

University of Oslo, Department of Informatics [Impact case #1]

Institution: University of Oslo
Administrative unit: Department of Informatics (IFI)
Title of case study: eHealth infrastructures
Period when the underpinning research was undertaken: 1994 - 2023
Period when staff involved in the underpinning research were employed by the submitting institution: 1994 - today
Period when the impact occurred: 1994 - today

1. Summary of the impact

The research promotes the introduction, uptake and scaling of digital infrastructures for the health sector (e-health infrastructures). In contrast to traditional project management emphasising control and, unfortunately not appropriately dealing with the complexity of today's digital world (which is reflected in frequent IT "scandals"), our work embodies alternative approaches. Our work has led to the formulation of alternative development strategies emphasising learning, more flexible architectures and adaptive governance mechanisms that have proven impactful. Our alternative approaches have ensured the scaling of the Health Information Systems Programme (HISP) across > [120 countries](#) (giving it a footprint of 3.2 bn people's health data). Beyond the modern, platform-based, open-source software ([DHIS2](#)), our approach involves an extensive capacity-building network for health workers, managers and IT developers worldwide.

2. Underpinning research

Since the mid-1990s, a group of researchers at IFI (now formally allocated to the IS and DIN research groups) has pursued mutually reinforcing agendas of theoretical and practical work. Theory development has been pursued based on a) empirical studies of healthcare IT projects in the Norwegian context and b) action-oriented, policy-relevant establishment of health information systems in developing countries. Over decades, the core of this group includes Professors Margunn Aanestad, Ole Hanseth, Sundeep Sahay, Jørn Braa, and Eric Monteiro. With a core competence in informatics, the group has leveraged an international network of multidisciplinary competencies ranging from public health, health informatics, social sciences, to development studies. Concretely, central aspects of the basis for the impact have been;

- The pioneering theoretical work of articulating the novel Information Infrastructure perspective (Ole Hanseth and Eric Monteiro)
- The practical work with the post-apartheid South African health authorities to establish an information system that supported local decision making through the "information for action" vision (Jørn Braa, Calle Hedberg, Arthur Heywood).
- The insights from research on global software outsourcing (Sundeep Sahay) applied to the building of South-South-North networks in the HISP community
- The work on generification, scaling, and modernisation of the DHIS2 software (to allow it to be spread across diverse countries, to sustain the growth in uptake, and to migrate to modern technologies) has happened through an action-research approach. These activities were extraordinarily productive for novel research insights and provided opportunities for capacity building to hundreds of PhD and Master students, both from the global South and in IFI.
- A close collaboration with several health IT actors in the Norwegian health sector, such as a long-term (>25 years) collaboration with Oslo University Hospital, the South-East Regional Health Authority, AHUS hospital, Sunnaas Hospital, Østfold hospital, the Directorate of e-health, and through the [SFI Center for Connected Care \(2015-2023\)](#) also

Oslo Municipality and the eHealth industry. This has constituted joint research, student projects, advisory work, and public engagement in debates on e-health strategies in Norway. The research has constituted theory development (from an extensive empirical base) on core IS topics such as architecture, governance, standardisation, infrastructures and platforms.

The ongoing research on information infrastructures has happened in a dialogue between studies from the Norwegian healthcare setting (conducted mainly by Ole Hanseth, Margunn Aanestad, Miria Grisot, Bendik Bygstad, Egil Øvreliid, Alexander Kempton, Troels Mønsted and others.) and from the HISP countries (conducted by Jørn Braa, Sundeep Sahay, Petter Nielsen, Johan Ivar Sæbø, Terje Sanner, Kristin Braa, Eric Monteiro, and many others). This ongoing engagement between action research activities, case studies and joint theoretical analysis has been immensely productive for the generation of novel insights on many areas of e-health infrastructures:

- Alternative strategies on development, implementation, and scaling strategies have been developed (for instance, cultivation, bootstrapping, grafting, open generification and modular implementation strategies).
- Insights about the role of architecture have been developed - such as the advantages of flexible platform architectures over monolithic architectures and the need for integration of “light-weight” and “heavy-weight” IT architectures - two areas which have found great resonance among IT practitioners.
- This work has also driven research on governance approaches, such as standardisation strategies (‘flexible standardisation’, ‘reflexive standardisation’), integration strategies, governing ‘two-speed innovation’ processes, the role of architecture-governance configurations, and realising ‘digital public goods’.

