Paper 3

Embedded relationships in information services: A study of Remote Diagnostics

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Abstract

Information technology (IT) is increasingly used in the production of services, enabling a selfserve channel that challenges the embedded relationship in services. To examine the implications of IT for embedded relationships, we undertook an interpretative case study of a remote diagnostics service in the mining industry. Our analysis suggests that the combination of IT and social efforts by the participants can support embedded relationships to a larger extent than has been shown in previous research.

Keywords: Business-to-Business (B2B); Information Services Organization; Issues of IT;

1. Introduction

In the contemporary economy, services are gaining interest as a way to provide unique value and improved revenues (Toivonen & Tuominen, 2007). Because services are performed through a series of activities

where the customer is involved in the production (Grönroos, 2000), the interactions and relationships between the customer and service provider representatives are a crucial part of the service delivery (Guttek, 1995). While human actions traditionally have been an essential part of service interactions, the development of IT has facilitated services and interactions provided by combinations of IT and people, a type of service referred to as information services (Mathiassen & Sorensen, 2008).

Depending on the specific technology and configuration, customer interaction may be facilitated in many different ways in service production. The technology may serve as a producer of “face-to-screen” interactions as well as a facilitator of “face-to-face” interactions (Froehle & Roth, 2004). Research on the role of IT for mediating interactions in service relationships has shown how IT is insufficiently sophisticated to enable interpersonal ties, but also how electronic media are rich enough to facilitate interpersonal exchanges (Schultze & Orlikowski, 2004). Kraut et al. (1999) suggested that the use of IT in interfirm interactions requires established personal relationships and trust, as these may not be developed through technology. Bensaou (1997) argued that IT can reduce physical, spatial, and temporal boundaries that have traditionally hindered interorganizational cooperation. Schultze and Orlikowski (2004) found that self-serve technologies negatively influenced service relationships while electronic media such as e-mail, phone, and fax supported communication in such relationships. Due to the contradictory findings in the literature, Schultze and Orlikowski (2004) argued for the need for further empirical studies of the role of IT in service relationships. Moreover, most of the existing research in this area (e.g., Bensaou, 1997; Grover, Teng, & Fiedler, 2002; Kraut et al., 1999) has left customers’ perceptions unexamined.

Remote diagnostics services are a type of information service provided using ubiquitous computing environments. These services are used to monitor the machines used in the process lines in industrial companies (Hibbert, 2000). Previously, these companies relied on human skills and the use of the senses to monitor the equipment’s conditions (Westergren, 2007). Today, they are more likely to be monitored through IT applications such as remote diagnostics systems that can automatically monitor performance, diagnose problems, and request attention from service technicians for any detected problems (Biehl, Prater, & McIntyre, 2004). The monitoring is increasingly being outsourced to remote service providers where experts use the IT infrastructure to access data from the customers and perform analysis. With remote diagnostics systems, no

direct user involvement is required in the data collection, as sensors are embedded into the machines to log their condition, and the subsequent data analysis often takes place at remote service centers by experts. The diagnostics service provided by the remote service center is a long-term focused service aiming at detecting upcoming problems in the equipment. The service also requires close cooperation with the customer staff as they are making decisions about upcoming repairs and maintenance activities. Moreover, they can complement the remotely collected information with information about environmental issues that the sensors cannot detect.

Encounters and relationship services are distinct service types that capture two opposing interaction forms in service production (Gutek, 1995). Encounters can be described as arm's length relationships while embedded relationships are a deepened form of service interaction (Uzzi, 1997), which best describe the remote diagnostics service. However, in contrast to embedded relationships, which are based on close cooperation between the actors, remote diagnostics services raise challenges because the technology reduces the need for human interactions in service production, similar to self-serve technologies (Schultze & Orlikowski, 2004). The technology thereby supports impersonal and arm's length linkages, rather than close human interactions, which are essential in embedded relationship services. To examine the effects of IT on embedded relationships in information services, we undertook an interpretative case study of a remote diagnostics service in the mining industry. The study is guided by the following research question: What are the implications of using IT for embedded relationships in information services? The study draws on Uzzi's (1997) embedded relationship analytic approach, but is extended to account for the influence of IT. Our analysis suggests that the combination of IT and social efforts by the participants can support embedded relationships to a larger extent than existing research has implied.

