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Open Source Software in Healthcare: International Case Series from the IMIA Open Source Working Group

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Abstract: In this case series, we demonstrate how open-source software has been widely adopted as the primary health information system in many low- and middle-income countries, and for government-developed applications in high-income settings. We discuss the concept of Digital Global Goods and how the general approach of releasing software developed through public funding under open-source licences could improve the delivery of healthcare in all settings through increased transparency and collaboration as well as financial efficiency.

Keywords: Open-source, digital health, digital global goods

1. Introduction

In low- and middle-income countries (LMICs), government funding agencies and donor organisations that support healthcare often require that the information systems they fund be released with open-source licences. Over the last several decades these systems have evolved to support a number of large scale "Digital Public Goods" (DPGs) with some systems becoming integrated into publicly funded healthcare systems and put into routine use. The Digital Public Goods Alliance (DPGA), a multi-stakeholder initiative consisting of several UN agencies and governments, define DPGs as open-source software, open data, open AI models, open standards, and open content that adhere to privacy and other applicable laws and best practices, do no harm by design, and help attain the Sustainable Development Goals (SDGs).

In high-income countries (HICs), publicly funded health systems often need to develop their own software, and this is increasingly developed using open-source software and with new code released under open-source licenses.

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In this paper, we provide a case series about several DPGs and discuss how open-source technologies can be used by governments from all parts of the world for supporting publicly funded healthcare

2. Methods

The IMIA Open Source Working Group conducted a series of case study reports collated from recent literature with input from the leadership of several major open source projects.

3. Results

3. 1 Case Study 1: DHIS2 Open Source Platform and HISP community of practice

District Health Information Software version 2 (DHIS2) is a Free and Open Source Software (FOSS) platform, which has been continuously evolving and further developed through an expanding networked community of practice called the Society for Health Information Systems Programmes (HISP) (https://dhis2.org/). The initial implementation of DHIS version 1 was to support the reconstruction of health services and health systems and aim for equity in post-apartheid South Africa in the 90's - with equity still being the foundational ideology of HISP to this day. Currently more than 70 countries in the global south are using DHIS2 as their main routine health information system and there is increasing presence in the fields of animal health, zoonoses, education, agriculture, forestry, climate and others. DHIS2 and the World Health Organisation (WHO) are collaborating on the development of health program specific standard metadata "packages", such as for HIV, TB, malaria, immunisation, non-communicable diseases, and, recently, for COVID-19 [1], which has led to a large number of such health program targeted applications.

Built on what were then cutting-edge java frameworks, the fully open-source and web based DHISv2 was launched in Kerala in 2006. In 2010/11, as mobile internet arrived in East Africa, Kenya became the first cloud-based and nation-wide DHIS2 implementation on the continent. Following the example of Kenya and the spread of Internet over the next few years, all African countries south of Sahara, apart from two, have implemented DHIS2 as their main routine HIS, as have more than 20 Asian countries. Over the last few years, DHIS2 has transformed into a multi-purpose software platform with a flexible meta-data structure and an open API (Application Programming Interface), through which the core system and generic apps, custom apps and external systems can interact with the database. The platform approach enables both flexibility and variety in information products, as was seen during the COVID-19 pandemic, when more than 30 countries applied DHIS2 in their information responses to the pandemic, such as for contact tracing and vaccination of the adult population.

As the type of use cases and number of countries implementing DHIS2 are increasing, the HISP network and support structure need to expand. We illustrate this expanding mode of work through the example of three countries in Southeast Asia, with HISP Vietnam as a driving force. Vietnam uses DHIS2 as their national health statistics system with 14,000 users at the community level in 61 provinces compiling and reporting

180 reports monthly and quarterly. The system was developed and maintained by the IT department in the Ministry of Health, and is running on their own infrastructure. Vietnam is also using DHIS2 for a national system for non-communicable disease management integrated with hospital systems and the health statistics system. While being part of the global software development team and supporting their own country, HISP Vietnam has also, since 2015, supported systems development in Lao People's Democratic Republic (Lao PDR), where DHIS2 is now supporting a range of health programs, such as TB, HIV and malaria as well as the general national routine HIS. The family folder census register system, electronic immunisation register and interoperability between the HIS and the national drug inventory system are other examples of the varied DHIS2 portfolio in Lao PDR. From the start, the sustainability strategy in Lao PDR has been to form a local core DHIS2 team and to build their capacity through hands-on training and by successively leaving more of the responsibility to them. In 2022 HISP Lao PDR was formally established and is now part of the expanding network of capacity and support, without which DHIS2, or any open source project, would not survive.

