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# HOW EARLY IMPLEMENTATIONS INFLUENCE LATER ADOPTIONS OF INNOVATION: SOCIAL POSITIONING AND SKILL REPRODUCTION IN THE DIFFUSION OF ROBOTIC SURGERY

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**We report on a multilevel study investigating the diffusion of robotic surgery in the Italian health care system between 1999 and 2010. A combination of qualitative and quantitative methods allowed us to link organization-level processes associated with the adoption and implementation of the innovation to its diffusion at the population level. Our findings advance the understanding of how early experiences with the implementation of an innovation influence later adoptions, and they draw attention to how the search for social gains drives some peripheral actors to pioneer an innovation and engage in practices of discursive persuasion and skill reproduction that, in turn, constitute them to be "exemplary users." These practices eventually trigger and support the isomorphic diffusion of the innovation, even in the presence of persistent uncertainty about its technical or economic benefits.**

> Robot-assisted prostate surgery has grown at a nearly unprecedented rate . . . Medical researchers say the robot situation is emblematic of a more general issue. New technology has sometimes led to big advances, which can justify extra costs. But, often, technology spreads long before investigators know whether it is worthwhile.
>
> (Kolata, 2010: A1)

Research suggests that the diffusion of innovations is driven by the interplay of rational assessments and isomorphic pressures (Strang & Soule, 1998). Theories of rational action emphasize the formal and informal conduits through which information regarding the benefits of innovation spread and encourage new adoptions (Rogers, 2003). Institutional accounts advance the notion that, as the number of adopters in a field increases, increasing numbers of actors will be encouraged (or feel the pressure) to do the same, regardless of considerations of technical or economic benefits (DiMaggio & Powell, 1983).

The case of robotic surgery mentioned in the opening quote, however, indicates that, at times, innovations may diffuse and be applied while uncertainty about their technical or economic benefits remains high. This case is theoretically interesting because it suggests how current theories of diffusion may only provide a partial account of the process, as they fail to convincingly explain how the diffusion of these innovations (and, more generally, all innovations) can progress beyond an early stage, when the cumulative number of adoptions is too low to trigger isomorphic responses, and high uncertainty and negative experiences of early informants are likely to discourage further adoptions based on rational assessments.

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Past research has generally assumed that the observation of a growing number of adoptions induces actors to take for granted improvements associated with new technologies (Rogers, 2003) or administrative practices (Tolbert & Zucker, 1983). This assumption, however, is problematic because it fails to consider the possibility that the decisions of adopters (or non-adopters) may be influenced by the way previous adopters have implemented an innovation, and not only by the fact that they adopted it (Strang & Soule, 1998).[1]

Mere adoption is no guarantee of successful implementation or continued use (Rao, Greve, & Davis, 2001). Organization-level research suggests that the implementation of technological or administrative innovations may unfold differently in different organizations (Barley, 1990; Lozeau, Langley, & Denis, 2002), and, possibly, lead to unexpected or undesirable outcomes (Canato, Ravasi, & Phillips, 2013). The likelihood that the direct or indirect transfer of knowledge about the difficulty of implementing an innovation may discourage subsequent adoptions appears particularly high in the early stage of the diffusion process, in the absence of isomorphic pressures.

Past studies have generally assumed that, in an early phase, diffusion is primarily driven by rational assessments of technical, economic (Tolbert & Zucker, 1983; Westphal et al., 1997), or, more recently, social gains—understood as improvements in the relative standing of the adopter within the social structure of the field (Kennedy & Fiss, 2009). In practice, however, we know little about how these assessments are formed and whether and how these decisions are influenced by earlier implementation experiences (Rogers, 2003).

To improve our understanding of the motivations of early adopters and how their experiences influence subsequent diffusion, we explored the spread of robotic surgery in Italy between 1999 and 2010. We adopted a multilevel method that allowed us to reconstruct the decisions leading to the first 50 adoptions, and to track changing patterns in the motivational drivers for adoption and in the mechanisms for the dissemination of implementation experiences that underpinned the field-level process over time.

Our findings contribute to current theories of diffusion by improving our understanding of the agentic processes that underlie the spread of innovation. First, they indicate that the structural position of actors in a field influences how they frame an innovation in a very early phase of the process: while central actors are more likely to frame it as a threat, peripheral actors are more likely to frame it as an opportunity to improve their positions by claiming mastery of a popular new technology or work practice. The strategic search for social gains that motivates early adoptions by peripheral actors will induce these actors to constitute themselves as "exemplary users" and to engage in intense efforts to promote the diffusion of the innovation, even in the presence of very high uncertainty about its technical and economic benefits.

Second, our findings begin to unpack how the dissemination of early adopters' implementation experiences influence the decisions of late adopters by gradually reducing uncertainty regarding how to implement an innovation, even in the presence of persisting ambiguity with respect to its outcomes. In particular, our observations complement and extend current accounts highlighting the discursive practices that agents of change engage in to encourage the diffusion of innovations (Munir & Phillips, 2005; Suddaby & Greenwood, 2005), by drawing attention to micro-level practices that exemplary users employ to facilitate the reproduction of skills required for the implementation of new technologies or work practices (Rogers, 2003).

## THEORETICAL BACKGROUND

### Rational Action versus Institutional Theories of Diffusion

Early research on the diffusion of innovation conceptualized the process as driven by a rational search for technical or economic benefits (Katz & Lazarsfeld, 1955). Central to these accounts was the notion that interpersonal interaction, the media, and other conduits spread information on the benefits enjoyed by early adopters, increasingly reducing the uncertainty associated with the innovation in the perceptions of late adopters (Strang & Soule, 1998).

In contrast to these accounts, social studies of technology questioned the notion that technical and economic benefits are always easily ascer-

[1] Following past work (e.g., Kennedy & Fiss, 2009; Westphal, Gulati, & Shortell, 1997), by "adoption," we refer to the decision to introduce an innovation in an organization (e.g., the purchase of a surgical robot), and, by "implementation," we refer to the actual introduction of the innovation in the organization (e.g., the actual use of the robot).

tained, and drew attention to the social construction processes that surround the diffusion of technological innovations (Garud & Rappa, 1994; Pinch & Bijker, 1984). Similarly, research on the diffusion of managerial practices has revealed that the benefits of administrative innovations may be contested (e.g., Fiss & Zajac, 2004; Sanders & Tuschke, 2007), and suggested that organizations may adopt new practices to conform to the prevailing norms of their field (DiMaggio & Powell, 1983) rather than to achieve the economic gains these practices may bring.

Early research in the institutional tradition proposed that motivations for adoption progressively shift as innovations diffuse (Baron, Dobbin, & Jennings, 1986; Tolbert & Zucker, 1983; Westphal & Zajac, 1994): whereas early adoptions are primarily explained by the search for technical or economic benefits, late adoptions reflect increasing isomorphic pressures. More recent findings, however, have challenged this model by indicating that economic and social motivations may not be easily distinguished (Lounsbury, 2007) and may coexist in both the early and late phases of diffusion (Kennedy & Fiss, 2009).

Current theories of diffusion, then, rest on the assumption that, to the extent that innovations improve organizational performance, the benefits enjoyed by early adopters will initially foster diffusion based on rational assessment and eventually trigger mimetic (Tolbert & Zucker, 1983) and/or defensive responses in the rest of the population (Abrahamson & Rosenkopf, 1993). Neither rational action nor institutional accounts of diffusion, however, provide a convincing explanation for how innovations progress beyond a very early stage, when diffusion is still limited and uncertainty regarding how to implement an innovation and ambiguity concerning its outcomes remain high.

### Implementation and Adoption Decisions in the Early Diffusion of Innovation

The implementation of innovation is typically fraught with uncertainty and bound to be problematic (Attewell, 1992). Organization-level studies have revealed that technological innovations may induce changes in users' roles, interaction patterns, and power relations (e.g., Barley, 1986, 1990; Burkhardt & Brass, 1990). They may disrupt existing routines (Edmondson, Bohmer, & Pisano, 2001) and require expert advice and support to be mastered (Eveland & Tomatzky, 1990). Similarly, administrative innovations often require adjustments after their introduction (Ansari, Fiss, & Zajac, 2010), as users collectively struggle to embed new practices into their everyday activities and master the new technologies with which these practices are associated (Canato et al., 2013). It is not unreasonable, then, to expect early adopters to encounter implementation problems and eventually fail to achieve the technical and economic benefits they expected (Zbaracki, 1998).

Extant theories, however, hardly explain why the numerous failures that are likely to characterize the very early stage of diffusion do not deter later adopters. These theories tend to overlook the possibility that adopters, even at an early stage, will base their decisions on how the diffusing practice has been *implemented* by previous adopters—the problems they encountered, the results they achieved—rather than simply considering whether it has been *adopted* and by whom (Greve, 2011). They do so despite the fact that, as Greve (2011: 952) reminds us, "one source of uncertainty about innovations is the lack of knowledge on how to implement them. Any knowledge that either facilitates implementation or reveals implementation difficulties could potentially affect adoption decisions."

This simplifying assumption can be partly explained by the fact that these studies adopt large-scale methods that hypothesize (or make assumptions regarding) whether and how past adoptions influence subsequent ones (Zilber, 2008), rather than examining them directly. As Strang and Soule (1998: 269) observe:

> We typically know that potential adopters are brought into contact with the diffusing practice, but do not know quite what they see, particularly whether they observe results. This inability to specify what is observed produces some theoretical fuzziness about the micro-processes involved in diffusion.

While research has gradually moved from simply tracking when innovation is adopted (e.g., Tolbert & Zucker, 1983) to examining whether and how it is adapted to local conditions (e.g., Fiss, Kennedy, & Davis, 2012; Kennedy & Fiss, 2009; Westphal et al., 1997), researchers nevertheless tend to consider implementation as a dependent variable and fall short of capturing whether and how the implementation experience of earlier adopters influences the decisions of later ones.

Research generally assumes that news of positive implementation experiences will travel through the media (Rogers, 2003), interpersonal networks (Coleman, Katz, & Menzel, 1966), alliances and partnerships (Goes & Park, 1997), and professional associations (Swan & Newell, 1995). The assumption is that adopters' successful experiences are smoothly conveyed across organizations as the accumulation of knowledge on the benefits of a new technology or managerial practice gradually reduces the uncertainty that initially surrounds these benefits (Terlaak & Gong, 2008).

This understanding carries the implicit assumption that, in the presence of negative experiences, the diffusion of an innovation will be delayed or even come to an end. This assumption, however, appears to be particularly problematic with respect to explaining how diffusion moves through the very early phase of the process, when high uncertainty and implementation failures may easily deter further adoptions. Moreover, if this assumption were correct, we could hardly explain how some innovations, such as robotic surgery, can diffuse at all in the presence of high uncertainty regarding technical or economic benefits.

These considerations indicate that we only have a simplified understanding of what motivates very early adopters and how the implementation experiences of these actors influence subsequent decisions as accounts of these experiences reach potential new adopters. Addressing this issue, however, is important in order to improve our understanding of the initial diffusion of innovation in the presence of high uncertainty about its benefits and the negative implementation experiences of early adopters.

## RESEARCH METHODS

### Research Setting

To address the questions outlined above, we studied the diffusion of robotic surgery in the Italian health care sector between 1999, the year of first adoption, and 2010. Robotic surgery belongs to the more general category of "minimally invasive" surgical techniques. It relies on remotely controlled, patient-side "arms" guided by a surgeon sitting at a console and operating the machine using sophisticated control gloves (Mack, 2001). The aid of a computer is supposed to overcome some of the limitations of laparoscopic surgery—the first minimally invasive technique, based on small incisions instead of the larger ones required in traditional "open" surgery. The console grants the surgeon a three-dimensional view of the operated area, and the surgical instruments on the robotic arms rotate and bend beyond what a human wrist could do.

Robotic surgery also has broader implications for work practices in the operating room and the organization of hospital activities. Operating at a distance requires high coordination between the head surgeon sitting at the console and the assistant surgeon working at the bedside. Nurses responsible for setting up the machine need training in handling expensive and sophisticated equipment; any technical drawback during the operation is not only risky for the patient but also prolongs operation time and generates inefficiencies for the hospital. Moreover, because of its bulk, a surgical robot requires a dedicated operating room, often built *ex novo* within the hospital's facilities. Finally, a multidisciplinary use of the robot requires the hospital to change the organization of surgical activities by having surgeons from different specialties rotate in the operating room and work with a dedicated nursing team.

Between 1999 and 2010, the diffusion of robotic surgery increased significantly—in Italy and abroad—even in the presence of persisting uncertainty regarding whether and how this innovation brought substantial benefits to the patient. Systematic reviews of applications of robotics to general surgery concluded that robotics failed to display significant benefits for patients relative to laparoscopy (Gutt, Oniu, Mehrabi, Kashfi, Schemmer, & Büchler, 2004; Kang, Hardee, Fesperman, Stoffs, & Dahm, 2010). It was only in 2012 that scientific research produced evidence of some benefits of robotic surgery (reduced blood loss and perioperative complication rates), compared to other pre-existing techniques, and only for a specific application in the field of urology—radical prostatectomy (Tewari, Sooriakumaran, Bloch, Seshadri-Kreadan, Hebert, & Wiklund, 2012). Whether these benefits justified the high economic costs of the new technology, however, remained a matter of debate (Mottrie et al., 2009; Pittman, 2012).

Italian surgeons pioneered the adoption of robotics, and they actively participated in the international debate on robotic surgery (e.g., D'Annibale et al., 2004; Ficarra, Cavalleri, Novara, Aragona, & Artibani, 2007; Giulianotti et al., 2003; Novara, Ficarra, D'Elia, Secco, Cavalleri, & Artibani, 2010). Shortly after the U.S. Food and Drug Administration's approval of the use of robotic technologies in medicine, three Italian hospitals acquired robots, soon to be followed by seven more in the following two years. By 2010, Italy was second only to the United States in terms of the absolute number of surgical robots.

### Data Collection

Our study began in 2009, and it was based on multiple sources of data (see Table 1).

In a preliminary phase, we contacted the distributors of surgical robots in Italy and obtained a list of hospitals that had purchased one. We then contacted and interviewed all of the surgeons and managers who had been involved in the decision, with the exception of two of them (who were deceased). We replaced the missing two by interviewing medical directors who, while not directly involved in the decisions, were informed of them. In addition, we interviewed managers at the local distributors, policymakers and public officers at the national and regional levels, and managers of private foundations that had contributed to fund certain adoptions (see Table 1 for additional details).