The article is organized as follows. Section two gives an overview of related research and introduces the embedded relationship framework. Section three describes the research methodology and the research site. Following this, the findings from the case study are presented and analyzed. This is followed by a discussion where the findings are related to previous research. The article ends with conclusions and issues for future research in section six.

2. Related research

Services have gained attention from industrial organizations because substantial revenue can be generated, customers are demanding more services, and they can become a sustainable source of competitive advantage (Oliva & Kallenberg, 2003). IT is one of the most important infrastructural elements in service production as it can enable information transfer, improved interaction within and between companies, and organizational transformation (Edvardsson, Gustafsson, Johnson, & Sandén, 2000). Services are generally comprised of a series of activities that normally take place in interactions between the customer and the service provider (Grönroos, 1990). Information services are, however, not limited to activities performed by individuals; they are rather provided by configurations of people and IT artifacts (Mathiassen & Sorensen, 2008). Remote diagnostics services are a type of information service provided by information systems and service technicians.

2.1 Remote diagnostics services

In maintenance-related services, one facet involves improving customer up-time (Armistead & Clark, 1991), as failures in maintaining machinery and subsequent breakdowns can cause losses in production and environmental hazards. These losses and hazards can be minimized if machinery failures can be predicted and corrected proactively. The aim of preventive maintenance is to replace components before a failure occurs, in contrast to a run-to-failure approach where maintenance is done after the fact (Tsang, 2002). Two main approaches to preventive maintenance are scheduled maintenance and condition-based maintenance. In the former, maintenance is performed at scheduled intervals regardless of the item's actual condition. In condition-based maintenance, actions are performed when failure is deemed to be imminent. Performance-parameter analysis, vibration monitoring, thermography, and oil analysis are typical condition-monitoring techniques that are used in condition-based maintenance. The challenges involved in condition-based monitoring include installing sensors that observe such conditions, maintaining the history of collected data to predict when a failure is imminent, and communicating this to the relevant parties.

New IT has emerged in which some of the condition-based monitoring can be transferred to remote field sites. These sites provide remote services organized around ongoing information gathering and exchange, and allow for remote access to machinery components

(Simmons, 2001). The IT infrastructure for remote diagnostics services consists of the remote diagnostics systems, which carry out continuous sensing, collection, transfer, and analysis of the machinery's condition parameters (Jonsson & Holmström, 2005). With sensors embedded in the equipment it becomes possible to go beyond object identification and measure the status or condition of products (Hackenbroich, Bornhövd, Haller, & Schaper, 2006; Hansmann, Merk, Nicklous, & Stober, 2003). Object location, temperature, and acceleration are examples of parameters that can be measured. The monitored parameters can indicate changes months and even years before a breakdown will occur, and the remote diagnostics services are thereby oriented towards a longterm focus. However, remote diagnostics services are not solely based on technology. The remote technicians play an important role in analyzing the collected data, and reporting and discussing the findings with the local workers. These local workers are important for the service as they are responsible for maintaining the products and have knowledge of and information about environmentally related issues. In addition, the remote diagnostics services do not fully replace traditional preventive maintenance, as scheduled maintenance is still needed and local interventions are necessary in cases of emergency.

2.2 Embedded relationships in remote diagnostics services

When both the service provider and the customer are involved in service production, as in the case of remote diagnostics services, the relationship and interactions between the two parties become crucial for service quality. Gutek's (1995) taxonomy of service interactions helps to further explore the interfirm relationships in service production. Gutek (1995) identified two main types of service interactions: service relationships and service encounters. Service relationships are characterized by a long-term focus where both parties expect to interact with each other in the future. Over time, bonds of trust and close linkages evolve as the parties cooperate for their mutual gain. Service relationships reflect what are referred to as socially-embedded relationships (Granovetter, 1985), which depict the commercial transactions as embedded in a web of social attachments (Uzzi, 1997; Uzzi & Gillespie, 2002). Service encounters, on the other hand, take place without expectations of future interactions and the exchange of additional information is unlikely, as is the development of trust (Schultze & Orlikowski, 2004). Service encounters are reflective of arm's-length relationships (Granovetter, 1985; Poppo & Zenger, 2002; Uzzi, 1997), which represent rational actors engaged in exchange relationships with self-interested motives.

In remote diagnostics services, interactions between the service provider and the customer take place both via the technology and via social interactions. The service provider collects data continuously from the monitored equipment with the use of the remote system, and social interactions take place with the customer representatives to collect complementary information and discuss the results. The remote diagnostics services are performed as a part of the preventive maintenance work, which is a long-term focused approach aimed at detecting and preventing errors. Over time, the service provider develops detailed knowledge of the customer's specific equipment. The service is focused on a long-term relationship with expectations of continuous interaction between the parties. The embedded relationship thereby best describes the interfirm relationship in such services.

