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When Stars Align. The Interactions and Transformations of e-Health Infrastructure Regimes

Ole Hanseth *

Abstract: *»Wenn sich alles fügt. Die Wechselwirkungen und Transformationen von E-Health-Infrastrukturregimen«.* I outline the shifting approaches to digital transformation of the Norwegian e-health sector from the 1970s through the lens of the multi-level perspective and its concept of sociotechnical regime. The digital transformation has taken place through the development, adoption, and use of a huge variety of IT solutions, which also increasingly have become integrated with each other into a complex national e-health infrastructure. This implies that health care institutions become interconnected and interdependent. Accordingly, digital transformation within the health sector needs to be addressed at the national or sector (or industry) level and not just at the organizational level. Digital transformation of health care involves a multitude of actors and stakeholders and is not managed in a hierarchical structure. The various actors have had different ideas and interests related to how the national e-health infrastructure should evolve and how the Norwegian health sector should be transformed. Over time, certain actors coalesce into a constellation that establishes a shared view on how the infrastructure should evolve and how the activities should be organized and governed. My focus is on the nature of different infrastructure regimes and how they interact and are transformed.

Keywords: Digital transformation, e-health, information infrastructures, sociotechnical regimes, multi-level perspective (MLP).

1. Introduction

Digital transformation has become a popular term. One reason is the fact that most organizations have adopted large numbers of IT solutions, which together supports virtually all activities within the organization as well as interactions with other organizations. In health care, there are lots of specialized solutions containing information about patients and their treatment

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supporting health care personnel's work tasks in hospitals, homes for elderly, nursing homes, General Practitioners' offices, etc., as well as collaboration and information flow between the various institutions. A large part of this information is stored in Electronic Patient Record (EPR) solutions. In addition, there are lots of instruments ranging from large X-ray machines to small sensors attached to or put inside patients' bodies, more or less all becoming digital, producing information that manually or automatically is entered into various IT solutions. For instance, this year (2022), eight hospital enterprises (in 18 physically differently located hospitals) within the south-eastern health region in Norway adopted a specialized solution (instrument and specialized medical record) for monitoring foetuses inside their mothers' uteruses. The solution is sharing data with the specialized "birth record"[1] solution, which again is sharing data with the hospitals' overall EPRs, which again share information with primary care institutions.[2] Accordingly, IT may enable not just organizational change and performance improvement within separate fields or units but change of a country's health care sector as a whole.

Based on a review of 292 information systems articles, Vial (2019) identified 23 different definitions of digital transformation. Of these only two mentioned industry or society at large as the possible scope of digital transformation. The remaining 21 linked it solely to the level of organizations. However, Vial pointed out that the scope of digital transformation should not be limited to individual organizations and defined it as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial 2019, 118). Vial's findings are consistent with that of Wessel et al.'s review published two years later. By reviewing the organizational science and information systems research literature, combined with two case studies, Wessel et al. (2021) contrast digital transformation with IT enabled organizational change, pointing out two distinctive differences: (1) digital transformation activities leverage digital technology in (re)defining an organization's value proposition or business model, while IT-enabled organizational transformation activities leverage digital technology in supporting the value proposition, and (2) digital transformation involves the emergence of a new organizational identity, whereas IT-enabled organizational transformation enhances an existing organizational identity.

Wessel et al. (2021) and Vial (2019) are becoming sort of canonical articles about digital transformation. The first has 230 Google Scholar citations less than a year after its publication, while the latter is cited 1900 times after about

[1] For normal pregnancies and deliveries, hospitals do not establish a patient record for the foetuses or babies, only the mother. But in complicated cases, they establish a special shared record for both the mother and the foetus/baby and the mother.

[2] https://www.dagensmedisin.no/artikler/2022/06/27/felles-losning-for-fosterovervakning-pa-plass-i-helse-sor-ost/ (Accessed November 2, 2022).

two years. I find, however, the perspective on digital transformation they present too narrow. First of all, even though Vial (2019) did not limit digital transformation in his definition to the level of individual organizations, the research he reviewed does. In many industries or business sectors, individual organizations are tightly integrated with each other, implying that how one individual organization may change or transform is severely constrained and shaped by the transformation of the industry as a whole. The media and advertising industries are paradigm examples of this (Lindskow 2016; Gonzalez and Gulbrandsen 2021; Alaimo 2021), and to a large extent also for, for instance, health care and banking and finance. This implies that the digital transformation of larger constellations of organizations or industries are important research objects.

Second, making the development and implementation of a new business model, identity, or value proposition a requirement for a change process to name it digital transformation out-defines many radical digital transformation processes. Large (global) oil companies and large hospitals are both using a myriad of different (but integrated) IT solutions, which are supporting virtually all work tasks and processes. Digital transformations of such organizations are important and very challenging for themselves and, accordingly, their digital transformation processes should be highly relevant cases for researchers. However, big organizations like oil companies, hospitals, public agencies, etc., rarely change their business model. Oil companies will continue producing oil (until renewable energy sources make it obsolete), and hospitals' business models will continue to be to treat patients.

Third, digital transformation is seen as a mere disruptive change that takes place within a limited period, i.e., assuming a kind of punctuated equilibrium model.[3] Large and complex organizations like those indicated above, not to mention an industry or business sector as a whole, can also go through radical and pervasive change, but that will take a long time and happen through a long series of smaller steps.

Based on my emphasis on these issues, I will use Vial's definition, but emphasising that the entity being transformed may be an industry or society as a whole just as well as an organization. I will describe and analyse aspects of the digital transformation of the Norwegian health care sector from the introduction of the first information systems around 1970 until today. Throughout its history, health care has increasingly becoming more complex: new instruments (for instance sensors and imaging instruments) are enabling new medical services and procedures (for instance robotic surgery, monitoring patients in their homes), new medical knowledge is leading to an increased degree of specialization, and more resources are being spent on patients suffering from not one but several chronic diseases (diabetes, cancer, high blood

3 Vial (2019) does not say directly that digital transformation is a disruptive process, but that "digital technologies create disruptions."

pressure, COPD, etc.) in addition to artificial implants, etc. All this requires more collaboration and sharing of patient information across professional and organizational boundaries. Virtually all activities, work tasks, and organizational processes are supported by a rapidly growing number of IT solutions. A common response to this among all European countries is to establish national strategies, architectures, and governance structures for managing the digital transformation of the health care sector at the national level as whole.

At the crossroads between research fields like science and technology studies (STS), media studies, information systems, and organization studies, the growing complexity of IT solutions and their integration across organizational borders have been addressed under the labels information, digital, or knowledge infrastructure.[4] Infrastructure research has addressed a wide range of issues, making such infrastructures different from ordinary information systems: the challenges of satisfying shared requirements of a large community of users in contrast to an organizational unit, the socio-technical complexity of standards, network effects and path-dependency, etc.

A defining feature of infrastructures is the fact that their development as well as use involves a multiplicity of independent development and user organizations (Star and Ruhleder 1996; Jackson et al. 2007; Hanseth and Lyytinen 2010). One strand of research has focused on issues related to infrastructure management – how their evolution is managed or governed when there is no manager on the top in control (Henfridsson and Bygstad 2013; Constantinides and Barrett 2015; Hanseth and Rodon 2021; Grisot, Hanseth, and Thorseng 2014; Paparova and Aanestad 2020; Kempton et al. 2020; Hanseth and Bygstad 2015; Bygstad and Hanseth 2018). This research has found that there are strong interdependencies between an infrastructure's architecture and its governance structures and that an infrastructure's evolution is not managed but rather shaped by its specific configuration of architecture and governance structure. Further, an infrastructure's architecture and governance configuration are seen as emerging rather than designed, which also means that an infrastructure's evolution and growth cause changes in its architecture (e.g., when new components are introduced, or existing ones are connected) and governance structures (as new actors are becoming involved) (Hanseth and Rodon 2021). The research present here extends this strand by adopting the concept of *socio-technical regimes* from transition studies and inquires into what kind of regimes have "controlled" the digital transformation of the Norwegian health care sector from 1970s until today, and, in particular, how regimes change.

The concept of socio-technical regimes covers the key characteristic of an industry and how an industry evolves and is transformed. In our case, we

[4] For a review, see, e.g., Plantin et al. (2016) and Lee and Schmidt (2018).

consider the totality of e-health solutions within the Norwegian health care sector as comparable to an industry or business sector, and, accordingly, that a national e-health infrastructure and its evolution can be characterised by its regime.

This research is based on data collected from 1988 until today.[5] Data about the projects have been collected primarily through interviews and documents like project plans and reports, strategy and policy documents, and, finally, by following debates in media and at conferences. Data have been collected in research projects focusing on challenges and strategies for establishing information infrastructures in general and the role of architectures and governance structures in particular.

2. Theoretical Framework

The multi-level perspective (MLP) is the dominant approach within the field of so-called transition studies, i.e., research on how industries are transformed, usually driven by the emergence and adoption of new technologies. However, I will supplement MLP with a "light" version of assemblage theory in order to pay more attention to how a technology's specific features shape a transition process.

2.1 Socio-Technological Regimes and Industry Transformations

MLP was first developed by Arie Rip and René Kemp (1998) and further developed by Frank Geels (2002). While research into many industrial transformations have been conducted, the focus has increasingly been directed towards sustainability transitions (Köhler et al. 2019; European Commission 2020; Geels et al. 2017; Geels 2011; Rip and Kemp 1998; Wang et al. 2022). It draws on a broad range of literature and combines ideas from evolutionary economics, the sociology of innovations, and institutional theory (Köhler et al. 2019; Geels 2002, 2004). MLP distinguishes three levels of analytical concepts (Rip and Kemp 1998; Geels, 2002): *niche-innovations, sociotechnical regimes*, and *sociotechnical landscapes*.

[5] During the period 1988–1992, I was involved as a practitioner in developing solutions for information exchange between health care institutions. Since 1992, I have collected data about a range of projects and activities related to the establishment of e-health infrastructures: standardization and message exchange, the development of a National EPR solution 1995–2002, various projects and activities at Rikshospitalet in Oslo from 1995 until today, National e-prescription solution from 2008, National Summary Care Record solution from 2010, the transformation of the overall IT solution portfolio in the south-eastern region of Norway from 2012, solution for patient – hospital communication, the evolution of a new minimal invasive heart surgery procedure 2012–2018, etc.

The concept of *sociotechnical regimes* is an extended version of Nelson and Winter's (1982) technological regime, which referred to shared cognitive routines in an engineering community. Sociologists of technology broadened this explanation, arguing that scientists, policy makers, users, and special-interest groups also contribute to the patterning of technological development (Rip and Kemp 1998; Bijker 1997). The sociotechnical regime concept accommodates this broader community of social groups and their alignment of activities and is defined as the rule-set or "grammar" embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems, etc.; all of them embedded in institutions and infrastructures, explaining patterned development along "technological trajectories" (Rip and Kemp, 1998, 340; Geels and Schot 2007). Sociotechnical regimes stabilise existing trajectories in many ways: cognitive routines that bind engineers to developments outside their focus, regulations and standards, adaptation of lifestyles to technical systems, sunk investments in machines, infrastructures, competencies, etc.

Technological niches form the micro-level where radical novelties emerge. These novelties are initially unstable sociotechnical configurations with low performance compared to existing technologies. Hence, niches act as "incubation rooms" protecting novelties against mainstream market selection (Kemp, Schot, and Hoogma 1998). Niche-innovations are carried and developed by small networks of dedicated actors, often outsiders or fringe actors.

