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TECHNOLOGY INNOVATION IN THE FACE OF UNCERTAINTY: THE CASE OF “MY HEALTH RECORD”

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Abstract

In this paper we address the challenges faced when new e-health components are introduced within an existing infrastructural arrangement by focusing on the delicate balance between immediate usefulness and forward-looking preparedness. While e-health solutions are currently seen as a core element of on-going health sector reforms in most European countries, much of the challenges related to their design, development and implementation remain understudied. Based on an interpretive case study of technology innovation in the Norwegian healthcare context, we study the practices of building and putting to use a novel web-based platform for communication between users and providers of healthcare services. In particular, we analyse the conceptual design, the association with the installed base, and the relationship with users as core enacting practices of the project team members. We make use of the concepts of generativity and robustness to bring into focus and articulate possible approaches for change anticipation.

Keywords: e-health, design, installed base, users, robustness, generativity, change anticipation
1 Introduction

A number of interventions in healthcare work organization have been making their appearance throughout Europe during the last decades. They are mostly induced by concerns about rising healthcare costs and a challenging future (aging population, increase of patients living with chronic conditions, citizens’ pressure for higher quality health services). These purposeful interventions are re-arranging people and material resources exploiting increasingly information and communication technology (ICT) capabilities that make possible new types of activity. The aim is to improve efficiency in healthcare delivery allowing better utilization of resources. However, the implementation of changes is far from straightforward; many studies have shown that the process of implementing novel ICTs in the evolving healthcare environment has been difficult (Berner et al. 2005; Currie and Guah 2007; Greenhalgh et al. 2010; Jones 2004; Westbrook and Braithwaite 2010). The complexity of the required sociotechnical transformations is such, that the linear path that foresees translating visions to policies, inscribing policies to technologies and embedding technologies to everyday work cannot be followed (Ellingsen and Monteiro 2008; Guah and Currie 2004; Hanseth et al. 2006), emergent dynamics have to be explicitly taken into account.

In the information systems literature, a way forward is proposed by the “information infrastructure” approach. This approach explicitly takes into account system dynamics and conceptualizes ICTs not as standalone objects, but as elements in larger infrastructural arrangements that are sociotechnical in nature (Hanseth and Lyytinen 2010). When studying the development and implementation of ICTs in healthcare settings, this approach directs the focus on how the interrelations between the existing infrastructure (installed base) and the new elements play out. Thus, new ICTs are never isolated and univocal, but embedded in an intricate web of technologies, practices, routines, to which they relate in specific ways and in specific situations of use (Star 1999). Furthermore, information infrastructures are constantly evolving and scholars have investigated strategies to effectively manage this evolution (Bygstad and Hanseth 2010; Ciborra et al. 2000; Hanseth and Aanestad 2003).

The present of any infrastructural arrangement has an impact on the scope of future innovations (Aanestad 2011) but the consideration of the future is not simply a matter of planning and visions; infrastructures have to remain open to possibilities currently unforeseen. Aanestad and Jensen have discussed the vulnerability of projects that attempt to fulfil long-term goals by elaborate plans that are based on future visions rather than current needs (Aanestad and Jensen 2011), along the same lines, Pollock and Williams note that anticipatory efforts to cater for all purposes including those not yet envisaged necessarily fail given the unpredictability of future activities (Pollock and Williams 2010). Furthermore, the US National Research Council recognizes the relevance of inscribing into IT the capacity to accommodate future changes, and calls for a shift in the approach to information technology (IT) for health. In a recent report it is argued: “organizations should architect healthcare IT for flexibility to support disruptive change rather than to optimize today’s ideas about healthcare (…) any IT-based infrastructure to support today’s healthcare needs must be designed to accommodate changes in roles and process tomorrow (…) otherwise, even deployment of healthcare IT successful in solving a problem today could stand in the way of solving tomorrow’s challenges” (Committee on Engaging the Computer Science Research Community in Health Care Informatics 2009).

