# The work of infrastructuring: a study of a national eHealth project

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**Abstract.** In this paper we examine a national initiative to further develop the Norwegian healthcare information infrastructure. Specifically, we analyse the work of a project team engaged in the design and development of new web-based capabilities for communication between citizens and primary healthcare practitioners. We foreground the work of infrastructuring which entails conceptualising new technological capabilities not as standalone objects, but as elements in larger arrangements that are sociotechnical in nature. Our findings show how the work within the project was shaped by concerns for embeddedness and durability that led to certain design decisions. Furthermore, we find that these decisions had significant repercussions on the development process and created a complex situation where the cooperation of an evolving constellation of multiple actors was required. Our research contributes an initial understanding of how an infrastructural project is different to projects aimed to the development of specific software artefacts.

## Introduction

Recently, Monteiro, Pollock, Hanseth and Williams argued that the CSCW field needs to take account of the ways in which computer support at work has changed over the last 20 years and called for a shift of focus from artefacts to infrastructures (Monteiro, Pollock, Hanseth, & Williams, 2013). Practically, they asked for studies that go beyond self-contained informatics' applications destined for specific work settings and situations of use (artefacts) and for more research on unbounded, interconnected infrastructures that span localities and temporal scales. They justified their call by referring to the wider turn towards systems' openness and interconnectivity which is fuelled by technological trends (e.g. virtualization, new flexible modes for linking applications via web-services,

social computing). With this paper we respond to this call by studying the work entailed in the design and development of a national healthcare information infrastructure.

We have studied the eDialogue project which is an on-going Norwegian Government effort to extend the national eHealth platform (called HealthNorway). HealthNorway currently gives access to personal health data sets, and to quality assured health information. The aim of the eDialogue project is to introduce new, additional web-based services for one-to-one communication between citizens and primary healthcare practitioners. The project is not only about organising work to implement additions to what is already in place. More importantly, it is about coordinating multiple actors in order to ensure that the new capabilities offered will be interweaved with existing arrangements and will be able to support evolving needs. Working for the introduction of novel technologies within healthcare is especially challenging because novelty has to link to historically built conventions of practice and to technologically congested landscapes that are the outcome of intensive digitalization efforts undertaken during the last decades. We refer to this work as the work of infrastructuring.

Infrastructures are "pervasive enabling resources in network form" necessary to human activities (Bowker, Baker, Millerand, & Ribes, 2010, p. 98). From the perspective of system builders infrastructuring is work that is cross-disciplinary, political, aiming at integrating differences while keeping a holistic view (Hughes, 1979). The work of infrastructuring is frequently overlooked, and is loaded with significant ethical and political concerns (Star & Bowker, 2002). Infrastructuring entails dealing with inherited strengths and limitations of the existing sociotechnical installed base (Hanseth, Monteiro, & Hatling, 1996; Star, 1999). Moreover, it entails a development effort that is multi-relational: socio-material, socio-historical and processual (Karasti and Syrjänen 2004). In infrastructure development work, different participants engage in complex collaborative processes for concerted action (Karasti & Baker, 2004; Karasti, Baker, & Millerand, 2010). We continue these lines of research by investigating the work of infrastructuring in a case of relatively simple electronic services development that proved to require complex and demanding coordination.

In this paper we foreground the work of the team engaged in infrastructuring. Specifically, we explore two concerns that are especially relevant in the early stages of design and development (before use) when key decisions have to be taken: embeddedness and durability. Embeddedness refers to how "infrastructure is sunk into, inside of, other structures, social arrangements, and technologies" (Bowker & Star, 1999, p. 35). From a system builder's perspective it is a concern related to how to set up infrastructures that are likely to blend in existing technologies and practices. As infrastructures are never built "de novo", but they always develop amidst a stream of technical antecedents, social conventions and professional rules (Ciborra & Hanseth, 1998), a concern for embeddedness relates

to decisions about how to intertwine novelty with existing technologies and conventions of practice. Nowadays, new infrastructural developments cannot link to conventions of practice without attaining embeddedness to multiple heterogeneous technologies that are already in use and have become integral parts of everyday activities. It is a situation where infrastructures come out of multiple different technologies controlled by distributed actors. Several studies have explored the evolution of relationships among people, organisations and technologies during infrastructuring work and have pointed to issues related to the creation of synergies, the alignment of interests and goals, the motivation of participation and cooperation sustainment (Bietz, Baumer, & Lee, 2010; Pennington, 2011; Procter, Rouncefield, Poschen, Lin, & Voss, 2011; Spencer, Zimmerman, & Abramson, 2011).