The first round of interviews was conducted between February 2009 and May 2010. Interviews lasted between 40 minutes and 3 hours, and they were all tape-recorded. They followed a common

**TABLE 1**
**Data Sources and Use**

| Data Sources | Type of Data | Use in the Analysis |
|---|---|---|
| Semi-structured interviews (1,116 pages) | *Interviews with adopters* (124 in total): managers (50) and surgeons (74) at 43 hospitals adopting robotic surgery between 1999 and 2010 | Reconstruct the decision processes. Investigate the motivations behind the adoption and how these adoptions were influenced by past implementations in other hospitals. |
| | *Interviews with other relevant actors* (43 in total): chairpersons of foundations (5), local distributor of the technology (2), regional policymakers (25), experts on the Italian health care system and issuers of technological innovation in health care (11) | Reconstruct the historical and institutional context within which robotic surgery diffused between 1999 and 2010. Integrate and crosscheck the accounts of adopters and non-adopters. |
| | *Interviews with non-adopters* (24 in total) | Integrate and crosscheck the accounts of adopters. Increase our understanding of the motivational drivers of adoption (or non-adoption), diffusion mechanisms, and barriers to diffusion. |
| Archival data | *Hospital-related documents*: correspondence between surgeons and managers, press releases, feasibility studies, documents produced by private foundations funding adoption (105 pages) | Support, integrate, and crosscheck accounts from semi-structured interviews. Corroborate understanding of motivational drivers for adoption. |
| | *Local popular press*, 1999–2010 (161 articles, covering 47 adoptions) | Gather information on who adopted robotic surgery and when. Support, integrate, and crosscheck accounts from semi-structured interviews. |
| | *National popular press*, 1999–2010 (86 articles, covering 24 adoptions) | Gather information on who adopted robotic surgery and when. Track media coverage of the new practice and the hospitals and surgeons associated with it. |
| | *National and international scientific publications*, 1999–2012 (178 articles) | Track the scientific debate over the technical benefits of the new practice, compared to preexisting surgical techniques. Track and examine diffusion mechanisms through the dissemination of implementation experiences |
| | *Programs and proceedings of national conferences of the main surgery associations 1999–2010* (250 pages) | Track the contribution of professional associations to the diffusion of robotic surgery. |
| | *Videos*, downloaded from the Internet (105 videos, for 8 hours of viewing) | Track and examine diffusion mechanisms through the dissemination of implementation experiences. |

protocol but had an open-ended format allowing us to capture a rich description of the events associated with the adoption and implementation of the innovation.[2]

As some of the events discussed in the interviews had occurred years before, we used techniques to alleviate potential recall bias (Huber, 1985). Despite our best efforts, however, it is possible that some of our informants might have overemphasized the "rationality" of the process (Athanassiades, 1973). It is also possible that an attributional bias (Huber & Power, 1985) might have induced some informants to stress their contribution to a decision that produced positive results, and other informants to distance themselves from decisions that produced negative ones. To obviate these methodological problems, we integrated and triangulated the information provided by the interviewees using multiple sources of archival data (Golden, 1992), in the form of internal presentations, correspondence between the surgeons and general manager, presentations and documents prepared for external funders, feasibility studies, etc. (see Table 1 for additional details).

We also carefully searched the national and local press. At the national level, we searched the four most widely circulated Italian newspapers (*La Repubblica*, *Corriere della Sera*, *La Stampa*, and *Il Sole 24 ore*). At the regional level, we searched one or two local newspapers for each hospital. We used different sets of keywords covering the most common combinations of terms associated with robotic surgery: "robot + *chirurgico*" ("surgical + robot"), "*chirurgia* + *robotica*" ("robotic + surgery"), and "robot + Da Vinci" (the latter specifically referring to the da Vinci Surgical System). Our search produced a total of 247 articles, covering 47 adoptions or more generally discussing the diffusion of robotic surgery. Archival sources were important to our analysis because they allowed us to crosscheck and integrate accounts from interviews when interviewees were uncertain of specific facts (e.g., the year of acquisition) or when we detected discrepancies between different accounts.

Finally, to track whether and how adopters disseminated their implementation experiences through presentations, live surgeries, and video surgeries, we collected the programs and proceedings of the conferences of the national associations of cardiac surgeons, general surgeons, and urologists (1999–2010). We tracked scientific publications of adopters (1999–2012) and downloaded 105 interviews with these adopters available on YouTube.

### Data Analysis

Our analysis proceeded through multiple steps. For the sake of simplicity, we present these steps sequentially, although, in reality, multiple iterations occurred.

***Step 1: Reconstructing a chronology and history of the diffusion of robotic surgery.*** In a preliminary phase, we combined archival sources with the list of adoptions provided by the Italian distributor of the technology to produce a detailed chronology of all adoptions of robotic surgery between 1999 and 2010. Consistent with the definition of adoption outlined above, we considered the innovation to have been adopted when a surgical robot was purchased by a hospital and made available internally.[3] This search produced a list of 50 adoptions in 43 hospitals (some hospitals purchased additional machines at different points in time as the application moved to other fields of surgery). For each hospital (cases "H1" to "H43" in Table 2), we gathered detailed demographic data that could be relevant to explain the observed patterns of adoption, such as the number of beds, geographic location, and affiliation with a medical school. Next, we combined interviews and archival data to reconstruct a more general history of the process, highlighting what informants described as key events, such as the organization of the first international conference of robotic surgery or the creation

[2] We used part of these interviews in a related inquiry on how policymakers make evidence-based decisions when governing the diffusion of technological innovation (Mele, Compagni, & Cavazza, 2014).

[3] Because of the considerable investment involved, the decision was ultimately made by the general manager, which, according to Rogers (2003: 403), qualifies this decision as "organizational." In the early years, the decision was often influenced by the personal reputation, ambitions, and skills of head surgeons. However, from the perspective of the managers, leveraging surgeons' skills and reputation would eventually benefit the organizations overall, as surgeons' accomplishments positively reflected on the standing of their hospitals. Even when surgeons moved elsewhere, hospitals often retained organizational benefits in the form of increased prominence in the community and well-trained local teams.

**TABLE 2**
**Adoption and Use of Robotic Surgery in Italy (1999–2010)**

| Case | Year of Adoption | # Beds at Adoption[a] | Position | Surgical Specialties Involved in the Adoption | Years of Usage | Surgical Specialties Using Robotics in 2010 (# Operations/Year) |
|---|---|---|---|---|---|---|
| H1 | 1999 | *1186* | Central | Cardiac | 1999–2001 | — |
| H2 | 1999 | *968* | Central | Cardiac | 1999–2001 | — |
| H3 | 1999 | *962* | Central | General | 1999–2002 | — |
| H4 | 2000 | 481 | Peripheral | General | 2000– | General (70), Urology (20) |
| H5 | 2000 | 123 | Central | Cardiac | 2000–2004 | — |
| H6 | 2001 | 629 | Peripheral | General | 2000– | General (120), Urology (35) |
| H7 | 2001 | *909* | Peripheral | Cardiac | 2001–2003 | — |
| H8 | 2001 | *1356* | Central | General | 2001– | General (20), Urology (20) |
| H9 | 2001 | *1551* | Central | Cardiac | 2001–2003 | — |
| H10 | 2001 | *1792* | Central | Cardiac | 2001–2003 | — |
| H11 | 2001 | 408 | Peripheral | General | 2001–2002 | — |
| H12 | 2001 | 1052 | Central | General | 2001–2002 | — |
| H13 | 2002 | *634* | Central | General | 2002– | General (20), Urology (30) |
| H14 | 2002 | 142 | Peripheral | General | 2002– | General (150) |
| H15 | 2002 | *1006* | Central | Cardiac | 2002–2003 | — |
| H16 | 2002 | *805* | Central | General | 2002–2004 | — |
| H17 | 2004 | 532 | Peripheral | Urology | 2004– | Multi-specialty (50) |
| H18 | 2004 | 120 | Peripheral | General, Urology | 2004– | Urology (40) |
| H19 | 2004 | 427 | Peripheral | General | 2004– | General (20), Urology (100) |
| H20 | 2005 | 605 | Peripheral | General | 2005–2007 | — |
| H15/2 | 2005 | | Central | Urology | 2005– | Urology (202) |
| H21 | 2005 | *1590* | Central | General | 2005– | General (20), Urology (100) |
| H22 | 2005 | 1238 | Central | General | 2005– | General (20), Urology (50) |
| H23 | 2005 | 517 | Peripheral | General | 2005– | General (20), Urology (90) |
| H10/2 | 2006 | | Central | Urology | 2006– | Urology (125) |
| H24 | 2006 | *202* | Peripheral | Urology | 2006– | Multi-specialty (391 Urology, 169 others) |
| H25 | 2006 | *406* | Peripheral | General | 2006–2008 | — |
| H26 | 2006 | 211 | Peripheral | General | 2006–2009 | — |
| H2/2 | 2006 | | Central | Urology | 2006– | Urology (165) |
| H27 | 2007 | 189 | Peripheral | General, Urology | 2007– | General (15), Urology (40) |
| H28 | 2007 | 489 | Peripheral | Urology | 2007– | Urology (180) |
| H29 | 2007 | 555 | Peripheral | General | 2007– | Multi-specialty (60 Urology, 70 others) |
| H30 | 2008 | 501 | Peripheral | Urology | 2008– | Urology (90) |
| H31 | 2008 | 150 | Peripheral | Urology | 2008– | Urology (90) |
| H32 | 2008 | *1037* | Central | General | 2008– | General (5), Urology (20) |
| H3/2 | 2008 | | Central | General, Urology | 2008– | General (60), Urology (85) |
| H33 | 2008 | 362 | Peripheral | Urology | 2008– | Urology (125) |
| H34 | 2008 | 314 | Peripheral | Urology | 2008– | Urology (40) |
| H9/2 | 2008 | | Central | General, Urology | 2008– | Multi-specialty (150) |
| H35 | 2009 | 340 | Peripheral | Urology, General | 2009– | Multi-specialty (150) |
| H36 | 2009 | *1477* | Central | Urology | 2009– | Urology (108) |
| H37 | 2009 | *805* | Central | Urology | 2009– | Urology (60) |
| H38 | 2009 | *570* | Central | Urology, General | 2009– | Multi-specialty (80) |
| H39 | 2009 | 120 | Peripheral | Urology | 2009– | Urology (not available) |
| H40 | 2009 | 150 | Peripheral | General | 2009–2010 | — |
| H20/2 | 2009 | | Peripheral | General | 2009– | Multi-specialty (198) |
| H1/2 | 2009 | | Central | Multi-specialty | 2009– | Multi-specialty (202) |
| H41 | 2010 | 800 | Peripheral | Multi-specialty | 2010– | Multi-specialty (120)[c] |
| H42 | 2010 | *991* | Central | Urology | 2010– | Urology (50)[c] |
| H43 | 2010 | 1735 | Central | Urology | 2010– | Urology (80)[c] |

[a] Italics denote affiliation with a medical school.
[b] Number of operations per year is for the latest available year.
[c] Extrapolated, with the help of a surgeon, to an annual timeframe on the basis of the first few months of experience with the robot.

of the national society of robotic surgery. According to our informants, these events reflected the intense efforts of early adopters to establish robotic surgery as a viable and, indeed, superior surgical practice. Theoretically, they draw attention to the gradual construction of a field-level infrastructure to promote the diffusion of robotic surgery.

***Step 2: Reconstructing organization-level adoptions and implementations.*** In a second step, we used semi-structured interviews, supplemented by archival data, to examine how adoptions and implementations had unfolded at the organizational level.

First, for each adoption, we produced a detailed narrative description of the decision process: the actors involved, the role they played, the information they relied upon, the length of the process, the nature and content of discussions, and the considerations that influenced their decision. This analysis helped us to familiarize ourselves with the cases and gave us an intimate understanding of the typical decision-making process in health care when technology adoption is involved. It also revealed how the involvement of managers in the decision changed significantly over time, as discussed below.

Next, we turned our attention to a more systematic analysis of the motivational drivers of adoption. Two members of the research team engaged in the open coding of interviews, searching for relevant text segments that referred to what had motivated surgeons and managers to consider the adoption of robotic surgery. Following recommendations for open coding (Locke, 2001), we relied on multiple rounds of coding to gradually combine first-order descriptive codes (e.g., "Search for organizational visibility," "Building reputation for technological leadership" and "Using technology as a marketing tool") into broader and more theoretically relevant second-order codes (e.g., "Search for social gains for the organization"). In a further round of coding, we grouped second-order codes into broader aggregate dimensions reflecting fundamental drivers of adoption (e.g., "Search for social gains," "Search for technical benefits," etc.).

Finally, we examined the ways in which later adoptions were influenced by the exposure to earlier implementations. We carefully searched interviews for text segments indicating early adopters' engagement in sharing and disseminating their experience and whether late adopters declared to have been influenced by these efforts (and how). Even in this case, multiple rounds of coding motivated us to move from first-order codes associated with specific practices (e.g., video surgeries, protocols, etc.) to broader, and more theoretically relevant, second-order codes ("Codifying early implementation experience"), and eventually into aggregate dimensions reflecting fundamental processes through which early adopters shaped the diffusion of robotic surgery ("Discursive persuasion," "Skill reproduction").

***Step 3: Tracing historical patterns in the adoption of robotic surgery.*** Having circumscribed the main motivational drivers and mechanisms of dissemination associated with each adoption, we organized these data in a longitudinal fashion to explore possible patterns along the diffusion process.

First, we tracked how motivations for adoption changed over time by associating each adoption with the main drivers that featured in our informants' accounts of the decisions. We were aware that accounts of a decision might not necessarily disclose the true motivational drivers. We addressed this potential problem by challenging our informants to substantiate their assertions, highlighting occasional inconsistencies with the accounts of other actors, and comparing and integrating multiple accounts of the same decisions (at times, including accounts by actors not directly involved).

Second, for each adopter, we used interviews and archival data to track the micro-level mechanisms for the dissemination of the experience in which they were engaged. We tracked the number of video surgeries and live surgeries that they performed at conferences. We produced a detailed table of the scientific publications and conference presentations of each adopter, tracking whether the data they presented were favorable, unfavorable, or neutral regarding robotic surgery. We tracked their presence in the national press and the number of interviews available on the Internet. As our interviews indicated that some adoptions were associated with the recruitment of a general manager or surgeon with previous experience in the implementation of robotic surgery, we also carefully tracked the migration paths of these actors.

Third, we used interviews to identify the dissemination mechanisms that each adopter described as influencing their decisions. This analysis revealed certain discrepancies with the results of the previous sub-step, in that (a) not all of the dissemination mechanisms that early adopters engaged in were mentioned by later adopters as being relevant to their decisions, and (b) not all adopters who engaged in the dissemination of their experience were mentioned as influential by later adopters. The results of these two sub-steps, however, largely converged in drawing attention to a narrow set of early adopters (H4, H6, and H24), who were among the most active disseminators *and* were mentioned as influential by the highest number of adopters. We conceptually labeled these early adopters "exemplary users."

At the end of this step, we produced a detailed map of who influenced whom, when, and how as the innovation diffused in the health care sector. At this stage, a comparative observation of changing motivational drivers and dissemination mechanisms over time led us to organize our longitudinal reconstruction of the process around three phases. As is common in longitudinal studies, this temporal bracketing did not correspond to sharp discontinuities, but, rather, to "certain continuity in the activities within each period and [. . .] certain discontinuities at its frontiers" (Langley, 1999).

***Step 4: Establishing the position of adopters.*** The notion that the structural position of adopters could partly explain their decisions emerged early in the course of our study, as we noticed that several informants related their motivations (or the motivations of other adopters) to their being "one of the most important," "prominent," or "central," on the one hand, or "peripheral," "marginal," or "small" on the other. Building on this insight, we first tentatively classified hospitals as "central" or "peripheral" based on our informants' categorization. Following past studies (e.g., Greenwood & Suddaby, 2006), we then searched for corroboration of our tentative classification in demographic data reflecting size (the number of beds at the time of adoption) and status (affiliation with a medical school). Our informants' classification roughly corresponded to hospitals that had more than 800 beds; 20 of these 23 hospitals were also affiliated with medical schools. Of the remaining 27 (peripheral) hospitals, only four were affiliated with medical schools. The substantial convergence of informants' indications (reflecting socially constructed understandings concerning the social structure of the field) and demographic indicators (reflecting scholars' beliefs regarding the attributes that shape the positioning of an organization within the social structure of the field) reassured us that our classification of adopters as central or peripheral was appropriate.

To more systematically investigate our early insights on the interrelations among structural position, time of adoption, dissemination mechanisms, and continued use versus abandonment of innovation (see Table 2 for a summary of these data), we built additional tables to uncover patterns across these constructs.

***Step 5: Interviewing non-adopters.*** As our interpretation of how the process unfolded began to coalesce, we turned our attention to those hospitals that could have possibly adopted the new technology, but, at the time of our study, had not.