The *sociotechnical landscape* forms an exogenous environment beyond the direct influence of niche and regime actors (macro-economics, deep cultural patterns, macro-political developments). Changes at the landscape level usually take place slowly (decades). The multi-level perspective argues that transitions come about through interactions between processes at these three levels: (a) niche-innovations build up internal momentum, through learning processes, price/performance improvements, and support from powerful groups; (b) changes at the landscape level create pressure on the regime; and (c) destabilisation of the regime creates windows of opportunity for niche-innovations. The alignment of these processes enables the breakthrough of novelties in mainstream markets where they compete with the existing regime.

Originally, transition studies focused on radical transformations, or "paradigm changes," of an industry as a whole, the transformation of the maritime industry from sailing ships built in wood to steam ships built in steel being a paradigm example (Geels 2002, 2005). Later, focus was expanded to include more incremental and modest transformation. Geels and Schot (2007), for instance, pointed out four such incremental transition pathways: transformation, reconfiguration, technological substitution, and de-alignment/re-alignment. Further, many recent contributions emphasize the need for a more nuanced analysis of the spatial dimensions of transition dynamics (Fuenfschilling and Truffer 2014, 2016; Fuenfschilling and Binz 2018). It is argued that transitions unfold unevenly across space and that certain countries and regions are more apt to transforming their economy than others. Further, more research has focused on issues like regimes at smaller scale like, for instance the Australian urban water sector, and competition between regimes, etc. Van Welie et al. (2018) introduced the concepts of sector regime, which may be composed by a number of service regimes and applied this distinction to the analysis of the evolution and transformation of the "splintered" sanitation regime in Nairobi.

As mentioned above, the transition studies field has increasingly turned their attention towards "grand challenges" and, in particular, sustainability transitions. This includes, for example, research on the German electricity transition, biomass district heating in Austria, and urban tram systems in France (Geels 2020). In addressing such grand challenges, the scope of issues that are playing a role in industry transitions has been expanded to include the role of politics and power; governance structures; civil society, culture, and social movements; businesses and industries geography; ethical issues like distribution, justice, and poverty; methodological issues; etc. (Wang et al. 2022). The increased attention towards sustainability transitions has also led to more focus on the interactions between a multiplicity of regimes (Geels 2018; Rosenbloom 2020).

2.2 Assemblage Theory "Light"

Langdon Winner (1993) as well as Kallinikos and Hasselbladh (2009) and Kallinikos, Hasselbladh, and Marton (2013) had forcefully argued that the social sciences do not seriously take into account the role of technology as a causal force in organizational and societal change. This is, according to Winner, the case even in STS, which claim to focus on technology and "open its black box." The same criticism can be raised against MLP. In MLP, technology is a "focal object," but the role of its specific features playing in regime transitions is not addressed. In this article, I will try to overcome this limitation by also drawing upon core concepts of Gilles Deleuze's assemblage theory, as it is presented by Manuel DeLanda (Deleuze and Guattari 1987; DeLanda 2006, 2016).

An assemblage is a composite of heterogeneous parts (which themselves are assemblages) forming a set of part-whole relationships in which the component parts may participate in other wholes. A component has both *properties* that define it and *capacities* to interact with (or affect or being affected by) other entities. An assemblage and its properties and capacities emerge from the interactions among heterogeneous parts. An entity's properties are given and may be denumerable as a closed list; its capacities are not given –

they may go unused (un-actualized) if no entity suitable for interaction is available. According to this view, the capacities to interact form a potentially open list since there is no way to tell in advance how a given entity might interact with innumerable other entities. This can be illustrated by a simple example. A human and a knife have certain properties and also capacities to interact with each other and form a man-knife assemblage. This assemblage has the capacity to interact with and cut a piece of meat, but not a stone.

Deleuze and Guattari (1987) analysed technology in a chapter on the "war machine." They started with describing a man-horse-gun assemblage where a man (soldier) has certain capacities to interact with a horse and a gun. This assemblage may interact with other man-horse-gun assemblages forming a cavalry with certain properties as well as capacities to interact with other military units forming an army. And each assemblage also has certain capacities to interact with (affect and being affected by) a military enemy.

I will in my analysis of e-health regimes draw upon these elements of assemblage theory in order to address the role of technology as a causal factor. I will also see socio-technical regimes as assemblages of assemblages where various technological and non-technological components are interacting and forming assemblages with various properties and capacities to interact.

While there is a lack of focus in the social sciences on the role of technology as a causal factor, there are exceptions. Among these was Langdon Winner's (1980) famous article about the politics of technological artifacts, arguing that the architecture of bridges on Long Island was intentionally designed so that buses (due to their height) could not pass and in that way blocking poor people's access to the beaches. Another important example was Larry Lessig's ([1999] 2006) analysis of the Internet and the role of its so-called end-2-end architecture. Based on this, he developed a (legal) theory of societal regulation, arguing that regulation is taking place through "regulatory modalities": law, technology, in particular technological architectures, social norms, and organizing (including use of market/pricing). The regulatory role of technology, primarily related to work and organizing, is also pointed out by Kallinikos et al. (2013). Together, these point to technology's architecture, and not just its functionality, as crucial in assessing its agency.

The topic of this article is on the digital transformation of the health care sector in Norway since computers were introduced into the sector. I do so by focusing on the totality of IT solutions within the sector and their integrations as an information infrastructure and its shifting regimes. In particular, I will pay attention to

- technologies involved and the role of their specific properties and capacities,
- the infrastructure's organizational and governance structures (including legislation),

- actors' involved practices, knowledge, ideas about which issues and principles are important, and
- these elements' properties and capacities to interact.

Regarding, technologies, I will look at their functionality, but first of all concentrate on their architectures in line with Lessig's ([1999] 2006) argument as well as recent research on information infrastructures (Grisot, Hanseth, and Thorseng 2014; Paparova and Aanestad 2020; Kempton et al. 2020; Hanseth and Rodon 2021).

2.3 Health Care and Socio-Technical Regimes

As far as I know, the MLP framework has been applied to neither the transformation of the IT industry or any parts of it like e-health, nor the health sector as such. However, there are a few studies of digital transformation of the health care sector at the national level. Currie and Guah (2007) studied the first four years of UK National Health Services national programme for information technology from an institutional logic perspective. They argued that the programme is struggling due to its market- and patient-choice-centred institutional logic, which conflicts with the profession-oriented and managerial logic that are dominant within the sector.

Bogumil-Uçan and Klenk (2021) conducted a comparative study of the adoption and use of Electronic Patient Records (EPRs) in Germany and Austria. They found, based on a policy-oriented research framework, that in spite of similar policies and ambitions, outcomes were very different with Austria being far more successful in reaching its goals. They explain this with the differences in the governance structures where Germany's were far more fragmented than Austria's. This led to a conflict-ridden process and, accordingly, poor results.

Øvrelid, Bygstad, and Hanseth (2017) and Øvrelid and Bygstad (2019) analysed the role of discourse in the digital transformation of the Norwegian health care sector during the period 2001–2018, drawing upon Foucault's concept of discursive formations focusing on how consensus about strategies emerges.

MLP has a lot in common with the studies mentioned here – it is inspired by institutional theory and addresses political as well as communicative issues. One important difference is, however, that MLP and transitions studies primarily focus on the long-term transformation of an industry or business sector based on the emergence and development of new technologies. Accordingly, it should be well suited for analysing the long-term digital transformation of the Norwegian health care sector. The Norwegian e-health regime can be seen as an infrastructure regime in the same way as the biomass district heating and urban tram systems in France mentioned above. Further, the research presented here focuses on digital transformation, i.e., on how the various directions the e-health infrastructure at any time is evolving along shapes the directions of the evolution of the health care sector. This means that we will look at regimes at two levels at the same time: the e-health infrastructure and the health care regimes. When the e-health infrastructure regime is transformed, the digital transformation of health care will change its direction and, accordingly, the health sector's regime as well. We will also to some extent look at the changing global IT regimes and how they are related to and interacting with the e-health regimes.

3. The Evolution and Transformation of the Norwegian e-Health Infrastructure

Norway has 5.2 million inhabitants who enjoy a high standard of living and public health services. Historically, hospitals have been owned by the 19 counties. Since 2003, however, they have been owned by the government and organised into four health organizations called Regional Health Authorities given the names Health North, Mid, West, and South-East respectively. Individual hospitals are organized into larger structures called hospital enterprises, which again are the owners of the individual hospitals.[6] The primary care sector is the responsibility of Norway's 356 municipalities where Oslo is the largest with 697,000 inhabitants and Utsira the smallest with only 192.

3.1 Evolution of the e-Health Infrastructure before 1990

Emergence and Stabilization of the Distributed/Local e-Health Regime

During the 1950s, several "punch card reading centres" were established around Norway to support the emerging automation of economic activities in the municipalities like taxation. Over the years, the centres expanded their activity and moved into health care. They started developing solutions, running on IBM mainframes, supporting economic activities, and expanding into patient administrative activities and clinical domains like outpatient clinics. KDØ (abbreviation for Kommunedatasentralen Østlandet, meaning Municipal Data Centre Eastern Norway) evolved into the largest of these centres. In 1987, they were operating a suite of applications in use by in total 25 hospitals.[7]

An important initiative was taken in 1976 by Kåre Fløisand, director of the Rationalization Directorate (R-dir), leading to the development of Patient

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[6] In Norwegian they are called "*helseforetak*." Each hospital enterprise includes several local hospitals. Before the government took over the hospitals in 2003, there were about 50 independent hospitals within the region.

[7] https://www.hamarhistorielag.no/2018/06/fra-hullkortsentral-til-teknologisenter/ (Accessed November 2, 2022).

Administrative Systems (PAS) in collaboration with Haukeland Hospital in Bergen, named NOMIS,[8] for keeping track of patient admissions and discharges and patient transfers between departments. The solution was running on the computers of the Norwegian minicomputer manufacturer Norsk Data. Its functionality was extended over the years, and it was adopted by several hospitals. After some time, it was also taken over by Norsk Data's software division.

In 1971, Intel launched the first commercially available microprocessor, leading to the development of so-called microcomputers and later PCs. This technology soon found its way into health care, leading to the development of simple solutions supporting specific clinical tasks. For instance, in 1976, a couple of IT researchers at the University of Tromsø and a couple of General Practitioners (GPs) working at a small primary care centre started the development of the first EPR system for GPs, which became known as the Balsfjord system.[9] At the children's heart section at Rikshospitalet in Oslo, they developed a solution called Berte[10] for keeping track of specific details of their patients' hearts and the thorax surgery department a solution called Datacor[11] for heart surgery patients.

In 1987, the IT department of the hospital in Bodø in northern Norway, employing two programmers enthusiastic about the future potential of networked PCs, Tor Arne Viksjø and Trond Hjortdal, the development of DIPS, a simple Patient Administrative System (PAS). The first version was in operation after less than half a year after.[12] Ever since, it has been constantly growing in terms of functionality and users as well integration with other solutions. By 1992, it had grown into an Electronic Patient Record solution in use by many hospitals. In 1997, the DIPS company was established, taking over the property rights of the software. Currently (2022), DIPS is used by all hospitals in three of the four regions in Norway. During the 1980s, many IT departments in hospitals and providers like KDØ and Norsk Data started integrating their solution using mostly proprietary communication technology.

Regime

Over the years, lots of efforts such as those mentioned were initiated at various hospitals, and a growing number of solutions were developed and used. Some of them, such as Berte and Datacor, were used only at their site of origin while others, such as NOMIS and DIPS, were adopted by other hospitals and

8 Norwegian Medical Information System.

9 https://www.utposten.no/asset/1999/1999-nr-5.pdf. The history of Electronic Patient Record Solutions in Norway is described in (Christensen 2015).

10 https://tidsskriftet.no/2015/02/kommentar/re-kjernejournalen-som-arbeidsverktoy-0 (Accessed November 2, 2022).

