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Examining Barriers in a Telehealth Innovation: the Social-system Perspective

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ABSTRACT

Research on IT-based innovations is often limited to technological characteristics or to organizational level analyses. By expanding analysis dimensions, we can gain complementary insights and enlarge the boundaries of theories on IT-based innovations. This study adopts Van de Ven's social-system perspective to examine a specific telehealth innovation. The analysis is carried out at two levels – the behavior of individual actors or organizations involved and the industrial infrastructure that constitutes the context in which the innovation unfolds. The analysis provides important insights into how the development and adoption of the telehealth innovation interacted with the larger social systems in which it was embedded. Also, the study suggests how Van de Ven's social-system perspective can help understand the challenges involved in innovating health organizations enabled by IT.

Keywords

Telehealth innovations, Social-system perspective, Industry infrastructure, Multi-level analysis

INTRODUCTION

The importance of understanding IT-based innovations as integral parts of the context they are embedded in is emphasized in many IS studies (Avgerou 2001; Chiasson et al. 2004; Chiasson et al. 2005; Crowston et al. 2004; Kling 1980; Lamb et al. 2003; Van de Ven 2005; Van de Ven et al. 1999). There are several good reasons to study IT-based innovations from a contextual point of view. Emergence of new industries may reveal novel phenomena which were unnoticed or not explained in previous studies and different patterns of IT diffusion offers opportunities to broaden our understanding of the IS research field (Chiasson and Davidson 2005). Also, the context of IT-based innovations varies across industries and economies (Avgerou 2001).

This study adopts Van de Ven social-system perspective (Van de Ven et al. 1989) and applies it to understand the development and adoption of a telehealth innovation by a network of hospitals. With its mission critical features, this innovation has a great potential to be life-saving and further diffused across the initial regional boundaries. In fact, efforts to commercialize the innovation have been in progress with two entrepreneurs joining the network of actors. However, the progress of the innovation is painfully slow and the negotiation for commercialization turns out to be a difficult, bumpy process. On this background, we investigate the following research questions:

1. How can the agency and network relationships in the telehealth innovation process be understood from the social-system perspective?
2. What are the key factors that shape the telehealth innovation from the social-system perspective?

The study makes several contributions. First, it applies the social-system theory to the real-life context of a particular telehealth innovation and identifies key factors that shaped its formation. Second, the presented in-depth case study adds insights on why the healthcare industry lags behind in adopting and using IT (Aarts et al. 1999; Berg 2001; Lorenzi et al.

2003; Raghupathi 1997; Tanriverdi et al. 1998). Finally, the study offers advice for healthcare practitioners by identifying barriers to implement and commercialize telehealth innovations.

The paper is structured as follows. The next section reviews healthcare IS research and presents the adopted social-system theory. Next, we present the design of the case study and continue with the analysis of the telehealth innovation informed by the social-system theory. Finally, we discuss the contribution of the study and the implications for both research and practice.

THEORETICAL FOUNDATION

Healthcare IS Research

Telehealth innovations are particular examples of IT-based innovations within the healthcare industry. In their early stages of development, hospital IS were primarily administrative, but the 1990s have witnessed a shift towards clinical IS used to deliver patient care (Anderson 1997). Since the late 1990s, IT has increasingly been used to deliver healthcare services over distance leading to an interest in telemedicine, telehealth, and e-health (Maheu et al. 2001). Healthcare institutions are information-intensive (Anderson 1997) and the use of IT continues to increase (Dwivedi et al. 2001) particularly related to telehealth innovations (Chau et al. 2004). This is not surprising given that IT infrastructures in the healthcare industry is considered to be 10-15 years behind other industries such as banking, airlines, and manufacturing (Raghupathi 1997). As a result there is a growing body of healthcare IS research (Chiasson et al. 2004) and many of these studies report the difficulties for successful implementation of IS (Aarts et al. 1999; Berg 2001; Lorenzi et al. 2003; Tanriverdi et al. 1998).