Uzzi's (1997) study of embedded relationships has become a well-established work in this field (e.g., Chatfield & Yetton, 2000; Hansen, 1999; McEvily & Marcus, 2005; Orlikowski & Schultze, 2004). Uzzi (1997) identified three main components in embedded relationships: trust, fine-grained information transfer, and joint problemsolving arrangements. These components regulate the expectations and behaviours of the partners in the service relationship. This framework is adopted in this paper to further explore the embedded relationship in remote diagnostics services.

The first component, trust, is a primary feature in the parties' embedded ties. Trust is expressed in a belief that the partnership is prioritized and that the other party will not act in self-interest at the other's expense. Trust is developed in the service relationship when the parties voluntarily give extra effort. "Trust promotes the exchange of a range of assets that are difficult to put a price on but enrich the organization's ability to compete and overcome problems" (Uzzi, 1997, p. 43). Trust can reduce stress associated with decision-making among customers who lack product knowledge, technical expertise, and confidence as they rely on a trusted service provider to assist them or even make decisions for them (Reynolds & Beatty, 1999). Trust can, however, turn into mistrust if it is repeatedly abused. Uzzi (1997) described that as trust emerges in the relationship between the individuals, it is a social process that is part of the social relationship.

The second component of the embedded relationship is the fine-grained information transfer between the parties (Uzzi, 1997). Compared with arm's-length relationships, the information entails more proprietary details as well as tacit information acquired through learning by doing. As the parties have a close relationship, the communication and

information flow is ongoing, even in between the business exchanges. The social relationship is critical for evaluating the information, for example to evaluate information from a manufacturer about the top selling items. The fine-grained information transfer reduces the information asymmetry between the parties and is holistic in nature, as more than just asset-specific information is transferred.

The last identified component of the embedded relationship is the joint problem solving arrangements. Over time, the parties develop routines of negotiation and mutual adjustment that help to resolve problems when they arise. The parties know each other's businesses and know that if something goes wrong they are able to work it out together. By working out problems together, the relationship is enriched; this promotes both learning and innovation (Uzzi, 1997).

As Uzzi's (1997) framework implies, the embedded relationship entails social ties, norms, and expectations of the social interactions between the parties. Such ties and norms form part of the social capital in the social setting (Coleman, 1988). Cohen and Prusak (2001) defined social capital as a stock of active connections among people that covers the trust, mutual understanding, shared values, and behaviours that bind people together as members in a social setting. In the embedded relationship, the social capital can take the form of mutual trust, goodwill, obligation, and reciprocity (Adler & Kwon, 2002). Social capital is not a property of any individual; it is rather embedded in the relationships among the actors. Once developed, it can be exchanged for economic capital (Bourdieu, 1986), as it may, for example, be used by customers to gain special treatment and service providers may rely on their customers' loyalty to charge less competitive prices (Orlikowski & Schultze, 2004). Social capital is therefore fundamental in the embedded relationship service, as it guides the interactions in such a relationship.

While IT can provide a mechanism for service encounters where the user typically interacts directly with the service provider via automated systems (Gutek, 1995), as in the use of an ATM, similar technology is also incorporated into embedded relationship services (Orlikowski & Schultze, 2004). When the adopted IT application separates the customer and the service provider, the implications for the embedded relationship may become turbulent, and there is a call for further research on such types of integrations (Schultze, 2004). Schultze and Orlikowski (2004) applied Uzzi's (1997) embedded relationship framework to explore the implications of a self-serve technology on an embedded relationship. Their analysis showed that this technology negatively influenced the conditions for the embedded relationship.

First, when IT reduced trust in the relationship, participants spent social capital to repair the relationship. Second, when IT reduced the exchange of fine-grained information, there was a decline in opportunities to create and sustain the social capital in the relationship. Finally, where IT reduced the opportunities for problems-solving arrangements, the collaboration between the participants declined, which challenged the service relationship. Schultze and Orlikowski (2004) concluded that the self-serve technology facilitated arm's length relationships, while embedded relationships were facilitated by electronic media such as phone and email. The remote diagnostics system has similarities with self-serve technologies as it also separates the service provider from the customer by allowing for remotely controlled data collection. With these systems, the need for physically visiting the plant increases, which also increases the occasions for direct contact between the customer and service provider employees. The remote service provided by means of the remote diagnostics system does, however, rely upon an embedded relationship. As existing research has identified, there is a need to further explore the implications of IT on embedded relationships, and this study provides insight into transforming remote diagnostics systems into an information service based on an embedded relationship.