11 Datacor was in use at least until 2016. https://tidsskriftet.no/2021/04/debatt/krav-til-kvalitetskontroll-av-kirurgi (Accessed November 2, 2022).

12 https://www.dips.com/om-oss/historien-om-dips (Accessed November 2, 2022).

acquired by commercial companies and marketed as commercial software products. During this period, a national e-health infrastructure emerged. In 1990, it was pretty simple compared to later stages. Most solutions were extended with functionality and an increasing number became integrated with each other, represented the beginning of an infrastructure where different solutions were directly connected. However, these solutions and the others represented a loosely-coupled infrastructure where the many solutions were connected indirectly through the exchange of paper forms like lab reports and orders, admission and discharge letters, etc.

The individual solutions were managed (or controlled) by various constellations of users and developers. The solutions that did not diffuse beyond its site of development were controlled in a collaborative structure involving local users and the local IT department while solutions that were taken over by software companies were controlled by the individual companies in collaboration with users, where some of the users were seen as strategic partners and being more influential than others. This includes the collaboration between R-dir, Norsk Data, and Haukeland Hospital in Bergen regarding the NOMIS solution, DIPS, the hospital in Bodø, and KDØ at Rikshospitalet in Oslo.

There was no national coordination or governance structure involved. However, the hospitals were owned by Norway's 19 counties, and county administrations were involved in decisions about investments beyond what the hospital could afford within their ordinary budgets. The overall aim driving the efforts of this regime was to develop solutions supporting a continuously larger number of use domains and work tasks.

3.2 1990–2002: The Message Standardization Regime

Destabilization of the Distributed/Local Regime

A side-effect of the number of solutions adopted during the 1970s and 1980s was growing data redundancies and inconsistencies across the solutions. This again created a feeling of wasting resources on entering the same data into several solutions, with, at the same time, inconsistencies being able to lead to poor quality of decisions. The development of improved and more standardized computer communication technologies offered a solution to these problems as well as enabling the establishment of new and improved health care services, in particular telemedicine services like transmission of real-time multi-media data related to, for instance, minimal-invasive (peephole) surgery.

Emergence of the Message Standardization Regime

Two efforts were especially influential in shaping the adoption of communication technologies: a lab report transfer solution established by a private lab and an applied research program launched by the incumbent telecom operator, Telenor. The first effort was initiated in 1987 by Dr. Fürst's Medical Laboratory (Fürst) in Oslo, establishing a solution for transmission of lab reports (across fixed-line telephony lines) from their lab to general practitioners (GPs). The system was very simple and was developed in only three weeks by one person.

Fürst's solution proved to be a big success. It quickly became very popular among GPs and brought Fürst lots of new customers. It was an "eye opener" for the health care as well as the IT sector. Within a few years, most labs (which with a few exceptions were located within hospitals) developed or bought systems with similar functionality.

During the 1980s, Telenor, like other telecom operators, concluded that new communication technologies created opportunities for developing new telecom services for various business sectors. They considered health care a large, information- and communication-intensive sector, and, accordingly, particularly promising in this respect. After a couple of rather simple experiments, they launched a larger program called Telemedicine in Northern Norway in 1987.[13] The program focused primary on sophisticated real-time multimedia solutions. But inspired by the success of Fürst's solution and the response it created, Telenor decided to also develop a similar solution, which was first adopted by University Hospital in Tromsø and GPs in Northern Norway.

Fürst's success triggered other labs' interest in similar solutions, which again created the interest of the IT industry. Many companies saw solutions for information exchange between organizations as a big and profitable future market. Alongside the growing number of labs adopting systems for the exchange of reports, an increasing number of actors (both from health care [including individual doctors as well as hospital managers] and IT) envisioned a wider range of applications of communication technology-based services. They also agreed that standards were crucial to achieve this. However, how such standards should be settled and which requirements they should satisfy were more contentious issues.

Three approaches can be identified: First, a pragmatic approach focusing on specifying simple data structures representing the various relevant documents similar to Fürst's lab solutions and its replications. This approach was adopted by the Ministry of Health during 1988–1989 when they engaged a GP and IT consultant to work out a proposal. They specified a set of simple data structures representing documents like lab orders and reports, admission and discharge letters, prescriptions, etc. The specifications were distributed to the members of the health care and IT communities for comments.

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[13] https://www.cw.no/artikkel/offentlig-sektor/telemedisin-en-norsk-fiasko (Accessed November 2, 2022).
https://www.telenor.com/wp-content/uploads/2012/05/T93_1.pdf (Accessed November 2, 2022).

Second, Accenture[14] promoted the HL7[15] standard and a US solution based on this. HL7 was at that time defined by a recently established group of smaller US companies developing software for the health care sector.

The third approach was championed by Telenor's telemedicine program. They argued that standards should be open, i.e., open for the participation of anybody interested. Further, it should be based on the International Standardization Organization's (ISO) Open System Interconnection (OSI) suite of protocols, which all governments within the Organisation for Economic Co-operation and Development (OECD) at that time had decided should be the basis for the establishment of information infrastructures within the public sector. This position represented the standardization orthodoxy of the telecommunication industry and global standardization community.

The pragmatic approach first adopted by the Ministry was quickly "shot down." In particular, the IT unit at the Health Directorate mobilized by inviting Telenor and computer communications researchers to write a joint commentary, basically arguing that the approach taken was totally wrong because it was not aligned with strategies for developing "real" and open standards.

HL7 was met with similar arguments, particularly from Telenor. But in addition, the fact that HL7 was promoted by Accenture in combination with their marketing of an US software product played a significant role. In the late eighties, there was no Norwegian, or European for that matter, solution that could match the functionality offered by this product. This made Norwegian IT companies that wanted to enter this market afraid that Accenture "would take it all" if HL7 was widely recognized as an accepted standard. Accordingly, the Norwegian IT industry adopted Telenor's position and arguments in support of OSI standards. This was particularly the case for a joint effort, called Edimed, by Infomedica and Fearnley Data. Infomedica, established in 1989 as a merge of Norsk Data and KDØ' health care businesses, was the largest provider of IT solutions for the hospital sector while Fearnley was majority owner of one of the two dominant Electronic Patient Record (EPR) solutions for primary care. Edimed became active in working out standards specifications based on OSI and, together with Telenor, teamed up with international standardization efforts. Similar developments were also taking place in other countries.[16]

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[14] Accenture was at this time called Andersen Consulting. It changed its name to Accenture in 2001. See: https://en.wikipedia.org/wiki/Accenture (Accessed November 2, 2022).

[15] https://www.hl7.org (Accessed November 2, 2022).

[16] In 1990, the Commission of the European Community delegated to CEN (Comité Europeen de Normalization) the responsibility to take care of working out European standards. CEN established a so-called technical committee (TC/251) on March 23, 1990, dedicated to the development of standards within healthcare informatics. CEN is the European branch of ISO, and as such they had to build on existing ISO standards, i.e., OSI.

Stabilization of the Message Standardization Regime

The Ministry of Health's first initiative aiming at establishing standards was abandoned after its negative reception. However, the Ministry continued their work and established a standardization program in 1991. The same year the Ministry also, in collaboration with Norwegian Association of Local and Regional Authorities (KS), established KITH (Competence Centre for IT in Health). KITH was delegated the responsibility for standardization and the coordination of the standardization program. The head of Telenor's telemedicine program, Bjørn Engum, was hired as director. KITH quickly decided that the Norwegian standardization activities should be tightly integrated with European ones.[17] In line with this strategy, during the 1990s, the Norwegian e-health community actively participated in the European standardization efforts and set up a number of pilots aimed at establishing national infrastructures based on European standards. The adopted strategy focused on the development of standards for information exchange only. However, the strategy was also based on the assumption that software vendors would continue the development of new solutions in collaboration with users as before and that old and new solutions should implement functionality for information exchange based on the standards settled. This strategy was explicitly formulated in the Health Ministry's first IT strategy published in 1997.[18] This strategy also described aims and actions to be taken to speed up the development and use of Electronic Patient Record systems and IT services for patients.

Regime Characteristics

The new regime established in the early 1990s was characterized by a certain loose-tight combination. The infrastructure should be developed based on a network-oriented architecture, i.e., network of independent solutions sharing information through message exchange where the messages were following established international standards. Further, the development of the infrastructure was based on a governance structure where the settlement of standards was managed centrally, i.e., by KITH on behalf of the Ministry of Health. Simultaneously, the various solutions were developed according to a distributed structure where vendors developed solutions autonomously at the same time as hospitals and other health care (i.e., primary care) institutions decided independently when and if they would adopt new solutions. Telenor only played a dominant role during the formative phase of the new regime. After that, it played a role similar to any other vendor.

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17 I.e., those of CEN TC/251 mentioned in the previous footnote.

18 Mer Helse for hver bIT https://www.nb.no/nbsok/nb/edd0f5e5c6fc6dc1ef63bc16f663158b?index=1#0 (Accessed November 2, 2022).

3.3 2003–2008: Standardizing Solutions and Centralizing Control

In 2002, the Norwegian Parliament decided that the government should take over the ownership of the hospitals from the 19 counties. The most important reason was the lack of overall coordination and management leading to several shortcomings like unsustainable use of resources and poor financial management, different quality of health services depending on where in the country the citizens lived, low degree of competence development, and unclear divisions of overall responsibility (Herfindal 2008).

The decision behind the reform as well as its implementation happened very fast (Herfindal 2008; Slagstad 2012). The initiative was taken by Prime Minister and head of Labour Party Jens Stoltenberg (currently General Secretary of NATO). First, he received the support of the Labour Party's central committee, then the government, and finally the Parliament. The decision was also (quietly) supported by the top bureaucrats in the Ministry of Health and the Medical Association. The reform was pushed through without the kind of analysis that this kind of major change is supposed to be based on. Later, however, the reform had become unpopular among many politicians and health care personnel as well as patient groups. The main criticism was that too much power is gathered in the hands of "faceless bureaucrats" (Slagstad 2012) and that health care personnel and politicians, in particular at the local level, did not have the influence they should have.

All regional enterprises quickly set up a management structure, and they decided to go for a centralized IT governance structure and transfer IT personnel at the individual hospitals into a new regional IT organization. Further, they decided that the focus of standardization should be the applications, i.e., all hospitals within a region should implement the same lab system, EPR, PAS, radiology system, etc. Applications should, then, be standardized in a process where the regional enterprise signed a so-called "framework contract" with vendors after a tendering process while the individual hospitals decided when they wanted to replace their existing solutions. Then they had to choose according to the framework contracts.

Message standardization continued but now primarily within a few larger projects – two important ones were ELIN[19] and ELIN-K.[20] These projects worked on standards development as a more integrated part of the development of infrastructures providing the functionality for smooth and efficient

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19 https://tidsskriftet.no/2003/01/aktuelt-i-foreningen/elin-prosjektet-nye-losninger-elektronisk-informasjonsutveksling (Accessed November 2, 2022).
https://tidsskriftet.no/2008/05/aktuelt-i-foreningen/bedre-meldingslosninger-med-elin (Accessed November 2, 2022).
https://www.legeforeningen.no/contentassets/9030375a5fff460ea7c037ef98f90ad2/151027-allmennlegene-og-ikt.pdf (Accessed November 2, 2022).

20 https://omsorgsforskning.brage.unit.no/omsorgsforskning-xmlui/handle/11250/2487379 (Accessed November 2, 2022).

collaboration within the primary care sector and between primary care and hospitals. In addition, the Parliament decided in 2003 that a national solution for sharing information related to drug prescribing should be established. The project received generous funding from the government, but the first successful pilot was not running before 2012 and after about a billion NOK (100 million Euro) were spent. Late in this period, work also started on the establishment of a national Summary Care Record solution, which was launched in 2013.[21] The development of new (simpler) solutions for specific domains continued.

