Tupaia - aggregating LMIS, HIS and EMR in Asia Pacific

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Digital Square Grants Submission – EMR expansion to Tupaia

Executive Summary

Principles and outcomes:

Expand and improve the use and functionality of two open-source platforms (DHIS2 and OpenMRS)

Expand the functionality of an existing health technology (Tupaia)

Background:

The 'Pacific Island Countries' are a group of 17 low-and-middle income countries and territories (excluding French and US territories) that have a combined population of just 10.5 million people. Despite this relatively small population, they cover an area more than 15% of the world's surface and their inhabitants are amongst the most susceptible people in the world to natural disasters and the effects of climate change. This ethnically diverse group are home to the most languages/capita in the world across three distinct regions - Polynesia, Micronesia and Melanesia.

Beyond Essential Systems (BES), in collaboration with Sustainable Solutions, have already rolled out an integrated regional health systems data platform – called Tupaia – which has been deployed successfully across six countries in the Asia Pacific region, focusing on the Pacific Island Countries (PICs). Tupaia, which aggregates and analyses data on supply chain, infrastructure, staff and service provision (and which is built on DHIS2) has reached 'medium' maturity and BES is seeking funding to expand this platform to further support the integration of HIS and LMIS data and to incorporate a contextually appropriate EMR for countries in the Asia-Pacific region. Tupaia uses world-leading, custom built reporting tools, with a cutting-edge mapping engine but is built on an open-source platform (DHIS2).

Obviously, digital EMR systems have been developed for low-income settings but contextualization is important, to avoid a 'one-size-fits-all' mentality. Health Ministries in PICs are smaller, work with more restricted budgets and with significant digital communication barriers such as unreliable and expensive internet connections; staff typically have limited computer literacy. They also have unique family structures, unusual epidemiology with high rates of both communicable diseases and NCDs, mixed political and religious systems and unusually disparate geographies extremely susceptible to natural disasters; the Melanesian countries also have the most languages/capita in the world. As such, software widely accepted in many countries is simply not suitable for the Pacific environment.

We propose building a contextually & culturally appropriate Pacific-Island skin on top of OpenMRS and syncing this to the existing Tupaia regional data platform, which is built on DHIS2. This will include building offline platforms for both mobile and desktop solutions, syncing to OpenMRS through APIs. This will borrow from the Bahmni model which has been successfully implemented elsewhere, using a modular structure, with a contextually appropriate design and UI.

In the last decade, health systems in many low and middle-income countries have been moving towards a digital future that has already seen the

implementation and embedding of Health Information Systems (HIS) and Logistics Management Information Systems (LMIS). There is also a push to embrace patient-level Electronic Medical Records (EMR) and – most importantly – to integrate hitherto disparate data sources on unified platforms to aid senior-level decision making. Overlaying LMIS and HIS data has been identified as a priority. Tupaia does this. It provides a proven, scalable platform to unify LMIS, HIS and EMR data, along with other potential data sources, such as accounting, environmental health and climate data.

As health systems in PICs join this shift towards a digital approach to healthcare, there remains a need to support this in the region by creating electronic healthcare systems that are contextually relevant to their needs but built on robust open-source platforms. With Tupaia providing a single, integrated data platform to overlay HIS, LMIS and EMR data, the biggest missing link is a contextually appropriate electronic medical record system for the Pacific region.

Electronic patient records, that include a mobile, comprehensive history of a patient's treatment, have been shown to improve communication between healthcare professionals, reduce errors, improve treatment and create a more holistic approach. This generates a patient treatment record that is more accurate, mobile and accessible to healthcare professionals and the patient themselves.

Consortium Team

Beyond Essential Systems (BES) is an Australian company that currently manages large contracts on behalf of international agencies including DFAT (iXc), WFP, WHO and Save the Children International. They have extensive experience throughout the Asia-Pacific region, having completed work in Solomon Islands, Kiribati, Tonga, Vanuatu, Timor-Leste and elsewhere in Africa and Asia. BES designs and implements technology solutions for medical supply chains and health systems. They include specialists and consultants in procurement, clinical services, project accounting, geospatial epidemiology and software development.