Some researchers report integration problems with existing hospital IS (Horsch et al. 1999) or problems related to the implementation process (Chau et al. 2004). Others focus on knowledge management issues (Dwivedi et al. 2001) and many studies point out behavioral and organizational reasons for unsuccessful adoption (Aarts et al. 1998; Anderson 1997; Bangert et al. 2003; Berg 2001; Davidson 2003; Lorenzi et al. 2003). Issues include changes in communication pattern (Davidson 2003) and users resistance grounded in cultural inertia (Anderson 1997; Bangert et al. 2003; Lorenzi et al. 2003). Finally, there are studies that consider the organizational impact of increased IT usage (Bali 2000; Bali et al. 2001; Ludwig 1998).

What is largely missing in those studies is consideration of the wider context of healthcare IS. Chiasson and Davidson (2004) argue that the technical and institutional environment in healthcare is different from other industries and recommend institutionalized theorizing balancing general IS theory with consideration of the healthcare context. Constantinides and Barrett (2006) focus on the relationship between the context, the ways in which IT-based innovations are enacted in practice, and the role of different technological artifacts. However, we still have limited understanding of the characteristics of the healthcare industrial context and the particular ways in which it shaped IT-based innovations.

Social-system Theory

Emphasis on context has been widely accepted in organization studies since the introduction of open systems concepts during the 1960s and the recognition of institutional factors from the late 1970s (Scott 2001). But few IS studies have adopted open systems views to gain institutional insights into the use of IT (Lamb et al. 2003). There is, however, an increasing interest in contextual studies (Avgerou 2001; Chiasson et al. 2004; Chiasson et al. 2005; Covi et al. 1996; Crowston et al. 2004; Lamb et al. 2003; Van de Ven 2005). While these studies differ slightly in their emphasis on contextual issues, they all suggest to focus on what DiMaggio and Powell call the “organizational field” (DiMaggio et al. 1983). DiMaggio and Powell (1983) define organizational field as those organizations that, “in the aggregate, constitute a recognized area of institutional life: key suppliers, resource and product consumers, regulatory agencies, and other organizations that produce similar services and products.”

The social-system theory (Van de Ven et al. 1989) was based on studies of cochlear implant technology and later extended and refined in subsequent studies. The framework is also referred to as the industry infrastructure perspective. The framework emphasizes the “augmented” or “community infrastructure” incorporating three dominant perspectives to describe innovations, namely the technological imperative, the institutional determinism, and the resource endowments perspective. Van de Ven argue that all three are highly interdependent and therefore must be analyzed within a context of continuing interaction (Van de Ven et al. 1999). Hence, the social-system framework incorporates the various components of an industrial infrastructure for technological innovation (see Figure 1): (1) institutional arrangements to legitimize, regulate, and standardize a new technology; (2) public-resource endowments of basic scientific knowledge, financing mechanisms, and a pool of competent labor; (3) market mechanisms to educate consumers and stimulate demand for a new technology; and (4) proprietary research and development, manufacturing, marketing, and distribution functions by private entrepreneurial firms to commercialize the innovation for profit. The main proposition of the social-system framework is that the success in

developing a technological innovation depends primarily on the extent to which the necessary components of the infrastructure are available or established at the industrial-community level (Van de Ven et al. 1999).