3.4 2008–2012: National Architecture

Emergence of a National SOA and Clinical Work Space Architecture

In 2004, the Health Directorate took the initiative to establish a forum called National ICT, NIKT, to facilitate coordination of IT activities between the regional enterprises. Within the framework of this institution, high-level managers from the regions – mostly from IT but also some hospital managers – met and informed each other about planned and ongoing activities, and they discussed possibilities for harmonizing and coordinating their projects and solutions. For this purpose, they established some joint projects. One such project was giving the mandate to work out a proposal for a national IT architecture for the hospital sector. Project participants were leading IT architects from the regional enterprises supplemented by some consultants. The project delivered a report in 2008, which proposed an architecture according to which the various solutions should be restructured into a Service Oriented Architecture (SOA). In addition, users should be provided coherent user interfaces to the various solutions they needed access to that would be based on portal technologies, which should provide individual users a "Role Based Clinical Work Space" (CWS).[22]

SOA had emerged as a popular approach within the global IT community since the late 1990s and appeared to be an obvious choice for the project members as well as the whole IT community within and related to the hospital sector. Portal technologies, however, had a rather turbulent history within the hospital sector.[23]

Rikshospitalet started a portal project just before the hospital reform in 2002. They had since 1995, together with the four other regional university

[21] https://tidsskriftet.no/en/2014/10/alert-informationin-norwegian-summary-care-record (Accessed November 2, 2022).

[22] https://docplayer.me/680006-Tjenesteorientert-arkitektur-i-spesialisthelsetjenesten.html (Accessed November 2, 2022).

[23] A Service Oriented Architecture (SOA) is an architectural style that focuses on discrete services instead of a monolithic design. A portal is (in this context) an IT solution put "on top" of a number of applications and giving its user a coherent interface to the underlying solutions, making them appear as one.

hospitals and an international software company, been developing an EPR solution that should give all relevant users in the hospital access to a complete medical record for all patients. In 2001, they saw that after six years of development, the solution covered only 20% of the different document forms and information of the paper record. Further, when they joined the EPR project in 1995, they identified five solutions in use storing clinical data about patients. In 2001, this had grown to more than 120. So, they concluded that the goal of the EPR project was utterly unrealistic and that they had to accept a growing variety of solutions, many of them tailored for specific specialist groups (Ellingsen and Monteiro 2003; Hanseth et al. 2006). Instead, they started working with portal technology, hoping that this could provide users unified interfaces to their solutions. This was initially a controversial initiative because the regional management found this to be in conflict with their IT strategy. However, over the years the challenges the portal project addressed were increasingly seen as important at the same time as Rikshospitalet succeeded in demonstrating the portal's feasibility. Important in this respect was the merge between the national cancer hospital, Radiumhospitalet, and Rikshospitalet in 2005. As a part of this operation, Rikshospitalet's portal solution was implemented at Radiumhospitalet in a way giving users an experience of having shared and integrated solutions. The portal team put a lot of effort into this to demonstrate the power and relevance of this technology. And they succeeded – the portal was implemented at Radiumhospitalet in very short time. This contributed substantially in making many actors within the sector see portal solutions as highly beneficial. The proposal to make portal technology a core component of the national architecture was based on this experience.

Stabilization of the SOA/CWS Architecture

The proposed SOA/CWS architecture was immediately widely accepted, and all regional enterprises started working on its implementation. Health North and Mid initiated activities related to the implementation of CWS solutions while Health West focused on how to make their portfolio of solutions more service oriented. HSE, however, embarked on a much more ambitious and challenging project.

In 2009, the Norwegian Parliament decided that Rikshospitalet/Radiumhospitalet should be merged with Ullevål and Aker Hospital into a new Oslo University Hospital, OUH (becoming the largest hospital in Europe with 24,000 employees). The new organization should have, according to the Parliament's decision, been fully operational by July 2010. This decision was made without considering IT. However, it soon became clear that the merged hospitals required a shared information space – and achieving this became extremely urgent. A project was established with the mandate of outlining alternatives for how to achieve this goal. The project recommended a portal solution.

However, due to legislation regarding public procurement, they had to run an open tendering process. And following HSE's IT strategy, they requested tenders for a solution that would satisfy the requirements of all HSE hospitals. They did so (in a hurry) by making the announcement for tenders, evaluating them, and deciding to go for a solution delivered by Orion Health from New Zealand and Logica as their local partner. The contract was signed the 17th of December 2009 (CCC [the Control and Constitution Committee] 2012, 4). The contract said that the portal solution should be fully implemented on top of the relevant solutions six months later – on the day Parliament had decided the new hospital organization should be operational.[24]

3.5 2012–2019: Centralization and Consolidation

The Destabilization of the SOA and CWS Regime

The portal implementation at OUH failed. One year after the implementation should have been completed, the project was discontinued and the contract with the vendor cancelled. This was a huge blow not only for the implementation project and the vendor, but also OUH management and HSE, as well as the Ministry of Health and the Government. When the project failed, the integration of the different hospitals had to be postponed until an alternative solution was implemented.

The establishment of OUH was a project attracting a lot of public interest – from media as well as politicians. So, the Control and Constitution Committee (CCC) of the Parliament decided to examine why the establishment of OUH so far had been a failure – i.e., why the government had failed to implement the Parliament's decision.[25] They first asked for information and explanation from the government, and then they organized a hearing in March 2012, interrogating the Minister of Health, current and previous top managers, as well as IT managers, at both HSE and OUH, the heads of the Norwegian Medical Association, the Norwegian Board of Health Supervision, etc., about why the portal project, and accordingly the merge of the hospitals, failed and its implications. This process got extensive coverage in national media, and the portal implementation project was unanimously portrayed as a huge scandal.

[24] https://www.digi.no/artikler/alle-sykehus-far-felles-brukerportal/205118 (Accessed November 2, 2022).
https://www.ntnu.no/documents/21469517/22230991/oeyvind_aassve_2.pdf (Accessed November 2, 2022).

[25] An overview of the process leading to the decision to merge the hospitals and the implementation of the decision is available in the report from parliamentary hearings that took place in 2012 and which I will describe below. See https://stortinget.no/globalassets/pdf/innstillinger/stortinget/2011-2012/inns-201112-316.pdf (Accessed November 2, 2022).
An extensive list of critical remarks on the on the decision ad its implementation is available at https://blogg.kuvas.no/wp-content/uploads/imported-media/documents/1396192936.pdf (Accessed November 2, 2022).

The project was also an object for audit by the Office of the Auditor General.[26] The focus of the members of the CCC was mainly on who had the responsibility for the failure and why HSE had decided to go for a portal solution instead of a shared implementation of the EPR solution, DIPS, used in the West and North regions and which seemed to work so well there. They were very critical about the governance model where HSE signed framework contracts with vendors (in this case Orion Health and Logica) while individual hospitals (in this case OUH) then had to choose products based on this contract. The chairman of the CCC, Anders Anundsen, concluded that "(the governance) model is […] designed for avoiding accountability" (CCC 2012, 3655).

Emergence and Stabilization of the Centralization/Consolidation Regime

After the hearing in the CCC, HSE management quickly drew some important conclusions. First of all, the concept of portal technology became a "concept non grata" – it became a synonym for scandal and a word nobody hardly dared to mention. Further, they decided in August 2012 to replace the existing EPR solutions at the merged hospitals with a shared DIPS implementation.[27] This would bring OUH one (significant) step towards a shared information space. But more had to be done. So, an alternative strategy for integrating the solutions at OUH was urgently needed. The hearing in The Control and Constitution Committee concluded that HSE management's lack of control of the portal project was the main cause of the failure. Accordingly, they decided to set up a new governance regime emphasizing more centralized control.

In December 2011, a new Director of Technology and E-health, Thomas Bagley, was hired. He did a review of the status of the IT domain and existing strategies. This was leading to consensus saying that the strategy (established in 2003) focusing on standardizing applications had not delivered. Each product had been adapted to different local needs among the hospitals, making information sharing just as challenging as if the hospitals had different products. At the same time, many hospitals were still using their old systems. The number of IT systems and applications in 2012 was reported to be around 4,000 (in 2018, 5,700 different applications were identified). The answer to the challenges was to establish a new governance regime and standardization strategy, according to which all applications, in principle, should be "consolidated," i.e., there should be one single patient record installation, one single lab system installation, etc., shared by all hospitals. In addition, they decided to implement a new shared basic IT infrastructure and outsource the IT

26 https://www.stortinget.no/globalassets/pdf/dokumentserien/2013-2014/dokumentbase_3_2.pdf (Accessed November 2, 2022). See also Rangvald Sannes http://sannes.info/web/ (Accessed November 2, 2022).

27 HSE could do this based on the "framework" contract. Decided in August 2012 to implement DIPS at OUH on the last day before the contract expired. http://admininfo.helse-sorost.no/styredokumenter_/OUS/Styresak%2056-00-2012%20Anskaffelse%20av%20DIPS%20som%20PAS-EPJ_20120810.pdf (Accessed November 2, 2022).

operations. A large programme, called Digital Renewal, was launched in 2012 to implement this strategy[28] and was planned to run until 2017 with a budget of 7 billion NOK (around 700 million Euro). It was organised and governed in a top-down structure, with a central programme board and a board for each sub-program. All boards were populated with top-level managers. All important decisions about strategy and investments were made by the board of HSE (headed by a former director of the central bank). The other three regions changed their strategy in a similar direction.

The CWS project at OUH and the hearing in the CCC were taking place at a time where IT was given a more prominent position on the political agendas. This was a consequence of more extensive use of IT within health care as well as the public sector as a whole, the rising cost related to IT and a growing feeling of an increasingly fragmented IT landscape. This was again leading to an increasingly stronger felt need for a more coordinated national governance of IT in the public sector. For instance, in 2007, a government-appointed committee with members from most parts of the public sector argued that the current state of affairs regarding IT required stronger national control over IT solutions and activities and proposed a national IT architecture and a more centralized governance structure.[29]

In 2008, the Minister of Health visited Kaiser Permanente[30] and was presented their enterprise-wide implementation of the Epic solution.[31] On his return, he appeared to have been going through an almost religious revival, totally convinced that the adoption of Epic or a similar solution would solve all fragmentation problems. His enthusiasm triggered several delegations of health managers and representatives of the e-health industry following his footsteps.[32] A department for e-health was established within the Ministry,

[28] A slightly modified and updated version of the original digital renewal strategy can be found here: https://www.helse-sorost.no/Documents/Digital%20fornying/086-2015%20Vedlegg%201%20-%20IKT-strategi.pdf (Accessed November 2, 2022).

[29] https://www.regjeringen.no/globalassets/upload/fad/vedlegg/ikt-politikk/felles_ikt_arkitektur_off_sektor.pdf (Accessed November 2, 2022).

[30] "Kaiser Permanente is an American integrated managed care consortium, based in Oakland, California, United States […] It is one of the largest nonprofit healthcare plans in the United States, with over 12 million members. It operates 39 hospitals and more than 700 medical offices, with over 300,000 personnel, including more than 80,000 physicians and nurses." https://en.wikipedia.org/wiki/Kaiser_Permanente (Accessed November 2, 2022).

[31] "Epic Systems Corporation, or Epic, is an American privately held healthcare software company. According to the company, hospitals that use its software held medical records of 78% of patients in the United States and over 3% of patients worldwide in 2022." https://en.wikipedia.org/wiki/Epic_Systems (accessed October 17, 2022). Their software product includes a comprehensive set of functions usually provided by separate solutions like EPR, lab, radiology, chart and medication solutions, etc.

