the heatsink onto the glue

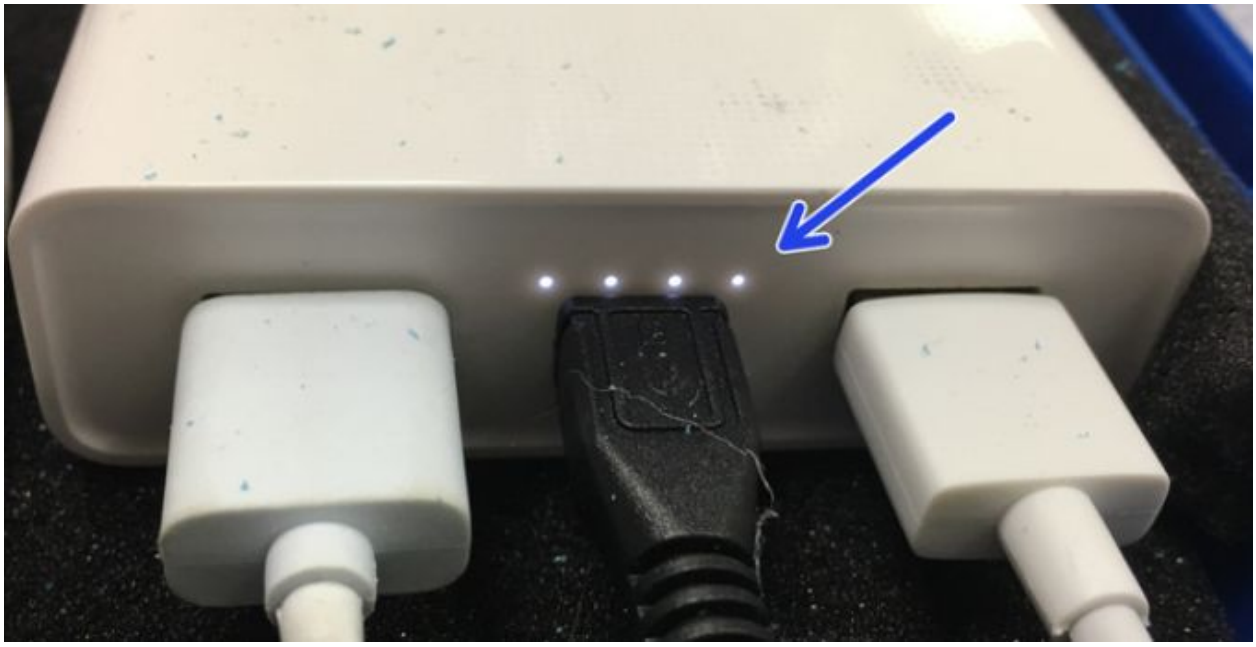
4.4 wait 5 min for the glue to dry

C Power bank

1. Connect to the Raspberry Pi 3 by micro-USB-USB wire(output)

2. Connect to the router by micro-USB-USB wire(output)

3. Connect the micro-USB plug to an extension wire(input)(optional)



D Router

1. Connect the router to Raspberry Pi 3

2. Connect the router to the power bank

3. Lan Cable

3.1 Follow this tutorial: https://www.cnet.com/how-to/how-to-make-your-own-ethernet-cable/

E LED

1. Solder one leg of a resistor (at least 3.3 ohms) to the positive branch of the LED (long)

2. Solder a red female jumper cable to the other leg of the resistor

3. Solder a black female jumper cable to the negative branch of the LED (short)

4. Insert the LED in its hole and secure it with its nut. Optional: add hot glue

5. Connect the red cable to the 3.3V pin of the raspberry pi and the black cable to the GND pin

F Fan with 3D-printing mount

1. Cut the cables

2. Solder a red female jumper cable to the red fan cable

3. Solder a black female jumper cable to the black fan cable

4. Secure the fan on its mount using two M3 screws and nuts diagonally

5. Plug the fan mount on some of the unused pins of the raspberry pi

6. Connect the red cable to the 5V pin of the raspberry pi and the black cable to GND pin

(Soldering tutorial:https://www.youtube.com/watch?v=O-ymw7d_nYo)

G Window

1.Measure

H Box

1.Make hole

-1 LED hole

-2 Ventilation hole(for heatsink and fan)

-1 Window hole

-1 Switch hole

-1 Micro-USB hole(optional)

2. Stick gauze to cover the heatsink and fan hole. Make sure it is stretched and well secured

3. Add foam for shock protection

- Thick foam on top cover with hole for the heatsink and fan
- Thick foam on the border of bottom cover, cut in an area to accommodate the switch connections
- Thin foam on the bottom cover

4. Stick Velcro strips on the box (cut out the foam for this) and on the electronic components (might need to reinforce it using hot glue)

I Switch and wiring

1. Cut a micro USB cable to the appropriate lengths of both sides of the cable
2. Strip both smaller cable pieces by removing the shielding layers. Cut the green and white cables and only keep the red and black cables on both
3. The switch is a double pole single throw switch: basically, two switches activated at the same time by the same button. Each pole (sub-switch) has two electrodes. If you hold the switch with the long dimension vertically, one pole is on the right, one pole is no the left. Choose one pole to solder on.
4. Solder the red cable of each piece of cable (so the red cable of the normal USB side and the red cable of the micro USB side) each to a different electrode of the selected pole.
Recommended: cover the electrode and soldered connection with heat-shrink. Else use hot glue.
5. Connect the black cables of the two cable sides to each other. Use heat shrink to cover the connection patch.
6. Repeat so as to have a connection between the battery and raspberry pi and another connection between battery and router, with their red lines respectively passing through one pole of the switch.

Note: use heat shrink to cover connections so as to avoid short circuit risk. It's not compulsory (and sometimes it is quite hard to do) but highly recommended**,**

(Soldering tutorial:https://www.youtube.com/watch?v=O-ymw7d_nYo)