Nearly 80% of the 1,241 hospitals in the Italian health care sector are small (fewer than 300 beds) and cater to a narrow geographic area. While some of these hospitals adopted robotic surgery between 1999 and 2010, they were primarily specialized or private clinics with above-average financial resources. We therefore circumscribed our search to those hospitals that were likely to have considered adoption in the period of our study because of their size (robotic surgery is highly expensive), specialization (at present, robotic surgery only has applications in general surgery and urology), and/or status as an Istituto di Ricerca e Cura a Carattere Scientifico, a public recognition of excellence in research and care.

Of the total considered, 29 hospitals fell within our search parameters. For each of them, we initially contacted the head urologist for an interview. If informants mentioned that the acquisition of the robot had been previously discussed for other branches of surgery and/or by other colleagues, we also contacted these colleagues. If informants mentioned that their proposals to adopt robotic surgery had been opposed by hospital management, we contacted the general or medical director. Of those receiving requests, 20 non-adopters agreed to be interviewed, for a total of 24 respondents.

The interview protocol was similar to that used for adopters: we asked informants whether and when they had considered adopting robotic surgery, how the decision process unfolded, the motivations for their decisions, and what influenced these decisions. We also asked them whether the issue had been raised again later, if they had changed their mind over time, and why. When informants mentioned that non-adoption was due to a lack of financial resources, we asked them why they would have adopted the new technology if they could have. These interviews were tape-recorded and transcribed.

Unsurprisingly, interviews with non-adopters drew attention to the availability of financial resources as an important constraint to the diffusion process. In 11 cases (out of 20), informants explained non-adoption by a shortage of funds and/or the refusal of the regional government to authorize the investment in the presence of budgetary restrictions and uncertainty about the benefits. The analysis of these interviews, however, largely corroborated observations from our main sample. Several informants mentioned that, financial considerations aside, they would have gladly adopted robotic surgery, and the motivational drivers they outlined were similar to those we observed for adopters (i.e., isomorphic pressures). Only five of these non-adopters mentioned that they deliberately refused to adopt the innovation, and they justified their decision with the persisting uncertainty surrounding the technical benefits and economic sustainability of the robot.

## FINDINGS

Robotic surgery was introduced in the Italian health care sector in 1999. By May 2010, 50 robots had been adopted in 43 hospitals (see Figure 1). Our investigation of hospitals' decisions to adopt the new technology suggests that this period can be conceptually divided into three phases, characterized by the relative prevalence of different motivational drivers and mechanisms for the dissemination of implementation experiences (see Table 3).

In the remainder of this section, we present a detailed narrative of these three phases, highlighting differences in what drove organizations to adopt robotic surgery and whether and how these decisions were influenced by previous implementations. Following common prescriptions for reporting qualitative data, we display selected quotes supporting our categorization of drivers and mechanisms in Tables 4 and 5.

### Phase I (1999–2001)

Between 1999 and 2001, 12 Italian hospitals adopted robotic surgery. Most adopters were medium- to large-sized general hospitals, often associated with a medical school (see Table 2). However, our informants described four adopters as peripheral hospitals (H4, H6, H7, and H11); these hospitals were located in relatively small towns, and had no association with medical schools. In all but one case (H8), local surgeons initiated the process and convinced hospital managers to acquire the necessary technology.

**FIGURE 1**
**Main Events in the Diffusion of Robotic Surgery in the Italian Health Care Sector (1999–2010)**

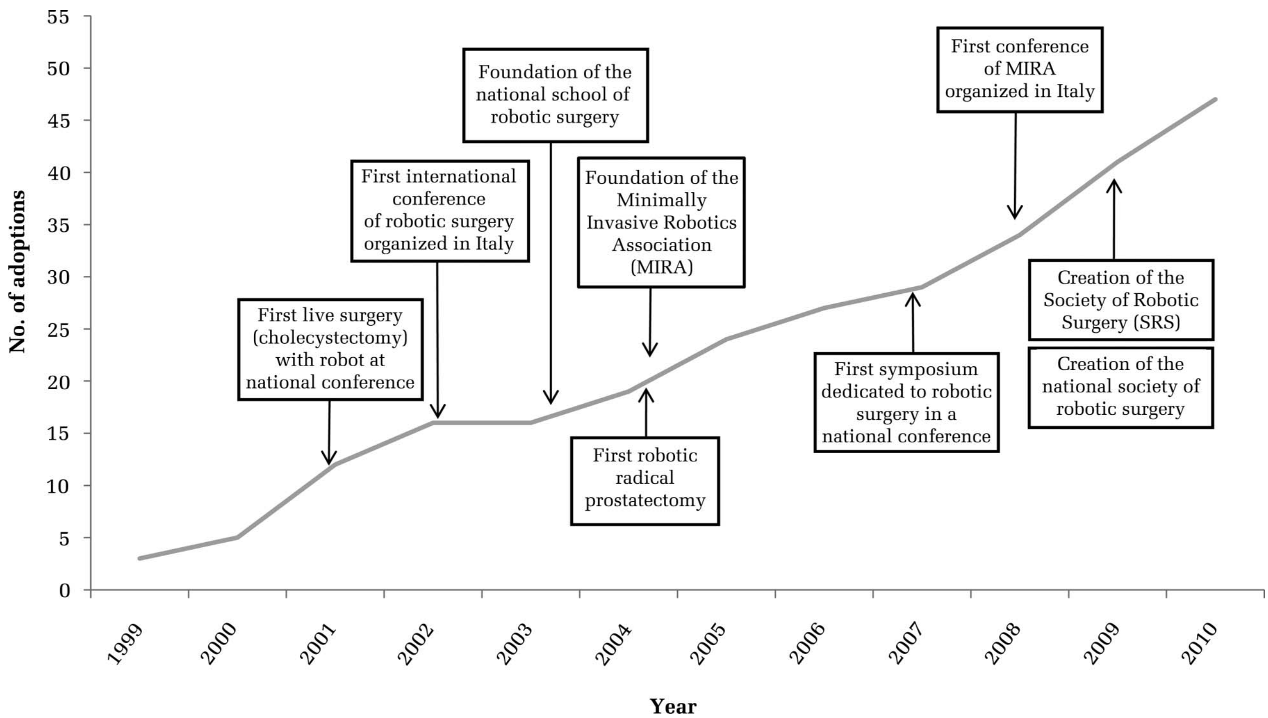


**TABLE 3**
**The Diffusion of Robotic Surgery in the Italian Health Care Sector, 1999–2010: A Summary**

| | Phase I (1999–2001) | Phase II (2002–2006) | Phase III (2007–2010) |
|---|---|---|---|
| Number of adoptions | 12 | 17 | 21 |
| Surgical specialties involved | Cardiac, General | General, Urology (few) | Urology, General (few) |
| Prevailing decision-making process | Surgeon driven (11/12) | Surgeon driven (14/17) | Surgeon-driven (11/21)<br>Manager-driven (10/21) |
| Prevailing motivational drivers for adoption | Search for social gains (peripheral actors)<br>Organizational imperative (central actors)<br>Propensity to innovate | Imitation (general surgeons)<br>Search for social gains (urologists)<br>Organizational imperative (urologists) | Coercive pressures<br>Bandwagon effect<br>Search for social gains (peripheral actors) |
| Prevailing dissemination mechanisms | [not relevant] | Exposure to operations<br>Video and live surgeries<br>Protocols<br>School of robotic surgery | Proctoring<br>Migration<br>Media and Internet interviews |
| Prevailing motivational drivers for non-adoption | Excessive risk and uncertainty regarding technical benefits | Lack of strong evidence regarding technical benefits<br>Concerns related to economic sustainability | Lack of funds<br>Low volumes of surgical activity |

The specialties involved in these early adoptions were, in equal measure, cardiac and general surgery (see Table 2). At that time, robotic surgery was still a fledgling practice and even international experiences were scant. The U.S. Food and Drug Administration had just approved the medical application of robotic technologies, but uncertainty regarding their benefits and how to use them in practice was still very high. Informants recalled how:

> There were no protocols or books to study. It was a time when all was invented and discovered for the first time.
>
> (Surgeon, H5)

> We were pioneers. Not even the producers of the robot really knew the potential of the machine, or how to really use it. They did not give us many indications on how to use it, where to put the machine, how to arrange the robotic arms. We had to figure it out on our own. At the beginning, none of us could know if such an expensive choice was correct.
>
> (Surgeon, H6)

***Motivational drivers.*** When asked what induced them to adopt robotic surgery at such an early stage, the informants rarely mentioned expected benefits for patients. These benefits were still unclear and unproven. More frequently, they referred to potential technical benefits for the surgeon, such as reducing tremor and tiredness, and, in a few cases, the futuristic notion of conducting operations at a distance (e.g., across neighboring hospitals or in other countries) (see Tables 4 and 6).

During this phase, decisions appear to be rather influenced by the surgeons' and, to some extent, managers' *propensity to innovate* (Table 6). Informants recalled how they "fell in love" with robotic surgery, and they used colorful expressions to describe the excitement that they felt as they experimented with the new technique (see Table 4). They mentioned how, at first, they regarded the robot as a "miracle" or a "dream come true." These informants also frequently underlined their openness to innovation, and their desire—for themselves or the hospital they managed—to keep abreast of developments in surgical practice (see Table 4).

While these attitudes partly explain the eagerness of robotic surgery's early adopters, the expected technical benefits hardly justified the high investment and additional cost of the new technique. When describing the motivations behind these early adoptions, both surgeons and managers explained the decisions as based mostly on a combination of *organizational imperatives* and a strategic *search for social gains*.

By "organizational imperative," we refer to the will, expressed by informants, to act in keeping with what they perceived as the distinctive cultural traits of their organization (*cultural imperative*) or the prominent position of the organization and/or its head surgeon (*reputational imperative*).

**TABLE 4**
**Motivational Drivers of Adoption: Selected Quotes**

| 2nd-order Codes | Selected Quotes on 1st-order Codes |
|---|---|
| Organizational imperative (Cultural) | *Coherence with organizational values*<br>"We are an IRCCS; therefore, innovation is part of our DNA and this led us to consider the robot immediately." (Manager H24)<br>*Coherence with organizational mission*<br>"Our mission states that we want to be chosen exactly for the quality of our work and we all felt the great responsibility of offering high-quality services." (Manager H5) |
| Organizational imperative (Reputational) | *Coherence with reputation for technological leadership*<br>"We had to maintain our reputation of being cutting-edge in cardiac surgery. The robot served that purpose." (Surgeon H1)<br>"We had to buy it. The development of mini-invasive surgical techniques has always been the main stream of research and clinical practice in our hospital." (Surgeon H2, hospital press release)<br>*Coherence with reputation of lead surgeon*<br>"Dr. Huscher had been the innovator in laparoscopy. It was obvious that he also wanted to operate with the robot." (Manager H3)<br>"I have substantial laparoscopic experience. I was the first in Italy to perform a laparoscopic prostatectomy in 2001. Who else, if not me, should have started using the robot?" (Surgeon H17) |
| Propensity to innovate (Openness to innovation) | *Surgeon's openness to innovation*<br>"I got interested in the robot as I get interested in every new technology." (Surgeon H2)<br>"I belong to that category of people that, I mean, if I read one night about a new intervention performed in Boston, the following day I was rushing there to see how they do it." (Surgeon H5)<br>*Manager's openness to innovation*<br>"Among the drivers of the robot acquisition was my predisposition to technological innovation." (Manager H4)<br>"[As a manager] you have to be proactive in proposing new technologies to physicians, you have to suggest new things and if they [physicians] do not look for new things there is something wrong!" (Manager H7) |
| Propensity to innovate (Fascination with new technology) | *Emotional response to robotic surgery*<br>"The surgeon, who was already familiar with the concept of mini-invasive technique, introduced me to this machine, and we both fell in love with it." (Manager H5)<br>"The robot had fired up our hearts and our minds . . . we were passionate about the robot." (Surgeon H7)<br>*Imaginative stimulation of robotic surgery*<br>"For me, the real fascination of robotics was the idea of having two surgeons using it at the same time . . . It was fascinating to observe . . . We were truly excited by the idea of the robot." (Surgeon H3)<br>"With the robot, we were all dreaming of having our hands in the abdomen without actually opening it." (Surgeon H6) |

Several informants, for instance, mentioned how the adoption of robotic surgery was coherent with the "mission" of the organization, with its "DNA," or with core "values" of innovation and quality of care (see Table 4). As such, they said, it was their "duty" to adopt it; they "could not *not* have it." Informants from hospitals associated with medical schools frequently mentioned how the experimental nature of robotic surgery fit the mission of their organizations to advance research in medicine—their "obligation to innovate, to try things out"—regardless of economic considerations.

Other informants related the adoption of robotic surgery to what they described as a leading position of the hospital and/or the head surgeon in minimally invasive surgery. They considered the adoption of the new technology justified by the presence of prominent surgeons, "precursors of minimally invasive surgery," "innovators" who had pioneered new techniques in the past. As one surgeon explained:

> The general manager told me: "This hospital is the point of reference for laparoscopy in Northern Italy!" We HAD to have the robot . . . I was the first to perform a laparoscopy in Italy in 1989. My team had experience in 30,000 minimally invasive operations. [We performed] 10 operations per day. I had to try.
>
> (Surgeon, H8)

**TABLE 4**
**(continued)**

| 2nd-order Codes | Selected Quotes on 1st-order Codes |
|---|---|
| Expected technical benefits (Surgeon) | *Distance surgery*<br>"We found the idea that you could work with it from one hospital to another—basically performing an intervention with the supervision of a surgeon who was physically in another hospital—quite interesting." (Manager H6)<br>*Reduced tremor*<br>"Robotic technology enormously facilitates surgical intervention. The movement is way more nimble and precise . . . Having a tool that eliminates tremor has been an important driver of our decision." (Surgeon H20)<br>*Reduced fatigue*<br>"The robot offered the possibility to operate in a way that was much less tiring and less risky than laparoscopy, with a tranquility and a safety that were noticeably higher because the gesture was safer and neater." (Surgeon H20).<br>*Ease of learning*<br>"The real advantage of robotics was the easy execution and the intuitiveness of the surgical act." (Surgeon H2) |
| Expected technical benefits (Patients) | *Reduced post-surgical pain and recovery*<br>"Robotic surgery is establishing itself for its 'social value': reduced surgical trauma, decreased post-operatory pain, shorter periods of incontinence and impotence: basically, patients resume their active life faster." (Surgeon H15, hospital press release)<br>*Reduced loss of blood*<br>"There is a long list of advantages for the patients. First, and foremost, a reduction in the post-operatory blood loss. Consequently, surgeons resort to transfusions less frequently." (Surgeon H31, interview, local press) |
| Search for social gains (Organizational) | *Search for organizational visibility*<br>"The top manager paid much attention to the hospital's image. He cared a lot about the visibility of the hospital . . . He preferred an intervention every two months, but reported in the newspapers, [than he would rather see] a hundred interventions per day that would remain unnoticed." (Surgeon H8)<br>"With the decision to acquire a robot, the top manager wanted to be in the spotlight." (Surgeon H15)<br>*Building reputation for technological leadership*<br>"The decision to acquire the robot was strategic . . . with the robot we wanted to characterize ourselves as a hospital specialized in mini-invasive techniques." (Manager H18)<br>"We unanimously agree on the importance to acquire this technology, which will enable the hospital to attract more complex pathologies, by offering a technologically more sophisticated treatment." (H20, internal document)<br>*Using technology as a marketing tool*<br>"When we requested the robot, we explained to the implications of such an important decision to management . . . in terms of technology and, for us, also—let's say—of marketing." (Surgeon H24)<br>"The robot was acquired in a context of renewal for our hospital . . . But it was mainly marketing." (Surgeon H27) |
| Search for social gains (Professional) | *Opportunity to gain prominence*<br>"Thanks to the robot, the surgeon had a promotion, and she is now known in the field of robotic surgery." (Manager H9)<br>*Opportunity for professional growth*<br>"Everyone wanted to jump on the robot bandwagon—and I am also talking about myself here—because it offered a professional opportunity." (Surgeon H15) |