[32] https://www.cw.no/artikkel/it-helse/helserush-til-san-francisco (Accessed November 2, 2022).
https://www.cw.no/artikkel/it-helse/helserush-til-san-francisco (Accessed November 2, 2022).
https://www.dagensperspektiv.no/--samhandlingsreformen-er-ingen-vidunderkur (Accessed November 2, 2022).

and the Health Directorate established a section for e-health in 2010. The latter grew until about 200 employees in 2015 and was established as a separate Directorate for e-health in January 2016.

In 2012, the Ministry of Health submitted a parliamentary notice with the title "One citizen – one medical record,"[33] outlining a vision where all medical record information about all patients should be available to all health care personnel in Norway. This vision was unanimously supported by the Parliament and the Health Directorate (later the Directorate of e-health) was delegated the task of analysing how this vision could become real. In December 2015, the Health Directorate recommended one shared national EPR solution.[34] However, all four regions argued strongly against this. They considered the complexity they were already struggling with was beyond what one can control. They all agreed that a national solution represented an unmanageable complexity, and they refused to join such a project. Based on this, the Directorate decided to concentrate on how to establish one shared solution for all of primary care, naming the envisioned solution "Akson."[35]

In June 2009, the Government launched their "Collaboration reform," which was approved unanimously by the Parliament.[36] According to this reform, which was implemented by January 1, 2012, primary care got an extended responsibility for patient care at the same time as it focused on closer collaboration between primary care and the hospital sector. This reform was facilitated by the results of the ELIN and ELIN-K projects mentioned in the previous section.

3.6 2019: Towards a Platform Ecosystem

Destabilization of the Centralization/Consolidation Regime

At the end of 2018, the Digital Renewal program was officially brought to an end. The consolidation of the EPR systems were found to be all too expensive compared to the benefits that would be achieved. Instead, they started implementing services (APIs) for queries across the different EPR installations. The

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https://www.cw.no/artikkel/sosiale-medier/slik-kan-helsefremtiden-bli (Accessed November 2, 2022).

33 https://www.regjeringen.no/contentassets/33a159683925472aa15ad74f27ad04cc/no/pdfs/stm201220130009000dddpdfs.pdf (Accessed November 2, 2022).

34 https://www.ehelse.no/strategi/en-innbygger-en-journal#Tidslinje%20med%20sentrale%20dokumenter (Accessed November 2, 2022).

35 An akson, or axon, is explained by *Wikipedia* as follows: "An axon (from Greek ἄξων *áxōn*, axis), or nerve fiber (or nerve fibre: see spelling differences), is a long, slender projection of a nerve cell, or neuron, in vertebrates, that typically conducts electrical impulses known as action potentials away from the nerve cell body. The function of the axon is to transmit information to different neurons, muscles, and glands" https://en.wikipedia.org/wiki/Axon (Accessed November 2, 2022).

36 https://www.regjeringen.no/contentassets/d4f0e16ad32e4bbd8d8ab5c21445a5dc/no/pdfs/stm200820090047000dddpdfs.pdf (Accessed November 2, 2022).

radiology solution was not functioning satisfactorily at the pilot hospital after five years and the contract with the vendor was cancelled. Instead, they decided to implement APIs just like in the EPR domain. Also, the lab project was reorganized, and a new approach was implemented. On top of this, mis-management of privacy legislation in the outsourcing project triggered a major shake-up of the IT management structure: the deputy director of HSE having a special responsibility for IT, the CTO, and the Digital Renewal program manager among others had to leave their positions. It also became widely accepted that important issues were neglected. Most important among these was the lack of attention to innovation and the potential for establishing new and improved services utilizing, for instance, mobile devices and new sensor technologies (Internet-of-Things). All this led to a consensus about the need for a new approach (Kvan 2018).

In 2019, the Directorate for e-health published a new report giving a more detailed description of how they planned to establish the Akson solution. The development and roll-out of the solution was planned to take about 10 years and cost 22 billion NOK.[37] This triggered a huge debate in the public media, in media focusing on health care an IT, at seminars and conferences, etc. A flood of heavy criticism was voiced from among others DIPS,[38] HSE,[39] The Norwegian Medical Association,[40] ICT Norway,[41] Oslo Municipality,[42] and e-health researchers.[43] Also, the quality assurance report was very critical.[44] The main criticism was that the envisioned solution was too complex and accordingly the risk of failure too high – in particular when taking the costs into account; the establishment of the solution would take too long; and it was argued strongly, in particular by the e-health research community, that the envisioned solution was based on outdated ideas – a national solution should not be established in terms of one single system delivered by one vendor, but rather as an ecosystem of one or more platforms and a number of "apps" accessing these platforms. And such an ecosystem should be established in a

37 https://www.dagensmedisin.no/artikler/2019/05/02/vil-ha-felles-journallosning-i-kommunene/ (Accessed November 2, 2022).
38 https://www.dagensmedisin.no/artikler/2019/10/09/refser-gigantisk-it-prosjekt/ (Accessed November 2, 2022).
39 https://www.dagensmedisin.no/artikler/2019/10/09/helse-sor-ost--vi-skylder-innbyggerne-losninger-sa-snart-som-mulig/ (Accessed November 2, 2022).
40 https://www.dagensmedisin.no/artikler/2019/10/09/legeforeningen--foles-veldig-rart-at-man-ikke-gjor-det-enkleste-forst/ (Accessed November 2, 2022).
41 https://www.dagensmedisin.no/artikler/2019/10/09/refser-gigantisk-it-prosjekt/ (Accessed November 2, 2022).
42 https://www.dagensmedisin.no/artikler/2019/10/29/oslo-kommune-sterkt-kritisk-til-it-milliardprosjekt/ (Accessed November 2, 2022).
43 https://www.dagensmedisin.no/artikler/2019/11/13/advarte-mot-risiko-i-journal-prosjekt/ (Accessed November 2, 2022).
44 https://www.regjeringen.no/contentassets/697dd17c89d24b1890d8eb3c511942f7/rapport-ks2-akson.pdf (Accessed November 2, 2022).

stepwise manner, building upon and improving what already exists and not by implementing a brand-new solution replacing all existing ones.

During this decade, a growing number of efforts aimed at developing and adopting solutions facilitating the delivery of primary care services remotely were initiated. The motivation was partly to save costs by making services delivery more efficient (reducing the need for visiting sick or elderly people in their homes) and by enabling elderly to stay in their homes instead of health care institutions. The solutions, called Welfare Technologies, included various instruments for measuring for instance temperature, blood pressure, lung capacity for COPD patients (spirometers), medicine dispensers, and tools for communicating with and reporting data to health care institutions. Over the years, this domain attracted a lot of IT companies (many of them start-ups) and a growing number of municipalities got engaged. While the activities were to some extent coordinated by the Directorate of e-health, in particular through the establishment of the Welfare Technology Hub for exchange of information between the new solutions and established patient record solutions, overall, this domain represented a loosely coupled innovation ecosystem. And as such, it stimulated the discussions about platforms and digital ecosystems.

The Emergence of an Ecosystem Regime

HSE hired a new CTO during the second half of 2018, announcing that the time of the big projects was over. Instead, they embarked on efforts that combined slowly restructuring their existing portfolio with innovation and the development of new services. This included the establishment of an “innovation framework” – i.e., processes and organizational structures for scaling successful local innovation across the region – and the establishment of a “platform for modern service development” in terms of simpler APIs, which enabled vendors developing new solutions to interact with core systems like the EPR and lab systems. A part of the new strategy was closer collaboration with the e-health industry regarding innovation. One important area for innovations was a highly prioritized strategic initiative aimed at developing new services described by various phrases like “digital home follow-up,” “home hospital,” and “digital out-patient clinic,” similar to the “welfare technology” solutions developed for primary care.

When the HSE gave up the consolidation of the DIPS installation, programmers involved saw that the IHE XDS technology that had been used in a project aiming to give patient access to their record could easily be used to give health care personnel access to a patient’s record documents across all installations. The Directorate of e-health became informed about this and saw that this solution could easily be integrated with the Summary Care Record solution and the Helsenorge.no patient portal and in that way give all Norwegians access to documents stored in the DIPS solutions in HSE. And as DIPS is used by all hospitals in the western and northern regions, these installations could also be integrated. Finally, this solution was modified to give GPs and personnel at hospitals access to patients' medical record documents across all hospitals (except those in the middle region). In this way, it was discovered that the existing installed base unintendedly had acquired the capacity to be rather easily extended to serve as a basis for an ecosystem-oriented strategy for the future evolution of Norway's national e-health infrastructure.

After the intense public discussion about Akson, the Ministry of Health and The Norwegian Association of Local and Regional Authorities, KS, (i.e., the association of the Norwegian municipalities and county administrations) agreed that the municipalities, being responsible for primary care, should take over the responsibility of further work related to Akson. They decided to establish a new organization for this task, named "Common Municipal Medical Record." The chairman of the board of KS made it clear that Akson had to be established based as a platform ecosystem where existing solutions should share information with hospitals as described above while a new one should be established for sharing information between primary care institutions in combination with the Welfare Technology Hub.[45]

The developments described here represent transformations towards what we see as a platform ecosystem[46] regime or a platform-oriented infrastructure (Hanseth and Bygstad 2021). However, the ecosystem is not built around a single platform, but a number of interacting ones. This infrastructure is different from that of previous regimes in the sense that information is shared through data platforms and not directly between the individual solutions. The platforms are managed and operated by the government-owned organization Norwegian Health Network. However, the functionality of the platforms is determined by the health sector collectively through a standardization body-like structure. This emerging regime is also supported by the new Minister of Health's strategy for IT in health: build on what we have, collaboration among institution in the sector, and collaboration between the sector and the e-health industry.[47]

45 https://www.dagensmedisin.no/dm-arena/arkiv/dm-arena-helsedagen-2021/ (Accessed November 2, 2022).

46 For a discussion of various definitions of ecosystem, see (Thomas and Autio 2020). What I refer to here as an ecosystem is in line with their definition: *"a community of hierarchically independent, yet interdependent heterogeneous participants who collectively generate an eco- system output"* (ibid., 220).

47 https://www.regjeringen.no/no/aktuelt/store-ambisjoner-for-e-helse/id2885941/ (Accessed November 2, 2022).

Table 1 Overview of the Various Regimes, their Emergence, Stabilization, Outcomes, and De-Stabilization

Time-period	Regime	Emergence	Stabilization	Outcomes	Destabilization
1980	Local solutions. User – developer constellations. First mainframe, then PC solutions.	The adoption of IT in all industries, also health care.	Growing number of solutions and projects.	Many applications developed and adopted.	The emergence of computer communication technology, growing redundancy and inconsistency challenges.
1990–2002	Standardization of information to be exchanged combined with development of local solutions.	Competing standardization approaches, Telenor's engagement and authority.	Ministry establishing a standardization program and KITH as responsible institutions Standardization proposal and pilot projects, CEN participation.	Some proposed standards and pilot implementations. Limited adoption of standards. Number of local applications growing. Ad-hoc integrations.	Government taking over ownership of hospitals, modest outcome of standardization strategy.
2002–2008	Regional application standards. Framework contracts. Centralizing IT organizations.	Government established regional management which decided on regional IT strategies.	Deciding on regional application standards through tendering processes and framework contracts.	Slow progress re-standardization of applications.	Increased problems re- information flow between regions and between hospitals and primary care. National project proposed architecture based on SOA and CWS.
2008–2012	Service-Oriented Architecture (SOA) and Role-based Clinical Work Space.	SOA and CWS proposal.	Proposal immediately accepted by all regions. Transformation projects started.	Slow progress, modest results.	Failure of OUH CWS project.
2012–2019	Consolidation of applications within each region. E-health Directorate working towards one national EPR solution, later one for primary care only.	Government's "one citizen – one medical record" proposal, hearing in Parliament's Control and Constitution Committee following collapse of OUH CWS project leading to delay of the establishment of OUH.	Establishment of Directorate of E-health, mandated to realize the "one citizen – one medical record" vision, establishment of the Digital Renewal program in HSE.	Eight years of analysis work on how to realize the "one citizen – one medical record" vision, few results from the Digital Renewal program.	Akson proposal "killed," Digital Renewal failure.
2019–	(Towards?) platform ecosystem.	HSE developing services (APIs) for queries across EPR (and radiology) installations, integration with Summary Care Record solution and Helsenorge.no giving patients and health care personnel access to all patient record documents.	Solution adopted by more and more users. Consensus about the ideas of platform and ecosystem as the core of new strategy.	?	?

