

Information Infrastructure Innovation as Path Creation: An Exploration of two Cases of Integrated Care in Germany

Daniel Fuerstenau*, Lauri Wessel, Martin Gersch

Freie Universität Berlin
Department of Information Systems

1. The Rigidity of German Healthcare and Information Infrastructure Ramifications

„By digitalization, the efficiency and extent of German health services could be significantly strengthened” (OECD 2015)

Dave, a German patient, faces a difficult choice. He used to be an active person, yet, he fell ill with COPD. This is a progressive lung disease that makes it difficult to breathe without technical aids. Hence, Dave needs permanent invasive respiration while being confined to his bed. Dave’s quality of life is suffering and he could profit from home care. However, an integrated approach to organizing health care and to providing information infrastructures, which support such organizing, would be needed. Otherwise professionals from different medical disciplines such as respiratory physicians, general practitioners, and nursing staff cannot coordinate their treatments of Dave with each other appropriately.

While the case of Dave is fictional, it shows some dilemmas in the restructuring of contemporary health care. Given increases in life expectancy, the spread of chronic diseases and the frequency of technological change (WHO 2015), health care faces challenges and opportunities. Challenges relate to the adaptation of health care delivery to the demands of the chronically ill. Services for the latter would ideally draw on neat information exchanges between medical professionals since chronically ill patients usually have to consult with many different medical professionals. Therefore, IT in general and information infrastructures (*II*) in particular provide major opportunities to support integrated care—i.e., the seamless flow of information among different medical disciplines. However, integrated care is inhibited by implementation problems of appropriate *II*s (Gersch and Rüsike 2011). And, despite the increasing need for integrated care, Germany has been identified as a particularly problematic case since implementation rates fall back behind other European countries (Lluch and Abadie 2013). The sectorial separation into primary, secondary and home care leads to diverse information systems in-use, which in turn, increases the difficulties to integrate these systems with each other (Wessel and Gersch 2015).

In this paper, we propose to analyze two cases of integrated care in Germany as path creation. The rationale is that the stagnant diffusion of integrated care can be seen as a problem of path dependence, which creates a trajectory for further attempts to create new paths via *II* innovation. The split into stationary and ambulant care with little permeability, then, becomes an outcome of dynamics dating back until Bismarck’s first social reforms in 1883.

The *II* in-use today mirror this split into “islands”. While hospitals draw on advanced clinical information systems, general practitioners and specialists use ambulant care systems with little integration. For nearly fifteen years, the development of a nation-wide *II* (e.g. electronic patient records) is ongoing with limited practical outcomes so far.

Against this background, we bring together data from two fairly successful “models” of integrated care in Germany. We use these cases to investigate the mechanisms and collective action creating *II* innovation. Based thereupon, we theorize how a holistic view of *II* innovation as path creation could inform efforts towards an integrated care path on a larger scale.

2. Information Infrastructure Innovation as Path Creation

Information infrastructures (II) are large scale socio-technical systems that share many characteristics with other infrastructures such as transportation systems or telecommunication networks (Hanseth and

* Refer to daniel.fuerstenau@fu-berlin.de as the corresponding author

Lyytinen 2010). Their infrastructural character implies important properties such as nonlinear evolutionary dynamics, openness, heterogeneity, and distributed control (ibid.). Healthcare is a good example for the importance of *II* in everyday life since the need to share data among many different medical professionals, care providers, insurance companies, patients and others is constantly increasing (Aanestad and Jensen 2011; Hanseth and Aanestad 2003).

Developing standards – e.g. protocols and formats for the exchange of medical documents – is important for *II* development as standards decrease conversion costs and thus enable self-reinforcing dynamics (Hanseth and Bygstad 2015; Braa et al. 2007). The latter also make standards susceptible to path dependency (Hanseth 2000). When an *II* gains momentum and attracts an increasing installed base it is, however, at risk of a lock-in – a situation with high switching costs and collective action problems, as observed in many instances in healthcare (e.g. Hanseth and Bygstad 2015; Wessel and Gersch 2015).

II innovation is a less well-spotted phenomenon as new components and technologies emerge in different areas of an *II*: *of*, *in*, and *on* infrastructures (Grisot et al. 2014). The main observation here is that innovation can be understood as constant *tinkering* on different levels (Ciborra 2004). At the heart of this “innovation mechanism” is the insufficiency of existing *II*s and their recombination into new services that are again integrated in the *II* (Henfridsson and Bygstad 2013). Such recombination comes at different labels such as *improvisation* (Ciborra 2004), *bricolage* (Ciborra 2004), or *hacking* (Rolland et al. 2015).

In contrast to a mechanistic view on *II* innovation, one can emphasize the agency of actors to influence *II* developments (e.g. Constantinides and Barrett 2014). This is in line with Garud and Karnøe’s (2001) observation that new paths may often be created by a process of mindful deviation. To account both for the mechanistic view (“path dependence”) and the agentic view (“path creation”), we refer to Sydow et al. (2012, p. 155), who argue that one should allow for the “integration of multi-actor constellations on multiple levels of analysis within a process perspective”. In such view, actors (e.g. care providers, vendors, medical professions) may align their interests within their scope of action to create interventions (“shocks”) that are powerful enough to introduce innovations into an *II* and infuse them on a larger scale.