Sustainable Solutions is a New Zealand based company with offices in Auckland and in Kathmandu, Nepal. First developed nearly 20 years ago, their mSupply software is used in over 30 countries worldwide, including Nigeria, Sierra Leone, Myanmar, Timor-Leste and most PICs. mSupply provides comprehensive end-to-end logistics management, with a procurement module, comprehensive warehousing and distribution functionality, customizable reporting, budgeting tools, a hospital dispensing module and a new mobile version (mSupply Mobile), which has recently been released open-source. They currently partner with a range of government donors, private enterprise and multilateral agencies, including DFID (UK), USAID, The Clinton Health Access Initiative, UNDP and CAIPA.

Tupaia is a regional project across six countries in Asia-Pacific that provides a free, integrated data portal for information on the availability of essential medicines, facility infrastructure, staff, equipment and service provision. It has been supported by the open-source release of mSupply Mobile and the free release of Tupaia MediTrak, a customizable data collection tool for health facilities. Data is synced from multiple sources onto a single, aggregation database (DHIS2) and displayed in customizable, cutting-edge reporting dashboards and interactive mapping tools. www.tupaia.org allows users a customized view of information ranging from the availability of Amoxicillin at a hospital in Kiribati to how many clinics in Solomon Islands have working fridges. Tupaia can also overlay HIS data through DHIS2 and other sources. Tupaia is also capable of layering important regional information, including patient tracking, environmental health, climate data, geospatial epidemiology and incorporating information from WHO's Regional Medicines Quality Assurance Information Sharing Mechanism.

Tupaia is owned by Beyond Essential Systems, working closely with Sustainable Solutions as technology partners. The project's development has been funded through DFAT's innovationXchange **and provided free of charge to participating countries**. Collectively, we are uniquely placed to understand the complex needs of building, implementing and operating technology solutions within these health contexts. **Both Sustainable Solutions and BES (through the Tupaia project) are members of the Health Data Collaborative LMIS Working Group** (Interagency Supply Chain Group, WHO, New York).

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Project Description

Most PICs still rely on a paper-based medical record keeping system. These records are easily damaged, retrieved without authority and cannot be easily accessed by healthcare professionals if the patient seeks treatment away from their usual provider. Electronic Medical Record (EMR) systems developed for countries such as Australia or the United States are large, complex systems that act to support equally large and complex health systems with complicated funding streams and large workforces. Digital EMR systems such as OpenMRS have been developed for low-income settings but contextualization is important, to avoid a 'one-size-fits-all' mentality. Health Ministries in PICs are smaller, work with more restricted budgets and with significant digital communication barriers such as unreliable and expensive internet connections and staff with varied computer literacy. They also have unique family structures, epidemiological patterns, mixed political and religious systems and unusually disparate geographies extremely susceptible to natural disasters. The Melanesian countries also have the most languages/capita in the world. As such, software widely accepted in many countries is simply not suitable for the Pacific environment.

Funding through the Digital Supply Grant would support additional software development to:

1)   Create and trial a contextually appropriate EMR user interface for PICs, incorporating a consultation period to facilitate user-centered design. Mobile and desktop based solutions will be built, accommodating offline use and syncing to an OpenMRS instance. OpenMRS is a tested, scalable open-source EMR database.

2)   Integrate the existing HIS and LMIS data on Tupaia with EMR data on the Tupaia platform – bringing together OpenMRS and DHIS2 for multi-country data analysis. This can be achieved both within the Pacific region and globally. We will also explore incorporating environmental health and climate data.

1. Develop a contextually appropriate EMR user interface, complementing our existing software platforms

Currently, the Tupaia project, works in collaboration with partner health ministries to generate high quality health data to inform decision making at all levels. Tupaia has already implemented health data mapping via the Tupaia MediTrak application in Solomon Islands, Kiribati, Tonga, Vanuatu, Cook Islands and Tokelau, as well as integrating LMIS data from existing platforms (mSupply) used within these countries. There are plans to expand across the next three years into Papua New Guinea and hopefully the rest of the Pacific Island Countries.