The concern for durability refers to the need to form strategies for future infrastructure evolution. Ribes and Finholt have introduced the concept of the "long now" to help us understand the forward looking concerns of infrastructural development, concerns that relate to the fact that today's planning will effect tomorrow's sustainability and evolvability of infrastructures (Ribes & Finholt, 2009). Similarly, Karasti, Baker and Millerand identified a temporal orientation (infrastructure time) that goes beyond project time (Karasti, et al., 2010). Steinhardt and Jackson labelled this aspect of infrastructure development "anticipation work" (Steinhardt & Jackson, 2015). Catering for a wide range of potential users and uses currently and in the future is challenging (Pollock & Williams, 2010); the need for durability cannot be addressed by developing today all capabilities needed for imaginary scenarios of possible organisational contexts and practices that will exist in the future, instead, approaches that allow openness and adaptability are needed (Avital & Te'eni, 2009).

The aim of our study is to explore and understand the particularities of working to design and develop technologies in projects with an infrastructural orientation, i.e. projects that are not oriented towards delivering self-contained applications (artefacts). Specifically, we focus on the decisions taken in the eDialogue project with attention to concerns of embeddedness and durability, and to the work implications of those decisions. Our research contributes a more fine grained understanding of what a shift from artefacts to infrastructures entails and insights on the intricacies of the work of infrastructuring.

The remaining of the paper is structured as follows. First, we describe the method we used to collect and analyse our empirical data, and then we provide an overview of the empirical setting. Subsequently, we present our analysis. Finally, we conclude by discussing our research findings and possible directions for further research.

# Method

The impetus for our study comes from our involvement in an ongoing research project on the interplay between new information technologies (IT) and existing modes of organizing within Norwegian healthcare. Within this project we study new patient-oriented, web-based technologies. We take a process approach where we examine how "things change over time" (Pettigrew, 1997). As one of the research activities in this project, we have conducted a case study on the eDialogue project with a focus on the activities of the project team members. In particular, our study has focused on examining how the project team members deployed their activities and cooperated in order to extend the information infrastructure that is already in place by creating new links and adding new technical capabilities.

The study had a first phase in the period January-June 2013 with a focus on the overall visions. In this phase we assembled and analysed a range of academic, government and industry studies, and programmatic and strategic government documents on the deployment of technologies in the Norwegian healthcare sector. A second phase of data collection took place from August 2013 to December 2014 with intensive fieldwork. In this second phase we have focused more closely on the eDialogue project. We have attended weekly project meetings, workshops, and other thematic meetings. In addition, we have conducted a total of 28 open-ended semi-structured interviews with various members of the project team, including the project managers. Interviews lasted approximately 1 hour each and have been recorded and fully transcribed. Finally, we reviewed preparatory meeting documents, presentation slides, reports, and project deliverables as we have been granted access to a shared directory with project documents. In summary, the research reported is based on data collected using a combination of fieldwork and documents' analysis (Table I).

| Source | Description |
|---|---|
| **Interviews** | 28 semi-structured interviews with project team members. All interviews were fully recorded and transcribed verbatim. |
| **Observations during weekly meetings, workshops and thematic meetings** | 49 weekly meetings (status meetings with the presence of the whole team, standard duration of 60 minutes each). Detailed notes taken. <br><br> 1 design workshop (full day) <br><br> 5 thematic meetings (approximately 60 minutes each) |
| **Document analysis** | Phase 1: Norwegian Healthcare Strategic Planning Documents; Policy, Regulation and Standards Documents; <br><br> Phase 2: Project documents (reviewed preparatory meeting documents, presentation slides, reports, and project deliverables) |