This has again been the basis for continued engagement with the practice field in Norway and abroad on novel developments such as remote patient care/digital homecare, mobile data entry, disease surveillance, digital public goods, and health data analytics. The global ehealth infrastructure is also a crucial precondition for the frontier work with [climate-health data](#). Thus, this group has delivered pioneering theoretical work on information infrastructure in combination with (and as a result of) research helping underserved communities, based on a pragmatic focus on achieving real-world benefits from digital infrastructures for healthcare.

3. References to the research

Braa, Jørn; Sahay, Sundeep; and Monteiro, Eric (2023). *Design Theory for Societal Digital Transformation: The Case of Digital Global Health*. Journal of the Association for Information Systems, 24(6), 1645-1669. DOI: 10.17705/1jais.00816. <http://aisel.aisnet.org/jais/vol24/iss6/2>

Nicholson, B., Nielsen, P., Sahay, S., & Sæbø, J. I. (2022). *Digital public goods platforms for development: The challenge of scaling*. The Information Society, 38(5), 364-376. <https://doi.org/10.1080/01972243.2022.2105999>

Roland, L. K., Sanner, T. A., Sæbø, J. I., & Monteiro, E. (2017). *P for Platform. Architectures of large-scale participatory design*. Scandinavian Journal of Information Systems, 29(2), 1. <https://aisel.aisnet.org/sjis/vol29/iss2/1/>

Henfridsson, O. & Bygstad, B. (2013). *The generative mechanisms of digital infrastructure evolution*. MIS Quarterly. 907-931. <https://www.jstor.org/stable/43826006> (Awarded MISQ Impact Award for highest 10-year impact)

Hanseth, O. & Lyytinen, K. (2010). *Design theory for dynamic complexity in information infrastructures: the case of building internet*. Journal of Information Technology. 25: 1-19.
<https://doi.org/10.1057/jit.2009.19>

Braa, J., Hanseth, O., Heywood, A., Mohammed, W., & Shaw, V. (2007). *Developing health information systems in developing countries: The flexible standards strategy*. MIS Quarterly, 381-402. <https://www.jstor.org/stable/25148796>

Hanseth, O., Jacucci, E., Grisot, M., & Aanestad, M. (2006). *Reflexive standardization: Side effects and complexity in standard making*. MIS Quarterly, 563-581.
<https://www.jstor.org/stable/25148773>

4. Details of the impact

The group - across various projects and activities in Norway and the Global South - has developed a unique international research profile but also significant practical impact. The group has engaged with practitioners in the Norwegian healthcare sector through collaborative project work, discussions, presentations of research in progress, and workshops. In particular, long-term collaborations have occurred with the IT department at Rikshospitalet (later Oslo University Hospital) since the mid-1990s, Sunnaas Rehabilitation Hospitals (since 2005) and for > 10 years also the regional Health Authority (Helse Sør-Øst RHF) which maintain Norway's largest digital infrastructure for its >80 000 employees. The regional collaboration has been significant for the region's IT strategy, reflected in the [FIGI project](#) and subsequent joint SFI application (2019), as well as collaboration on ongoing initiatives (digital homecare, AI implementation, data infrastructures). As one concrete example, the FIGI project's fundamental framework for distinguishing between 'lightweight' and 'heavyweight' IT has been taken up by many actors in the sector. This includes the Regional Health Authority, which used the framework both in its innovation strategy and its Enterprise Architecture. In general, they have worked to shift their IT strategy towards more agile and learning-oriented processes based on architecture choices that build on research-based knowledge. In addition, the framework was used in the national digital collaboration architecture developed by the Directorate of e-health. We have collaborated with Sunnaas Hospital on their development of digital services to support collaboration with the primary sector and patients at home. The research collaboration has been instrumental in giving the work legitimacy and has helped Sunaas establish a frontrunner position and spread the new service models of digital healthcare widely. Also the collaboration has been extensive around digital innovation initiatives with Østfold hospital (process innovation), Oslo Municipality (digital homecare) and AHUS hospital (digital homecare, AI implementation).