By observing the implications of IT for embedded relationships, this article is part of a body of informatics research that examines the social aspects of IT. Kling (1999) gave a more formal description of this type of research as "the interdisciplinary study of the design, uses, and consequences of information technologies that takes into account their interaction with institutional and cultural contexts" (Kling, 1999, p. 1). The social aspects of IT may, for example, include topics such as the ways people develop trust in virtual teams (Iacono & Weisband, 1997) and the ways that disciplinary norms influence the use of electronic communication media (Kling, 1999). This paper contributes with a social perspective on the use of remote diagnostics systems in services.

3. Methodology

The research on services in ubiquitous computing environments may be viewed as being in an exploratory phase, as researchers have only just started to explore the business use of ubiquitous computing (Roussos, 2006). To study the implications of remote diagnostics systems for embedded relationships, this paper uses an interpretive case study methodology (Klein & Myers, 1999; Walsham, 1993). According to Walsham (1993, pp. 4-5), the interpretive approach of IS research is "aimed at producing an understanding of the context of the information

system, and the process whereby the information system influences and is influenced by the context”. This perspective resonates well with the objectives of this paper because the interpretive approach is well suited for social studies of IT (e.g., Henfridsson, 1999; Holmström, 2004; Orlikowski, 1992, 2002; Rolland, 2003; Walsham, 1993; Zuboff, 1988), as it pays special attention to the phenomenon’s context (Patton, 2002).

3.1 The studied organizations

As services always involve customers to some extent (Grönroos, 2000), both the service provider and the customer were included in the case study. The study involves one service provider, Monitoring Control Centre (MCC), and one of their customers, Alpha (fictitious name). MCC is a provider of services in the mining and minerals market and Alpha is a company in the mining industry. The rationale behind selecting the organizations was their willingness to cooperate, the availability of multiple sources, and the possibility of purposeful sampling (Peppard, 2001; Yin, 1989).

The services that MCC provides consist of various elements such as operations analysis, implementation of infrastructure for condition monitoring, and the collection and analysis of measurement data. This study focuses on the remote diagnostics services. At the time of the study, MCC employed ten technicians performing measurements and analyses, three people in management/ administration, and three developers. Alpha has a number of different plants in which MCC has conducted remote diagnostics since 2003. Unplanned production breaks are very expensive for Alpha, so with the diagnostics service the company hopes to prevent unplanned breaks and instead perform maintenance during planned stops. The maintenance is organized in a hierarchy with a maintenance/production manager at the top who is responsible for the whole production of the company. The company also has a person responsible for the development of the maintenance organization. Six different maintenance managers are responsible for the maintenance in different parts of the organization. Below them, sixteen different maintenance planners are organized to take care of the daily planning of the maintenance. The maintenance planners have direct contact with the MCC technicians.

This study employed a qualitative data collection technique of semi-structured interviews. Two rounds of interviews were carried out by the author and a co-researcher. The first round occurred in 2003-2004, during which we followed the initial discussions in designing and producing the remote diagnostics service. The second phase of the study

was conducted in 2006, where we revisited the organizations and followed up on their insights from utilizing these services in practice. In all, the study included 31 interviews with people from Alpha and MCC. Seven interviews were held at MCC and twenty-four at Alpha. The interviews lasted between 45 minutes and 2 hours, with an average of about 60 minutes. Each interview was recorded, which allowed the researchers to focus upon the respondent and formulate follow-up questions. The interviews were then transcribed to enhance the analysis. Twenty-eight of the interviews were conducted on site at the respondents' workplace, which enabled the researchers to gain some insight into the work. Three of the interviews were conducted via telephone, as meetings could not be arranged with them at the times when the researchers visited the company.