Table I.     Data Sources

We have approached our study by engaging in infrastructural inversion (Bowker, 1994), and focusing on the activities that result to the functioning of the infrastructure (the design and development work of the project team), rather than those supported by the infrastructure (e.g. healthcare practitioner - patient communication practices). Infrastructural inversion in our case is witnessed when the effort to design and develop the new eDialogue services makes visible to the project participants the existing (or non-existing) infrastructural components. Thus, we followed closely the project work and the trajectories of project participants. During interviews we asked participant to identify key decisions taken as the project evolved. The material from the interviews helped us to map key concerns in the project work which we have then enriched with information from the project documentation. We have then focused on those design decisions related to our specific interest to understand how concerns for embeddedness (Bowker & Star, 1999) and durability (Ribes & Finholt, 2009) shaped the work of the design team. We have then organised the analysis in two steps. First we described how key decisions were reached and how concerns emerge from discussion of alternatives and rationales provided by the participants. Second we have analysed implications of the key decisions for project work making an effort to foreground the work to make these decisions work.

## Case Background

The empirical material for this paper is sourced from the study of the eDialogue project which is an on-going Norwegian Government initiative to enable digital communication between citizens and General Practitioners (GPs). The eDialogue project builds upon and extends the capabilities put in place through an initiative with a wider scope: HealthNorway. HealthNorway is a national web-based platform which was launched in 2011 with the aim to provide a basis for the development of new electronic health services and a single point of access to existing services. Through HealthNorway citizens can access data related to their own health from various sources (national summary records, e-prescription records, vaccination records) and browse quality assured health information (on prevention and treatments, patient's rights, and quality indicators for healthcare facilities).

The efforts for eDialogue officially started in 2012 with a preparatory study. The whole endeavour was initiated, ran and funded by the governmental agency which is bestowed with the authority to implement national health policies and to ensure secure and simple information flows in the health and care sector (from now on referred as the Agency). The Agency had already developed and launched the HealthNorway platform and had an interest in extending it. In its initial form the platform supported only one-way information access (citizens accessing their own health data and general health related information) and the aim with

eDialogue was to extend it in order to support interactive services (exchange of information between citizens and healthcare providers both asynchronous and synchronous). The outcome of the preparatory study for eDialogue was the specification of four new types of electronic services that would have to be supported: booking of appointments, renewal of prescriptions, electronic contact for administrative purposes and e-consultation. The study was concluded in September 2012, then, a pre-project ran to evaluate the feasibility, relevance and expected benefits of the new services. The final report of the pre-project was published early in 2013 and confirmed the desirability of all four services. Subsequently, a fully-fledged eDialogue project started in spring 2013. The new services are now (January 2014) in testing phase and a pilot will run during 2015 in a number of GP offices.

As already explained, eDialogue is not meant to be a standalone suite of electronic services but rather, it is conceptualised as an extension of the existing HealthNorway platform. Furthermore, it has to relate to other technologies in place such as the various Electronic Patient Record Systems (EPRs) that GP offices use and the secure, closed network that connects healthcare units throughout Norway. Currently, 98% of GP offices, 97% of municipalities, all hospitals and all pharmacies are connected to this network (Norsk Helsenett, 2014). This network is vital for all electronic exchanges of information with healthcare providers and is developed and managed by a government enterprise (Norwegian Health Network -NHN). Figure 1 provides a graphical overview of how eDialogue's expands HealthNorway.
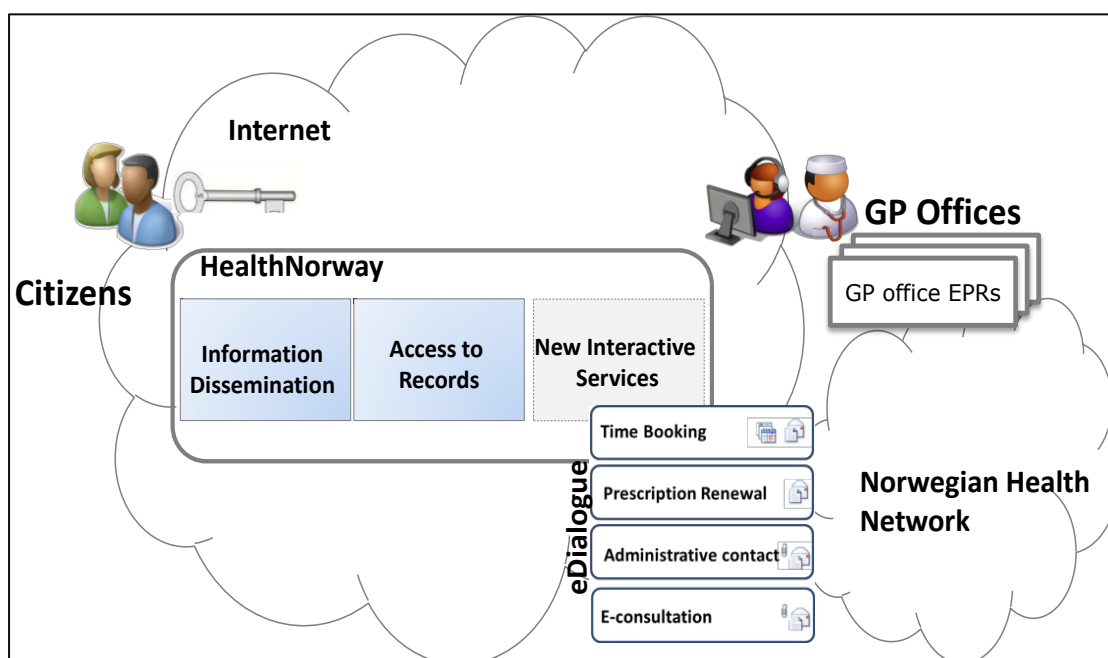