While the majority of central actors adopting robotic surgery at this stage appeared motivated by the desire to justify their reputation, informants at the four peripheral hospitals instead mentioned how they regarded robotic surgery as an opportunity to increase their professional standing or the standing of the hospital that they managed or where they worked (see Table 6):

> Robotic surgery found fertile ground in some young surgeons, who, like me, wanted to emerge.
>
> (Surgeon, H7)

**TABLE 4**
**(continued)**

| 2nd-order Codes | Selected Quotes on 1st-order Codes |
|---|---|
| Isomorphic response (Imitation) | *Imitation of successful pioneers*<br>"There was Giulianotti at H4, who was a pioneer, and D'Annibale at H6—by looking at them, I understood . . . the route to be followed in robotics. Casciola had been the first to believe in robotic surgery . . . I saw it later, but, as soon as I saw it, I went along with it." (Surgeon H14)<br>"I saw that Dr. Giulianotti was working a lot with robotic surgery, doing great things. I thought that for us the time had come to adopt this technology, and I went to talk about it with our general manager." (Surgeon H20)<br>*Imitation of close rivals*<br>"Several surgeons have been facilitated by claiming that 'at H17, they made it . . . We cannot lag behind.' For example, at H2, they had it, but were not using it. At that point, they decided to make an effort." (Surgeon H17)<br>"Our hospital competes with H10. Clearly, having the possibility to catch up from a technological point of view with H10 and be on equal footing was crucial." (Surgeon H15/2) |
| Isomorphic response (Coercive pressures) | *Patients demand robotic surgery*<br>"If a patient comes and asks to be operated on with the robot—right or wrong—you must be in a condition to offer this treatment or otherwise you lose a client." (Surgeon H15/2)<br>"It became mandatory because patients asked for it. When they heard the words 'laser' and 'robot' in surgery, they went crazy." (Surgeon H38)<br>*Media shape patients' preferences*<br>"By now, with all the fuss in the media and on the Internet, people come and ask, 'Do you have the robot?'" (Surgeon H30)<br>"You hear a lot about it . . . and also the media give out information. And patients ask, 'What about the robot?'" (Surgeon H14/2) |
| Isomorphic response (Bandwagon effect) | *Fear of being left behind by technological evolution*<br>"Why do I want to have a technology such as the robot? Because, if something new happens, I do not want to start from scratch, I want to be there . . . I do not want to miss the train." (Surgeon H27)<br>"As knowledge cumulates, you should be in touch with it. This is what I thought of the robot. I was already lagging behind in laparoscopy because I had not believed in it. I could not do the same with the robot." (Surgeon H37).<br>*Conforming to a common trend*<br>"There was pressure to acquire [a robot] because it is booming. Until a few years earlier, there were 20 or 25 robots installed in Italy. By then, we had already 40–45, and in such a short time. This technology is spreading rapidly!" (Surgeon H31) |

> I told the manager: "Let's make a quantum leap with robotic surgery! To distinguish ourselves from other hospitals, we should bet on technological innovation."
>
> (Surgeon, H4)

Some informants described the decision to adopt the innovation as a "strategic choice," to "build distinctive competences" or gain "excellence" in the field of surgery, reflecting the entrepreneurial attitude of hospital managers:

> Robotic surgery was a strategic choice. We wanted to make this organization a leader in the field . . . We aspired to other positions, to do what others did not do.
>
> (Manager, H9)

These motivational drivers reflect what has been described in past studies as a purposeful search for social gains, understood as the instrumental use of innovation to distinguish oneself and improve one's position within the social structure of the field (Kennedy & Fiss, 2009).

***Dissemination of experience.*** The initial results of robotic surgery failed to meet expectations. In several cases, the innovation was abandoned within a few years (see Table 2). Cardiac surgeons found the robotic procedure difficult and time consuming. Complications occurred during operations, leading to the loss of several patients and accusations of malpractice. Although these negative experiences were common knowledge among cardiac surgeons, they were rarely voiced in public or at national conferences. As one informant explained:

> Among cardiac surgeons, we talked about the robot all the time, at each conference, but we talked about it with some hesitation. Everybody had reservations, but few were willing to express them in public. Nobody wanted to publicly declare in front of everybody: "I am not as good as the others are, because I don't get the robot to work!"
>
> (Surgeon, H15)

Even general surgeons were aware of implementation problems among cardiac surgeons in Italy and internationally. General surgeons who pioneered robotic surgery, however, dismissed the negative experience of cardiac surgeons as specific to their specialty:

> Giving the robot to cardiac surgeons was a big mistake! They had to start immediately with complex and risky operations, using a completely new technology. General surgeons had cholecystectomy to start with. Robotic surgery really took shape only when general surgeons started to use it.
>
> (Surgeon, H3)

Even among general surgeons, however, the implementation of the new practice was not smooth. Two of six surgeons stopped using the robot after a year. Two other surgeons, in hospitals H3 and H8, compared clinical results with other minimally invasive techniques and found no strong evidence of the superiority of robotics (e.g., Benincà, Garrone, Rebecchi, Giaccone, & Morino, 2003; Morino, Benincà, Giraudo, Del Genio, Rebecchi, & Garrone, 2004).

In this phase, only two general surgeons, Dr. Giulianotti (H4) and Dr. D'Annibale (H6), publicly claimed positive experiences with robotics. In the following years, they intensified their activity and increased the volume of operations, making robotic surgery a distinctive feature of their respective hospitals. Their experience found its way to the national press. Media coverage of robotic surgery in the observed period peaked at the end of this phase. Articles in this period described the new technique as "revolutionary" and highlighted potential benefits that, in reality, were still unproven.

**Phase II (2002–2006)**

Between 2002 and 2006, 17 more adoptions occurred. Surgeon-driven decisions still prevailed, as surgeons attempted to convince managers to acquire a robot and occasionally even procured necessary funding from private foundations or regional governments. In 11 cases, general surgeons promoted the decision. In another 4, urologists, who, around this time, had begun to explore applications of robotic surgery in their own field, promoted it.

During these years, a specific operation, radical prostatectomy, emerged as a feasible application for the new technology in the field of urological surgery. In this phase, three hospitals that experienced difficulties implementing robotics in cardiac surgery adopted it in the urology department and began to use it regularly to conduct radical prostatectomies. Where general surgeons had initially promoted adoption, urologists eventually stepped in and, in the following years, often became the main users of the technology (see Table 2).

At this time, however the controversy and uncertainty surrounding the new technology was far from resolved. "It was a matter of investing millions of Euros in equipment," one informant said, adding, "the outcome of which was still unsure." Several informants mentioned how, at this stage, the possibility to lease the new technology facilitated its tentative adoption for a trial period:

> There were some in Italy who already used the robot successfully. No doubt. But what would have happened if [we had acquired it, and] then my surgeon had told me that it was too dangerous? That he could not get it to work? Or that it was useless? Others had already failed and left it there. We gave ourselves an exit strategy.
>
> (Manager, H13)

Systematic evidence that the new technique generated any significant benefit for patients was lacking, as scientific research had produced inconclusive results (Gutt et al., 2004). As an informant explained:

> At that time, there was much conflict around the robot . . . The fiercest criticism came from laparoscopists. Some said that the robot did not really add anything and it was just more expensive. And we all knew that few of the first adopters of the robot had succeeded. Many robots lay unused under a plastic cover.
>
> (Surgeon, H23)

General surgeons who adopted the technology during this phase, however, made little public mention of their disappointing experiences. As one informant remarked, "[D]irty laundry remained in the family"; another referred to the robot as a "skeleton in the closet" that none ever mentioned, but with which those involved in the decision were still uncomfortable.

Moreover, the two early adopters (H4 and H6) that had encountered some success with relatively simple operations intensified their efforts to disseminate their implementation experiences to promote the diffusion of robotic surgery, even amid multiple failures and persisting uncertainty. The relentless efforts of H4 and H6 offered arguments to countercurrent critiques as biased and reflecting the defensive attitude of surgeons who had mastered existing minimally invasive techniques.

***Dissemination of experience.*** In the previous period, the dissemination of implementation experiences had been limited to informal conversations or occasional visits by colleagues. In this phase, to reach a broader audience, early adopters performed video surgeries and conducted demonstration live surgeries.[4] In 2001, for instance, Dr. Giulianotti (H4) conducted the first live robotic cholecystectomy at a national conference, while, in 2002, Dr. D'Annibale (H6) organized the first international conference of robotic surgery, bringing numerous pioneers in robotic surgery to the small Italian town of Camposampiero. Early adopters also began to disseminate their experience through scientific publications (e.g., Giulianotti et al., 2003; D'Annibale et al., 2004). Informants observed that, although these publications were based on case collections, with no attempts to systematically compare robotic surgery to pre-existing techniques, they nevertheless contributed to advance the notion that robotic surgery was "feasible, reproducible, and safe."

In 2004, Dr. Giulianotti and Dr. D'Annibale were among the founders of an international professional association—the Minimally Invasive Robotics Association (MIRA)—which Dr. Giulianotti chaired for several years. The association gathered surgeons from different disciplines and was tied to a new scientific journal founded in the same year.

In this period, surgeons at H4 and H6 also hosted numerous colleagues and demonstrated how they operated with the robot. While not directly involved in the operation, these colleagues nevertheless had the opportunity to observe how robotic surgery could be implemented, including potential drawbacks and unexpected complications. Indeed, several informants mentioned that, while they first heard of robotic surgery from scientific publications or conference presentations, it was only when they had the opportunity to see an operation being performed and to interact with the surgeon performing the operation that they convinced themselves that the new technique "could really work." Figure 2 maps who hosted whom and documents the centrality of H4 and H6 in the dissemination of implementation experiences at this stage.

Dr. Giulianotti also engaged in a massive effort to codify the new surgical practice by writing detailed protocols illustrating how to perform numerous operations through robotic surgery. As the hospital manager recalled:

> These protocols did not exist before. They could be used the next time another surgeon tried that operation. And, today, they are used by the whole world of surgery . . . Every movement is described in detail: "First, you need to position the robotic arm like this, and then you need to introduce the trocar in the body like that."
>
> (Manager, H4)

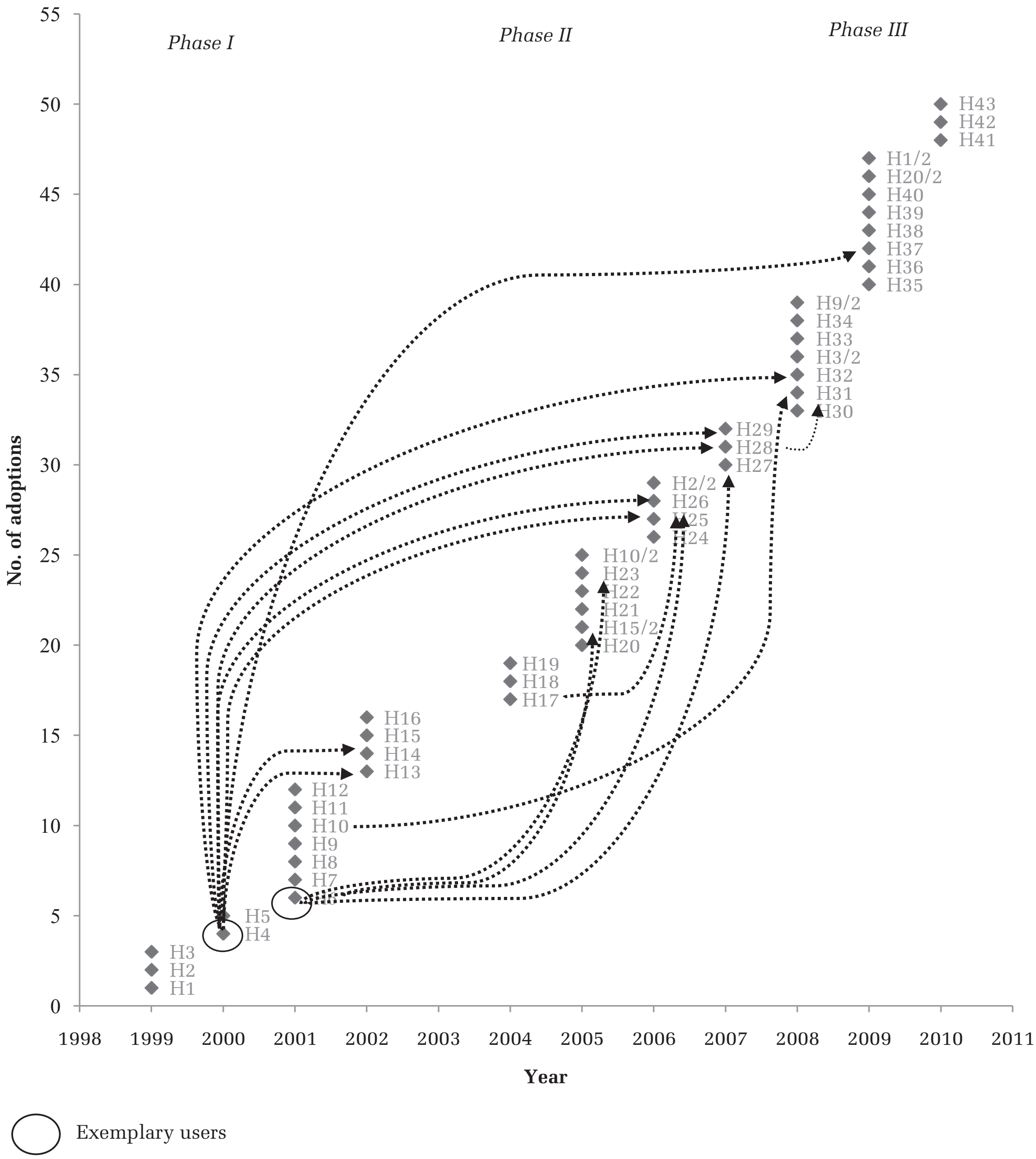
In 2003, only three years after the adoption of robotic surgery at hospital H4, these efforts culminated in the opening of the first school of robotic surgery, promoted and recognized by the national association of general surgery. The school initially attracted surgeons interested in robotics, who did not have the technology in their hospitals. The local distributor also began to promote the new technology in combination with a course offered at this school. Several informants mentioned that the opportunity to attend this school substantially influenced their decision (see Table 5, Figure 3).

Informants mentioned that the possibility to directly engage in the new surgical technique, although only on animal models and in a controlled setting, had been important in familiarizing themselves with the skills it required. They also mentioned that this school facilitated the transfer of these skills across communities, as applications of robotics began to migrate from general surgery to urology.

***Motivational drivers.*** An analysis of the motivational drivers in this period reveals differences not only between central and peripheral adopters but also between general surgeons and urologists. These differences can be explained by the time lag

[4] Video surgeries are parts of an operation filmed and presented on video to highlight innovative surgical movements. Live surgeries, instead, are performed during conferences and commented on by the operating surgeon and/or colleagues, with the possibility for the audience to ask questions regarding the steps of the operation.

**FIGURE 2**
**Dissemination Mechanisms: Exposure to Operations**




that characterized the diffusion of robotic surgery across the two communities.