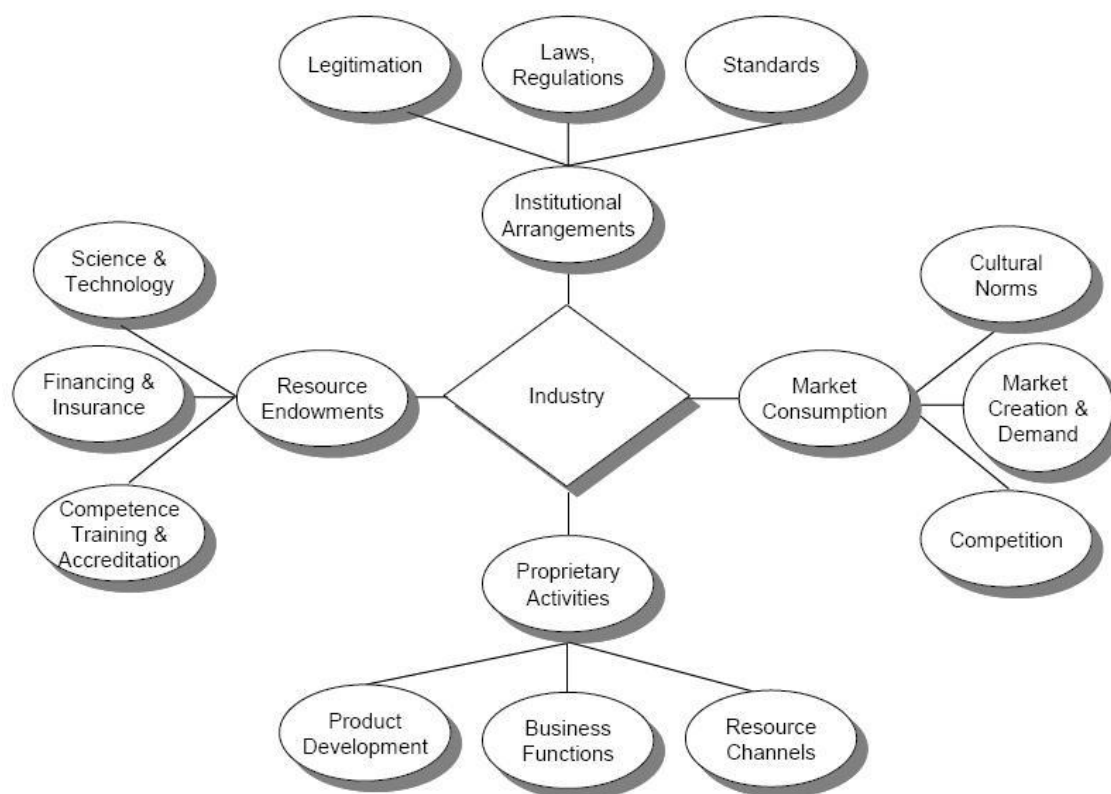


Figure 1. Industrial Infrastructure for Technological Innovation (Van de Ven 2005)

Our investigation of the case follows Van de Ven (1999)'s methodological suggestions with two levels of analysis to investigate the process of innovation: (1) the behavior of individual entrepreneurs and firms, and (2) the community infrastructure as a whole and the interrelations among its components or functions. We also follow the suggestion to address a number of macro-issues embedded in the framework: (1) how and when different components in the system emerge and are organized over time; (2) what actors create and perform these components; and (3) what impact these infrastructure components have on the time and cost of the developing the innovation.

The social-system framework was first conceived to illuminate the social, economic, and political infrastructure that can sustain members of a technological community. The framework belongs to the "collective action" perspective on institutional change, and, is suggested as an appropriate theoretical framework to explain emergence of technological innovations within an industry (Van de Ven et al. 2004). The framework is useful to explain and manage technological innovation in an increasingly knowledge-intensive service economy (Van de Ven 2005). The social-system framework is therefore a good theoretical lens to examine IT-based innovations in the healthcare industry.

RESEARCH METHOD

Context of Study

There is a critical lack of stroke specialist expertise in most rural areas and in many urban areas as well. This contributes to a higher rate of stroke deaths in rural and underserved communities (*Atlas of Stroke Mortality: Racial, Ethnic, and Geographic Disparities in the United States*—the Centers for Disease Control and Prevention (January 2003)). For the case of non-bleeding stroke, or ischemic stroke, TPA (Tissue Plasminogen Activator), a blood-clot dissolving agent, greatly reduces chances of severe disabilities if it is administered within three hours from the first show of stroke symptoms. It should,

however, be avoided for non-bleeding patients, because it is fatal to them. Despite the potential benefits of the drug for ischemic stroke patients, it is estimated only 2% of stroke patients receive its benefits, due to lack of on-site expertise of stroke specialists who can discern ischemic and non-ischemic strokes.