Figure 1.    The positioning of eDialogue in relation to HealthNorway

# Case Analysis

In the paragraphs that follow we present our analysis of the eDialogue case. The analysis is structured in two parts: first, we identify key decisions related to embeddedness and durability concerns, and then, we analyse the implications of these decisions for project work.

## Decisions related to concerns for embeddedness and durability

Embeddedness concerns shape decisions on how to reach citizens and GP offices

During the early stages of the project conceptualisation there was a need to decide how eDialogue would reach citizens and GP offices. For the citizens' side a major concern was to ensure a seamless user experience. This could not be achieved by simply providing a single gateway to different types of disparate services via HealthNorway. The design of the user interfaces for eDialogue services would have to ensure that new visual elements and additional screens follow the same styles adopted for the rest of the site to ensure a consistent users' experience, furthermore, synthetic overviews of information would have to be provided. A team member said: "*we want this information from your GP to be linked to information from other instances, from hospitals so that you can see everything together*". Another informant said that *«the argument was that the users would expect to have everything in one place to build their own timeline of data"*. Hence, the project participants were concerned with how the new services would become embedded into the already established service offering of HealthNorway. Following the same logic, it was decided to re-use authentication mechanisms which were already employed by HealthNorway for identifying citizens. This way, citizens would access after a single log-in the whole spectrum of HealthNorway electronic offering (both old and new services).

For the interface with the healthcare practitioners' side the project team aimed to ensure embeddedness within the pre-existing work arrangements. For instance, they wanted to avoid the introduction of a new system that would require extra work e.g. additional authentication procedure, and additional work to learn how to use it. Alternatives were discussed and it was decided to make use of the existing EPRs in GP offices and extend them with a module that would provide access to the new interactive services. Norwegian GPs already use EPR systems for documenting and accessing patient health information, and are familiar with how to use the systems. The decision to reach out for the GP offices via the existing EPRs implied that the private software companies that developed the EPRs would have to be enrolled to the project in order to adjust their products. By enrolling the EPR vendors to the eDialogue project, the project team became dependant to the collaboration with the vendors for the development of the GP's interface. Vendors were assigned the task of reconfiguring the existing EPRs by applying

their understanding about GP office practices and by working with users' panels that they have established while developing and improving their EPR systems.

Durability concerns shape decisions on message routing

The decision to link the healthcare practitioners' side with the citizens via the existing EPR systems created the need to think about the linkage itself. Since GPs' EPRs were already linked to the secure network (Norwegian Health Network - NHN), they could be easily physically linked to HealthNorway. But for the actual information exchange to happen there would be a need to put in place a mechanism to route the messages exchanged between GPs and citizens. It was soon realised that routing is a "cross cutting need"; other actors in the sector would also need some kind of mechanism for routing messages. An informant said: "*a solution that is just for us would not help the sector at all because if one doctor wants to communicate with the hospital or two doctors with each other, or the public health institute with a doctor, this solution would not help*". Thus the decision about the type of routing mechanism was shaped not only by concerns within the project but also by a concern for the sector. This meant that the routing mechanism would potentially constitute a core lasting component of the sector infrastructure upon which various services could be built. It needed to be a solution that could support the routing of various types of messages exchanged between heterogeneous actors. This forward looking concern was translated to a discussion on how to create a solution that would be durable.