The group's research on handling complex sociotechnical infrastructures, encouraging bottom-up, user-driven, and learning-oriented approaches to the design of digital infrastructures, was also the base for group members' engagement in the broader public debates around the "One Citizen-One Record" national strategy and its implementation, (the Akson project, later Felles Kommunal Journal). A constellation of healthcare practitioners, researchers, and the IT industry was instrumental in re-directing a problematic project onto a more feasible trajectory during 2021-2023.

The open-source, web-based software platform [DHIS2](#) (District Health Information System v2) supports data collection, management, and analysis. The development started as a doctoral research project in post-apartheid South Africa in 1994 and was based on a strong commitment to participatory design and action research. Healthcare workers were included in designing systems to support their work and provide "information for action". Today, DHIS2 is the world's largest Health Information Management System (HMIS) platform used by Ministries of Health in 80

countries in the global South and by NGOs in others, totalling [123 countries](#). It is estimated that 3.2 billion people (40% of the world's population) live in countries where DHIS2 is used. The system and the associated capacity building have revolutionised the collection and use of health data in developing countries. For instance, it offers health managers access to powerful analysis tools and health workers the ability to access and capture data on mobile devices. While DHIS2 was originally tailored for the health sector, due to its generic platform architecture, it is also used in other areas, such as water, sanitation and hygiene, health logistics, education, agriculture and climate health. HISP works in partnership with national and international actors, including Norad, the Global Fund, the Gates Foundation, PEPFAR, the CDC, Gavi, Unicef, and the WHO — with a combined investment of more than USD 21 million for 2022, supporting DHIS2 software development, implementation and capacity building. Through engaged scholarship and based on interventionist and action research approaches, we have followed and built our network of partners around [design principles](#) including 1) start small and keep simple, 2) user-led design integrating research, education and implementation, 3) build local capacity for scaling and sustainability, 4) link the local solutions to the global network, and 5) promote alliances through collective action.

HISP's achievements in strengthening health information systems in low- and middle-income countries are significant on their own. In addition, HISP has allied with universities in the global south and helped build alliances between public health and informatics/computer science departments. With support from HISP, cross-disciplinary and impact-oriented teaching programs at Master's and PhD levels are established in South Africa, Mozambique, Malawi, Tanzania, Ethiopia, and Sri Lanka, and more than 60 PhD candidates at UiO and over 500 Master's students globally have graduated within the program. Over 25,000 health workers have received training in health information management through the on-site and/or online [DHIS2 Academies](#). As a result of the [UN Secretary-General's High-Level Panel on Digital Cooperation](#), the [Digital Public Goods Alliance](#) was established in 2018. The government of Norway plays a leading role in this effort to accelerate the attainment of sustainable development goals by facilitating the discovery, development, use of, and investment in digital public goods (DPG). DHIS2 has been a decisive motivation factor for this endeavour and has been promoted as an [exemplar DPG](#).

Since 2017, and renewed in 2022, the HISP Centre has been a World Health Organization (WHO) Collaborating Centre for Innovation and Implementation Research for strengthening health information systems. In this capacity, HISP partners with WHO and its Member States to strengthen Health Information Systems implementations and data use at the country level. This partnership will expand and improve the [DHIS2 Health Toolkit](#), including developing metadata packages for new health programs, implementation tools, and technical guidance for integrated routine health information systems. To date, 64 primarily low- and middle-income countries have installed standards-based metadata packages from the WHO DHIS2 toolkit with support from partners, moving towards integrated national health data platforms that serve data analysis and data use at all levels of public health services based on WHO recommended data standards. This work was also foundational in helping 60 countries rapidly adapt existing DHIS2 systems to support national disease surveillance and vaccination problems during the [COVID-19 pandemic](#).