In March 2003, the department of neurology at a large university hospital (referred to as the hub hospital) in the state of Georgia in the U.S. launched a telehealth system, called REACH (the Remote Evaluation for Acute Ischemic Stroke Program). REACH provides round-the-clock neurological service to rural hospitals in near-by areas through a telemedicine system. It makes centrally-located neurologists available to ER staff at the rural hospitals enabling the central neurologists to hear and see the patients over distance in real time. CT scan and other vital information about the patient at the rural hospital are transferred to the central expert over REACH and the neurologist makes a decision on the administration of TPA and follow-up treatments. By the time of writing this paper, seven rural hospitals had joined the program and the hub hospital was preparing to establish another hub by joining forces with another large hospital in the state.

In January 2005, two entrepreneurs sponsored by a state R&D funding agency joined and formed a company (referred to as the Firm in the following) to commercialize REACH. The hub hospital and the two entrepreneurs went through several rounds of negotiations, but failed to reach an agreement on licensing and operation terms and conditions. As a result, the sponsorship of the state to the Firm ceased and the two entrepreneurs instead sought partnership with another company which possessed a similar technology.

Research Design

A single case study (Yin 2003) was planned to study this telehealth innovation involving multiple organizations. Case study research is well suited to understand IT-based innovations in organizational contexts (Darke et al. 1998) and single cases allow researchers to investigate phenomena in depth to provide rich description and understanding (Walsham 1995).

There were three main data sources for the research: documents, interviews, and participant observation. All available documents were analyzed such as those related to system development and project management, financial documents, and publicly available articles from news media. 25 individuals in five hospitals including the hub and four rural hospitals were interviewed. Seven were doctors, five administrative staff, three technical staff, nine nurses, and one radiology technician. All interviews were semi-structured, lasted typically between 30 and 60 minutes. The majority of interviews were individual and a few were group interviews of two to four. Interview notes were prepared right after each interview. The researchers also held nine advisory workshops with the two entrepreneurs of the Firm and these were documented in field notes. All interviews and workshops were recorded. One of the authors had continued interaction with the state research funding agency having opportunities to hear about its position and support of the entrepreneurial launch for REACH.

The data were then analyzed to develop a social-systems view of REACH. First, individual actors were identified and data were analyzed according to the four main components of the social-system framework. Second, major events were identified to anchor the industry-level analysis of the infrastructure and interactions of the components of the system. These events played a pivotal role in answering the macro-level questions to understand the process of the innovation. Differences among the researchers were resolved through discussions that resulted in iterative refinements of the overall analysis.

RESULTS

Behaviors of Individual Actors

The hub hospital, the rural hospitals, the Firm, and the state R&D funding agency sponsoring the entrepreneurial initiative of the Firm were identified as the main actors driving the telehealth innovation. In the following, behaviors of these actors are analyzed in terms of the four components of the social-system framework (see Table 1).

The hub hospital was active in terms of proprietary activities, since they sponsored and hosted the development of the telehealth innovation. It financed the development process and the installation and maintenance of REACH in the participating rural hospitals. However, there was no business function involved to commercialize the innovation, given the nature of the organization as a medical service provider. In addition, the project was initiated as a research project. Accordingly, there were no efforts to develop additional resource channels within the hospital. In terms of resource endowments, mature scientific and technological research provided the knowledge that underlies the telehealth innovation. In an interview, the system developer pointed out that LCD monitors and wireless network became affordable in the market, making the innovation economically affordable. The hub hospital and the neurology department financed the entire development and diffusion costs of the innovation without external funding sources. A pool of competent human resources existed in the market to develop and maintain the innovation. The hub hospital successfully appropriated resource endowments by hiring competent IT resources to develop a web-based, cost-effective innovation. However, the hub

hospital's activities in institutional arrangements were minimal. Little consideration for governance and legitimization was given and activities to align the innovation with institutional arrangements were minimal. This was reflected in adoption of a one-way video communication design, which would not allow medical services to be reimbursed under current insurance schemes. There existed no technological standards for such a new-to-the-world innovation. Nor did the hub hospital make an effort to apply or develop technology standards. In terms of the market consumption component, the hub hospital tried to expand REACH to more rural hospitals, but their perspective was far from creating demand and ultimately a market. No business transactions existed between the hub and the rural hospitals. There were a couple of other telestroke systems like REACH in the U.S., but virtually no vendor-supplier-distributor channels, hence, no markets had been established despite some commercialization efforts for two of the systems including REACH.