When choosing participants at MCC, we wanted to include persons in management, one technician from each location where MCC provides services to Alpha, and one developer. At Alpha, we wanted to interview the two managers, all six maintenance managers, and a number of the maintenance planners. Among the sixteen planners, we included persons from all types of plants and one person from every location where Alpha operates. To cover this, eleven of the maintenance planners were chosen for interview. Table 1 lists the respondents from the two organizations. The focus in the interviews was to probe the effects of the remote diagnostics system on the embedded service relationship. Applying Uzzi's (1997) framework, we identified three key areas of inquiry to recognize these impacts: 1) trust, 2) fine-grained information transfer, and 3) joint problem solving arrangements. The interview materials and field observations make up the major corpus of the empirical database. The data analysis involved reading the data set and organizing the data into themes corresponding to the three identified areas. During the first reading, the material was grouped into two main categories – the customer and service provider – and their perception of the relationship. Next we applied the three components of the embedded relationship framework to analyze the implications of the technology. In the following section, these three categories are presented separately. Quotes are used to highlight perceived implications and changes in the relationship due to the technology.

MCC staff	Date	Alpha staff	Date
Manager	2004-04-27	Technician	2003-10-09
Manager	2006-01-31	Maintenance/production manager	2003-10-10
Team leader	2006-01-31	Maintenance manager 6	2004-04-27
Technician A	2006-01-31	Maintenance technician	2004-04-27
Technician B	2006-02-01	Maintenance technology manager	2004-04-28
Technician C	2006-02-01	Maintenance/production manager	2006-01-31
Developer	2006-02-01	Maintenance developer	2006-03-21
		Maintenance planner 1	2006-03-21
		Maintenance planner 2	2006-03-21
		Maintenance planner 3	2006-03-21
		Maintenance planner 4	2006-03-21
		Maintenance planner 5	2006-03-21
		Maintenance manager 1	2006-03-21
		Maintenance manager 2	2006-03-21
		Maintenance manager 3	2006-03-21
		Maintenance manager 4	2006-03-22
		Maintenance manager 5	2006-03-23
		Maintenance planner 6	2006-03-23
		Maintenance planner 7	2006-03-23
		Maintenance planner 8	2006-03-23
		Maintenance planner 9	2006-03-23
		Maintenance planner 10*	2006-04-06
		Maintenance planner 11*	2006-04-10
		Maintenance manager 6*	2006-04-28

Table 1. Interviews conducted in the study (interviews marked with * were conducted via telephone)

4. Research results

Traditionally, the preventive maintenance at Alpha was mainly performed by technicians manually inspecting the equipment physically by the use of their senses. These inspections could either be performed by internal employees or by external service providers. When the

external service providers physically visited the plants to conduct their work, the good relationship between the service provider and the customer was enhanced, as they could meet and talk directly face-to-face. Use of the remote diagnostics system caused a change due to the ability to perform inspections at a distance from the equipment. Sensors installed in the equipment measure vibrations in bearings, which are transferred to the service provider for further analysis by their technicians. With the remote diagnostics systems, the technicians can spend much of their time at their offices, far from the machines they are monitoring and far from the customer employees. This part of service production is thus invisible to the customer. In the case of MCC, a report is written once a month to summarize the condition of the monitored equipment, which is sent to the maintenance planner and the maintenance manager at Alpha. The reports are followed up in a meeting with the customer where the findings are presented and where they discuss the remaining lifetime of the components.

The remote diagnostics system, due to its ability to enable calm and invisible information transfer, can be said to support arm's length relationships rather than embedded relationships in a similar way to Internet-based self-serve technologies (Schultze & Orlikowski, 2004). However, the condition monitoring enabled by the remote diagnostics system has a long-term focus, as potential problems in the equipment can begin years before they cause a breakdown. Long-term orientation is thus a key in remote diagnostics services and requires close interaction between the participants, which pushes the technology into an embedded relationship service. To further explore the service relationship between MCC and Alpha, this section is organized based on the three components of the embedded relationship: trust, finegrained information transfer, and joint problem-solving arrangements.

4.1 Trust in the service relationship

When applying a remote diagnostics system to the maintenance work, two separate groups are created: the remote group and the local group. For the maintenance work, it is important that these two groups be able to work in cooperation and complement each other.

Actually it is a new way of working. Earlier they [the customers] did this in their own plants but now they have to release it and trust this group [the remote group]. You have to understand the borders, what are the remote group and the local group doing? It should not become two different camps; the groups should complement each other. (Technician A, MCC)

The two groups have different capabilities for monitoring the equipment. The remote group can perform detailed monitoring of certain parameters, and the use of sensors for remote monitoring expands human sensing as they can monitor things that humans cannot, and in places where humans cannot go. For example, a sensor can pick up sounds that the human ear cannot recognize. Status data can also be collected when the machines are in use, which due to machine design and safety regulations is often impossible for humans to do. However, the diagnoses that can be performed with the system are only based on the parameters that are monitored. A physical walk-around by an experienced engineer who can see, hear, and feel when something is abnormal can detect things that the technology and the remote technician cannot. Cooperation between the two groups is thus essential for successful maintenance.