To get more insight into the challenge of future-readiness, in this paper we investigate the case of a project within the Norwegian healthcare context that is being implemented during turbulent times and under significant future uncertainty. The project concerns the development and implementation of a web-based platform (named MyHealthRecord, from now on MHR) for patient-healthcare provider communication. The MHR project is running while several changes are taking place simultaneously. First, the on-going reform of the health sector (Norwegian Ministry of Health and Care Services 2009) that is envisioning a more active role for patients, and requiring a major shift both in the way healthcare delivery is organized (from a provider-centric mode to a patient-centric mode), and in the way information is managed, accessed and shared across institutions and outside the hospital milieu. Second, the hospital hosting MHR is being merged with other large hospitals in Oslo, and task
redistribution and reorganization of the clinical departments is taking place. Third, at the same time, the hospital’s information systems are undergoing major changes including the replacement of the electronic patient records’ system and of the internal clinical portal. Moreover, as MHR aims at supporting novel types of patient-healthcare provider communication, there is significant uncertainty about the applicable legislation now and in the future amplified by the fact that Norway has a stricter privacy and security health data legislation compared to other countries. In this challenging context, it is interesting to study how the MHR team dealt with uncertainty. More specifically, we have investigated how the project team worked to build change-readiness capabilities in order to create a durable solution. Our research interest is centred on the question of how an e-health solution can be prepared to deal with future changes.

We view MHR as a new component in the heterogeneous Norwegian health information infrastructure, and we analyse our case focusing on the new communication platform’s properties (its conceptual design) and on its relationships with the rest of the infrastructure (association with the installed base and relationship with the users). Our analysis is based on two core concepts, generativity and robustness. Both concepts are related to the dynamic capabilities of information systems and to change anticipation. However, they indicate different innovation paths: robustness is about the capability of systems to react to change, while generativity is about systems’ capability to stimulate change. We make use of these two concepts to bring into focus and articulate possible approaches for change anticipation. The remaining of the paper is organized as follows: first, we present the concepts of robustness and generativity, we discuss their theoretical underpinnings, and explain why they are a useful lens for analysing our case; then, we describe our methods for data collection and analysis, the case context and our case analysis; we conclude with the discussion of key findings.

2 Theoretical Background

Bringing together notions from systems’ theory and science studies, and an ethnographic approach, scholars of information infrastructures (Bowker and Star 1999; Contini and Lanzara 2009; Hanseth and Lytinen 2010; Star and Ruhleder 1996) discuss how ICT capabilities, materialities, people, and social forces evolve and interoperate over time, forming an infrastructure. One of the core ideas in this approach is that an information infrastructure is never designed from scratch, but it is historically developed through the evolution of an installed base, and by means of diverse evolutionary dynamics such as, for instance, path dependencies, lock-ins, and self-reinforcing mechanisms (Hanseth and Lytinen 2010). The installed base is offering the stability required to support existing activities, and at the same time enables future developments. Thus, information infrastructures embed the idea of offering both a reliable environment supporting activities and work, and a basis for further opportunities in a long term perspective. This dual nature poses to evolving infrastructures the challenge of balancing standardization and flexibility (Hanseth et al. 1996). In order to be more specific about the evolutionary dynamics of information infrastructures, we engage in this paper with the two concepts of robustness and generativity.

Robustness is a concept mostly used in biology and evolutionary systems’ thinking and relates to coping with perturbations or conditions of uncertainty. In information systems, robustness is a system’s “capability of adapting efficiently to changing environments” (El Sawy and Nanus 1989). It guarantees “the maintenance of some desired system characteristics despite fluctuations in the behaviour of its component parts or its environment” (Carlson and Doyle 2002) and enables systems to function within a wide range of possible settings and gradually evolve based on its interaction with the environment. Robustness can be attained through structural configurations that allow timely gathering of information on shifting conditions and generation of responses to a wide range of inputs.