4. Analysis and Discussion

I will now first look at the overall digital transformation of the Norwegian health care sector. I will then look more closely at how the regime transformations have taken place and finally the causality of technology in the evolution of the e-health infrastructure and its regime transformation processes.

4.1 Digital Transformation of Health Care

The historical overview of the evolution of the Norwegian e-health infrastructure should give ample evidence for the claim that the health sector has been digitally transformed in line with the definition I provided in the introduction. This transformation is pervasive, but it has taken place through a series of small steps and over a long time, where each step has been shaped by the different regimes representing the infrastructure at specific points in time, but also by the larger historical and institutional contexts. The digital transformation has happened through a combination of events:

- development of new digital instruments in combination with new medical knowledge, leading to the establishment of new services like, for instance, digital images guided surgery and the introduction of "robot surgery,"
- leading again to increased specialization among health care personnel, which again requires more collaboration among specialists, and
- requiring information sharing, and with more instruments generating more information, more information needs to be shared in more complex collaborative arrangements.

The increased specialization of health care has unfolded in parallel with the changes in the overall governance structures (the government taking over the ownership of the hospitals in 2002) and the establishment of new kinds of health care institutions. For instance, following to "collaboration reform" in 2009, which aimed at extending primary care's responsibility for patients, many municipalities collaborated in establishing what were called "district-medical centres" and "health houses" to take care of patients discharged from hospitals, but they demanded services beyond what many smaller municipalities were able to provide individually. Overall, this means that during the 50 years since the introduction of computers into the Norwegian health care sector, the sector's "socio-digital" complexity has been rapidly growing in a way where digital technologies, physical devices, practices, and organizational structures are deeply embedded into each other. And this complexity implies that the digital transformation of health care needs to be analysed at the national or sector level and not just the organizational. And it needs to be analysed in a long-term historical perspective.

The digital transformation of health care is also shaped by changes and trends outside the sector. Two such are an aging population and globalization. The first put a pressure on the raising costs of health care, which has contributed to the focus on using digital technology to establish services enabling patients to receive services remotely in their homes. The latter means people are traveling more and need increasingly to be provided services outside their home country, which again requires information sharing across national borders as reflected in the EU's proposed new regulation of "The European Health Data Space."

4.2 The Anatomy of Regimes' Rises and Falls

I will now look a bit more closely at regime change – how an existing regime is destabilized and a new emerges and stabilizes. We see that a regime is stabilized by a mix of factors: new technologies, organizational change, the evolution of the e-health infrastructures themselves, and, not the least, special events.

Destabilization Processes

In the transformations, we see that destabilization of existing regimes unfolded through very different processes. Around 1990, the existing regime was destabilized by the interaction between a mix of different elements. The existing regime had been very successful in developing a wide range of solutions. However, over time this also caused an increasing degree of redundancies and inconsistencies. Emerging communication technologies offered a solution to this problem as well as opportunities for new solutions and services, like for instance telemedicine as well as new business opportunities for the e-health industry.

The destabilization of the existing regime in 2002 was of a very different nature: an external shock – the government takeover of the hospitals and the establishment of regional enterprises with their management structures and regional focus.

In 2008, the regime was destabilized by what may be characterized as a mere small internal event coming out of ordinary ongoing activities within the existing regime, i.e., ongoing discussions about how to continuously coordinate the evolution of the e-health infrastructures of the regional enterprises, leading to the report proposing a SOA and CWS (portal) based architecture. Since its establishment in 2003, NIKT had achieved a high degree of legitimacy since its board and management were populated with high level general and IT managers from the regions. At the same time, the national architecture project also included representatives from the regions that were seen as the most competent IT experts.

In 2012, the existing regime was destabilized by an internal shock, the failure of the CWS project, which instantly escalated to a big political scandal. Finally, in 2019, the regime was destabilized by the failure of the Digital Renewal program combined with a broad public debate about strategies for the future evolution of the national e-health infrastructure – a debate which again was heavily influenced by global trends related to platform ecosystems.

When a regime is destabilized, is it because it is not "suitable" for the task? That a reverse salient (Hughes 1987) has emerged and that the regime is not able to make the infrastructure evolve as desired? When the existing regime was destabilized in 1990, that was clearly the case. And so also around 2018. The destabilization of the existing regime in 2012, however, I would argue was not because the SOA/CWS strategy was wrong. Rather the opposite. The strategy was sound, but the CWS project failed for a whole series of interacting factors:

- The merge of the hospitals and the timeline for how this should happen was decided on without taking into the account the need of a shared information space and what was required to establish this. And when the HSE management, government, and finally the Parliament had made the decision, everybody thought they had to accept it even though many knew it was unrealistic. This created a time pressure on the exploration of alternatives for how to establish the shared information space, as well as the requirement specification and implementation processes.
- The framework contract strategy was inappropriate for this task. This required that they should specify the requirements of a solution that would satisfy all hospitals within HSE. To do so for a technology being as immature as portal technologies still was a risky project. The requirement specification and tendering phase would have been simpler if concentrated only on OUH's urgent needs.
- All with competence on portal technologies were considered to have too close relations to the vendor that had taken over the property rights of the portal developed and used at Rikshospitalet/Radiumhospitalet and that was competing for the contract. Accordingly, the requirement specification process and the evaluation of the tenders had to be carried out by people with limited knowledge about portal technologies.
- Orion did not know anything about the Norwegian health care sector, nor did their local partner Logica.

So, while the strategy can very well be seen as appropriate for the task, when the project had failed so miserably and created such a big political scandal, it was too time-consuming and too politically risky to start yet another tendering process.

Emergence of New Regimes

Just as in the destabilization of existing regimes, new ones also emerged in different ways, and the emergence of a new regime was shaped by the way the existing regime was destabilized. Around 1990, the emergence of communication technology and how this technology came to be seen both as a solution to the redundancy and inconsistency problems, but also enabling new services, triggered many members of the IT-industry to engage in the discourse on how new solutions, and in particular standards, should be established. And we see that Telenor played a major role in the emergence of the new regime. They did so partly because of their engagement and partly because they were seen as standardization experts due to the importance of standards throughout the long history of telecommunication. Telenor played, in my view, a key role in the process leading to the establishment of a regime base of the settlement of standards in line with the traditional formal standardization approach of the telecom industry instead of a more practical approach like the one first adopted by the Ministry of Health, and which was followed in the most innovative and successful initiatives later on (Hanseth and Bygstad 2014).

The government's establishment of the regional enterprises and their governance structures and the focus of the efforts related to e-health infrastructures changed the scope regarding standardization from national to regional level, relegating primary care and communication between primary care and hospitals more into the background. This new and central role of regional management also implied that the new regime was dominated by a managerial approach rather than the engineering approach that was dominant in the formal standardization regime between 1990 and 2002.

The new regime that emerged after the release of the document outlining a national SOA/CWS architecture was extensively shaped by the fact the IT architects, after a long process, had ended up in a position where their world view, i.e., ideas about how the national e-health infrastructure should be structured and evolve, had been granted a very high degree of legitimacy, and accordingly their world view shaped the new regime.

In 2012, the emergence of the new regime was heavily influenced by the political context of the CWS project failure and the way it was framed in the parliamentary hearings in the CCC. Here, the committee's position was that the lack of top management control and clear responsibilities were the main source of the failure combined with the fact that HSE had chosen a solution different from the other regions. This led to the emergence of a new regime dominated by the regions' top management.

In 2019 the poor outcome of the Digital Renewal program, including the privacy scandal, in combination with the rising cost estimates of Akson triggered a huge public debate where the e-health researcher community became actively involved and had significant impact on the discussions and the emerging consensus about seeing the “consolidation” and Akson approaches as outdated and that e-health infrastructures should be built as concepts of platform ecosystems.

Stabilization of New Regimes

Looking at the regime transformations, we see that in some of the cases, key actors in the emergence and shaping of a regime may be different from those playing key roles when new regime stabilizes. Around 1990, for instance, Telenor heavily influenced the emerging regime without being much involved later on. The key players in the new regime became, first of all, KITH with the responsibilities and legitimacy it was delegated from the Ministry of Health, in collaboration with the Norwegian e-health industry and voluntary user participants in the standardization committees and pilot projects. The new regime that emerged around 2002 was primarily established by the regional management, which also played the role during the regime’s lifetime. In 2008, IT architects played a key role in the destabilization of the exiting regime and the emergence of a new one while regional management continued in its dominant role when the new regime was in place. And the same happened in 2012: The CCC played an important role in the emergence of a new regime. However, their involvement lasted only for a short episode.

4.3 Technological agency: Installed Base and “The Geology of IT”

I will now look a bit closer at the role of technology in the evolution of the Norwegian e-health infrastructure and the regime transitions by drawing upon assemblage theory’s concept of (an assemblage’s) capacities to interact (or affect and being affected).

The emergence of computer communication technologies triggered, as mentioned in section 3.2, the emergence of telemedicine services where, for instance, a remote expert could participate in diagnosing a patient. And digital technologies also interact with other technological and non-technological elements forming more complex assemblages. For instance, a patient suffering from aortic stenosis may get a new artificial aortic valve (regulating the flow of blood between the heart and the aorta) which is implanted when a cardiologist is operating a catheter, inserting it into the patient’s artery through a small incision in her groin, leading it to the patient’s heart and releasing the valve in its correct position guided by images produced by digital laparoscopy (live x-ray images).[48] In this case the digital imaging technology is enabling the performance of this procedure by exercising its capacities to interact with the patient, the cardiologist controlling the catheter, and the

[48] For an assemblage theory description and analysis of this procedure, see (Hanseth, Masovic, and Mørk 2019).

valve at the same time as the other components are exercising their capacities to interact with each other.

Technology not only interact with other technological or non-technological components at certain moments – existing technology also interact with actors developing new technologies. This is in particularly the case for infrastructures which evolves over long time. An infrastructure as it is at a certain point in time, its installed base, has certain capacities to interact with, or being affected by, certain actors and their strategies for changing the infrastructure. Both the infrastructure as a whole as well as individual components will always have some capacities for including additional components. And the Norwegian e-health infrastructure has constantly been growing in terms of new functionality being offered and components included (as illustrated by the more that 5.000 solutions in use in HSE in 2018).

The existing infrastructure, especially its architecture, has embedded certain capacities constraining its ability to be changed in the direction the strategies of the various regimes have aimed at. This was the case regarding the message standardization regime during the 90s, the application standardization regime during 2002-2008, the installed base at OUH did not have the capacity to be integrated with the Orion portal technology, and the HSE's infrastructure did not have to capacity to be consolidated – at least not for an affordable cost.

On the other hand, when the HSE gave up the consolidation of the DIPS installation, the transformation towards a platform ecosystem regime were driven by the capacities to interact the actors involved discovered that the installed base, the IHE XDS document exchange technology, the DIPS installations, the Summary Care Record, the e-prescription solution, the Helsenorge.no portal, had. In this way, it was discovered that the existing installed base unintendedly had acquired the capacity to be rather easily extended to serve as a basis for an ecosystem-oriented strategy for the future evolution of the Norway's national e-health infrastructure. And the regime of this platform ecosystem-oriented infrastructure is largely determined by its installed base as it was around 2020.