The concerns about ensuring durability related to various aspects of how to make the solution relevant in the long term. First, they decided to adopt a messaging standard that would work with different type of messages. This decision was also related to the requirement of the Agency for Public Management and eGovernment (Difi) for ensuring re-use. One of the architectural principles defined by the Difi stipulates that: "*any solution that is established must be developed in a manner that enables it to be reused in other contexts and within other frameworks*" (DIFI, 2009). Finally, it was decided to have the routing mechanism developed and owned by NHN (the network provider). As NHN is another governmental entity (fully owned by the Ministry of Health and Care Services) the full assignment of the development and maintenance of the routing mechanism to this third party was politically unproblematic. As NHN already provides the network to the sector, it has the technical capabilities and institutional resources available to support all potential new users in the future. Furthermore, the involvement of NHN would ensure greater visibility and create better opportunities for further reuse. By creating favourable conditions for wide adoption of the new routing mechanism within the sector its potential for being sustained in the long term was strengthened.

Durability concerns shape decisions about data storage

Another key decision was the one about storing and making available for retrieval messages exchanged between citizens and GPs. From the healthcare practitioners' side the messages would be sent from the EPR systems and consequently, they could be stored there and considered part of the patient record. However, storing them only at the EPRs would not be a good solution for ensuring accessibility for the citizens. For instance, GPs would likely switch off their computers after working hours or might have temporary network connection problems potentially disrupting access. Although eDialogue was initially envisioned as a thin mediating layer between citizens and healthcare practitioners, it was soon realised that an archive would be needed. The archive would serve the need for making messages continuously available and also, would provide a number of opportunities for further development in the future, ensuring that the eDialogue services will be expandable ensuring durability.

The project team considered the possibility to develop the archive in-house. However, this option was discarded based on concerns over future oriented requirements for scalability. In the future the archive would probably need to also include messages from the hospitals with attachments of heavy files from picture archiving and communication systems (PACS) and extracts from records. An informant explains the potential for future developments around the archive as follows: "*So that a hospital doesn't print out and sends to a patient, but the patient can access his or her information in only one place, and whether it is information generated or synchronised, you will find it in one place, and you decide if you want to print it out or if you want to download*". In this case the forward looking concern for durability meant to select a solution that would be able to expand and scale in the long term. Another aspect of durability was related to maintainability in the long term, this would be better ensured by the adoption of an already mature, standard solution. An informant explains: "*a standard solution is giving us quite a few things, it is stable, it is well proven so we know it works, it has been handling huge databases for other customers around the world, so we know is capable of taking this amount of data, it is of course secure, it has very good support for security within the solution, and all the kind of basic services you need like putting in documents, deleting, changing who can access a document, logging everything that is happening, all these are kind of standard*".

The requirements for the archive were initially assessed against standard storage solutions already in use for e-government services and an ongoing national initiative to put in place a national secure digital mailbox. By looking at the specifications of these storage solutions it was identified that not all of them would provide good encryption support. Although storage encryption is not currently a regulatory requirement it made sense to adopt encryption for a national archive of sensitive health related data to ensure preparedness for stricter regulations that could be introduced in the future. Furthermore, it became evident

that it would be good to manage the storage solution within the project and not to rely on a shared generic public sector resource because the team recognized a great potential for future developments of eDialogue services based on the archive. In this case the concern for durability related to the long term management and control of the new component, as the archive could prove to be the cornerstone of all upcoming citizen oriented electronic health services. An informant clarified: *"maybe, we do not know, maybe the archive will have an important role (…) potentially we talk of terabytes and petabytes, so it is big, if this is widely used it will probably be in a few years the biggest database in Norway"*. Differently to the routing mechanism which was conceptualised as a generic solution for all types of actors within healthcare, the archive was viewed as a component dedicated to citizens' storage needs now and in the future.