Beyond Essential Systems seeks to expand their digital health work in these countries, and across the Pacific region by creating software to support a contextually appropriate Electronic Medical Record (EMR) and Patient Administration System (PAS). This is being built in Electron (desktop) and React Native (mobile) and will interact with OpenMRS via an API.

This project would support the improved delivery of healthcare across the Pacific by:
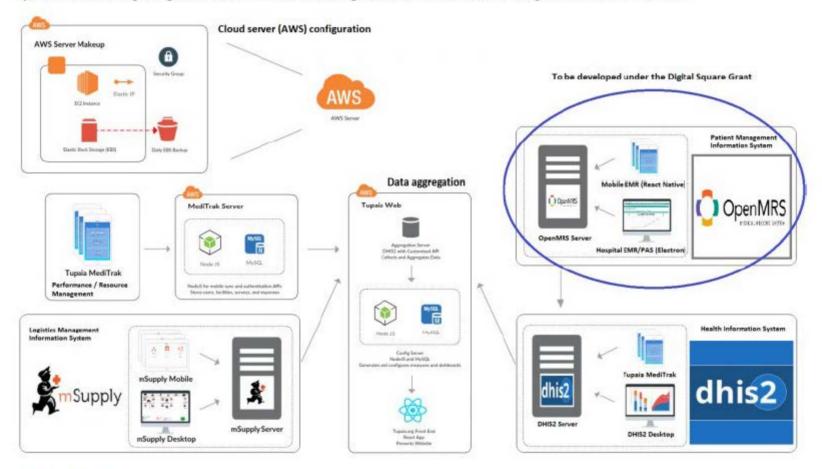
- Providing more accurate and complete clinical information about a patient, incorporating medication, lab and radiology results alongside a treatment history
- Creating a patient record that moves with them throughout the health system
- Provide more accurate and safer treatment options and avoid errors due to miscommunication or incomplete information
- Improving communication between health professionals, both within hospitals and across the healthcare system
- Allowing partner organizations to maintain contact with patients to provide additional health and behavior change information following a diagnosis or treatment

At the hospital level, our software would incorporate a Patient Administration System (PAS) to support hospital workflows. This would include managing health assets to support patient treatment (i.e. scheduling surgery theatres and staff), patient billing, incident reporting, decision-support and strengthening business processes. The underlying architecture is OpenMRS, with a customized user interface (built in Electron), language translations and powerful syncing to the central Tupaia platform.

2. Integrate LMIS, HIS and EMR data using world-leading GIS and reporting tools

Tupaia is already integrating data from multiple sources such as LMIS and mobile data collection tools. In 2018, this will expand to include country-level DHIS2 systems (Tonga) and under this funding proposal, we would expand this to include de-identified data from the new EMR

system, as well as exploring other sources such as accounting software, environmental health platforms and climate data.

Initial Workplan:

We anticipate this project can be completed in the next 1.5 years, incorporating tasks such as UI design, UAT, data aggregation, advanced functionality, testing, debugging and post-release optimization. The complete workplan is attached, with clear linkages to strengthening areas based on the Global Good Maturity Model

Project Timeline (Gantt Chart)

Timeline columns span weekly periods from Mar 12th–Mar 18th through June 2019, then monthly: July 2019, January 2019, February 2019, March 2019, April 2019, May 2019, June 2019, July 2019.