Many theories from the social sciences have successfully been adopted to help understand processes related to how IT solutions are developed, implemented into user organizations, and contributing or leading to organizational change. I think, however, that concepts and theories from geology also can be uses, at least as metaphors, to help use capture core issues in the way information infrastructures evolve and contributes to digital transformation. A typical geological phenomenon is water flowing downhill, following the landscape, creating creeks and rivers, transporting sand which is left where the landscape flattens. Over the years sediments of sand are laying upon each other, turning into rock. In the domain of IT, regimes can be seen as a landscape determining the directions individual solutions are evolving and which other solutions they become integrated with, i.e., layered on top of. And over the years, sediments of IT solutions are put on top of each other and gradually turned into "stone" and becoming almost impossible to change. On the other hand, rock is a solid foundation for raising houses and other physical constructions. And so also a "rock solid" installed base on IT solutions.

The history of DIPS, now the EPR used by all hospitals in three of the four regions in Norway, can also be seen as an example of "the geology" of IT, starting out as a simple Patient Administrative System (PAS) with limited functionality in 1987. Ever since, it has been constantly growing in terms of functionality and users as well integration with other solutions, based on decision decisions taken in the beginning regarding data structures, architecture, and development tools like programming language taken in the early days. Over the years, it became clear that future development of the system required a major restructuring and in 2011 this task was undertaken. Already in 2016 the development costs had exceeded one billion NOK (100 million Euro).[49] However, the complexity of the software and the challenges in redesigning it was beyond expectation and large-scale replacements of the old version started first this year (2022).

4.4 Multiplicity of Regimes; Overlapping, Supporting, Competing

I have outlined the historical evolution of e-health infrastructures in Norway as a sequence of phases, each being characterized by a specific regime. However, these infrastructures and their regimes did not exist in isolation – at any time, there is a multiplicity of infrastructures and regimes. Each infrastructure and regime is overlapping with, connected to, supporting, and being supported by others. Regimes may also be competing with each other. For instance, the Norwegian e-health regime is related to the health care or medical regimes, i.e., how the health care sector is organized, i.e., which institutions exists and how are they managed, how they interact, the emergence and evolution of medical specialities and how they are certified, etc. We can also talk about different health care regimes – the hospital sector regime (where the institutions are owned by the government) and the primary care regime (where the institutions are owned by the municipalities). These regimes are linked together in a way where each element is providing services to others. They are linked in into a symbiosis in Geel's (2018) vocabulary. They are also linked through legislation regulating, for instance, the responsibilities of the municipalities and the hospitals as well as the individual health care worker, and through a licencing system regulating the requirements for becoming a medical specialist (which is managed by the Norwegian Medical Association).

49 https://www.dagensmedisin.no/artikler/2016/02/22/norsk-helsepersonell-utvikler-it-systemer-i-verdensklasse/ (Accessed November 3, 2022).

Norwegian e-health regimes are also related to the overall regimes in the IT sector. Historically, we can say that the IT sector has evolved through a series of regimes characterized by specific computing technologies: mainframes, PCs, networks, and today's emerging cloud-based platform regime. Mainframes were expensive to buy and operate; accordingly, they were controlled by user organizations' central IT departments and mostly supporting administrative functions. PCs, on the other hand, were cheap and easy to operate, and, accordingly, stimulated the development of a plethora of locally developed and used solutions. This also happened within health care. It all started when the large hospitals bought mainframes and developed solutions supporting primarily administrative tasks. With the arrival of the PC, things changed and lots of simple solutions supporting various work tasks, like the Berte and Datacor solutions mentioned above and the early versions of DIPS. Solutions like these were often developed and adopted "under the radar" (Grisot et al. 2014) of hospital management. Because of the low costs compared to mainframes and mainframe solutions, the costs could be covered by the local budget of smaller units, as a part of research grants, or, for instance, projects funded by patient associations like the Norwegian Cancer Association or the National Association of Heart and Lung Diseases.

The arrival of networking technology brought the integration and information sharing within and across organizational and geographical borders into focus, which again generated a need for structures and mechanisms to be coordinated activities across all levels. Recently, the symbiotic emergence and evolution of cloud technology and platform ecosystems have been a dominant trend within the IT field. So far, the impact of this trend within health care has been modest. It has, however, been important in what I see as the latest and ongoing regime transition in Norway. The solutions developed and introduced recently to support remote (home) monitoring and the follow-up of patients are also cloud-based. The same has been the case for solutions established in a hurry to support the tracking of COVID-19 infections in 2020. The fact that these solutions are cloud-based, and accordingly need not to be implemented on the health care organizations basic IT infrastructure, has made in much easier, quicker, and less costly to adopt the solutions. However, this moves control away from the IT departments and more towards constellations of users and vendors as was the case during the PC era.

4.5 Digital Transformation of Industries

The research presented here should demonstrate the relevance of research on the long-term transformation of industries. And this argument is also supported by three notable recent contributions – Alaimo's (2021) research on the transformation of the global advertising sector, Scott and Orlikowski's (2022) research on the transformation of the global book publishing industry, and Gonzales and Gulbrandsen (2021) research on the Norwegian newspaper industry. This research shows that the digital transformation of industries varies a lot and it is difficult to point out what one industry can learn from others. We see, based on the research mentioned above and other research, that there are different characteristics that make a difference. For instance, what we can call the information or bit industries like media, finance, and advertising goes through different and more radical digital transformations compared to the "heavy asset" industries like oil and gas. We also see that different digital technologies are playing different roles across industries. One issue that seems to matter is to what extent an industry is consumer-oriented. We see that that many industries were using computer communication technology extensively before the diffusion of the Internet took off outside academia (and the military) during the eighties,[50] and that the Internet has not contributed to a radical transformation of these organizations compared to others. However, the Internet has had a huge impact and contributed to digital transformation at the societal level, primarily, by bringing individual consumers or citizens online. And this has led to a radical digital transformation of industries like the media, banking, airline booking, and online shopping, not to mention social media.

This article started out with the argument that all business sectors and industries are adopting more and more IT solutions that are increasingly integrated within as well as across organizational borders, making the digital transformation of one organization increasingly dependent on the digital transformation of the industry as a whole. While this is the general picture, there are, of course, huge varieties. While the industries mentioned above are examples of rather tightly integrated ones, others, like restaurants, are certainly different. However, even restaurants are becoming more digital and digitally integrated as they are adopting shared platforms offering integrated services for booking, ordering, and payment.

While comparing digital transformation of different industries is highly relevant, it might be more so to explore the similarities and differences between digital transformation at the organizational level. One important difference is different levels of complexity. Another that might be more fruitful to address is differences in lack of hierarchical control. This means that the evolution of the industry wide information infrastructure as well as industry transformation processes will be shaped by the interactions between the infrastructures' architecture and organizing structures. I believe the concept of sociotechnical regime (extended with concepts from assemblage theory to allow for a more careful treatment of technology's causality) as it has been used in this article is a fruitful approach to these issues.

[50] For instance, the SABRE airline booking systems were available to American Airline's ticketing offices already in the 60s, and the SWIFT network for interbank transfers was in operation in the mid-1970s.

Institutional theory has long been popular in IS and organization studies and Alaimo (2021) used the concept of institutional field in her analysis of the transformation of the advertising industry. This concept has a lot in common with the concept of regime and MLP. However, there are a few differences that I believe "make a difference." First of all, MLP focuses explicitly on technology and technology driven industry transformation (with the limitations mentioned above). In addition, the focus on regime interactions in transformation processes now emerging in research on sustainability transitions appear to be highly relevant for analysing industry level digital transformation, as demonstrated in my analysis above of the interactions between changing global IT regimes, the Norwegian e-health infrastructure regimes, and the health care regimes combined with the interactions between different regimes within each of these domains. Institutional theory, on the other hand, tends to focus more on stability and conflicting logics.

5. Conclusion

I have in this article outlined the shifting approaches to digital transformation of the Norwegian e-health sector through the lens of the multi-level perspective and its concept of sociotechnical regime. The digital transformation has taken place through the development, adoption, and use of – over time – a huge variety of IT solutions that also increasingly have become integrated with each other. These transformation processes have involved a multitude of actors and stakeholders – medical personnel, IT personnel employed by health care institutions, IT vendors, politicians, health care bureaucrats and managers, etc. The various actors have had different ideas and interests related to how the national e-health infrastructure should evolve. And we have seen that over time, certain actors coalesced into constellations that established a shared view on how the infrastructure should evolve, the aims that one should strive for, what the core technologies are, the critical challenges to be addressed and resolved, the infrastructures overall future architecture, the steps that should be taken to make the infrastructure evolve in the desired direct, how the activities should be organized and governed, etc. All these elements form a whole, which is captured by the concept of regime.

The nature of the health care sector as well as its e-health infrastructure has changed during the period described in this article: both have become more complex and embedded into each other. This implies that the challenges related to the digital transformation has changed and, accordingly, different regimes would be fit for task at different times. The infrastructure's regime should ideally, then, change in a way so that it is at any time "aligned with" the state of affairs in the health care sector and its infrastructure. We have portrayed the evolution of the national e-health infrastructure's regime as going through six transformations where the existing regime is destabilized and a new one emerges and get stabilized. And we have seen that these transformations unfold in many different ways. Some transformation happens rather abruptly while other transformation processes – both the destabilization of the existing as well as the emergence and stabilization of a new regime – takes place over a longer period of time. Some issues are involved in more or less all: the evolution of the infrastructure and the health care sector generates new challenges and new technologies offer new opportunities for addressing the challenges. But we have also seen that each transformation is in many ways unique. In all transformations there are specific and situated events taking place that play a critical role in the transformation. Further, we have seen that the interaction of the status of the health care sector and the services delivered, the status of the infrastructure, new technologies becoming available, *and specific events* bring new (constellations of) actors into the "arena." Further, some of these actors emerge as dominant and are shaping the emerging regime with their world view. The role of Telenor with its emphasis on formal standards around 1990, the regional management in 2002, IT architects in 2008, the Parliament's Control and Constitution Committee in 2012, and the e-health research community in 2020 illustrate this. How and when a regime transformation takes place is the outcome of when and how certain "stars" align.

References

Alaimo, Cristina. 2021. From People to Objects: The digital transformation of fields. *Organization Studies* 43 (7): 1091-1114.

Bijker, Wiebe E. 1997. *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*. Cambridge, MA, and London: MIT Press.

Bogumil-Uçan, Simon, and Tabja Klenk. 2021. Varieties of health care digitalization: Comparing advocacy coalitions in Austria and Germany. *Review of Policy Research* 38 (4): 478-503.

Bygstad, Bendik, and Ole Hanseth. 2018. Transforming Digital Infrastructures Through Platformization. *Research Papers* 74. https://aisel.aisnet.org/ecis2018_rp/74 (Accessed September 07, 2022).

CCC (the Control and Constitution Committee). 2012. Innstilling fra kontroll- og konstitusjonskomiteen om sak om deler av omstillingen ved Oslo universitetssykehus. https://www.stortinget.no/globalassets/pdf/referater/stortinget/2011-2012/s120530-ny.pdf (Accessed September 07, 2022).

Christensen, Tom. 2015. Fra da til nå - den lange historien om elektronisk pasientjournal i legekontor. *Norsk forening for allmennmedisin Referansegruppen for EPJ og elektronisk pasientjournal i legekontor. Den norske legeforening*. https://www.legeforeningen.no/contentassets/9030375a5fff460ea7c037ef98f90ad2/151027-allmennlegene-og-ikt.pdf (Accessed September 07, 2022).

Constantinides, Panos, and Michael Barrett. 2015. Information Infrastructure Development and Governance as Collective Action. *Information Systems Research* 26 (1): 40-56.