Key project tasks resulting from decisions taken

The decisions described in the previous paragraphs, were taken during the early stages of the project. Based on these decisions, the overall project plan was developed and key project tasks were defined (summarised in Table II). Tasks one and two are about reaching citizens and GPs. The related decisions show the project team's concerns for embeddedness. Tasks three and four are about satisfying the needs for message routing and storage. The related decisions show the project team's concerns for durability as new reusable components with significant growth potential are favoured. The table also describes the involvement of key external actors in each of the tasks.

| Concerns | Key tasks | Description of eDialogue project activities (external actors marked by underlining) |
|---|---|---|
| embeddedness | 1. Develop citizens' interface by extending HealthNorway | Elicit user requirements, develop a concept, implement the graphic interface, develop functionality and link to the other components. |
| embeddedness | 2. Develop healthcare practitioners' interfaces by extending EPRs | Develop specifications for <u>EPR vendors</u>. Work with vendors to refine specifications. Negotiate collaboration terms. Check deliveries, integrate components and collaborate with vendors to fix problems. |
| durability | 3. Develop message routing mechanisms | Develop specifications for <u>NHN</u>. Prepare terms' agreement. Check deliveries, integrate components and collaborate with NHN for fixing problems. |
| durability | 4. Put in place an archiving solution and link it to other components | Develop specifications and call for tenders. Evaluate proposals. Prepare contract for <u>solution provider</u>. Check deliveries, integrate components and collaborate with archive solution provider for fixing problems. |

Table II.        Key eDialogue project tasks

## The implications of decisions for project work

The project was conceptualised from the start as an infrastructuring effort with a focus on embedding the novel services in the existing landscape and developing new components that would be durable and reusable. The decisions that were taken made the project activities complex and created the need to manage multiple interdependencies among a number of actors. A project participant commented: "*there is a lot of complexity to handle, it seems simple but it is not. Of course it is complex there are multiple providers, 5 platforms and 4 different languages involved.*" This complexity required the team to work on different levels in relation to the sector, to the existing platform, to various EPR vendors and to other technology providers. In the next subsections we analyse the project work by elaborating on: the work to achieve sector-wide agreement, the work with specifications before reaching maturity, the work with multiple different paces, the work with nested interfaces and the work of assembling parts.

### Working to achieve wide agreement

The development of the routing mechanism and the procurement of the archive solution made the work of the project team less about the eDialogue services and more about the design of patient-oriented services in general in the context of HealthNorway. Thus, work had to be expanded to include complex "anchoring" work both internally to the Agency and externally. For instance, the development of the routing mechanism as a new component that would be durable and reusable for the health sector created the necessity to expose the architectural blueprints to sectorial fora and ensure agreement before actually proceeding to implementation. Furthermore, the decision to purchase the archive initiated a process for building consensus internally in the Agency. Consensus to the decisions taken was critical as one of the project participant explained: "*ForumY is very important when solutions like this are developed and planned, so our risk was that they would say no, and we would have to start from scratch again. But they found it to be a good work foundation.*" Consequently, much of the work of the project team was directed towards engaging other interest groups, explaining, obtaining consensus and stimulating interest.

### Working with specifications before reaching maturity

The project team had to work and coordinate with several external actors were technically involved in the project and had to develop specific components: a) the EPR vendors which are companies of different sizes and with different interests, then, b) the vendor of the archive solution and c) the Agency that would develop and maintain the message routing mechanism. Thus ordering work within the project was far from trivial. To ensure synchronisation of deliveries the specifications for external actors had to be developed very early in the process

and much before the internal development team would start work. A project participant said: "*the vendors wanted the implementation guide before they would sign the agreement and I fully understand this of course. But the problem on our side, was that the functional side was actually just beginning to be worked out at the time (…) we had to take a lot of decisions that maybe would not be the same today, now that the functional side has done a lot of work, maybe something would have now been different.*" Additionally, at the early stages of the project not all the legal preparations that would delineate the design space were completed. Working within healthcare where a number of strict privacy laws and regulations apply dictated a close collaboration with lawyers in order to clarify things and also to try and change the rules in place when needed. One of the lawyers working with the project said about project members: "*sometimes they forget they need to be within the legal framework because you cannot just do whatever you want and make it work technically, it has to be within the legal frame which is not easy for the technologists to see, or they do not want to see because they are creative and they want to make good solutions.*" Changing the laws and regulations would require very lengthy processes. One of the lawyers working with the project said: "*it can take years. That's why we wanted to ask just for a policy or agreement thing. Because we know that it can take years for new regulation.*" Thus, project participants had the difficult task of preparing full specifications for the external actors involved in technical development without having available a fully developed legal framework.