Anticipation of the future is not only about accommodating contingencies, it is also about providing the means for advancement, for “encouraging mutations, branching away from the status quo” (Zittrain 2008) producing unanticipated change. This relates to generativity which is a notion that transcends the robustness of the technological artefact being associated with the overall dynamics of
sociotechnical configurations. “Generative systems are built on the notion that they are never fully complete, that they have many uses yet to be conceived of, and that the public can be trusted to invent and share good uses (...) a system’s generativity describes not only its objective characteristics, but also the ways the system relates to its users and the ways users relate to one another” (Zittrain 2008). Generativity is the capacity of information technology to induce change (Zittrain 2006), to “enable the creation of contextually new possibilities and configurations for as-of-yet unknown problems” (Hovorka and Auerbach 2010). To recapitulate, robustness relates to the fact that infrastructures are capable of retaining their stable characteristics while accommodating a wide range of emergent and shifting human practices; generativity relates to their potential to support the creation of a wide range of applications and services that are currently unforeseen. In the discussion, based on the case analysis we make use of the concepts of generativity and robustness to bring into focus and articulate possible approaches for change anticipation.

3 The case of “My health record”

3.1 Case Background

The empirical material for our analysis is sourced from the study of an on-going Norwegian effort to design, develop and implement a novel web-based platform for communication between users and providers of healthcare services (the MHR platform). The conceptualization and development of MHR started in 2005 within the IT department of a major Norwegian hospital which coordinated the joint effort of a number of healthcare institutions and patient organizations. MHR is nowadays adopted and used by approximately 20 clinical groups in various hospitals and gradually enrolling more and more users. Information technology has been used in Norway to support healthcare information management for more than three decades. The earliest use of electronic documentation of patient information in health services dates back to the 1970s while the first releases of information systems for entire hospital coverage started in the 1980s (Norwegian Center for Electronic Patient Records 2009). Today, electronic health records are used in almost 100% of hospitals and general practitioner offices and in approximately 80% of nursing homes (idem.). Additionally, a great number of supplementary systems that contain patient related information (e.g. laboratory applications, Picture Archive and Communication Systems (PACS), solutions for operation planning and administration etc.) exist in most of the healthcare organizations in Norway. MHR is built upon this extensive grid of health information systems. The original intention of developing the new platform was guided by the idea of providing patients with on-line access to their own records, but also access to information and direct communication with clinicians. Thus, MHR is positioned at the interface between the clinical side of care and the patients (see also Figure 2), and represents a novel patient-provider secure communication channel. The current functionalities include: secure messaging between patients and healthcare workers, possibility to change or cancel appointments, access to discharge notes, forms to be filled-in for export to clinical systems and services specially tailored to specific patient groups (e.g. for patients with blood diseases).

3.2 Method

Our research is designed as an interpretive case study (Eisenhardt 1989; Klein and Myers 1999). Case study research is particularly suited for catching the particularity and complexity of a single case and developing an in-depth understanding of a certain phenomenon of interest. We have paid particular attention to the contextualization of our case and took into account the historical background by accessing previous studies conducted in the same organization and the IT strategy documents for the healthcare sector in Norway. This provided important information on the local project context and the context at large. The contextual understanding is essential for analysing the case from an information infrastructure perspective and especially for the investigation of the associations MHR develops with the rest of the installed base. Of special interest to the case is the evolution of the electronic patient
documentation systems that exchange information with MHR, the development of citizen digital authentication mechanisms and the security and privacy regulations for healthcare data.

The study presented here is part of a larger research project, Flexible Integration Processes in the Public Sector (FIPP) concerned with exploring and analysing various instances of on-going efforts to integrate healthcare practices with the implementation of novel ICTs in Norway. In particular, this study has focused on the activities of the project team of MHR. This team consists of three managers and one interface designer, supported by a group of developers. This investigation took place over a period of approximately one year (August 2010-June 2011) during which MHR increased its number of users (clinics and patient groups). All information related to MHR used herein, were sourced during this period and are relevant to the status of the platform as of June 2011. The primary method of data collection was through interviews with the managers of the project team. Interviews were conducted on a regular basis for a total of twelve semi-structured interviews of about one and half hours which were fully audio-recorded and transcribed verbatim. The interview guides covered several topics, among others, managers were asked to describe the historical origins of the concept-idea of MHR, as well as to talk about technical challenges and solutions, the organization of the users’ workshops, the consultations with the hospital managers and the privacy ombudsman. In addition, the research design entailed data collection from multiple sources including the analysis of MHR presentation documents for various audiences (at seminars, conferences and management presentations) and technical reports, observation sessions of health personnel at work and attendance of design workshops with users.