The DHIS2 Annual Conference is the biggest HISP/DHIS2 yearly event and provides an opportunity for the global DHIS2 community to meet at UiO — a diverse group including implementers, developers, ministry representatives, technical partners, donors, and other DHIS2 experts from around the world — to meet and share experiences with DHIS2, learn about the latest developments and innovations, and make connections that can lead to new partnerships and collaborations. In 2023, the conference attracted 414 in-person participants, representing 72 different countries and 169 organisations, and additional more than 800 online participants. The programme includes the introduction of new and upcoming features from the DHIS2 core

development team, presentations by national Ministries of Health and global public health partners such as WHO and the CDC, community-driven presentations selected from an open call for presentation topics and ample opportunities to network with peers and experienced DHIS2 implementers.

5. Sources to corroborate the impact

1. Speaking at a UN event on The Future of Digital Cooperation in 2022, Norway's Prime Minister Jonas Gahr Støre praised DHIS2 as a free and open tool that revolutionises how countries can collect and use health data: <https://dhis2.org/unga-dpg-dpi-event/>
2. Norway's Prime Minister Presents DHIS2 as Leading Example of a Digital Public Good: <https://dhis2.org/new-america-digital-public-goods/>
3. DHIS2 presented at SDG Digital 2023, an event hosted by the International Telecommunication Union (ITU) and United Nations Development Programme (UNDP) as part of the UN's SDG Action Weekend, to highlight how digital solutions can help get the world back on track toward the Sustainable Development Goals (SDGs), which are now at the halfway point toward 2030. As part of the event, one impactful digital solution was chosen for each of the 16 SDGs, with DHIS2 selected to represent SDG3: health.
4. DHIS2 mentioned in the Norwegian Aid Strategy from 2022: ["Better Health, Better Lives. Combating Non-Communicable Diseases in the Context of Norwegian Development Policy \(2020-2024\)"](#)
5. The United States Centers for Disease Control and Prevention (CDC) EID Journal elaborates on how DHIS2 has been used to emplace more effective surveillance systems for COVID-19 using lessons from the Ebola outbreak: https://wwwnc.cdc.gov/eid/article/28/13/22-0711_article
6. The German Federal Ministry of Economic Cooperation and Development describes the role of DHIS2 in strengthening the health information systems in Bangladesh: https://health.bmz.de/wp-content/uploads/studies/HIS_Bangladesh_long_EN.pdf
7. HISP was awarded the University of Oslo's Innovation Prize in 2013, 2020 the [Roux Prize](#), an international award for turning evidence into health impact, and the Association of Information Systems (AIS) [Impact Award](#) in 2023 - an award that "recognizes information systems research with widespread impact on practice in business and society".
8. The practitioner-oriented book entitled ["Information Infrastructures within European Health Care: Working with the Installed Base"](#) on Springer (2017), pulling together health infrastructure studies from our European researcher network has >150,000 downloads.
9. The research conducted in the SFI Center for Connected Care resulted in the practitioner-oriented publication "Handbook in Health Innovation - Research-based tools and methods for shaping the health service of the future" in [Norwegian](#) and [English](#).
10. When the COVID-19 pandemic hit Norway in March 2020, it quickly became apparent that there were no digital health tools available to help local authorities organise their disease surveillance. The Norwegian Association of Local and Regional Authorities (KS) chose to use DHIS2, and just three months after the first COVID-19 cases were registered in Norway, KS's DHIS2 system was ready for municipalities to take into use. [By the end of 2021, more than 3,000 users in 130 municipalities were using DHIS2, registering more than 330,000 people and over 1,500,000 events.](#)