The rural hospitals were more passive actors regarding the innovation. They did not engage in any proprietary activities as a free-recipient of the innovation developed and financed by the hub hospital. They were operating under similar conditions as the hub hospital in terms of the resource endowment component. In a sense, they faced tougher condition in terms of resource endowments since many of rural hospitals had financial problems even to install the minimum infrastructure such as digitized CT scanners and fast-network connections to run REACH. They also confronted a severe problem of technological human resources to maintain hospital IS. All the four interviewed rural hospitals reported the same problems with either no IT staff or a single IT staff member with high turn-over ratio. The limited budget and operation deficits prevented them to take actions to solve these problems. The rural hospitals operated in the same environment as the hub in terms of institutional arrangements and market consumption. They did not make contributing activities either in creating or expanding infrastructure in these two components.

By early 2005, the Firm was established to commercialize REACH by the two entrepreneurs, who were sponsored by the state R&D funding agency. Their main area of activity focused on the market consumption component. Their initial activities concentrated on developing a viable business plan and carving out a contract with the hub hospital about licensing terms, shares of ownership of the Firm, and operational agreement. If the firms' activities were considered as marketing and sales of the innovation on behalf of the hub hospital, it could be said that the firm was active in subcomponents of the proprietary activities. However, the Firm and the hub hospital could not reach an agreement by the end of the year. Rounds of negotiation between the two parties started summer 2005, and finally ended in December 2005. At this point, the state agency, after failing to mediate the conflicts of negotiation, decided to cease funding the commercialization efforts.

There were not many other organizations involved, since the innovation was very new-to-the-world and had not yet created enough attention and response from potential actors such as the regulatory agencies and insurance institutions, actors particular to the healthcare industry. Only the state funding agency emerged as a main actor by sponsoring the two entrepreneurs to commercialize the innovation. The funding agency's sponsoring was also an indirect support to create the market consumption component. Later, it was engaged in mediating the negotiations between the entrepreneurs and the hub hospital. Such legitimizing activities are critical for new-to-the-world innovations because they help attract a critical mass of researchers to the field and build consumers' trust in the market (Van de Ven 1999). In case of REACH, actors and activities in the institutional components that would legitimize and support it were nearly non-existent, hindering further diffusion and adoption of the innovation.

	Hub hospital	Rural hospitals	Firm (Entrepreneurs)	Other actors (Funding agency)
Proprietary activities	<i>Proactive</i>	<i>Reactive</i>	<i>Proactive</i>	
Resource endowments	<i>Utilize</i>	<i>Utilize</i>	<i>Utilize</i>	
Institutional arrangements	<i>No consideration</i>	<i>No consideration</i>	<i>Consideration</i>	<i>Legitimization</i>
Market consumption	<i>No consideration</i>	<i>No consideration</i>	<i>Active</i>	<i>Indirect impact</i>
Table 1. Activities of Individual Actors				

Industry-Level Analysis

Next, we look at the industry infrastructure as a whole and the interrelations among its components and functions. This analysis is anchored around major actions or events identified and focused on the three macro-issues of the innovation process. We identified three major events for the innovation, which are the conception of the innovation in 2001, the system rollout and installation during 2003, and the commercialization efforts in 2005, see Figure 2 and Table 2.