3.3 Case Analysis

Creating a new infrastructural arrangement that will be successfully appropriated is a challenging effort. It is a recursive process facing many uncertainties. Observing the activities of project participants we are specifically interested in bringing to the surface and exploring how they strive to develop technology that will be able to deliver now and in the future by aiming to robustness and generativity. Both aims have a significant effect on: (i) the way project participants conceptualise and design the new platform (the morphological choices they make), (ii) the way they handle the associations of the new solution with the existing ICT landscape (making choices related to the installed base) and (iii) the way they approach prospective users (making choices related to user involvement for the configuration and adoption of the solution). In the empirical material, we traced numerous decisions related to these three main areas that affect robustness and generativity of MHR. We analyse each of the three areas in the following paragraphs.

3.3.1 Conceptual design

MHR is based on a modular architecture (Baldwin and Clark 1997, 2000; Parnas 1972) that allows modules to be developed based on specific requirements. For instance, it is possible to create digital forms that patients can fill-in on line, web-shops for ordering medical supplies, or special views for direct access to laboratory test results. Each clinical group can select modules from the existing repertoire, or they can require the development of new ad-hoc modules. This modular architecture is a core design choice made by the MHR team which aimed through this to create a tailorable solution. A project team member says: “the idea to tailor to different groups of patients was there from the beginning … I am very convinced that one size does not fit all but it should adapt to different users, users’ needs and ideally also throughout a life time”. However, modularisation creates also the challenge of managing a patchwork-like solution. In the current status (at the time when fieldwork was conducted) MHR is constituted by modules that are either active (e.g. for secure messaging, for on-line bookings, for forms filling, for patient self-reporting of drug consumption, for self-reporting of diet and lifestyle, etc.), or planned to be activated (e.g. access to admission summary, functionality for patients with diabetes), or planned to be expanded (as for the drug self-reporting module) or recently discontinued (e.g. patients’ forum, patients’ diary). The dynamics of each module are not fully predictable: some modules will be heavily used and some will need to be discontinued due to lack of
interest, some will have to be frequently updated while other will remain stable for long periods, some will yield expansions and additions while other might need to be merged. The modular design of the platform is exemplified in communications and presentations prepared by its management team by the simple graphical representation of a jigsaw puzzle (Jor 2009) (Figure 1).

**Figure 1** Illustration of MHR as presented by its project management to non-technical audiences

A manager from the team describes the different evolution of two modules: “the origin of both initiatives was very similar, it was the head of the department that approached us, they had a very well defined need, and for both cases we developed functionality especially for them: ModuleY for the first and ModuleZ for the second, it was a very similar process at the beginning but the outcome was very different … success story ModuleY while for ModuleZ everything stopped”. It is not the intention of this paper to analyse the reasons behind the different trajectories of the two modules, the important thing is that the delays for ModuleZ did not jeopardize the overall development plans for the platform.

In another case, a piece of functionality had to be removed because of data privacy concerns. The module had to be obliterated but its misfortune was not contagious to the rest of the platform. A project team member says: “to have to remove it was not a big deal because there was not a lot of information that got lost”. As we see, changes are already evident in the short period that MHR operates, but, its conceptual design allows it to address them. Modularity is not per-se a design principle that supports robustness. To ensure robustness a configuration of modules that minimizes interdependence among them is required, i.e. modules have to be loosely coupled (Glassman 1973; Orton and Weick 1990; Simon 1969). There are benefits even in tightly coupled modular designs (e.g. possibly distributed development, staged deployment, re-use of parts, etc.) but although modularity solves by itself a number of coordination problems, loose coupling is a prerequisite for robustness.

Adopting a loosely coupled modular architecture the new platform can adapt to different future scenarios and absorb local variations without being destabilised.