Most general surgeons that adopted robotic surgery at this stage mentioned the apparent success of H4 and H6 as highly influential in their decisions. Most hospitals (8 out of 11) that adopted the robot for general surgery in this phase were small and peripheral, quite similar to H4 and H6 (see Table 2). Informants from these hospitals often mentioned that their decisions reflected the ambition to replicate the experience of H4 or H6 (*imitation*) to increase their prominence in the health care sector (*search for social gains*), increase and expand their activities, and be able to recruit and retain the best

**TABLE 5**
**Mechanisms for the Dissemination of Implementation Experiences: Selected Quotes**

| 2nd-order Codes | 1st-order Codes | Sources of Influence | Recipients of Influence |
|---|---|---|---|
| Peer-oriented narratives | Publishing scientific articles | "We have published some works in which we show that robotic hemicolectomy has slightly better results than traditional laparoscopic hemicolectomy." (Surgeon H6) | "Giulianotti had just published his first articles, and it seemed that the robot worked well, so I got interested." (Surgeon H19) |
| | Presenting at conferences | "I have already brought my data to congresses . . . I have observed that, for many operations, I had no advantage . . . For others, I was able to decrease the patients' post-surgical pain." (Surgeon H38) | "At conferences, I had the chance to hear some surgeons from Milan present their results in urology. So I became interested too." (Surgeon H35) |
| Publicly oriented narratives | Releasing media interviews | "The quality of the operation improves and this goes to the benefit of the patient . . . Robotics will be the 'gold standard' in the future." (Surgeon H4, *Corriere della Sera*, November 17, 2002) | "Some hospitals, such as H24, are always in the newspapers. We are [. . .] 400 km from there, but how much do you think it takes for a patient to take a train and go there? Having the robot is not enough anymore, one needs to also be a good communicator." (Surgeon H36) |
| | Releasing Internet interviews | "The robot is a cultural revolution . . . The advantages are many . . . But the surgeon remains fundamental." (Surgeon H4, http://www.youtube.com/watch?v=lf5wPc06Sp8). | "By now patients, especially those with prostate cancer, get a lot of information from the Internet. There are sites on which you have the list of hospitals in which there is a robot and the names and videos of the surgeons that operate with this technology." (Surgeon H2/2) |
| Codification | Writing protocols | "I have created a number of protocols for general surgery describing all the steps of the operations. I did this from the beginning." (Surgeon H4) | "For us, the manuals written by Giulianotti with the protocols were like the Bible. For some time, it was the only thing we had. Then video surgeries started to be more popular." (Surgeon H29) |
| | Video surgeries | "I have recorded tons of videos showing advantages and disadvantages, the challenges and also the complexity of robotics." (Surgeon H3) | "Since 2002–2003, we have had many videos of radical prostatectomy available, and I watched some of them. With video surgeries, one can get to see all the steps." (Surgeon H17) |
| Mediated exposure | Allowing attendance to own operations | "Surgeons came from everywhere to understand how we could succeed in some robotic techniques that they could not perform." (Surgeon H6) | "I had visited hospitals where the robot was already at work, such as Dr. Giulianotti's. I had seen what he was doing before proposing to get a robot." (Surgeon H13) |

professionals in the field (see Tables 4 and 6). The two head surgeons had become professional reference points for many of their colleagues, and the two hospitals also became perceived as models to be imitated by other hospital managers:

> When the general surgeon came to tell me about buying the robot, we talked for long about what was happening in [H4], and how a small peripheral hospital had managed to set up a robotic surgery program and was doing well; how they attracted patients from all over Italy. If they had managed to do it, we could do it too!
> (Manager, H20)

Theoretically, this observation suggests that the efforts of H4 and H6 to disseminate their experi-

**TABLE 5**
**(continued)**

| 2nd-order Codes | 1st-order Codes | Sources of Influence | Recipients of Influence |
|---|---|---|---|
| | Live surgeries at conferences | "I organized the first international event at Camposampiero in May 2002 with pioneers in robotics from all over the world, from the U.S.A., from Germany . . . and we performed live surgeries with our robot." (Surgeon H6) | "We were thinking about moving to laparoscopy, but then we saw the robot operate live at a conference, and we got convinced not to waste time with laparoscopy and go directly to robotic surgery." (Surgeon H24) |
| Assisted engagement | Schooling | "The idea we had was also to establish a school that would train specialized surgeons that would pursue robot surgery." (Manager H4) | "I went to H4 to attend the course that, at the time, everyone was attending. And this is when I gave [the robot] some serious thought." (Surgeon H26) |
| | Proctoring | "[Proctoring] means that I go there, I operate, and one of them is, first, close to the patient and sees what I do through the video. Then, he [or she] starts doing it himself [or herself], one step at a time." (Surgeon H28) | "The surgeon [H19] came to mentor the urologist several times. This was important to start the overall activity well." (Surgeon H26) |
| Migration | Purposeful recruitment of robotic surgeons | "At H28, they bought the robot because they hired a urologist who had learned his robotic skills together with me. They recruited him because they saw that we were doing well." (Surgeon H18) | "We recruited this surgeon who was already an expert in robotic surgery. After our experience with cardiac surgery, I wanted to make sure that the robot would be used extensively." (Manager H1/2) |
| | Promotion of local adoption after move | "At H15, I had already had the robot for a trial period. When I moved to H10, I immediately asked for another one." (Surgeon H10/2) | "The surgeon had experienced robotic surgery on a trial period in another hospital. When he got here, he immediately proposed to have it here too . . . He became the spokesperson and secured the commitment of other surgeons to use the robot." (Manager H41) |

ence, and the initial social gains that they had gained from it, induced imitative isomorphic responses among other actors that shared similar social positions and ambitions.

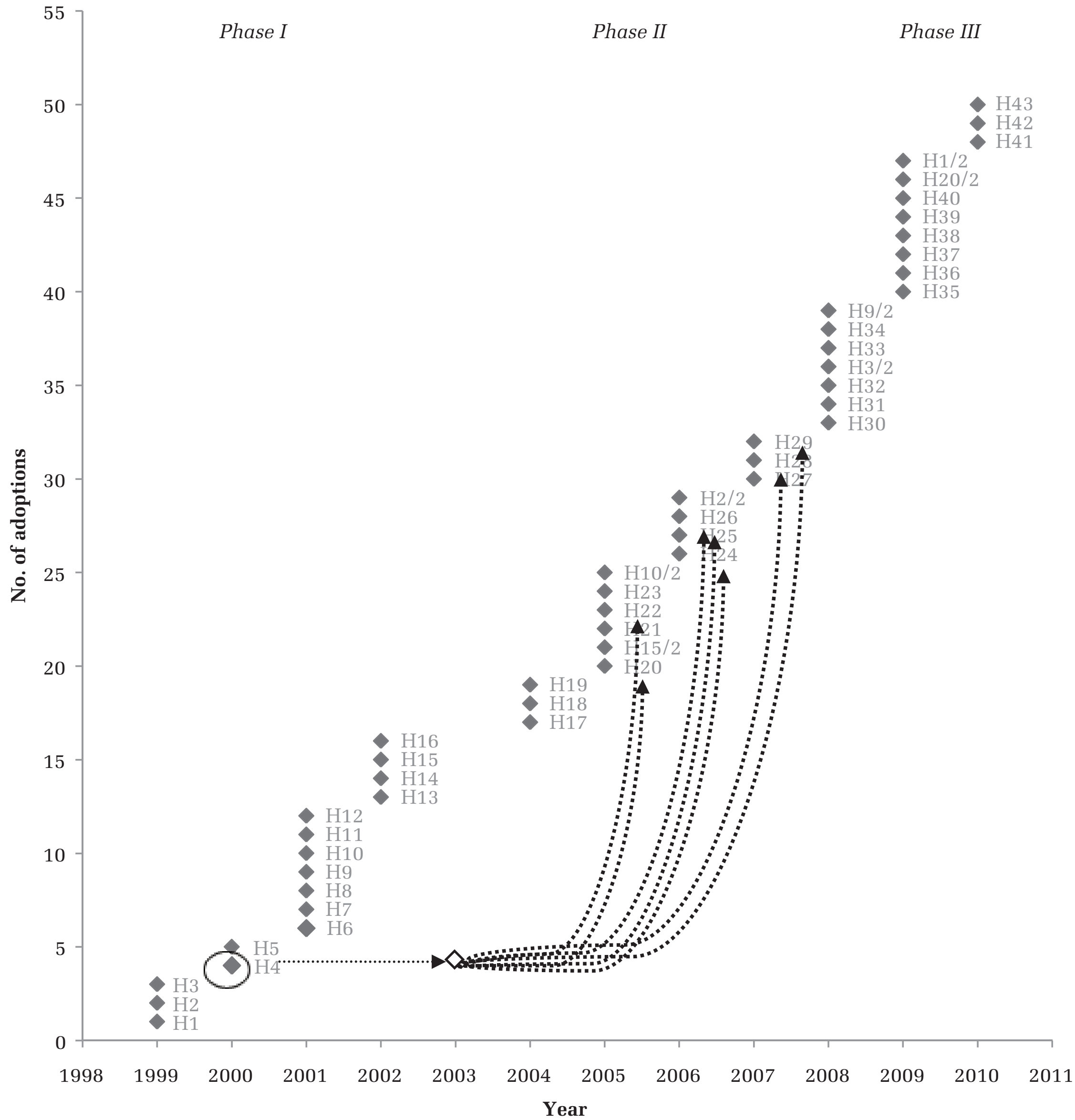
Unlike general surgeons, urologists that adopted robotics in this phase (e.g., H17, H24) did not have examples to follow: the first robot-assisted radical prostatectomy in Italy was conducted in 2004. Their motivations, therefore, were similar to the pioneers of Phase I: a combination of *organizational imperative* and the *search for the social gains* associated with leading the application of robotic surgery in their own subfield (see Table 6). A prominent urologist, for instance, told us, "I have a great history in laparoscopy. I was the first one in Italy to do a laparoscopic prostatectomy. Who should have started using the robot if not me?" (Surgeon, H17). Indeed, adopters were well aware of the social and symbolic implications of their choice, as exemplified in the following remark:

> I wondered whether the technology we were choosing were really useful, or whether it was mainly a way to position oneself—a marketing device, so to say—with respect to the population, citizens, patients, or even colleagues.
>
> (Manager, H24)

### Phase III (2007–2010)

During Phase III, 17 new hospitals adopted robotic surgery. Four additional hospitals, which had experienced problems in the previous phases, acquired a new machine and initiated a new implementation program. The problems encountered in the previous phase of the implementation of robot-

**FIGURE 3**
**Dissemination Mechanisms: School of Robotic Surgery**




*Note:* The white diamond corresponds to the national school of robotic surgery created by Hospital 4 (H4) in 2003.

ics in general surgery, however, had raised serious concerns regarding the economic sustainability of the new surgical practice. Six of nine hospitals that, in the previous phase, had attempted to follow the examples of H4 and H6 had soon abandoned robotics or only used it on a limited scale (Table 2). One informant described the new technology as "real bloodshed." Another recalled:

> When one saw Dr. Giulianotti doing those complex operations, it all seemed fine. But then, when we had to place those operations in our context—the context of a small hospital—problems began . . . In the end, we used the robot less and less, and only for special things that were difficult to do in laparoscopy . . . The less you use the robot, however, the more expensive every single operation becomes. It became difficult to economically sustain the use of the machine and to justify having it only for general surgery. This is what happened in pretty much all the hospitals that adopted it in those years.
>
> (Surgeon, H26)

**TABLE 6**
**Motivational Drivers for Adoption**

| | | Organizational Imperative | | Propensity to Innovate | | Search for Technical Benefits | | Search for Social Gains | | Isomorphic Response | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Case | Year | *Cultural Imperative* | *Reputational Imperative* | *Openness to Innovation* | *Facination with New Technology* | *Expected Benefits for the Surgeon* | *Expected Benefits for the Patients* | *Search for Org. Social Gains* | *Search for Prof. Social Gains* | *Imitation* | *Coercive Pressures* | *Band-Wagoning* |
| **H1** | *1999* | | x | | | x | | | | | | |
| **H2** | *1999* | x | | x | | x | | | | | | |
| **H3** | *1999* | | x | x | x | x | | | | | | |
| **H4** | *2000* | | | x | x | x | x | x | x | | | |
| **H5** | *2000* | x | | x | x | x | | x | | | | |
| **H6** | *2001* | | x | | x | x | | x | x | | | |
| **H7** | *2001* | | | x | x | | | x | x | | | |
| **H8** | *2001* | | x | x | x | | | | | | | |
| **H9** | *2001* | x | x | x | | | x | x | x | | | |
| **H10** | *2001* | x | | | | | | | | | | |
| **H11** | *2001* | | x | x | | | | x | | | | |
| **H12** | *2001* | | x | | | | | | | | | |
| **H13** | *2002* | | x | | x | | | x | | x | | |
| **H14** | *2002* | | | x | | x | | x | | x | | |
| **H15** | *2002* | | | | | | x | x | | | | |
| **H16** | *2002* | | | | | | | x | x | x | | |
| **H17** | *2004* | | x | | x | | | x | x | | | |
| **H18** | *2004* | | | | | | | x | | x | | |
| **H19** | *2004* | | | | x | | | x | | x | | |
| **H20** | *2005* | | | x | | x | | x | x | x | | |
| **H15/2** | *2005* | x | | | | | | | | x | | |
| **H21** | *2005* | | | | | | | | x | x | | |
| **H22** | *2005* | | x | | | | | | | x | | |
| **H23** | *2005* | | | | | x | | x | | x | | x |
| **H10/2** | *2005* | | | | | | | | x | | | |
| **H24** | *2006* | x | | x | x | x | x | x | x | | x | |
| **H25** | *2006* | | | | | | | | | x | | |
| **H26** | *2006* | | | | | | | x | | | | |
| **H2/2** | *2006* | | x | x | | | | | | x | x | |
| **H27** | *2007* | | | | | | | x | | | | x |
| **H28** | *2007* | | | x | | x | | x | | x | x | |
| **H29** | *2007* | | | | | | | x | | | x | x |
| **H30** | *2008* | | x | | | | x | | | | x | |
| **H31** | *2008* | | | | | x | x | | | | x | |
| **H32** | *2008* | | | x | | x | | | x | | | |
| **H3/2** | *2008* | | | | | | x | | | | | x |
| **H33** | *2008* | | x | | | | | | | | | x |
| **H34** | *2008* | | | | | | | x | | | x | x |
| **H9/2** | *2008* | | | x | | | x | | | | | x |
| **H35** | *2009* | | | | | | | x | | | | |
| **H36** | *2009* | | | | | | | | | | x | x |
| **H37** | *2009* | | | | | x | | | | | | |
| **H38** | *2009* | | | | | | | | | | x | x |
| **H39** | *2009* | | | | | | | x | | | x | x |
| **H40** | *2009* | | | | | | | | | | x | |
| **H20/2** | *2009* | | | | | | | | | | | x |
| **H1/2** | *2009* | x | | | | | | | | | x | x |
| **H41** | *2010* | | | | | | | x | | | | x |
| **H42** | *2010* | | | | | | | | | | x | |
| **H43** | *2010* | | | | | | | | | | | x |

Indeed, a manager who had rejected an adoption proposal in this period (N20) mentioned that he had previously acquired a robot in another hospital, but "it was problems, problems, problems; problems with costs, problems with personnel . . . a robot is only a source of problems." Regional governments also began to express concern with the costs of the technology and its long-term economic sustainability. In particular, 11 of the 20 non-adopters we interviewed mentioned that their requests were refused based on budget constraints.

During this phase, the prominence of economic concerns in the adoption decisions in part reflected the increasing awareness on the part of field members of the difficult economic sustainability of the new practice, and, in part, the more active role hospital managers played in the process. During Phase III, managers initiated 10 out of 21 adoptions. These adoptions were often associated with the recruitment of surgeons with pre-existing experience in robotic surgery.