For a well-functioning collaboration between the customer and the service provider, it is important that the customers have knowledge of what they can expect from the remote service provider. If not, there is a risk that they will not be satisfied with the service outcome. One of the planners at Alpha expressed some thoughts he had about doing the measurements online.

I had some thoughts and hesitations when they [MCC] got access from their office and could see the results there. How would it be then; do we lose a lot? But it has worked better than I thought [...] our technician [at MCC] is great. I think we have the best guy working with our plant. (Maintenance planner 1)

The qualities of the technicians are important for the staff at Alpha and help them to overcome the disadvantages they perceived when a remote service provider performs the monitoring.

Our guy [the MCC technician] is part of the team. Everyone knows who he is. It is important that he knows our guys. He must know who is working with what. It's all about personal chemistry. He must be visible. It's important that these things work because sometimes when he calls me I may be busy. Then it is better that he talks to the guys who are directly involved in the maintenance. Those things are important. (Maintenance planner 9)

The information service enabled by the remote diagnostics system is dependent upon an embedded relationship. The system does, however, enhance arm's length relationships, as no interaction is required with the local staff to perform the data collection and analysis. The parties thus recognize the necessity of trusting each other. The technicians' importance to the services was expressed in different ways by many of the maintenance planners at Alpha. All maintenance planners highlighted

the personal relationship with the service technician as being important, and they thought it was important to have a technician who is competent, but almost every planner also stressed issues of having a technician who is sociable, trustworthy, easy to talk to, and visible. Moreover, the maintenance planners appreciated when the technicians were ambitious and showed interest in their work. Many of the technicians at MCC give extra effort in their relationship with Alpha to build up a good relationship. They serve as a discussion partner for modernizations in the plant, they give tips, and they help the customer with risk analysis and cause analysis of breakdowns.

*Even when our technician is at home or is sick we can call him, he is amazing.
(Maintenance planner 1)*

According to Uzzi (1997), such efforts serve to develop trust between the individuals in the service relationship. However, remote diagnostics services are not merely provided by individuals; they are provided as a configuration of IT and people where the technology enables distant and invisible collection of data. The technology is thus also an essential issue in service production, and the respondents at MCC and Alpha think it is important to understand the technology. Moreover, the technology has to be trustworthy; otherwise the analysis results can be mistrusted and neglected. For some of the respondents at Alpha, it has taken some time to trust the technology, but visual inspections of replaced parts have convinced them.

*The measurements indicated a problem in the motor, it was replaced, but then the measurements indicated problems in the new motor as well. That motor was also replaced and sent for inspection, which revealed that there actually were problems in the new motor as well. So the measurements were correct. Then I started to believe that they actually work.
(Maintenance planner 8)*

As the technology is invisible to the customers in remote diagnostics services, it is difficult for them to know how the measurements actually are performed and what data is collected. Sometimes the technicians at MCC try to help the customers in trusting the technology and teach them its benefits and limitations.

Sometimes they [the customers] have questions about trusting the measurements. Usually I invite them to come and look at my measurements, and sometimes I bring the computer with me and show them. (Technician C, MCC)

MCC also offers courses for the maintenance planners where they can learn about the technology and its limitations and benefits.

Some breakdowns are impossible to predict even if you monitor the equipment. But the customer understands that. My contact persons have the understanding and know what it's all about [...] but some others don't have that knowledge. If I put a sensor on a bearing they believe that vibrations far away will affect the measurement. They don't understand that I get a value for a certain bearing. (Technician B, MCC)

Knowledge of the technology and its benefits and limitations are thereby important for the service relationship. Knowledge helps to create realistic expectations about the service and helps define the limits of what tasks each party can and should perform. Moreover, it also helps the customer to trust the results presented by the technicians. If the result of the monitoring is not seriously considered due to a lack of trust in the technology, it might lead to reduced machine availability.