Task	Status / Timing
EMR scope, tech stack design, commence build	Complete
Global Good Maturity Model: Funding and revenue	
Digital Square funding application	Mar 19th – Apr 1st
Hire solution architect (software lead)	Apr 2nd – Apr 29th
Socialise with regional donors	Apr 2nd – ongoing
GGMM: Interoperability and accessibility	
Determine standards adoption and integration	Apr 9th – Apr 29th
Build and publish customized APIs to OpenMRS	May 21st – Jun 10th
GGMM: Security	
Design security, data governance protocols	Apr 16th – May 6th
Patient identification simulations and scenario testing	May 21st – Jul 8th
Basic UI build, test sync engines, mock-up main user tools and data analysis	May 21st – Aug 12th
GGMM: Software roadmap, community governance, user documentation, country strategy, multi-lingual support	
In-country UAT across region. Develop regional user community	Aug 6th – Sep 2nd
Build training tools, begin language translations	Aug 13th – Sep 30th
Build out UI, complete functionality in prototype, basic debugging	Sep 10th – Oct 7th
Post-release evaluation, maintenance, debugging	May 2019
Complete data aggregation and analysis tools	Dec 10th – May 2019
Country utilization	
Complete in-country demos	Nov 12th – Dec 2nd
User testing, formal evaluation, complete debugging	
Product launch	Dec 3rd – Dec 9th
Implementation	January 2019 – June 2019

Use Cases, User Stories and Activities

Current state usage case (True story: Cyclone Gita)

In February 2018, Cyclone Gita hit the island of Tongatapu in Tonga. 7 health facilities were in the path of the Category 4 storm and all had been mapped on Tupaia, with baseline data collected in late 2017 (www.tupaia.org). Within 48 hours of the storm passing, local assessment teams – supported by international aid agencies – had assessed all 7 facilities with Tupaia MediTrak and this data was made available in near real-time to all responders, as soon as the assessment teams were able to return to an area with internet and sync their survey responses. The new data, including photos of damage, were compared with the baseline data on disaster preparedness and the Ministry of Health were able to see which services had been lost and which damage was pre-existing.

In this case, Tupaia was able to quickly indicate that despite extensive damage to other public property, the health facilities were relatively undamaged. This allowed resources to be allocated more efficiently to communities and WASH restoration. A small amount of damage (some broken windows and minor water damage) was noted and could be appropriately prioritized for a later date.

Incoming medical response teams on standby were stood down until further notice, saving on unnecessary responses that so often cost enormous amounts of money – in the event that there had been major disruptions to service, Tupaia could have been used to best plan the location of field hospitals to service the greatest need.

Future state usage case 1

In rural Samoa, a 30 year old male presents to a clinic with a persistent cough and is seen by a nurse, who enters an episode of care into her mobile EMR and refers him to hospital. At the hospital, a doctor sees him in emergency and brings up his medical record on the laptop computer in the department. The internet has been down all morning but the patient's notes have synced to her local instance overnight and she is able to view his most recent presentation. She sees this is the second presentation with a persistent cough and she notes weight loss over a 12-month period. She orders a sputum sample and a chest x-ray. The next day she brings up the results of these two investigations on her computer and makes a confident diagnosis of TB. She commences treatment and admits the man onto the TB ward. A warning alerts her to the fact the man should be screened for HIV as well – she orders a test, which is negative and this is attached to his electronic record.

The diagnosis is reported from OpenMRS to DHIS2 and the TB/HIV team is automatically alerted to the fact that this is the third diagnosis of TB from that village in a short space of time. Along with a contact tracing officer, they send an environmental health officer to assess living conditions in the village.

After completing the first stage of treatment, the patient is transferred back to their home clinic for follow-up care and continuing DOTS therapy. The patient cannot remember the name of what he has been diagnosed with or his ongoing treatment needs but the local nurse is able to bring up his patient record again on her phone and continue therapy. Her Mobile EMR sends the man a text message in his local language that explains his condition and the need to continue taking medicine for several more months. He continues to receive weekly reminders until the completion of therapy.

The pharmacy team in the capital is alerted by Tupaia to the fact that the number of TB patients in the village now exceeds their stock levels and they will run out of stock before their next order is due. They send a message to the local nurse suggesting that she place a supplementary order. She does so and whilst placing it, mSupply Mobile automatically suggests she order additional ampicillin and gauze bandages because she is likely to run out of both before her next order is due.