Even the technical benefits of the new surgical technique remained quite uncertain. Despite the hopes and clamor aroused by H2, H4, and, later, H14, the comparative advantage of using robotics in general surgery remained a subject of debate. Between 2007 and 2010, then, few adoptions were driven by general surgeons, and, even when they were, general surgeons were typically part of a multi-specialty team that was expected to use the new technology to ensure that the high investment and maintenance costs of robotic surgery were spread over high volumes.

Even in urology, however, the superiority of robotic surgery remained unproven, as no conclusive evidence of its benefits for patients existed (Schroeck et al., 2008). One informant, who adopted the robot in 2008, admitted that, at that time, "[R]obotics was too young to produce clear results, comparable with 'older' techniques" (Surgeon, H30). Interestingly, however, despite the persisting uncertainty surrounding its technical and economic benefits, the diffusion of robotics accelerated. Managers and surgeons were well aware of the many robots "abandoned in the cellars" by early adopters or used only for a limited number of operations a year. Yet, between 2007 and 2010, hospitals acquired the technology at a more rapid pace than before. According to our informants, these decisions reflected the urge of managers and surgeons to acquiesce to the increasing pressures of patients and to conform to what they now perceived as an inevitable trend (Table 6).

***Motivational drivers.*** In this period, the efforts of early adopters to disseminate their positive experiences were amplified by the media, which continued to spread news of robotic surgery and its potential benefits, among the general public (see Table 5). An increasing number of patients—especially those diagnosed with prostate cancer—asked to be "operated on with the robot." "It was the magic word," one informant said. Hospitals that did not offer robotic surgery, especially when other nearby hospitals did, risked losing appeal and patients:

> Patients came here and said: "I have prostate cancer, do you have the robot?" If you didn't have it, they went somewhere else. We had begun to see a decrease in our activity in urology. This was one of the reasons why we decided to buy the robot.
>
> (Manager, H38)

Informants that, at the time of our study, were still in the process of acquiring a robot (N1 to N4) expressed similar motivations. As one of them mentioned, "[R]ight now, not having the robot would damage our image severely . . . Patients ask to be operated on with the robot, and [if we did not have it] they might go somewhere else" (Surgeon, N1).

While remaining uncertain as to the superiority of robotics, surgeons feared finding themselves left behind by what appeared to be the next step in the technological evolution of surgical practice. Several informants mentioned that their decisions were heavily influenced by the fact that "everybody was getting a robot." "Regardless of the evidence," an informant said, "it was always 'I want the robot because the others have it too.'" As another informant remarked:

> When we discussed acquiring the robot, we said: "[I]n Italy, there are already many robots; some hospitals have even more than one! The train of robotics has already left by now and we cannot miss it."
>
> (Surgeon, H20/2)

Another informant, a non-adopter, observed:

> In conferences, there is no debate about robotics anymore. There are just great surgeons who have a robot and losers who do not have one. Whenever one is critical about robotics, everybody says that he is just envious because he does not have the machine.
>
> (Surgeon, N16)

The majority of adopters in this phase lay within geographic areas, such as Milan, Rome, Padua, and the central parts of Apulia and Tuscany, where earlier adopters were concentrated and managers feared losing patients and surgeons alike to close competitors:

> In Rome, after I got [a robot] everybody else bought it. Competition. Competition. Do you understand? They went crazy in Rome. Three in a row were bought just for that . . .
>
> (Surgeon, H31)

Furthermore, non-adopters, who saw their applications for funding denied by regional governments, portrayed themselves as "victims" of the "inexorable" spread of robotic surgery, and they expressed their frustration at being unable to keep pace with the rest:

> The regional government has decided to stop new acquisitions with the excuse that there is not enough evidence to support robotic surgery. This is nonsense! While we wait for evidence, patients will go to other hospitals that have a robot.
>
> (Surgeon, N13)

These observations indicate that the diffusion of robotic surgery, at this stage, was largely driven by isomorphic responses. In part, these responses reflected *acquiescence to the coercive pressure* exercised by critical resource holders (in this case, the patients),[5] who subordinated their support (i.e., their willingness to be operated on) to compliance with what they perceived as a desirable organizational practice (i.e., robot-assisted surgery) (DiMaggio & Powell, 1983).

In part, these responses reflected a *bandwagon* effect (Abrahamson & Rosenkopf, 1993), whereby late adopters were driven to adopt the new practice regardless of their own assessment, under the pressure of the sheer number of current adopters. Unlike the imitative responses observed in the previous phase, these late decisions were not attempts to replicate the choices of successful early adopters. Instead, they reflected the increasing fear of losing competitiveness, should the new practice spread

[5] The Italian health care system is financed by general taxation and "money follows the patient": patients can choose their care providers throughout the country, and the provider will be completely reimbursed by the region in which the patient resides for the delivered services and treatments. The migration of patients in search of the best care, especially from Southern to Northern Italy, is common.

and render existing ones obsolete (Abrahamson & Rosenkopf, 1993). Haunschild and Miner (1997) also refer to this driver of diffusion as "frequency-based imitation," as opposed to the "outcome-based imitation" observed in the previous phase.

Motivations differed for hospitals located in peripheral geographic areas, such as Sicily or Sardinia, where robotic surgery was not yet available. These hospitals—like the early adopters years before—perceived the new technology as an opportunity to increase their prominence locally (*search for social gains*) (see Table 6). As one surgeon wrote in a document addressed to the hospital manager:

> It is important to consider the long-term advantages for the hospital in acquiring the robot, in terms of improving the general image of the hospital and increasing its strategic relevance within the regional health system.
>
> (Surgeon H41, internal document)

***Dissemination of implementation experiences.*** During this phase, the experience of earlier implementations remained important, but the emphasis shifted from whether the robot worked to how to make it work.

General surgeons produced few videos and live surgeries. They published little, and they were not particularly active at conferences. Only surgeon H14, who managed to use the robot extensively, engaged in the same influencing practices that H2 and H4 employed: he published results and performed live surgeries at conferences, he invited colleagues to attend his operations, and he became one of the most assiduous teachers at the national school of robotics. Among urologists, in contrast, encouraging results led surgeons at H2/2, H15/2, and H10/2 to actively publish, arguing in favor of robotics in the national and international debate (Artibani, Ficarra, & Guillonneau, 2007; Ficarra et al., 2007; Mottrie et al., 2009). Very few late adopters, however, mentioned these publications as being influential in their decisions.

One of the very early adopters in urology (H24) was particularly active in the dissemination of news on robotic surgery in the popular press. Surgeons at this hospital also produced a number of video interviews and posted them on YouTube, in which they shared their experience with the robot in a form directed to and accessible by the general public. Some of these videos celebrated the team's achievements, such as completing its 1000th robotic radical prostatectomy. Between 2006 and 2010, their videos were viewed more than 10,000 times.

Very early adopters in general surgery, however, intensified their efforts to constitute specialized venues for the dissemination and sharing of experiences. In 2007, they organized the first symposium entirely dedicated to robotic surgery in a national conference. In 2008, Dr. D'Annibale (now at H3) organized the first conference of MIRA in Italy. A year later, urologists at H24 were among the founders of the Society of Robotic Surgery, an international association gathering all specialties interested in robotic surgery, which eventually merged with MIRA in 2012. In 2009, Dr. Giulianotti, now chief of the Division of General, Minimally Invasive, and Robotic Surgery at the University of Illinois, founded the Clinical Robotic Surgical Association. In the same year, Dr. Spinoglio (H20/2) founded and chaired the Italian Association of Robotic Surgery.

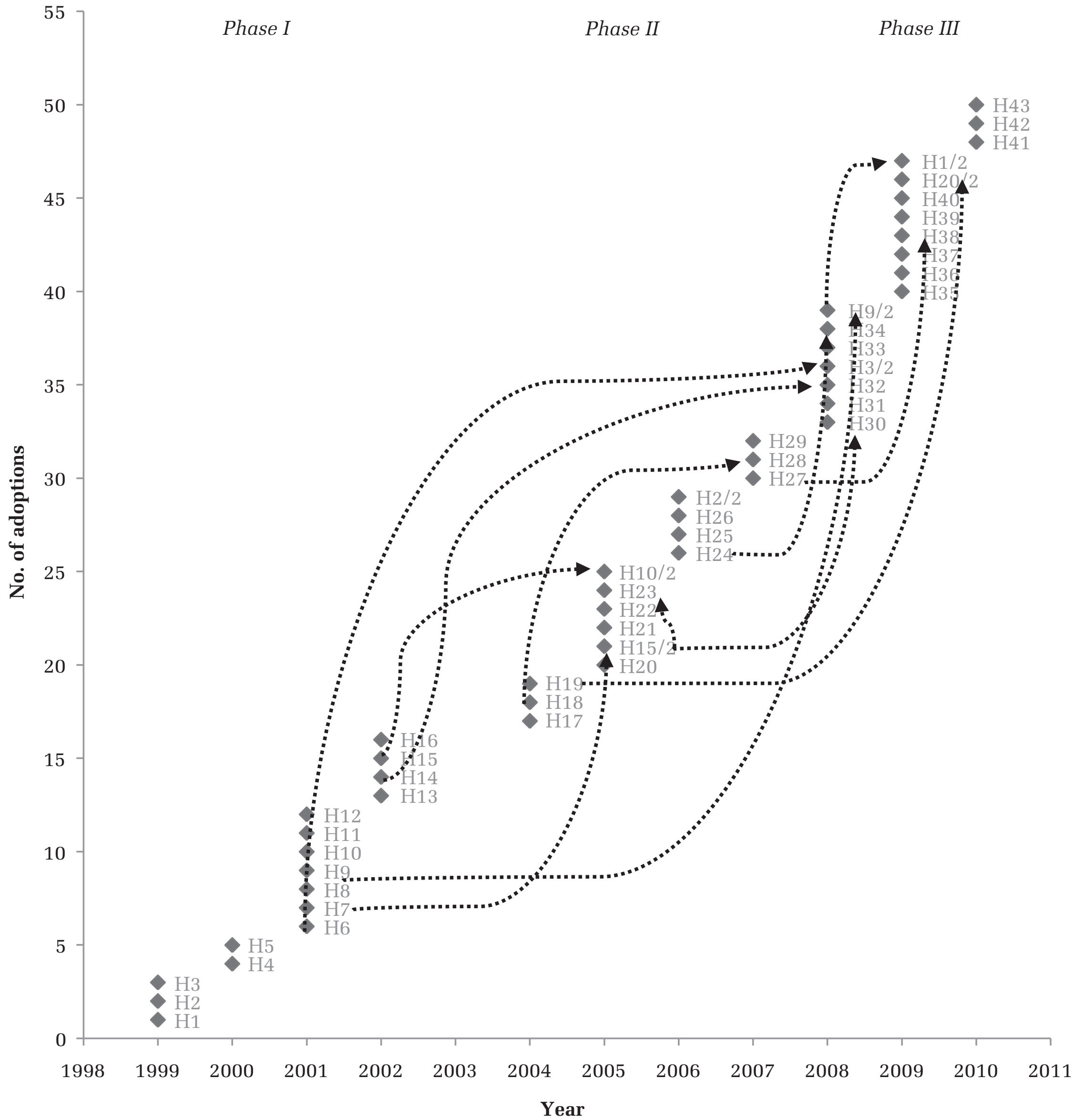
However, hospital managers initiated most adoptions during this phase, and these managers' primary concern was to acquire the necessary skills to implement the new technology and ensure its economic viability. As an informant mentioned, "[T]he issue now is not whether to have the robot or not, but how to use it."

In part, the migration of surgeons and managers from hospital to hospital facilitated the transfer of the skills required to implement robotic surgery from a clinical and organizational perspective (see Figure 4).

According to the informants, however, the possibility to exploit the "proctoring" of more experienced colleagues was more influential on adoptions. Proctoring refers to the willingness of earlier adopters—a team of urologists at H24 in particular (see Figure 5)—to visit colleagues and share their experience. They would introduce new users to robotic surgery on site, correct their movements, and step in if the local surgeon could not complete the operation or a surgical step. Several informants observed that, compared to video surgery and protocols, proctoring and, to a lesser extent, schooling facilitated the sharing of experiences—the "tricks" early adopters had learned, how they addressed complications, etc.—that these adopters could not, or would not, report in surgical protocols and videos.

Informants, however, considered proctoring a more effective dissemination mechanism than schooling, as it facilitated the sharing of tacit, practical knowledge that was more difficult to convey through protocols and simulations:

**FIGURE 4**
**Dissemination Mechanisms: Migration of Surgeons and Managers**

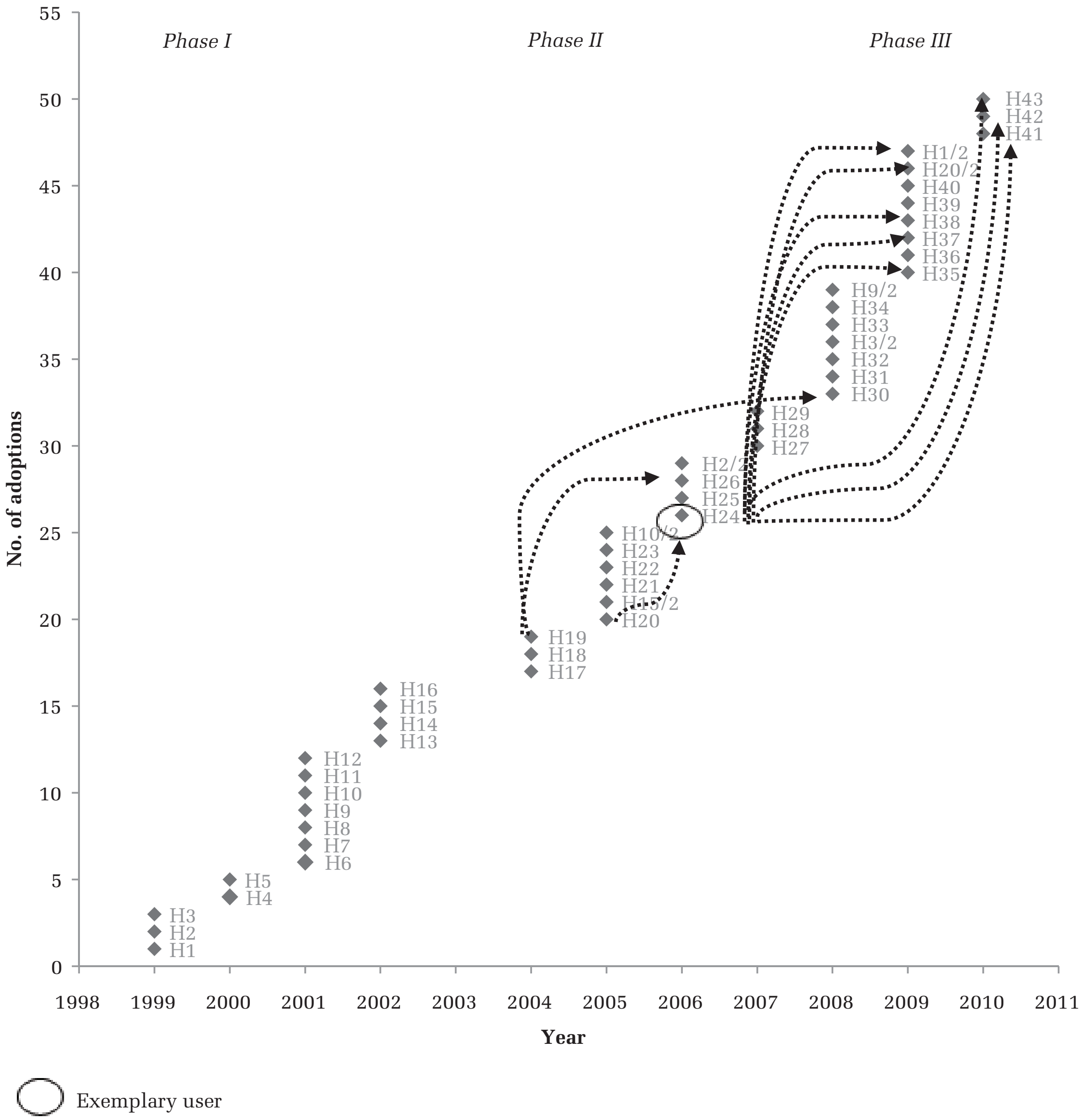



The school is fine—we have started one too—but it is not the best. Colleagues who did not have the robot went to the school at [H4], but, after one or two operations, they stopped if they could not get the machine at their hospital. Proctoring is better because teaching robotic surgery is more like a driving school. Theory is good. A couple of simulations are good. But, in the end, what one needs is to know that someone will be close to you during the operation, to teach you the exact surgical movements that you need to do, and to get you out of trouble.