While Uzzi (1997) identified trust in the relationship between the individuals as a primary feature in face-to-face relationships, this study adds trust in technology as a feature for information services. The relationship between the individuals and their mutual trust is, however, still a primary issue as it is in that relationship that trust is developed. The social efforts by the participants develop trust between the parties as well as in the technology. Trust in technology is thereby also developed and resides in the social relationship.

4.2 Fine-grained information transfer

The remote diagnostics service is dependent upon information transfer in two directions. Data has to be transferred from the customer's setting to the service center for analysis. Thereafter, the analysis results are transferred back to the customer. The information transfer has to be fine-grained in both directions in order to enable reliable maintenance planning. The information flow from the customer site to the service center mainly depends upon the remote diagnostics system. This information flow is, however, invisible to the customer, which can raise uncertainties about whether or not the monitoring is performed and whether the data collection is functioning well. An ongoing dialog between the service and customer representatives is therefore important, even when there are no problems. The dialog serves as a sign to the customer that the monitoring actually works.

It's important that MCC informs us about their work so that people know what they are doing. Otherwise there is a risk that people start to talk. (Maintenance planner 2)

In addition to the data collected by the on-line system, additional information about the machines is necessary and can only be provided by the local workers that are present in the plant.

Our guys have a good collaboration with MCC. It's important to know what happens. They [MCC] do measurements, but MCC must also get feedback, what has happened before and so on. (Maintenance manager 3)

Mutual interest is therefore important for the service delivery, and it must permeate all persons directly and indirectly involved in the service, from top management to the persons on the floor.

If this is to work we can't ignore their reports. We must treat them seriously. I always discuss my decisions with our MCC technician. We must consider their findings. (Maintenance planner 3)

We must have contact with the customer staff present on the floor. They should be our eyes and ears. If a mill sounds abnormal, did it begin this week or has the oil temperature suddenly increased? Yes, he [customer staff] might say, it is very hot in the plant and the oil temperature has increased 20 degrees; maybe that has caused the sound. When we get an alarm we always want additional information to be able to refine the data so we can tell what has caused the alarm. To refine the information is the difficult part at a distance. (Developer, MCC)

After the data has been analyzed in the service center, the results are transferred back to the customer so appropriate actions can be taken. This information transfer is highly dependent upon the interaction between the service provider and customer's representatives. A regulated information flow takes place once a month when a report is e-mailed to the maintenance planner at Alpha. However, this report served only as a document that could be stored. The reports were followed up with a meeting every month but the main part of the information transfer took place over the phone and in occasional meetings.

It would be another thing if we just received a monthly report, but we have a continuous dialog that's good. Actually, it works well. (Maintenance planner 9)

It's important that we get rapid feedback from the measurements regarding the product's status. At the monthly meetings we can discuss the machines in detail. (Maintenance planner 2)

The experienced service technicians often answer questions and give additional information and advice in the dialog with the customer. This information is not written in the report, as they cannot take

responsibility for the advice. The customer representatives know this and highly appreciate the extra information that is received, as it helps them in their risk estimates. The customer representatives think that the information given by the service technicians provide their organization with know-how that is important. They feel that they have learned more about preventive maintenance and have become extra attentive to certain machines. This is knowledge that remains within the organization.

The maintenance managers do not have any regular, direct contact with the technicians from MCC, but they emphasized the same issues as the maintenance planners and thought it is important that the dialog between the maintenance planners and the technicians is continuous and fruitful. A plan to make the information transfer more fine-grained is to give MCC access to the internal maintenance system at Alpha. MCC would then have direct access to information about the maintenance work, and the MCC technicians would be able to write instructions about repairs to Alpha directly in the system.

Following Uzzi's (1997) definition of fine-grained information as the transfer of proprietary details and tacit knowledge, the technology in this case reduced the transfer of fine-grained information, as such information is not transferred in the system and the system reduced the need for direct interactions with the customer workers. The parties did, however, compensate for this through additional interactions over the phone and in occasional meetings.

4.3 Joint problem-solving arrangements

Both MCC and Alpha thought it was important to have direct and open communication with the other party. When problems arise, the customer or the service provider directly calls their representative to solve the problem. The customer representatives rarely have contact with the management at MCC, as problems are mainly solved directly with the service technician. Both parties thought that this is a good way to handle upcoming issues. Close collaboration and open communication are also important in order to improve the customer's equipment.