In the case of MHR, modularity supported also generativity of the solution on two aspects. First, modularity supported the open-ended character of the platform reflected in the original vision for MHR: “we did not want anything with “disease” or “sick” in the name because it should be also about prevention…But it was not only access to record from the beginning… and taking into account that a person is not sick most of his life, so when one is not sick it should be about health maintenance and prevention, more than disease and treatments. It is not visible now but it is possible.” (MHR manager).
Secondly, it also supported inventiveness and the emergence of ideas for the use of modules. For instance, the module of the web-shop was originally designed for medical equipment (specifically gastro equipment) that some patients need to order on a regular basis. However, it was designed so that it would be re-usable with different contents, and after being approached by the archive department one of the managers suggested to use the module also for ordering document packages: “what they want to do is to have a journal (record) web-shop, and they want to make packages such as ‘change general practitioner package’ or ‘second opinion package’ so they can help guide patients to obtain the documents they need” (quote from a project member). Thus, the conceptual design of the platform does not only support robustness but also allows it to exhibit high generative fit: “a system with high generative fit can generate a virtually infinite number of configurations. It is inherently open-ended … systems should incorporate a modular architecture in support of renewal processes.” (Avital and Te’eni 2009). Experimentation with new ideas is facilitated by MHR’s design.

3.3.2 Association with the installed base

The development of the new platform is both enabled and constrained by the installed base: the pre-existing infrastructural resources. The infrastructural resources for a given activity refer to those adjunct resources which help carry out the activity smoothly (Kling 1992), they can be technological but also social: e.g. the regulatory framework, the organisational configurations, the staff skills etc. How to build associations and how to select resources requires a strategy that goes beyond the need to ensure stability and reliability under the existing circumstances and it has to relate to forward-looking concerns and uncertainties: “the varied compendium of work done today with an eye toward generating a sustainable future” (Ribes and Finholt 2009). Overall, the project team had to juggle many balls. On the one hand, they wanted to create an independent solution both technically and organisationally, on the other hand, they also needed to constructively relate to the existing infrastructural context; a manager says: “MHR was built to be a solitary system in many ways. This was a strategic choice we took very early on” but then continues to say that the platform has to “assimilate things done elsewhere, because we did not want to create the system all over form the beginning”. Following this balancing rationale MHR team made a number of decisions on the associations with the installed base: they opted for exclusive reliance to some resources while they used some others interchangeably. For instance, on the issue of security, important decisions had to be taken. Norway has implemented since 2003 a shared, closed, secure broadband network for electronic communication within the health sector (Norsk Helsenett SF). Health related information can only be exchanged via this secure network using messaging standards so for example, exchanging information over email is not allowed. However, this network does not support communication with patients. A manager says: ‘part of the reasons we got funds and support was the email problem: it was illegal to use email in the communication with patients… so the secure communication part was seen as the most important service in MHR’. Today, patients get connected to MHR using the internet (Figure 2). Patient authentication is ensured using two alternative solutions: BankID (the Banking Sector’s common digital authentication and online signing solution) and Buypass (jointly owned by Norway Post and Norwegian Lottery). This way, without developing a tailor-made authentication component but also without being dependent to a single infrastructural resource, MHR meets the standards of the highest security level (level 4, defined by Norwegian law as the level intended for access and protection of sensitive information). Furthermore, to accelerate acceptance and diffusion MHR embraced applications that were already established, including them in the repertoire of functionality available. “And ComponentW is a very good example of this and it is now assimilated in MHR. There are many initiatives related to MHR that should be able to be assimilated into it” (MHR manager).
The existing infrastructural configuration creates opportunities for development but also imposes obligations for compatibility and conformance (Hughes 1987; Star and Ruhleder 1996). Although every new tool is built amidst a stream of technical antecedents and social conventions its degree of connectedness to the installed base and the specific associations are always a matter of choice. The more the infrastructural resources are exploited, the less investment in building from first principles is required, but these gains do not come without a cost. The resources that are associated with a platform become crucial for its existence, a failure in an infrastructural resource can threaten the platform itself. We see that two kinds of decisions became important in the case of MHR when thinking about the installed base: decisions on the selection of infrastructural resources to associate-with and decisions on the type of associations to be established. Selecting to rely solely to one infrastructural resource for a specific need, or to establish multiple associations with resources of the same type but independent to each other or to simply establish a loose alliance that reinforces positioning without creating any type of dependence can be challenging. In practice, as we have seen in the case of MHR there are many different options that require different infrastructural resources and have different merits.