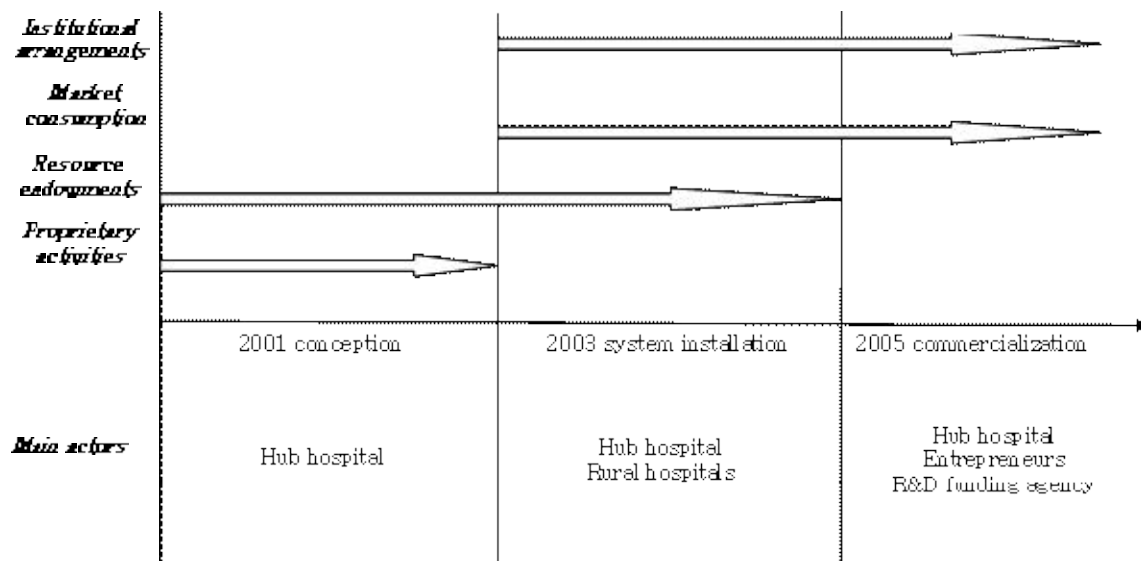


Figure 2. Relative importance of social system components and main actors

The telestroke innovation was conceived by the neurologists at the hub hospital in 2001 and the development of the system began in 2002 financed by the neurology department. A core project team consisting of four stroke specialists and one system developer was formed around the investment. The development project was driven mostly by pure scientific and humanitarian motivations amongst the core project team members. The development was successful due to mature resource endowments in the industry infrastructure such as affordable hardware, software, and fast-access communication network services. Successfully appropriating the resource endowments, the hub hospital was able to create the innovation. However, the activities were quite isolated without any collaboration with other actors, and also without active consideration of other components of the industry-level infrastructure. At this stage, no other actors emerged as significant except the hub hospital. Activities were concentrated in the proprietary components with resource endowments being a given condition for the hub hospital.

The system rollout began in March 2003 with the first installation in a rural hospital and continued to include seven rural hospitals by summer 2005. The project champions had the ambition to expand the innovation to the entire state and even to other states. New actors, namely rural hospitals, joined and interaction between the hub and the rural hospitals increased to handle complicated issues like contracts, legal issues, installations, and training of medical staff at the rural hospitals. The relations between the hub and the rural hospitals were largely cooperative, as the hub hospital was solely in charge of system provision from installation to staff training. However, with the growing use of REACH, the rural hospitals began to face unexpected difficulties in getting insurance reimbursement. The rural hospitals mainly served Medicare, Medicaid, or self-insured patients, for whom the hospitals got under-reimbursed for services based on REACH. The rural hospitals began to realize the misalignment of the innovation and institutional arrangements for reimbursement. They needed innovative systems like REACH to complement lack of specialists they could not afford, but under-reimbursement added to the operational deficits most rural hospitals were experiencing. On the hub side, the medical consultation by the neurologists was a free-service, since the innovation did not meet the two-way communication requirements for proper reimbursement. No regulatory agencies such as state regulatory or insurance-related agencies were involved to resolve the problems. Institutional

arrangements such as these were considered major barriers to further adoption of the innovation. The group of participating rural hospitals could be considered as an initial market segment for the innovation, but transactions were implicit rather than explicit, indicating before-market stage of development. Market consumption with critical mass and demand could potentially have large impact on institutional arrangements by directing influential actors to pay attention and actively seek resolutions. For now, the underdevelopment and non-alignment of these components delayed further adoption and diffusion of the innovation.