3. Empirical Results

We analyzed two cases of comparatively successful integrated care providers. The first, dubbed “Gas SE”, is a large multinational that created a model to treat COPD. The second, dubbed “HealthNet”, is a smaller provider, which delivers integrated care to treat all diseases of a delimited patient population. We tracked both cases of multiple years (see below). Therefore, we collected about 3,000 pages of longitudinal, qualitative material per case. Our analysis of these cases was largely inductive. Details of the analysis process are available from the authors.

3.1 The Gas SE Case

The core business of *Gas SE* was industry gases for a long time. In fact, the company is a world-wide leader in this market. Over a period of nearly fifteen years, Gas SE expanded to healthcare services and got involved in creating an *II* for integrated care. In 2000, Gas SE took over a Swedish gas producer, and, in 2002, as a critical event, the first care center (*Romeo*) for patients with long-term mechanical ventilation was opened in a metropolitan region of Germany. In 2005, Gas SE acquired *Romeo*. Shortly thereafter, the care center was expanded. *Romeo* was integrated in Gas SE’s medical gas division.

At the same time, in 2004, the *Charity*—a major university hospital in the region—started evaluating the potential of integrated care. As an important outcome, in 2007, the hospital set up a competence center for ambulant breathing patient services (CBPS). It brings together patients, practicing doctors, and health insurance funds. In 2008, the medical gas division of Gas SE started collaborating with the CBPS center.

In 2008, Gas SE participated in a research project (*eHealth@home*) to evaluate the economical dimension of *Romeo* as an integrated care concept and to delve into the potentials of digital technologies such as ambient assistant living or telemedicine. Furthermore, the company has been active in promoting collaborative research projects together with research centers, hospitals, and scientists in the new area of applying medical gases (e.g. by research funds or fellowships). In 2009, Gas SE launched more care centers in Germany. Further centers followed, scaling the care model *Romeo* up to sixty centers worldwide in 2015.

The Charity also strengthened its efforts in the area of integrated care. In 2011, a *weaning center*—aiming at detaching patients from ventilation—got accreditation as the first of its kind in the metropolitan area. A major goal was to combine specialized state-of-the-art scientific practices with ambulant care. In 2014, the CBPS also intensified its activities in integrated care by agreeing on a cooperation with a network of ambulant doctors and other partners (e.g. physiotherapy, speech therapists, and health supply stores).

Important for our argument on *II* innovation as path creation, the collective action by Charity and Gas SE shapes the emerging *II* for integrated care. In 2014, *Romeo* started implementing a new patient record system, called *R-COM*. The new system was intended firstly to replace the paper procedures for patient documentation. It secondly integrates with Gas SE's administrative systems, such as SAP, used for settlement with health insurances. Finally, it aims at providing access for *Charity* to patient records via a funneled virtual private network (VPN) connection. This links *R-COM* with Charity's internal IS, most importantly a modified SAP clinical IS (in addition to around one hundred-fifty special-purpose systems).

At the moment, a new *II* is emerging linking both sectors in a new way. The main flows of information include the *patient record* and later *physician letters*. Thereby, the implementation team struggled long on how to align their design with specifications for standardized patient records on the national level (i.e. the so-called “telematics infrastructure” and related initiatives). So far, they have decided to take into account the specifications but they had to make idiosyncratic choices as standard implementations are not yet available.

Teleconsultation is another boundary spanning object in the project. Physicians from the hospitals' weaning center and/or intensive-care unit consult with specialists from the care center. Different disciplines could use the audio-video communication tools for sharing diagnosis- and patient-related data.

In sum, our analysis suggests that Gas SE as a new player with limited amount of historical legacy faced less rigidity in moving towards a new *II* in this integrated care setting. For instance, the company could implement a new patient-record system almost by adopting a green-field approach. Within the ongoing implementation process, quality-enhancing guidelines, equally developed within the project, such as how to transit a patient from the hospital to the care center, became inscribed in the new system. This process resembles a collective effort, mainly by Gas SE and Charity.

3.2 The HealthNet Case

HealthNet is a care provider, which receives a budget from the statutory health insurance in order to treat a population of patients, which resides in a specific area in Baden-Württemberg (a federal state in Southern Germany). HealthNet is responsible for covering the costs, which are related to *all* diseases of these patients (not just one as in the Gas SE case). This business model closely resembles the idea of “Accountable Care Organizations” (Barnes et al. 2014). We tracked HealthNet's pre-founding period (2000 until 2005) and continued our analysis for nine years of the post-founding period (2005 until 2014).