Future state usage case 2

The Director of Pharmacy in Solomon Islands arrives on Monday morning and receives a pop-up warning on their email, which is cc'ed to the Undersecretary for Healthcare and the local WHO office. Case reports from the previous week indicate that there is a minor diarrhoea outbreak in Western Province and that there appears to be insufficient stock of zinc sulphate and ORS in the province. A phone meeting is held with the Provincial Health Director and it is determined that the outbreak is contained to two islands and that WASH teams are being dispatched from the provincial capital to investigate.

The Director of Pharmacy can see on   www.tupaia.org   that there are 5 clinics in the affected area and he messages the provincial pharmacy officer to push zinc sulphate and ORS stock down to those clinics immediately. The provincial health director signs off on the additional fuel expenditure and the manager of the National Medical Stores arranges for additional stock to be sent to the provincial capital on a ship departing that night. That stock will be in Western Province in the next 48 hours.

A follow-up meeting on Friday indicates that the rates of diarrhoea have not increased and that sufficient stock is now available in the area. The WASH teams find during their assessment that toilets are broken in 2 affected clinics and this data is displayed in real-time at www.tupaia.org . Clinic nurses are requested to arrange maintenance and again the provincial health director signs off on the additional expenditure, noting on Tupaia when the work has been completed.

Digital Health Technologies

We intend to build an EMR system for mobile (in React Native) and desktop (in Electron), with complete offline functionality and syncing to an OpenMRS instance. The data gathered in OpenMRS would then be aggregated through local DHIS2 instances (almost every country in the Pacific is now using DHIS2) and in turn to Tupaia (a regional DHIS2 platform that uses DHIS2 for data aggregation but then configures the data and displays it through a React front-end).

The complete tech stack is attached.

Community Feedback

Global support communities for DHIS2 and OpenMRS already exist but Pacific-based software developers are not well connected to these networks.

We intend to build and nurture a Pacific Island based community of software developers, software maintenance teams and eHealth project managers, overseen and funded by a consortium of regional donors. Experienced software developers are increasing in number across the Pacific but – particularly in eHealth – they have tended to work in silos, often creating small-scale, bespoke software solutions that have proven unsustainable or ineffective. There is not a lack of talent but a lack of connectivity between these developers and global projects. Consequently, especially for implementations of DHIS2, consultants are usually brought in from Europe or elsewhere in Asia and there is a lack of knowledge-transfer.

We believe we can foster a Pacific-based community of developers and bring them into the global eHealth community.

This would allow countries to implement software but engage tech support, debugging, implementation and customizations from a local pool of developers. Tupaia is an example of this – a regional customization of DHIS2 that has been completed predominantly by software developers in New Zealand. We aim to expand this developer community into countries such as Fiji, Vanuatu and PNG, with others to potentially follow. This community would work as a satellite to larger global communities involved with the development and maintenance of (primarily) DHIS2 and OpenMRS. Initially, it could be run as a loose consortium of individuals, coordinated by a development partner. As a private company, we believe there is a conflict-of-interest in us coordinating this group but we would participate actively and help to catalyse its growth. There are several potential hosts for coordinating this consortium, including an Australian or regional university, a reputable research center or multi-lateral donor.

Funding for this body is not included in this application but several donors have expressed enthusiasm for such a group or community and we believe that getting funding on the back of this work is realistic.

Global Good Maturity Model

See attached Excel spreadsheet

Total Budget
USD $270,963.00

Budget Narrative
Staff

Recruitment

Full Stack software developers	**2.0 FTE**

Software Lead: Edwin Monk-Fromont (CV attached)

Project coordination   **0.5FTE**

Project Lead: Dr Michael Nunan (CV attached)

Clinical and training lead   **0.5FTE**

Clinical Lead: Sahar Khalili (CV attached)

UI designs, translations

UI: Manu Vallyon

Translators to be determined

Flights and other travel costs

8 return flights to PICs

Per diems

Meeting costs

Supporting Documents:
- global_good_maturity_model_assessment.xlsx
- workplan.docx
- tech_stack.png
- edwin_monk-fromont_cv.pdf
- michael_nunan_cv_current.pdf
- sahar_khalili_cv.pdf