Working with multiple different paces

The different types of external actors' involvement had their own paces and this entailed different work requirements and agreements. For the archive, a public procurement process had to be followed, with an open call, a prequalification process, a formal evaluation and ranking of proposals and contracting. For the EPR vendors the situation was different as there are only three specific companies that provide EPRs to the Norwegian GP offices and all of them had to be engaged to ensure full national coverage. This means that vendors had to be persuaded to participate and a negotiations' period was needed. A project participant said: "*one of the things that were difficult was that the three vendors are very different, they have very different organization, they have very different culture of how they communicate and work (…) It took time to understand how to cooperate with them, even if the agreements are equal, we can cooperate differently in practice.*" Finally, working with the network provider (that was also given the responsibility for message routing mechanisms) had its own particularities as this is another governmental agency. A project participant said: "*when it comes to NHN we have agreements, or when we come to a point we have agreements. But we have a sort of cooperation and dialogue before we have the agreement, before the really start to work with something, so you can say we work with NHN like they are a kind of*

*friend, until a certain point, then we have to make an agreement about what they are going to do for us, price, at what time and so on.*” Thus the project team had to learn to negotiate and cooperate according to different modalities with the various partners in the process, and on top they had to learn to articulate work across multiple negotiation and cooperation lines.

Working with nested interfaces

Developing the user interface for the citizens as part of the overall HealthNorway platform proved also to be tricky. This work had three facets. First, it dealt with envisioning the positioning for the eDialogue within HealthNorway. A project participant said: “*so we cannot just make eDialogue an island in this portal, we have to know now how important eDialogue is, is this what most people want when they come in here? Is it other stuff? (…) What does the user see when logging on? Is it your next appointment or your newest article or what is it?*” Thus, in order to develop the specific interface to citizens, the project participants had to work out the overall user experience within HealthNorway and to relate the interface concept to the “big picture”. Second, this work entailed involving users in design by organizing panels of representatives with informational roles. A project member informed us: “*we are going to establish a new user panel with eight users, we had one last year but now we are going to have a new one, (…) including sick people, healthy people, someone with a foreign background (…) and we also have a GP panel (..) but they are also giving important information about the patient, so when I say ok so ‘what does the patient want?’ and they say “they are very much into book and choose”, then maybe the calendar should be the focal point*.” Finally, the work of the project team dealt also with developing an understanding of the current practices of patient-GP communication as these would shape future patterns of use by the citizens. The project members did not only rely on the information gathered from GPs participating in the panel established by the project, but also, organised visits and observation sessions in GP offices.

Working to assemble the parts

Finally, the project team engaged in the work of assembling the parts. Putting everything together and testing the whole development from end to end proved to be challenging. For instance, not all parts were completed at the same moment but full testing would only be performed when all the links in the chain were available. In addition, fixing errors was challenging as it was not always obvious where the causes were to be found and alterations in one of the parts would sometimes require adjustments to the rest of them. Obviously, canonical agile development where all testing has to be completed within each sprint was not fully applicable and a lot of testing had to be performed at the end of the process. At the beginning of 2015 testing and fixing was almost completed and final

preparations for piloting were underway. Modifications and adjustments decided after piloting will again require complex coordination among the various actors.