Currie, Wendy L., and Matthew W. Guah. 2007. Conflicting institutional logics: a national programme for IT in the organisational field of healthcare. *Journal of Information Technology* 22 (3): 235-247.

DeLanda, Manuel. 2006. *A new philosophy of society: Assemblage theory and social complexity.* London: Bloomsbury Publishing.

DeLanda, Manuel. 2016. *Assemblage theory.* Edinburgh: Edinburgh University Press.

Deleuze, Gilles, and Felix Guattari. 1987. *A thousand plateaus: Capitalism and schizophrenia* [Trans. Brian Massumi]. Minneapolis, MN: University of Minnesota Press.

Ellingsen, Gunnar, and Eric Monteiro. 2003. A Patchwork Planet Integration and Cooperation in Hospitals. *Computer Supported Cooperative Work (CSCW)* 12: 71-95.

European Commission, Directorate-General for Research and Innovation, Frank W. Geels. 2020. *Transformative innovation and socio-technical transitions to address grand challenges*. Publications Office, May 25. doi: 10.2777/967325.

Fuenfschilling, Lea, and Christian Binz. 2018. Global socio-technical regimes. *Research Policy* 47 (4): 735-749.

Fuenfschilling, Lea, and Bernhard Truffer. 2014. The structuration of socio-technical regimes - conceptual foundations from institutional theory. *Research Policy* 43 (4): 772-791. doi: 10.1016/j.respol.2013.10.010.

Fuenfschilling, Lea, and Bernhard Truffer. 2016. The interplay of institutions, actors and technologies in socio-technical systems–an analysis of transformations in the Australian urban water sector. *Technological Forecasting and Social Change* 103: 298-312. doi: 10.1016/j.techfore.2015.11.023.

Geels, Frank W. 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy* 31 (8-9): 1257-1274.

Geels, Frank W. 2004. From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy* 33 (6-7): 897-920.

Geels, Frank W. 2005. The dynamics of transitions in socio-technical systems: A multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930). *Technology Analysis and Strategic Management* 17 (4): 445-476.

Geels, Frank W. 2011. The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions* 1 (1): 24-40. https://www.sciencedirect.com/science/article/pii/S2210422411000050 (Accessed September 07, 2022).

Geels, Frank W. 2018. Low-carbon transition via system reconfiguration? A socio-technical whole system analysis of passenger mobility in Great Britain (1990–2016). *Energy Research and Social Science* 46: 86-102.

Geels, Frank W. 2020. Transformative innovation and socio-technical transitions to address grand challenges. *European Commission R&I Paper Series, Working Paper 2*. https://euagenda.eu/upload/publications/transformative-innovation-and-socio-technical-transitions-to-address-grand-challenges.pdf (Accessed November 2, 2022).

Geels, Frank W., and Johan Schot. 2007. Typology of sociotechnical transition pathways. *Research Policy* 36 (3): 399-417.

Geels, Frank W., Benjamin K. Sovacool, Tim Schwanen, and Steve Sorrell. 2017. The Socio-Technical Dynamics of Low-Carbon Transitions. *Joule* 1 (3): 463-479.

Gonzales, Jakoba S., and Magnus Gulbrandsen. 2021. Innovation in established industries undergoing digital transformation: the role of collective identity and public values. *Innovation: Organization and Management* 24 (1): 201-230. doi: 10.1080/14479338.2021.1938578.

Grisot, Miria, Ole Hanseth, and Anne Asmyr Thorseng. 2014. Innovation Of, In, On Infrastructures: Articulating the Role of Architecture in Information Infrastructure Evolution. *Journal of the Association for Information Systems* 15 (4): 197-219. doi: 10.17705/1jais.00357.

Hanseth, Ole, and Bendik Bygstad. 2015. Flexible generification: ICT standardization strategies and service innovation in health care. *European Journal of Information Systems* 24: 645-663.

Hanseth, Ole, and Bendik Bygstad. 2021. *Managing IT in large organizations as Platform-oriented Infrastructures. A Norwegian e-Health Case*. Working Paper of Information Systems Group, Department of Informatics, University of Oslo, February 2021, Oslo. https://www.researchgate.net/publication/354435940_Managing_IT_in_large_organizations_as_Platform-oriented_Infrastructures_A_Norwegian_e-Health_Case.

Hanseth, Ole, Edoardo Jacucci, Miria Grisot, and Margunn Aanestad. 2006. Reflexive standardization: Side effects and complexity in standard making. *MIS Quarterly* 30 (SI): 563-581.

Hanseth, Ole, and Kalle Lyytinen. 2010. Design theory for dynamic complexity in information infrastructures: the case of building internet. *Journal of Information Technology* 25 (1): 1–19.

Hanseth, Ole, Jasmina Masovic, and Bjørn Erik Mørk. 2019. The Dynamics of Complex Sociomaterial Assemblages. In *Organizing for the Digital World.* Lecture Notes in Information Systems and Organisation, ed. Frerico Cabitza, Carlo Batini, and Massimo Magni. 28: 247-263. Springer, Cham. doi: 10.1007/978-3-319-90503-7_19.

Hanseth, Ole, and Joan Rodon Modol. 2021. The Dynamics of Architecture-Governance Configurations: An Assemblage Theory Approach. *Journal of the Association for Information Systems* 22 (1): 130-155. doi: 10.17705/1jais.00656.

Henfridsson, Ole, and Bendik Bygstad. 2013. The Generative Mechanisms of Digital Infrastructure Evolution. *MIS Quarterly* 37 (3): 907-931.

Herfindal, Sturla. 2008. *Veien frem til sykehusreformen – En studie av beslutningsprosessen bak lov om helseforetak*, ATM – Skriftserie, Nr. 2, Rokkansenteret.

Hughes, Thomas P. 1987. The Evolution of Large Technical Systems. In *The Social Construction of Technological Systems*, ed. Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch, 51-82. Cambridge, MA: MIT Press.

Jackson, Steven J., Paul N. Edwards, Geoffrey C. Bowker, and Cory P. Knobel. 2007. Understanding infrastructure: History, heuristics, and cyberinfrastructure policy. *First Monday* 12 (6). doi: 10.5210/fm.v12i6.1904.

Kallinikos, Jannis, and Hans Hasselbladh. 2009. Work, control and computation: Rethinking the legacy of neo-institutionalism. *Research in the Sociology of Organizations* (27): 257-282.

Kallinikos, Jannis, Hans Hasselbladh, and Attila Marton. 2013. Governing social practice. *Theory and Society* 42 (4): 395-421.
Kemp, René, Johan Schot, and Remco Hoogma. 1998. Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management, *Technology Analysis and Strategic Management* 10 (2): 175-198. doi: 10.1080/09537329808524310.
Kempton, Alexander M., Miria Grisot, Kristin Brænden, and Marguun Aanestad. 2020. Infrastructural Tuning in Public-Private Partnerships. In *Proceedings of the 28th European Conference on Information Systems (ECIS)*, An Online AIS Conference, June 15-17.
Köhler, Jonathan, Frank W. Geels, Florian Kern, Jochen Markard, Anna Wieczorek, Floortje Alkemade, Flor Avelino, et al. 2019. An agenda for sustainability transitions research: State of the art and future directions. *Environmental Innovation and Societal Transitions* 31: 1-32.
Kvan, Ole J. 2018. *Veien videre for Helse Sør-Øst?* Presentation at FIGI seminar on Local and Regional Innovation: Balancing lightweight and heavyweight IT. University of Oslo, May 4th, 2018.
Lee, Charlotte L., and Kjeld Schmidt. 2018. A Bridge Too Far? Critical Remarks on the Concept of "Infrastructure" in Computer- Supported Cooperative Work and Information Systems. In *Socio-Informatics*, ed. Volker Wulf, Volkmar Pipek, Dave Randall, Markus Rohde, Kjeld Schmidt, and Gunnar Stevens, 177-218 Oxford: Oxford University Press.
Lessig, Lawrence. (1999) 2006. *Code and other laws of cyberspace*. New York: Basic Books.
Lindskow, Kasper. 2016. *Exploring Digital News Publishing Business Models: A Production Network Approach*, PhD diss., Copenhagen Business School. PhD series No. 07.
Nelson, Richard R., and Sidney G. Winter. 1982. *An Evolutionary Theory of Economic Change*. Cambridge, MA: Harvard University Press.
Paparova, Dragana, and Marguun Aanestad. 2020. *Governing Innovation in E-Health Platform Ecosystems – Key Concepts and Future Directions*. Selected Papers of the IRIS, Issue Nr 11 (4). https://aisel.aisnet.org/iris2020/4 (Accessed Sep-tember 07, 2022).
Plantin, Jean-Christophe, Carl Lagoze, Paul N. Edwards, and Christian Sandvig. 2016. Infrastructure studies meet platform studies in the age of Google and Facebook. *New Media and Society* 20 (1): 293-310.
Rip, Arie, and René Kemp. 1998. Technological change. In *Human choice and climate change, Vol. II, Resources and Technology*, ed. Steve Rayner and Elizabeth L. Malone, 327-399. Battelle Press.
Rosenbloom, Daniel. 2020. Engaging with multi-system interactions in sustainability transitions: A comment on the transitions research agenda. *Environmental Innovation and Societal Transitions* 34: 336-340.
Scott, Susan, and Wanda Orlokowski. 2022. The Digital Undertow: How the Corollary Effects of Digital Transformation Affect Industry Standards. *Information Systems Research* 33 (1): 311-336.
Slagstad, Rune. 2012. Helsefagets strateger. *Tidsskrift for den Norske Legeforening* 132: 1479-1485.
Star, Susan Leigh, and Karen Ruhleder. 1996. Steps toward an ecology of infrastructure: Design and access for large information spaces. *Information Systems Research* 7 (1): 111-134.

Thomas, Llewellyn D. W., and Errko Autio. 2020. Innovation Ecosystems in Management: An Organizing Typology. In *Oxford Research Encyclopedia, Business and Management*, ed. Ramon J. Aldag, 204-228. Oxford: Oxford University Press.

van Welie, Mara J., Pauline C. Cherunya, Bernhard Truffer, and James T. Murphy. 2018. Analysing transition pathways in developing cities: The case of Nairobi's splintered sanitation regime. *Technological Forecasting and Social Change* 137: 259-271.

Vial, Gregory. 2019. Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems* 28 (2): 118-144.

Wang, Cheng, Tao Lv, Rongjiang Cai, Jianfeng Xu, and Lya Wang. 2022. Bibliometric Analysis of Multi-Level Perspective on Sustainability Transition Research. *Sustainability* 14 (4145): 2-31. doi: 10.3390/su14074145

Wessel, Lauri, Abayomi Baiyere, Roxana Ologeanu-Taddei, Jonghyuk Cha, and Tina Blegind Jensen. 2021. Unpacking the Difference Between Digital Transformation and IT-Enabled Organizational Transformation. *Journal of the Association for Information Systems* 22 (1). doi: 10.17705/1jais.00655 .

Winner, Langdon. 1993. Upon opening the black box and finding it empty: Social constructivism and the philosophy of technology. *Science, Technology, and Human Values* 18 (3): 362-378.

Øvrelid, Egil, and Bendik Bygstad 2019. The role of discourse in transforming digital infrastructures. *Journal of Information Technology* 34 (3): 221-242.

Øvrelid, Egil, Bendik Bygstad, and Ole Hanseth. 2017. *Discursive formations and shifting strategies in e-Health programmes*. Proceedings of the 25th European Conference on Information Systems (ECIS) (pp. 873-886), June 5-10, in Guimarães, Portugal. http://aisel.aisnet.org/ecis2017_rp/57 (Accessed: September 07, 2022).

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