All the previous examples on the careful selection of infrastructural resources not only contribute to the robustness of the platform, but also to its generativity. By allowing information exchange from different systems and domains and enabling patients’ participative action and collaboration across healthcare practices the new system evokes new thinking and enables users to translate their ideas into a new context (Avital and Te'eni 2009). This way, the conditions that can lead to the generation of new ideas and accelerated evolution are created. Project participants aim to stimulate and support creative usages of MHR presenting practical healthcare workers with examples (e.g. the development of electronic forms tailored to specific needs), providing the required technological competence (i.e. undertaking development of specific functionalities) and encouraging end-users to visualise the future.

3.3.3 Relationship with users

Unlike to other information systems, MHR is not presented and promoted as a full package of services. It is designed and developed so that users can select the functionalities they need to be implemented. Moreover, units and groups independently take the decision to use MHR and it is not implemented top-down in the whole hospital. The adoption decision initiates a tailoring process where already existing functionalities can be selected and new ones can be developed. However, approaching
the clinical departments is not unproblematic. A manager says: “It is so difficult to attain involvement of clinical departments. Very difficult! For each clinical department, we need at least one, preferably more, champion. Champions that really want to do it and think it is a splendid idea (...) that can talk to their patients and to their colleagues and tell them to go for it. We are not in a position, and we should not be, to push this directly to the patients. So we need the champions.” We witness here the aim of the platform advocates to expand the user base by developing support communities and enrolling sponsors for platform adoption. The strategy followed is not to impose usage, but to stimulate uptake by promoting the qualities of the new platform, attract interest and provide support for exploring possible uses.

The project team did not address clinics in a random way, they made a conscious effort to pick the ones that were more probable to be interested: “we started looking for patient groups with long lasting and high intensity relationships to the hospital, like chronic diseases. We asked the rheumatologists who have patients who have been through 30 or 40 surgeries, so we thought that they might be interested … Then based on previous knowledge, we looked at those that have high volume emails, and Audiology is one of them. When implants stop working they cannot use the phone and they use mail a lot, and they also have ideas on what they need. And it is not only about communication but also ordering spare parts, implants. So now the web shop is implemented” (MHR manager). By linking so closely the development and expansion of the platform to users’ needs, MHR’s project team fosters a close relationship between tool capabilities and work practices. This sets the ground for continuous improvement and robustness. Clinical departments are operationally co-owners of their respective modules and as they will be the first to identify shifting needs, they are also enabled to propose changes and amendments. This kind of approach is not problem-free, uptake is slow and although usage can be sustained, growth is difficult to achieve. “The conclusion was that patients were ready to take up this kind of services, the technology was ready … it was the hospital organisations that were not quite ready yet! And this is the hard part of it, how to integrate this in the clinical workflow…more users is a difficult thing. The only way to get users, is to push the clinical departments” (MHR manager). The choice was to opt for robustness downplaying the need for growth.

By linking the platform closely to clinical groups generativity is also taken care of: “a system with high generative fit can be used by a diverse set of people in their own respective environments and for various tasks within an intended scope. It is adaptive with respect to the type of users or groups it serves in diverse problem spaces” (Avital and Te'eni 2009). Adaptability and end-user customisability are guiding principles for MHR: “The aim of MHR was to be able to tailor the content down at the individual level if we wanted to. This has to be a two-way thing: we cannot just sit down and decide what content is relevant for each and every patient” (MHR manager).

4 Discussion and Conclusion

This paper adopts the information infrastructure perspective to study a niche initiative within Norwegian healthcare. We have analysed the MHR project with a focus on its management practices in a challenging context. Engaging with the concept of generativity and robustness, we have pointed out how in the conceptual design, association with the installed base and relationship with users, the MHRs team confronted contextual uncertainties. The analysis is summarised in table I. As mentioned, both change preparedness concepts used are related to uncertainty anticipation but they embrace different change patterns. Robustness relates to the exploitation of technology for the accommodation of contingencies while generativity is linked to the exploration of new opportunities that technology can bring.