(Surgeon, H24)

Several managers among the later adopters also mentioned the influence of proctoring on their decision (see Table 6), as this practice reduced uncertainty about the actual capacity of local surgeons to implement the new technology. The diffusion of proctoring was enabled by the release of a new version of the surgical robot, with a double console, which facilitated sharing experiences across and within hospitals and addressed growing concerns among hospital managers regarding the transferability of skills from one surgeon to

**FIGURE 5**
**Dissemination Mechanisms: Proctoring**




another (and the retention of these skills in the event that the head surgeon left).

Importantly, through proctoring, surgeons at H24 also transferred a set of administrative activities, which they had pioneered at their hospital, with the aim of ensuring sustainable engagement in robotic surgery: the careful planning of applications across a number of surgical specialties, forecasting the volumes of operations to be performed to break even, and the optimization of the use of expensive surgical instruments associated with the robot.

## DISCUSSION

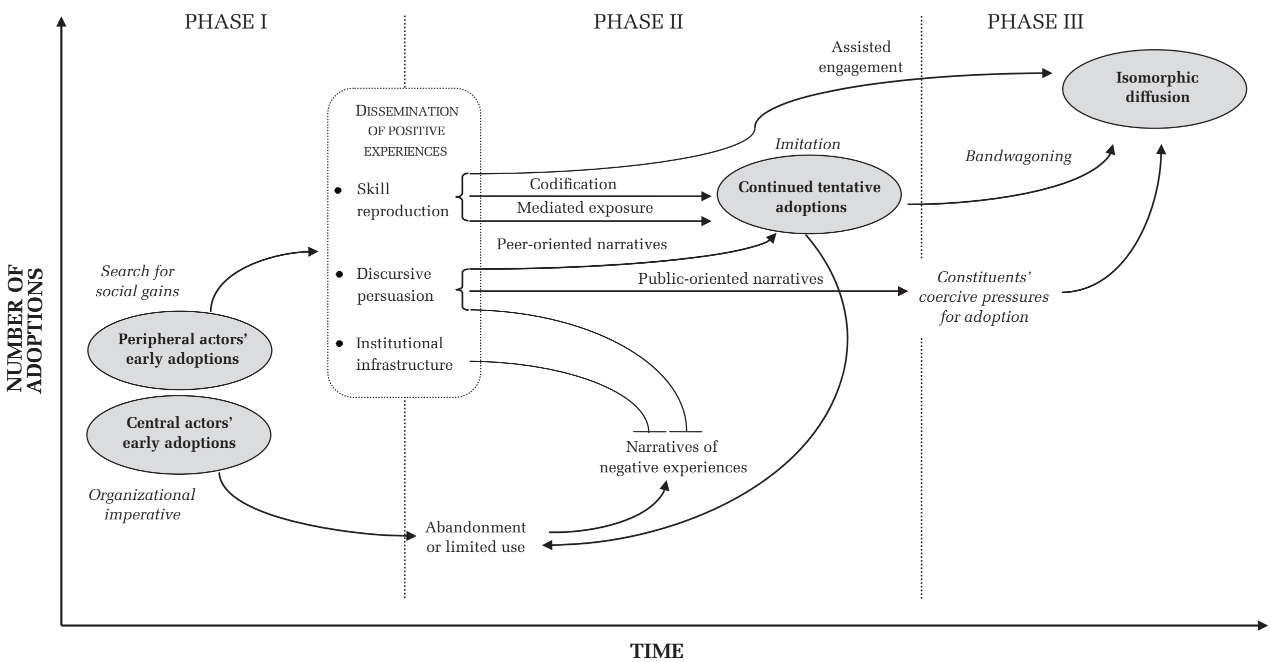
Traditional reliance on large-scale studies has limited the capacity of researchers to capture the micro-foundational processes that drive the diffusion of innovation (Greenwood, Oliver, Sahlin, & Suddaby, 2008; Zilber, 2008). Observed correlations were subjected to potential confounds (Van den Bulte & Lilien, 2001), and they were based on untested assumptions about the motivations that drive adoption, which research has only begun to examine directly (Kennedy & Fiss, 2009). As a consequence, we assume much but know much less regarding whether and how adopters' decisions are influenced by previous adoptions and implementations. This is particularly problematic in explaining the very early stage of diffusion, during which implementation failures and substantial uncertainty surrounding technical and economic benefits could easily discourage further adoptions.

To improve our understanding of the motivations of very early adopters, and of how their experiences with the implementation of new practices influence subsequent diffusion, we explored the spread of robotic surgery in Italy between 1999 and 2010. Our findings portray the early diffusion of robotic surgery as promoted and facilitated by early adopters seeking social gains and engaged in multiple efforts to shape the construction of the new surgical technique as viable and beneficial, even in the presence of persistent uncertainty concerning these important aspects, and to transfer the skills required for its implementation (see Figure 6).

As illustrated in Figure 6, in a very early phase, adopters were a combination of central and peripheral actors, impelled by different motivational drivers. Only the latter, however, actually had a stake in the diffusion of the new technology, as they considered it an opportunity to improve their social positions. The practices of *discursive persuasion* and *skill reproduction* that these "exemplary users" engaged in—along with the *development of institutional infrastructures* to support their dissemination efforts—triggered imitative responses and encouraged further adoptions. Continued tentative adoptions and the increasing coercive pressure of resource holders (stimulated by public-oriented narratives disseminated by exemplary users) increased the isomorphic pressures for diffusion, leading to the spread of the new practice even in the presence of persisting uncertainty surrounding its technical and economic benefits. During this phase, the mechanisms for the dissemination of experience that had promoted earlier diffusion (i.e., *mediated exposure* and *codification*) were less influential, as their limited capacity to effectively support the transfer of know-how had by then become apparent. They were replaced by more sophisticated ones (*assisted engagement*) that reassured decision makers regarding the possibility of effectively implementing the new practice.

We believe that this grounded portrayal of diffusion in a very early stage of the process advances our understanding of the interplay between the social positions and motivational drivers of early

**FIGURE 6**
**A Grounded Model of the Early Phase of the Diffusion of Innovation**



adopters, the micro-level practices they engage in to promote the diffusion of a fledgling innovation, and the unfolding of the process at the field level. In the remainder of this section, we deepen the discussion of the theoretical underpinnings of our emerging framework and the implications of our observations for theories of diffusion.

### Motivational Drivers in Very Early Adoptions

Our rich, qualitative methodology for data collection allowed us to trace a nuanced portrayal of the motivational drivers of adoption, how these motivations change as innovations diffuse, and, importantly, how different motivations for adoption differentially affect the efforts of very early adopters to implement the innovation and engage in the dissemination of their experiences. By doing so, our observations extend the current line of inquiry on how motivational drivers shape the diffusion process by showing that not only are some early adopters motivated by the search for social gains (Kennedy & Fiss, 2009), but it is also this very motivational driver that triggers the efforts of these actors to foster the diffusion of the new practice to increase their visibility and standing in the field.

***Structural positions and motivational drivers.*** Our study increases our understanding of the relationship between the social positions of field members and the timing of their adoption of innovations. Some studies suggest that peripheral members—characterized by small size, lower status, and/or lower network centrality—are more likely to adopt innovations early, as they are less aware of institutional expectations (Davis, 1991; Kraatz, 1998) and their interests are less associated with the established institutional order (Leblebici, Salancik, Copay, & King, 1991). More recent research suggests, instead, that central members—larger organizations, characterized by higher status and network centrality—may lead the diffusion process, as they are better positioned to detect and resolve contradictions in the institutional orders (Greenwood & Suddaby, 2006). Our observations suggest that both central and peripheral actors may adopt new practices very early in the process, but they do so for different reasons: while central members are driven by an internal imperative to preserve their leading position in the presence of a new practice that could possibly disrupt the social order, peripheral members do so in the hope of improving their social position by constituting themselves as "exemplary users" of the new practice.

Our findings, then, extend the understanding that adoption decisions are partly framed in terms of opportunities and threats (Kennedy & Fiss, 2009). They do so by showing that framing the diffusion of a new practice as an opportunity or a threat is not exclusive to early adopters and late adopters, respectively, but may depend on the structural position of the adopter. Central actors are more likely to frame a fledgling innovation as a threat, to the extent that the diffusion of this innovation may challenge their leading position based on the mastery of current practices. These actors, then, are likely to engage in very early adoption as a possible strategy to preempt the threat of a disruption in the dominant practices and social order in the field. Peripheral actors, instead, are more likely to perceive a fledgling innovation as an opportunity to improve their social positions and reap the social gains associated with the claimed mastery of practices that come to be recognized as superior by peers and powerful constituents (Staw & Epstein, 2000).

Our findings also indicate that the relationship between structural positions and motivational drivers may change during the process. As an innovation diffuses and gains increasing social recognition by peers and powerful constituents, it is likely to be framed by both central and peripheral actors as a threat, triggering isomorphic responses even in the presence of persisting uncertainty regarding its technical or economic benefits. At this stage, certain peripheral actors may nevertheless frame the diffusing innovation as an opportunity, to the extent that its adoption will help them to distinguish themselves from a subset of comparable organizations. In our case, the boundaries of these subsets were defined geographically (e.g., some late adopters perceived an opportunity to distinguish themselves from other regional competitors), but it could be argued, for instance, that, in stratified fields, the late adoption of diffusing practices may nevertheless be perceived by low-status actors as a means of distinguishing themselves from other actors in their "league."

Some contextual conditions might have influenced our observations. In the medical field, for instance, technological innovation—and the ability to employ the latest technological advances—is central to the reputation of hospitals and surgeons alike (Fennell & Warnecke, 1988; Timmermans & Berg, 2003). This particular condition might have heightened the influence of reputational dynamics in the early stage of diffusion (a reputational imperative for central actors and a search for social gains for peripheral actors), and amplified the incentives to constitute oneself as an exemplary user. Past research, however, posits that reputational issues may also affect the diffusion of non-technological innovations (e.g., Kennedy & Fiss, 2009; Staw & Epstein, 2000). Future studies, then, may investigate whether the dynamics we have observed occur even in the case of innovations that are less important for the reputations of the actors involved (the organizations that adopt them and/or the persons who implement them), and, if not, what explains the diffusion at a very early stage in these different circumstances.

A second important contextual condition for our study is that actors should perceive the reputational and social gains that can be reaped by sharing one's implementation experience (thus facilitating the diffusion of the new practice and constituting oneself as a master of the new practice) as more important than direct economic gains (arising, for instance, from higher relative efficiencies) that may flow from the exclusive mastery of the new practice. This condition may characterize interorganizational fields in which members are interested in positioning themselves or their organizations within a social system (such as a professional community, the business community, or society at large) that only partly overlaps with the system of relationships that shape competition among organizations. In this respect, our findings are compatible with the observation that the adoption and mastery of popular management practices will increase the reputation of an organization in the business community and the rewards accruing to their managers, even if these practices have no significant effect on performance (Staw & Epstein, 2000).

***Organization-specific attributes and motivational drivers.*** Our findings also begin to shed light on why some (and not all) peripheral actors pursue the opportunity to increase their standing by being among the very early adopters of innovative practices. Interviews with non-adopters reinforced our initial assumption that, to the extent that the adoption and implementation of a new practice requires a considerable investment, peripheral actors are less likely to be in a position to fund a highly risky endeavor. Our findings, however, suggest that resource constraints can be overcome in the presence of a strategic determination to reap the potential gains associated with early adoption, and they shift attention to motivational drivers that have been traditionally overlooked by research on diffusion.

In addition, as illustrated in Figure 6, our observations suggest that central actors' adoptions may be motivated less by the search for economic benefits or social gains than the will to act in keeping with their prominent position in the field (*reputational imperative*) and/or their understanding of the mission and values of their organization (*cultural imperative*). These observations indicate that motivational drivers cannot be simply inferred from the timing of adoption or the position of an organization in the social structure of a field, but, instead, in part reflect decision makers' understandings of their organization and concerns for their own social position, or for the social position of the organization.

By doing so, our observations indicate that a more fine-grained appreciation of motivational drivers may help us to improve our understanding of diffusion patterns. They encourage future studies to incorporate archival or survey-based measures that directly capture (rather than assume) the motivations for adoption, and to do so in a manner that accounts for a more nuanced range of possible motivations than traditionally hypothesized.

More generally, whereas past research broadly assumed that adoption decisions reflect the search for organization-level benefits (e.g., increased performance) or a response to organization-level threats (e.g., a loss of legitimacy), our findings suggest that, when making decisions of whether to adopt an innovation, decision makers are influenced by their understanding of organizational goals and imperatives, as well as by the social and economic benefits that the decision may bring to them personally. It is the interplay between these two sets of motivational drivers that ultimately shapes the decision. While, to some extent, the interests of the organization and those of decision makers may coincide, the case of robotic surgery shows how individual users may be able to use the increased personal standing in the field associated with their claimed mastery of the new practice to migrate to more attractive organizations. In this respect, our observations encourage future studies to explore whether and how the personal ambitions and concerns of decision makers and influencers affect the diffusion of innovation in greater depth.

### The Dissemination of Implementation Experiences and the Diffusion of Innovation

In a much-cited review of research on diffusion, Strang and Soule (1998: 267) acknowledge that, "since innovations are risky and uncertain, adopters carefully weigh the experience of others before acting." Past research, however, has only devoted scant attention to whether and how early adopters share their implementation experiences with potential new adopters, and whether and how this affects adoptions. Institutional accounts of diffusion have largely assumed that, as increasing numbers of actors in a field adopt an innovation, other actors would be induced (e.g., Tolbert & Zucker, 1983) or pressured (e.g., Abrahamson & Rosenkopf, 1993) to do so, regardless of the outcomes of early implementations.

Our findings instead highlight how early adopters influence later adopters' decisions by sharing their implementation experiences. In part, as described by past research, very early adopters did so through the dissemination of positive narratives and the development of institutional infrastructures. In part, they did so by sharing and transferring part of the skills required for the implementation of robotic surgery (see Figure 6). This observation is particularly significant because it draws attention to the importance of micro-level practices of knowledge dissemination from early to later adopters. While discursive practices and institutional infrastructures contribute to shape field members' understandings of the potential benefits of an innovation (Ulucanlar, Faulkner, Peirce, & Elwyn, 2013), it is the dissemination of knowledge that increases the perceived capacity of late adopters to benefit (or extract "value") from it, encouraging diffusion even in the presence of high uncertainty and multiple failures.

***Disseminating positive implementation narratives.*** Past research has emphasized the rhetorical practices that innovators engage in to legitimize new technologies (Munir & Phillips, 2005) and work practices (Suddaby & Greenwood, 2005). In line with these understandings, our observations highlight the propensity of exemplary users to actively disseminate positive accounts of their experiences among peers and powerful constituents—a mechanism we refer to as *discursive persuasion*.