The HISP collaboration with universities and the MOH in Indonesia started in 2014 and represents another example of expanding networks. Starting with a pilot project in 10 districts aiming for integrated dashboards, the ASDK (Aplikasi Satu Data Kesehatan - One Health Data Application) was established based on DHIS2 and acting as an integrated data warehouse receiving data from other national systems, such as for TB, HIV and human resources. A number of other DHIS2 open source projects have been established, such as for developing integrated health data warehouses and dashboards in Jakarta city health department, as well as in other cities and districts. In Makassar city, a similar data warehouse approach is expanded to include social services and other departments and is developed for the city government. During the COVID-19 pandemic DHIS2 have been applied nationally for contact tracing and including integration with WhatsApp for self-registration of tens of thousands of users involved in tracing. Currently a national system for malaria control and elimination based on DHIS2 is designed for implementation from January 2023. While the target for the eastern parts of Indonesia where malaria is endemic (Papua, Moluccas), is control, the target for the rest of the country is elimination. The system will thus consist of a range of sub-systems and features. These various DHIS2 initiatives have been developed based on local initiatives and capacity, which have led to the forming of HISP Indonesia, in 2020.

3.2 Case Study 2: OpenMRS in the Philippines

Researchers from the University of the Philippines Manila extended OpenMRS (Open Medical Record System) to fit the workflow of frontline government health centres. Called Community Health Information Tracking System or CHITS, the Free and Open-Source Software (FOSS) nature of OpenMRS allowed it to be reconfigured to fit the workflows of these government facilities which followed the same manual of operations. Installed on-premise due to connectivity challenges, CHITS is now being used in more than 140 facilities around the country. Being open source, it empowers health administrations to customise whenever new reporting formats are imposed by the government.

3.3 Case Study 3: NHS Digital and the NHS Covid-19 App

Despite the trend by individual hospitals in the UK's publicly-funded National Health Service (NHS) to acquire proprietary EHR systems, NHS Digital have stated in the NHS Service Standard (Point 12) that new source code created with public money should be open, giving the following reasons:

"Public services are built with public money. So, unless there's a good reason not to, the code they're based on should be made available for other people to reuse and build on. Open source code can save teams duplicating effort and help them build better services faster. And publishing source code under an open licence means that you're less likely to get locked in to working with a single supplier." [2]

The NHS have released source code on a wide variety of projects (currently 185 GitHub repositories) and, as the government takes on more ambitious digitisation projects in the future, this guidance will have an impact on the proportion of systems based on open source technologies used in the NHS.

A good example of NHS Digital developing new software and releasing open source code is the Covid-19 App developed in response to the coronavirus pandemic. A digital contact tracing app was suggested to help mitigate the COVID-19 epidemics curve from the experience of real world data in Singapore and mathematical theoretical models [3]. However, privacy implications were pointed out for contact tracing by smartphones. For the transparency of the algorithm of contact tracing apps, some of them were developed as open-source software.

The NHS Covid-19 App uses open source contact tracing technology developed by Google and Apple to allow users to receive notifications if they have been in contact with someone who tested positive for Covid. The app is also used for checking in at locations by scanning a QR code, recording symptoms, ordering tests and informing users about how long they need to self-isolate for.

The app has been one of the most successful government-funded digital health applications with 31,491,108 downloads as of 2/11/2022 [4].

Other countries around the world also developed open source contact tracing apps building on the Google and Apple open-source code. For example, in Japan a voluntary group launched to develop a digital contact tracing app, and transferred software code and management to the Ministry of Health, Labor and Welfare (MHLW) using GitHub for sharing code, discussing issues and developing software updates.

4. Discussion

In the above case studies, we have shown the potential for how open source software can be used for major healthcare applications in different countries around the world. In some regions, the expense of proprietary software could be seen as a primary driver of the adoption of open source systems but many other factors also come into play, making open source relevant for high-income settings such as the UK and Japan. The need for code transparency to enable trust of particularly invasive types of healthcare monitoring such as the Covid-tracing applications prompted the adoption of making the code for the NHS and Japanese tracing application publicly viewable on GitHub. In contexts where funding for major healthcare challenges (such as managing HIV, TB and malaria) comes from international donors, there is a growing consensus on the need to release source code funded in such a way through open source licences to maximise the impact of the

donated funds. This trend has also translated into NHS guidance for any code written by government funded organisations such as the NHS to be released as open source.

We argue that for an open-source solution or a DPG to be safely adopted for sustainable use by governments it needs to focus more broadly on a generic framework on maturity, capacity and sustainability. Sæbø et al. emphasises that the definition by DPGA focuses on the production side of the DPG, including the processes of design, development and distribution, so there is a need to expand the definition to include the demand side and how the DPG meets local needs [5].

5. Conclusions

While free and open source software has found its place in mainstream health information systems, there are still challenges around its governance and adoption. It is important for researchers to continue documenting FOSS development and adoption and identify the benefits, risks, and resources that accompany it. The increased focus on digital public goods, as demonstrated by the DPG Alliance, may be used as an arena to promote FOSS in health care as well as the open source principles of developing communities of practice, sharing, networking and working with users to develop useful and practical solutions. Our cases have demonstrated that FOSS may be important for developing countries in developing their capacity, ownership and local solutions and argue that a gap often remains between FOSS development and sustainable implementation, the latter of which depends more on the availability of a community of practice, capacity-building, structured institutionalisation plan, and governance.

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