# Discussion and Conclusion

The case analysis presented in the previous section has focused on how concerns related to the embeddedness and durability of the infrastructure shaped eDialogue's design and development. A concern for achieving embeddedness led to the decision to provide novel technological capabilities by extending existing technologies in use: the EPR systems and the HealthNorway presentation layer. By introducing the new information exchange functionality to GP offices via the existing EPR systems the project team is aiming to link to the existing technologies in place and the conventions of practice. By extending existing interfaces used by citizens the project team aims to create a coherent and homogeneous space for all electronic interactions of the general public with the healthcare system. Furthermore, a concern for durability (anticipating future evolution) has shaped decisions related to the message routing mechanisms and the archiving solution. The aim there was to ensure that new developments will be extendable and reusable in the future. Overall, these specific concerns led to decisions that defined the character of the project and created the need for close cooperation with multiple actors (the Agency, the EPR systems' providers, NHN, a software house that provided an archive solution).

Our empirical material relates to the early stages of infrastructural design and development (before use) and our analysis is focused on those early stages. We suggest that an understanding of the early work required for systematic infrastructural development is essential in order to grapple with the particularities entailed in putting infrastructures in place. Such an understanding can support a shift of focus from artefacts to infrastructures (Monteiro, et al., 2013) and provide insights to those engaged in introducing further computer support within today's already digitised work settings where there is little scope for introducing new closed systems and tools. The early stages of infrastructure development entail visionary work performed under uncertainty by multiple actors, in different institutional settings, that have to coordinate their activities and technically interweave their outputs. As we have shown with our case study, the problem that we now have to address is how to introduce new technological capabilities that afford connections to what is already in place, mobilizing and recombining pre-existing resources, blending resiliently in the already densely populated landscapes.

Our primary goal in this paper was to understand the work of the project team engaged in the eDialogue project. For this project the development of specific

functionality was only a small fraction of the total effort required: most of the work entailed conceptualising the different components in the infrastructure, negotiating with stakeholders in the sector, agreeing on long term mutual relationships, and coordinating internal work with the work of external actors that were gradually enrolled to the project. Additionally, quite differently to what would have happened in an application development project, the key challenges were less about modularising the work required for a well-defined delivery and more about developing a sensitivity to the constraints and singularities of all the actors enrolled and the emerging interdependencies. We have shown that the work for eDialogue entailed further developing what was already in place (for instance by using the EPRs in the GPs offices), mobilising and recombining pre-existing resources (for instance the health network and the institution that supports it), and how to add new versatile, reusable components (for instance by introducing the archive). We conceptualise this form of design and development work as infrastructuring.

Other researchers have engaged in a discussion on the work of infrastructuring (Aanestad, Jolliffe, Mukherjee, & Sahay, 2014; Pipek & Wulf, 2009). Overall these studies denote an urge to develop an approach that emphasises a processual view in order to capture infrastructures 'in the making' but also to capture users' engagement with the technologies and the ensuing modifications when technologies are introduced in various local setting. For instance, Pipek and Wulf make a clear distinction between compromises made during design–before-use and those made during design–in-use and explicitly use the notion of infrastructuring to denote "all activities that contribute to a successful establishment of usages" (Pipek & Wulf, 2009). The focus of our paper is explicitly on work before new technologies are introduced to use.

Within its explicit scope of researching design and development before use our study offers important insights on what the shift from artefacts to infrastructures entails. *First*, we show the repercussions of infrastructural concerns in the design and development process. We find that decisions driven by concerns related to the embeddedness and durability of the infrastructure created the need for distributed collective work. However, the constellation of the collaborating actors is not predefined but evolves dynamically, making cooperation, work synchronization and work assemblage very challenging. *Second*, by recounting the implications of these decisions for the subsequent unfolding of work we associate the configuration of software processes to the specifics of the technology under development (unbounded, interconnected, spanning localities and temporal scales). Although CSCW research has addressed recent changes in software process such as agile development and global development (Avram, Bannon, Bowers, Sheehan, & Sullivan, 2009; Bjorn et al., 2014; Cohn, Sim, & Lee, 2009;

Dittrich, Randall, & Singer, 2009), these changes have been discussed as important contemporary trends and have not been explicitly linked to the specifics of technologies developed. From our case analysis it becomes evident that tailored software processes are needed when aiming for technologies that will have infrastructural qualities. However, it is difficult to be more specific about software process requirements by drawing from one singular case. Our exploratory research has been designed to generate an initial understanding of how a project conceptualised to be of infrastructuring nature is different to a project aiming for the development of a specific artefact. Further research including cross case analyses could provide a basis for methodological reflections on plausible types of collaborative software processes for extending infrastructures.

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