Similar to the Gas SE case, *II* innovation at HealthNet can be seen as collective action because three different actors defined HealthNet's overall purposes during the pre-founding period. These definitions prompted the development of an *II*. The first actor was a statutory health insurance organization (“Fund”). Fund would only sign a contract with HealthNet if the latter would outperform the average German health care expenditures (per comparison of a statistical twin population). The second actor was a community of medical professionals, who stressed that the improvement of the quality of health care

services was of utmost importance. This emphasis put quality over costs and, sometimes, the professionals even defied Fund's strong emphasis on costs. These two actors represented distinct institutional logics of the state (Fund) and the profession. Their powerful roles had grown out of the historicity of German health care. Therefore, they strongly embedded the agency of the third actor, a consultancy firm specialized in accountable care (HealthConsult). HealthConsult depended on both the state and the profession since Fund would pay for the services and the medical professionals would deliver them. These three actors developed a business model, which correlated quality-outcomes and cost-outcomes in a quite complex calculation. This calculation was inscribed into an *II*, which was catered to HealthNet's idiosyncratic demands.

During the post-founding period, HealthNet's *II* innovation process shows several instances of integrating different artifacts and inscribing new routines into the infrastructure. The integration of different artifacts was important because the aforementioned calculation drew on different data sources and no infrastructure existed, which integrated them. Therefore, the workstations of all medical professionals had to be linked to a central database, which gathered the medical documentation data. This would allow the calculation of the de facto costs of health care services. Moreover, this database had to be linked to another database, which included information on the average German health care expenditures. The latter would allow the calculation of the costs of a statistical twin population. Comparing both datasets would indicate whether HealthNet outperformed the German average or not. Inscribing new routines was another pivotal element of *II* innovation at HealthNet. The latter developed new routines in order to improve treatments of the chronically ill. Given that chronically ill patients have to consult with diverse medical professionals frequently, the coordination of these treatments was supposed to be facilitated by using an electronic medical record (EMR), which enabled different medical professionals to access medical documentation data in the aforementioned database. Over time, new routines were inscribed into the *II* in two steps: First, HealthNet developed concepts for treating specific chronic diseases and defined how these treatments should be documented. Second, the fields to document these treatments electronically were inscribed into the documentation program, which was used by the medical professionals.

II innovation at HealthNet was intended as path creation because HealthConsult wanted to replicate the *II* in other regions once HealthNet's *II* would be fully functioning. However, the crux was that both integrating and inscribing were severely difficult. Integrating led to numerous problems because the interoperability of the medical documentation software programs and the databases was dysfunctional for several years. Inscribing added on these problems since the integration of new routines often changed the settings of the programs in the infrastructure, which reinforced the interoperability problems. Cumulatively, this led to a cut in 2012 when HealthNet exchanged all suppliers. All treatment routines (see above) were included into a new system, which was based on a software by a major health-it supplier.

4. Concluding Remarks

Based on two cases of integrated care in Germany, we have examined *II* innovation as an act of path creation. We highlighted that both collective action and self-reinforcing mechanisms were important factors for creating *II* innovation in the cases at hand. We found that an important enabler was the intensive and long-term collaboration of key partners with complementary knowledge and their collective effort in creating a new *II*. Second, and equally important, successful *II* innovation started with the playfulness of project participants (e.g. to use a teleconsultation solutions) and exploited the self-reinforcing dynamics created by key opinion leaders and scaled them up to other sites and locations.

The design process of *II*'s for integrated care and adjacent home care models (e.g. "Buurtzorg" in the Netherlands) is an important societal challenge. Based on the approach we have outlined, we encourage future *II* research to delve deeper into the unique challenges of integrated care.

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Appendix: Timeline of Events for Gas SE and Charity University Hospital

Year	Gas SE/Gas Care	Charity University Hospital
1988	1st specialized care service for patients with permanent respiration in the region	
2000	Acquisition of Swedish medical gas producer strengthened the market segment of medical gases within the company	
2002	First care center (<i>Romeo</i>) for patients with respiratory diseases opened in metropolitan area	
2005	Acquisition of <i>Romeo</i> by <i>Gas SE</i>	Evaluation study for integrated care (2004-2008)
2006	Extension of <i>Romeo</i> center	Evaluation study of integrated care for knee and hip joint replacements (2006-2009)
2007	Medical gas division collaborates with CBPS	Foundation of center for breathing patients (CBPS)
2008	Research project <i>eHealth@home</i> in cooperation with technology partners and universities (2008-2011)	
2009	Opening of another care center for breathing patients in metropolitan area and in another region	
2011		Accreditation of first weaning center in region
since 2013	Consortium leader in <i>breathe@home</i> (2013-2016)	Participation in research project <i>breathe@home</i>
		Master program on integrated care for patients with psychological disorders (together with others)
2014	Implementation of electronic care documentation system / patient record system (in <i>breathe@home</i>)	Participation in the definition of quality indicators to enact the medical guidelines for breathing care
		Collaboration of CBPS with network of ambulant doctors and other partners (Ambulance partners)
2015	Piloting of tele-consultation tool for audio-video communication within <i>breathe@home</i>	Access to care documentation system of Gas SE by the means of virtual private network (VPN)
	Planned piloting of tablet solution for AAL	Participation in field test of teleconsulting solution