Concerning conceptual design, MHR is built as a synthesis of loosely coupled modules, this enables MHR to respond to contingencies. At the same time the conceptual design is open-ended, and it supports continuous renewal, reuse and extension. Concerning the association with the installed base, MHR enacts multiple modes of association in order to ensure its survival in a changing healthcare landscape: there are dependency relationships with core health infrastructural elements,
interchangeable relationships with equivalent infrastructural elements whenever this is feasible and also loose alliances with parallel initiatives that strengthen its position. At the same time, MHR shows integrative and communicative capabilities that allow cutting through different but related elements of the healthcare installed base in an innovative way. Concerning the relationship with users, MHR’s distributed nature and co-ownership with different user groups make possible the dynamic alignment of the platform to emerging work practices and patient needs. At the same time, MHR is adaptive because it allows customization and the flexible development of tailored facilities to fit user needs.

Table I

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<th>MHR’s generative and robustness features</th>
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<td>Conceptual Design</td>
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<td>Robustness “setting the ground for incremental change”</td>
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<td>Generativity “setting the ground for radical change”</td>
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We are not contrasting these evolutionary dynamics against each other. Robustness and generativity are co-present and co-shaping MHR. Using both concepts, we attempt to elaborate on change preparedness acknowledging that there are different modalities for it. These different modalities are both related to stances against change (proactive/reactive) and to schemes to handle change (centred around the technological object/centred around the sociotechnical arrangement). As it concerns different stances, robustness is about the capability of systems to react to change while generativity is about systems’ capability to stimulate change. Furthermore, similar to the concepts of flexibility and adaptability, robustness does not focus much on systemic output. Instead, it is centred on the IT object that has to be tailored to accommodate turbulences and variation (Hanseth et al. 1996; Hanseth and Lyytinen 2010; Tilson et al. 2010). Generativity considers not only the IT object’s characteristics, but also the ways it relates to its users and the ways users relate to one another (Zittrain 2008) and shifts attention to the creativity of users that can stimulate growth or change over time. The combination of the two concepts can be used to bring into focus and articulate approaches for change anticipation that take into account the recursive relationship of human and material agencies that shape information systems in healthcare settings.

Future research may proceed in two directions. The first direction is towards the analysis of similar cases that followed similar or totally different trajectories (e.g. similar systems in different hospitals or even countries). This direction can lead to analytical generalization by the comparative examination of multiple cases. A second future research direction is related to extending our analysis by following this specific project trajectory in the future. At this moment we cannot predict the fate of MHR, it may flourish as the main patient-provider communication platform in the country, or be merged with other endeavours and contribute to the national health portal that is currently underway, or shrink to some local “appointment booking” solution, or even simply cease to exist altogether. By following the evolution of this specific platform over an extended period of time we can get insight on the effectiveness of the measures taken to ensure robustness and generativity.

References


Ciborra, C., et al. (2000), From Control to Drift. The Dynamics of Corporate Information Infrastructures; Oxford: Oxford University Press


Greenhalgh, T., et al. (2010), The devil's in the detail: final report of the independent evaluation of the Summary Care Record and HealthSpace programmes, (London: University College London).


Hanseth, O., et al. (2006), Reflexive standardization: Side effects and complexity in standard making, Mis Quarterly, 30, 563-81.


Klein, H. K. and Myers, M. D. (1999), A set of principles for conducting and evaluating interpretive field studies in information systems, MIS Quarterly, 23 (1), 67-93.

Kling, Rob (1992), Behind the terminal : the critical role of computing infrastructure in effective information systems development and use, Technical report; Irvine: Information and Computer Science University of California Irvine


Pollock, N. and Williams, R. (2010), e-Infrastructures: How Do We Know and Understand Them? Strategic Ethnography and the Biography of Artefacts, Computer Supported Cooperative Work (CSCW), 19, 521-56.


Simon, Herbert A. (1969), The sciences of the artificial; Cambridge,: M.I.T. Press


Westbrook, J.I. and Braithwaite, J. (2010), Will information and communication technology disrupt the health system and deliver on its promise?, The Medical Journal of Australia, 193 (7), 399-400.


Zittrain, J. L. (2008), The Future of the Internet and How to Stop It; New Haven, CT: Yale University Press