Peer-oriented narratives are primarily intended to persuade peers of the possible implementation and superior benefits of a fledgling innovation. In our case, for instance, some very early adopters did so through scientific publications and demonstrative videos. Peer-oriented narratives allow early adopters to claim mastery of the new practice and establish themselves as positive points of reference in its implementation. As indicated in Figure 6, by doing so, these adopters also inhibit the spread of alternative narratives that might question its benefits, emphasize difficulties in implementation, and eventually halt diffusion (Greve, 2011). Organizations are typically more eager to report how they successfully implemented new practices than disclosing the problems and failures they encountered (Zbaracki, 1998). In the presence of the apparent success of some very early adopters, unsuccessful ones may be even more reluctant to publicize their failures to avoid appearing incompetent in the eyes of their peers. Thus, while narratives of failure may circulate through word of mouth, it is less likely that they will be divulged in public.

While peer-oriented narratives are primarily intended to reassure peers of the quality of a fledgling innovation, public-oriented ones may indirectly increase pressures on late adopters by influencing powerful constituencies (see Figure 6). In our case, exemplary users did so by releasing videos on YouTube, where they could be accessed by potential patients, and by making themselves available to the national and local press. Current theories emphasize the role of the media in promoting imitative adoption by circulating the "success stories" of early adopters (Abrahamson, 1991; Strang & Macy, 2001). To the extent that the audiences that these narratives address—such as the popular or business press—do not require solid evidence of the benefits of the innovation (or are incapable of assessing exemplary users' claims), public-oriented implementation narratives may not only attract the attention of powerful constituents but also influence their perceptions of (purported) benefits. As illustrated in Figure 6, by doing so, publicly oriented narratives may also indirectly intensify the coercive pressures facing late adopters, who might be led to disregard technical or economic considerations if they wish to preserve their legitimacy (see also Abrahamson & Fairchild, 1999).

***Disseminating knowledge and skills.*** Narratives of implementation are important in diffusing awareness of a new practice and its claimed benefits. As Rogers (2003) notes, however, mere awareness may not be sufficient to induce the adoption of innovation:[6]

> In the case of innovations that are relatively complex, the amount of how-to knowledge needed for adoption is much greater than the case of less complex ideas . . . To date, few diffusion investigations deal with how-to knowledge although it MUST be a fundamental variable in the innovation-decision process.
>
> (Rogers, 2003: 173; capitalization by the author)

Past research has shown that professional expert advice is important for the acquisition of the skills required for the implementation of complex technologies (Attewell, 1992) and managerial practices (Abrahamson, 1991; Strang & Macy, 2001). Our findings extend these ideas by revealing the importance of the intense efforts of exemplary users to transfer their implementation experiences to prospective new adopters in an early stage of the diffusion of an innovation, when pressure from constituents may still be low, professional expert advice is unavailable, and the diffusion is largely driven by the imitative responses of other field members encouraged by the apparent social gains that seem to accrue to very early adopters (see Figure 6).

In our case, exemplary users began to do so by inviting colleagues to attend their operations and conducting live surgeries at medical conferences. We collectively refer to these practices for the dissemination of implementation experiences as *mediated exposure* to innovation—in that they allow potential new users to observe and discuss applications of a new practice, but not to engage in it directly. Examples from other settings include, for instance, arranged visits to organizational facilities employing new information technologies or manufacturing practices. Through mediated exposure, exemplary users enrich potential new adopters' understanding of an innovation, allowing them to observe—albeit briefly—how an innovation can be implemented in a real setting. By doing so, they may also reinforce confidence in the innovation, based on the principle that "seeing is believing" (Angst, Agarwal, Sambamurthy, & Kelley, 2010).

While mediated exposure contributes to the dissemination of information concerning a fledgling innovation, its capacity to transfer the skills required to effectively implement it is limited. These skills, to a large extent, comprise tacit knowledge (Sennett, 2008) accumulated by early adopters as they develop and/or experiment with new practices. A second important mechanism facilitating the dissemination of experience between exemplary users and late adopters, then, is the cumulative *codification* of early adopters' experience in manuals, protocols, guidelines, software packages, etc. The codification of early experience not only facilitates the transfer of knowledge (Nonaka & Takeuchi, 1995) but also increases the reach of exemplary users, to the extent that material or digital embodiments allow a broader audience of potential new adopters to access this experience regardless of their physical co-location. By sharing templates to be followed by future adopters, exemplary users begin to address potential concerns raised by early failures. By reframing these failures as resulting from poor implementation rather than the ineffectiveness of the innovation, they also reassure potential adopters of the possibility to effectively replicate their own "success stories."

Even the codification of cumulated knowledge, however, has limits. The verbalization or codification of tacit knowledge is intrinsically difficult (Pinch, 2008), and its transfer requires direct contact and prolonged interaction between an expert practitioner and untrained individuals (Pinch, Collins, & Carbone, 1997; Roberts, 2000). The skills required for the successful implementation of innovation are partly developed on site and cannot be entirely codified *ex ante* (Rice & Rogers, 1980). To overcome these difficulties, exemplary users of robotic surgery eventually turned to a third set of practices, which we collectively refer to as *assisted engagement* with innovation, in that they offer prospective new adopters the opportunity to implement the new practice with the prolonged assistance of an expert advisor. By doing so, exemplary users not only create more favorable conditions for the transfer of the tacit portion of the knowledge they have accumulated, but also, to the extent that this engagement occurs on site, their prolonged interaction with novice users offers them the opportunity to share their experience in ways that are

[6] Moreover, as our case indicates, potential adopters easily recognize these narratives as "edited" to the extent that they only present a partial and selected account of the implementation experiences. Videos, for instance, only presented successful cases and rarely mentioned complications and failures. More substantive dissemination mechanisms, therefore, are required to reassure potential adopters of the possibility to systematically replicate these apparently successful experiences in their organizations.

tailored to the novices' specific (individual and organizational) needs.

Thus, by increasing access to the tacit knowledge they accumulated, exemplary users reassure potential new adopters that a fledgling innovation can be implemented and used extensively and problems can eventually be successfully overcome. By doing so, they facilitate the diffusion among other actors seeking social gains and, subsequently, among late adopters succumbing to isomorphic pressures while uncertainty regarding the benefits of the innovation remain high (see Figure 6). As our case indicates, once adoption decisions come to be driven by isomorphic pressures, paradoxically, knowing "how to do it" may come to be more important for the spread of an innovation than ascertaining "whether it is worth doing it" in the first place.

By underscoring the importance of skill reproduction in the diffusion of innovation, our observations suggest that current understandings of practice diffusion relying on discursive practices (Green, 2004) may only provide a partial account of this phenomenon. It is possible, however, that the importance of this process might have been amplified by the complexity of the implementation of the practice we observed (Rogers, 2003: 257). The implementation of certain innovations (whether technological or administrative) may be relatively straightforward and/or only have a limited impact on the day-to-day activities of organizations. Other innovations (such as TQM, CT scans, or robotic surgery), instead, require the substantial modifications of organizational routines (Edmondson et al., 2001) and social relations (Barley, 1986, 1990; Burkhardt & Brass, 1990), as well as the acquisition of specialized technical or managerial skills (Pinch et al., 1997). Combined with more general uncertainty about the benefits of these innovations, difficulties associated with their implementation may heighten the importance of exemplary users engaging in skill reproduction in the early phase of the process, to reassure late adopters of the possibility of actually using (and doing so efficiently and effectively) the innovation they are considering adopting.

Our single-case design made comparison with other fields impossible; hence, we can only speculate that it is precisely the substantial uncertainty surrounding the technical benefits and economic gains (possibly combined with limited capacity to satisfy all potential demand) that induced some early adopters to disclose their experiences. It could be argued that, in the absence of significant social gains, if very early adopters ascertained substantial technical and economic benefits over direct competitors, they would have lower incentives to disseminate their implementation experience, to prevent direct competitors from replicating an important source of competitive advantage (Reed & DeFillippi, 1990). However, it could also be argued that, in the case of highly complex innovations, early adopters may be less concerned with transferring valuable knowledge to direct competitors, as they may only be able to disseminate a minimal amount of knowledge required for the implementation while retaining the (largely tacit) portion that allows them to claim mastery of the new practice, along with the reputational and economic benefits associated with this distinctive position.

Our observations might have also been influenced by the relative observability of the new technique and its outcome (Rogers, 2003: 258). Compared to certain administrative innovations, such as so-called "golden parachutes"—the actual benefits of which, for the organization and its stakeholders, are less clear (Fiss et al., 2012)—the functioning and outcome of robotic surgery, the precision of surgical movements, and the clinical results of operations are easier to observe. This characteristic might have heightened the impact of mediated exposure in an early stage, whereas this mechanism may be less influential, or entirely unavailable, if the functioning and outcome of an innovation cannot be easily observed by prospective adopters.

While certainly observable, however, whether the results of robotic surgery were better than the results of preexisting surgical techniques was more difficult to establish. Multiple criteria are available to measure the outcome of surgery (perioperative complications, blood losses, etc.), and even patients' satisfaction with recovery tends to be biased by expectations (Schroeck et al., 2008). This observation resonates with past research indicating that establishing the relative superiority of alternative practices or technologies is often not straightforward and the criteria employed are the result of a process of social construction, in which users themselves are involved, along with other constituents (Garud & Rappa, 1994). In this respect, if, as in the case of robotic surgery, the observability of relative performance is low or it is difficult to ascertain exemplary users' claims regarding the benefits of a fledgling innovation, engaging in the construction and development of institutional infrastructures, such as specialized arenas and professional associations, becomes important for exemplary users to shape the process that will establish the relative superiority of the new practice.

Overall, these considerations indicate the possible influence of the characteristics of the innovation on patterns of diffusion, and whether and how adopters' dissemination efforts influence these patterns. They should encourage future research and theory development to be more sensitive to this contextual condition when positioning one's observations within past research or relating findings from studies on different types of innovation.

***Developing institutional infrastructures.*** Past research has highlighted the important role of professional associations (Greenwood, Suddaby, & Hinings, 2002; Swan & Newell, 1995) and conferences (McInerney, 2008; Zilber, 2011) in the diffusion of new practices. Our findings extend these understandings by suggesting that exemplary users' engagement in the construction of institutional infrastructures may be instrumental to supporting micro-processes of discursive persuasion and skill reproduction and re-structuring social relationships around these early adopters' claimed mastery of the new practice.

Professional associations and conferences contribute to shape field members' understandings of appropriate behavior (Lampel & Meyer, 2008). They do so by offering venues for the articulation of a "shared conception of the problems to be solved and the approaches to be employed" (Scott, 2008: 225). Actively engaging in the organization and development of these infrastructures, then, becomes important for early adopters to attract attention to fledgling innovations (Anand & Watson, 2004), and to engage in the renegotiation of community-level understandings of the relative quality of alternative practices (Ferlie, Fitzgerald, Wood, & Hawkins, 2005) and of the criteria used to assess them (Garud & Rappa, 1994). Moreover, as our case suggests, the development of new and specialized institutional infrastructures not only offers very early adopters the opportunity to "showcase" their experience (as they would, for instance, in special workshops at more general conferences, or by publishing in generalist outlets), but also gives them some degree of control over the content and source of official narratives regarding the relative quality of the new practice.

Institutional infrastructures also contribute to shaping the structuration of social positions and hierarchies within a community (Anand & Jones, 2008; Hardy & Maguire, 2010). Active engagement in the development of these infrastructures, therefore, is also instrumental to the attainment of early adopters' social goals, in that it helps them build and/or consolidate their position as central and prominent members of a community (Glynn, 2008). In this respect, the constitution of separate, specialized infrastructures may facilitate the repositioning of exemplary users by offering them the opportunity to partly restructure social relationships and/or constitute a new subfield around a new domain of practice (see also Scott, Ruef, Mendel, & Caronna, 2000).

## CONCLUSIONS

In this paper, we reported on a multilevel study investigating the diffusion of robotic surgery in the Italian health care system. The purpose of our study was to improve our understanding of the motivations of early adopters and how their experiences influence subsequent diffusion.

Our observations outline the motivational drivers impelling organizations characterized by different structural positions to adopt fledgling innovations. They draw attention to the efforts of peripheral adopters, constituting themselves as "exemplary users," to promote the diffusion of an innovation of which they claim mastery to improve their social position. Finally, they begin to unpack the practices that exemplary users engage in to disseminate their experience among prospective new adopters to improve later adopters' capacity to exploit the expected technical benefits or, at a later stage, ensure the economic viability of decisions driven by isomorphic pressures.

Our observations are important, as they begin to shed light on micro-level practices that influence the diffusion of innovations. Reliance on large-scale studies and archival data led past research to focus on structural sources of influence on diffusion, such as network ties (e.g., Davis, 1991; Palmer, Jennings, & Zhou, 1993) and positions (e.g., Greve, 1995; Westphal et al., 1997) and geographic proximity (Davis & Greve, 1997). Our study complements this line of research by beginning to unpack the agentic practices that underpin the dissemination of knowledge across communities and networks as innovations diffuse.

Traditional research based on a rational search perspective has been accused of a "pro-innovation" bias because of its implicit assumption that innovations spread because of their superior technical or economic benefits (Rogers, 2003). Similarly, institutional theories of diffusion implicitly assume that innovations initially diffuse because of their technical or economic benefits, before this diffusion reaches a critical mass that triggers isomorphic pressures (Abrahamson, 1991; Tolbert & Zucker, 1983). These assumptions are problematic because they are incompatible with the notion that, during a very early stage, the relative performance of an innovation will be highly uncertain, and they struggle to properly explain the diffusion of poor-performing innovations (Greve, 2011).

Our observations enrich this body of research by drawing attention to the purposeful engagement of certain very early adopters, motivated by the will to improve their social position, in practices that promote the diffusion of an innovation with uncertain benefits. It could be argued that it is exactly the proactive efforts of these early adopters that encourage experimentation with and trials of the new practice until a form of implementation is found that consistently delivers technical and/or economic benefits, thus explaining how fledgling innovations move beyond the failures and uncertainty of the very early stage of their diffusion.

Our findings, then, question the understanding, implicit in past studies of diffusion, that late adoptions will largely be driven by the observation of earlier *adoptions* (how many and by whom). They suggest, instead, that, in an early stage, adoption decisions are partly shaped by what adopters come to know of past *implementations* (the problems encountered and the purported results) and by the extent to which knowledge accumulated by past adopters becomes available to facilitate subsequent implementations.

Our observations also question the assumption, implicit in current theories of the diffusion of poor-performing innovations, that the potential value of an innovation is defined a priori for each potential adopter (e.g., Greve, 2011). They instead suggest that imitators of "success stories" (Strang & Macy, 2001) and late adopters joining the bandwagon (Abrahamson & Rosenkopf, 1993) are more likely to yield to isomorphic pressures to the extent that early adopters (or other actors) facilitate the reproduction of the skills required for the successful and continued implementation of the innovation—or, in other words, increase the potential value that these late adopters can "extract" from the innovation. By doing so, we argue, the efforts of exemplary users may reduce the likelihood that diffusion will reverse and become a faddish cycle once late adopters experience difficulties in implementation.

It is possible that, by assuming the possibility of decoupling symbolic adoption from substantial implementation and/or focusing on the diffusion of practices characterized by relatively low observability of outcomes and low complexity of implementation, past research in an institutional tradition might have emphasized discursive practices that actors employ to persuade constituents of the benefits and/or legitimacy of a new practice, while overlooking the importance of knowledge dissemination processes. By drawing attention to the centrality of these processes in the diffusion of innovation, then, we encourage future researchers to devote greater attention to how knowledge exchanges—the mechanisms they rely on, the nature of the knowledge being transferred, etc.—from earlier to late adopters influence patterns of diffusion.

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