In early 2005, two entrepreneurs sponsored by the state R&D funding agency created the Firm with an ambition to commercialize the innovation. The mission of the Firm was to identify and respond to a market demand. At this stage, the Firm and the hub hospital's activities were conspicuous compared to other actors, since they were actively engaged in a process to reach an agreement about licensing REACH. In terms of proprietary activities and resource endowments, there were no new, additional activities besides the funding from the state agency. The Firm, while negotiating with the hub, tried their business ideas with potential investors such as large medical organizations and venture capitalists. However, its negotiation with the hub hospital was difficult due to a gap in understanding between the two parties, ultimately holding the Firm's activities to a halt. The funding agency's activities were concerned with institutional arrangements helping to legitimize a social system, which would permit the Firm to operate and gain access to the resources needed. The agency tried to mediate the negotiation of a license agreement, a critical and principal resource to launch the Firm's activities. These attempts ended in a failure to reach agreement. As a consequence, the hub, the Firm, and the agency lost this opportunity for rapid adoption and diffusion of the innovation.

	Community level analysis	Consequences
Proprietary activities	<i>Hub hospital took lead in development of the innovation.</i>	<i>The innovation was successfully developed.</i>
Resource endowments	<i>Hub hospital appropriated resource endowments successfully.</i>	<i>The innovation was adopted by a network of hospitals, but limited institutionalization and diffusion.</i>
Institutional arrangements	<i>Misalignment between institutional arrangements and the innovation.</i>	<i>No major efforts to resolve problems and overcome a major hurdle for diffusion of the innovation.</i>
Market consumption	<i>Emerging with negotiations between the hub and the Firm.</i>	<i>Underdeveloped market consumption component will increase time and costs of wider diffusion.</i>
Table 2. Community-level Infrastructure Analysis		

DISCUSSION

We have presented a case study of a telehealth innovation using Van de Ven's social-system framework (Van de Ven et al. 1989; Van de Ven 2005). The innovation makes real-time, remote medical expertise of stroke specialists accessible to multiple rural hospitals, and it has been successfully developed and adopted by a network of hospitals. Despite its affordable and easy-to-use technical features and potential life-saving medical benefits, the innovation's adoption and diffusion rate is slow. To understand why, we have used the social-system framework in an attempt to broaden the boundaries of our knowledge about diffusion and adoption of telehealth innovations. The two-level analysis went beyond individual organizations identifying multiple actors and examining the innovation process in terms of the four components of the community-level infrastructure: proprietary activities, resource endowments, institutional arrangements, and market consumption. The case analysis shows that activities in the components of proprietary activities and resource endowments were sufficiently effective to explain the successful development and initial adoption of the innovation. However, the other components of institutional arrangements and market consumption were not mature enough. Nor were influential actors or activities engaged to effectively develop these components. Some actors emerged in attempts to address these components, but their initial efforts failed without tangible results. We suggest on that basis that this unbalance between various components and actors created major barriers for further and wider adoption of the telehealth innovation under investigation.

This research, as a theory application study, contributes to our understanding of institutional theory, the social-system

perspective in particular, in relation to IT-based innovations within healthcare. The social-system theory was initially proposed to be appropriate for emerging market segment and for knowledge-intensive IT innovations. Also, the study expands our understanding of healthcare innovations, especially telehealth innovations. It provides a plausible and alternative explanation of why the healthcare industry is lagging behind in adopting and using IT. The study indicates that institutional arrangements are an important barrier, possibly more rigid within healthcare than in other industries. Based on our findings, we agree with Van de Ven (2005) that an individual organization's development and diffusion of an innovation is highly dependent on the maturity of the industry-level infrastructure.

While our case suggests that the innovation has the potential of creating and penetrating a market, some may argue that more information is needed about future actions and events to effectively relate this particular innovation to each component of the framework. We have also only presented a single case, and further applications of the theory in the healthcare domain are therefore needed to further validate its usefulness.

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