We can sit in our office and remotely tell them to change a bearing year after year, but nothing is done to avoid the problem so it keeps coming back. Those who are present in the plant can see if there is a problem with the lubrication, for instance, and if that's why the problem keeps coming back. (Developer, MCC)

As the remote diagnostics system creates a distance between the service technician and the monitored equipment, the customer representatives serve as the local eyes and ears for the remote technician. This stresses

the importance of a close collaboration between the parties, a collaboration that also serves as an arrangement to solve upcoming problems.

The distance created by the technology in one way reduces the opportunity to solve problems directly when they occur. It could, for example, be problems with the equipment that are not discovered immediately as the sensors cannot collect all the necessary data. The parties in this study did, however, make efforts in their collaboration to compensate for this and solve problems by direct and close interactions.

5. Discussion

Because IT is increasingly becoming integrated into new forms of services, there is a need to understand the implications of the technology in the embedded relationship service. The objective of this research was to explore the implications of using IT for embedded relationships in information services. The studied service was an information service provided through a combination of service technicians and remote diagnostics systems. The service provider in this study, MCC, introduced the remote diagnostics service to provide improved maintenance for mining industry companies, and the customer, Alpha, used the service to improve the preventive maintenance of its plants.

The analysis drew on the embedded relationship framework by Uzzi (1997) and the following implications are suggested:

- In information services, social efforts by the participants, which develop trust in their relationship, should also be complemented with efforts to develop trust in the technology. Trust is, however, mainly created and maintained in the interaction between the participants, which confirms the findings by Kraut et al. (1999) that trust is not developed through the technology, but rather is created in the personal relationship between the participants. In contrast to Schultze and Orlikowski's (2004) study, which suggested that IT reduces trust in the relationship, this study suggests that social efforts by the participants still develops trust, but additional efforts are needed to develop trust in technology.
- When IT reduces the fine-grained information transfer, the participants will begin to make social efforts to compensate for this and provide information in other ways. Additional electronic media such as phone and e-mail support these social efforts. This view can be contrasted with Orlikowski and Schultze's (2004) suggestion that

there is a decline in the opportunities to sustain the social capital in the relationship when IT reduces the finegrained information transfer. This study suggests that the participants instead spend social capital to compensate for such reductions.

- The physical distance in the relationship due to the remote technology reduced the opportunities for face-to-face joint problem solving. The participants did, however, find additional routines based on close and continuous interactions via phone to help solve problems. Orlikowski and Schultze (2004) suggested that when IT reduced the opportunities for joint problem solving, there is less collaboration among the participants. This study suggests that when IT reduces such opportunities, the participants seek additional ways and routines for joint problem solving.

While Schultze and Orlikowski (2004) argued that IT with self-serve capabilities negatively influence embedded service relationships and support arm's length relationships, this study shows that such technology can be used in embedded relationships when provided in a configuration with people. The self-serve technology studied by Schultze and Orlikowski (2004) left the user alone with the technology in the service situation and social capital was not able to compensate for the technology's negative influences on the embedded relationship. This shows that the particular configuration of the information service plays an important role in the embedded relationship and that there is a need to pay detailed attention to the specific service configuration.

As previous research has shown, technologies such as phone, e-mail, and fax can directly support the embedded relationship (Schultze & Orlikowski, 2004). Such technologies were also used in the remote diagnostics service studied in this paper, as they allowed for direct contact between the service participants. The embedded relationship does therefore not just include one type of technology; rather, it may include a web of technologies. Each technology may change the boundaries in the service relationship by allowing for functionalities that may change old work routines and create new ones. A challenging task thus becomes to organize a web of technologies that complement one another and suits the specific service level.

6. Conclusion

This article provides insights into embedded relationships in information services. The aim of the study was to explore the implications of using

IT for embedded relationships in information services. The contribution of the article is threefold: 1) embedded relationships rely upon a web of technologies that need to support the specific service level, 2) when IT that facilitates arm's-length relationships is incorporated, the individuals spend additional social capital to compensate for the technology's weaknesses and to maintain the embedded relationship, and 3) the value of the information service therefore highly depends upon the efforts by the individuals, but in contrast to previous studies this study shows that such a relationship can be sustained even with the use of distancing IT.

An important contribution of this article is the illustration of social capital as a critical enabler for embedded relationships in information services. More research is, however, needed to further explore in more detail how such capital can be built up and sustained when the technology undermines its foundations. Moreover, the grouping of technologies and the ways in which they interact needs further exploration, as there has been limited research in this area and this is a critical issue to cope with in practice. The development in technologies and their compositions also enables new forms of services that would also benefit from further research.

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