Managing Industrial Maintenance—Networked Model

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Abstract Industrial maintenance services are outsourced more and more as manufacturers' own maintenance units are nowadays rare. However, instead of outsourcing the maintenance as a whole, many companies are acquiring the needed resources from several actors. Thus, maintenance practices on a site can be performed by the customer itself, an equipment provider, or an independent maintenance company. How should this be orchestrated? We begin our study with explaining the current state of industrial maintenance business. Next, we offer insights from the services networks literature. Then we move on exploring maintenance through seven case companies, which brings us to our suggestions for two optional future maintenance models: (1) capacity-based maintenance and (2) locally networked maintenance framework.

1 Introduction

Industrial maintenance services are being outsourced more often making the manufacturers' own maintenance functions limited if not rare. Furthermore, companies are more often acquiring the needed resources across from several companies providing maintenance. These maintenance providers can be classified under two broad categories. First, equipment manufacturers are driven to provide more comprehensive offerings that go beyond the traditional product, e.g. by providing various services including maintenance. Second, specialized maintenance companies are enlarging their offerings from basic operations to cover more complex maintenance

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processes. A maintenance customer often uses both of these types when outsourcing the maintenance function. Hence, a network of maintenance providers takes often part in maintaining a particular site. This can be regarded as *networked maintenance offering* from the customer's viewpoint.

B2B services have received growing academic attention but the lack of further studies is still acknowledged (Ostrom et al. 2010). Moreover, services networks (e.g., Henneberg et al. 2013) have been studied mainly in the B2C context (e.g., Morgan et al. 2007). Also, extant literature on offering concept (e.g., Ulaga and Reinartz 2011) points out the variety of different elements. Hence, we acknowledge the importance of context when studying the concept of offering. The scarcity of studies on maintenance offerings, with few exceptions (see e.g., Stremersch et al. 2001) demonstrates a research gap on this area. Lastly, maintenance related research has focused mostly on technical issues and studies regarding the management of maintenance service are yet quite scarce.

Accordingly, our research aims to analyse the current maintenance operations within seven case companies and to develop a networked offering framework. This framework is aimed to help to understand the complexity of service networks, which is one of the Henneberg et al.'s (2013) service network research agendas. The study contributes to B2B service and network literatures by answering to the following research questions: (1) How maintenance is currently managed? and (2) What could be the role of networks in industrial maintenance?

2 Industrial Maintenance

Traditionally industrial companies have had quite massive maintenance departments. Maintenance has been seen merely as a necessary expense and its status and role is not highly recognized among companies (Alsyouf 2009). Alsyouf (2009) argues that maintenance strategies, functional organizational structures, top management support, and impact on performance should be highlighted when developing maintenance as a part of overall manufacturing and corporate strategy. However, operation efficiency, quality and effectiveness are all consequences of proper maintenance practices that together contribute to overall business performance (Alsyouf 2009). Regarding to different maintenance strategies, Swanson (2001) suggest three different approaches; reactive, proactive, and aggressive. In the era of harsh competition and tight process schedules, industrial companies cannot count on reactive strategies, which result in massive costs and time losses compared to a more planned maintenance strategy.

Instead of developing maintenance internally, many industrial companies have outsourced their maintenance function, which has created a new market for maintenance services (see e.g., Muchiri et al. 2011). To satisfy the need, often the

outsourced maintenance unit has been established as an independent maintenance company (see e.g. Hatinen et al. 2012). On the other hand, also equipment providers are eagerly developing their offerings to cover more and more services including maintenance. Thus, maintenance practices of a plant can be performed by the plant (customer) itself, an equipment provider, or an independent maintenance company. Nowadays at industrial plants, maintenance is usually done by combining these options. A customer and an equipment provider can agree on sharing the maintenance practices together or a maintenance company can take an integrator role and provide all maintenance services. Thus, the customer believes that there is a chance for added value from a new kind of network model.

Offering means the variety of goods and services a company can deliver, it explains both what and how for the customer. Shepherd et al. (2000, p. 101) argue that instead of increasing different service elements in an offering, companies should develop their integrating capabilities and change business models—and become more customer centric. Our aim is to understand different maintenance actors and their offerings that exist in industrial maintenance arena. In the following, we examine the offerings from both the equipment providers' and the maintenance companies' perspectives.

Equipment providers have long traditions for offering basic service, such as spare parts and warranties, with their products. However, they have quite recently developed more strategic service elements to differentiate their products. Industrial offerings have shifted away from product-centric with customer ownership and only supporting services to value co-creating and sharing solutions for customer's specific challenges (see e.g. Kindström and Kowalkowski 2009). Many equipment providers see services as a tool for ensuring long term customer relationships where different kinds of operating agreements are the key element. Their offerings form a continuum (see e.g. Penttinen and Palmer 2007) of services from less binding training services to closer operational relationships, in which the provider might even own the customer's operation facilities. Often, the services are mainly focusing on the specific equipment provided. This is due to the background of the companies, usually their businesses have started with products and the services are heavily bounded to these products. Although equipment providers may have made a clear strategic choice towards operation agreements, but due to their background, the development of turnkey offerings has shown to be quite an obstacle (Tuli et al. 2007).

Maintenance companies often root from the discontinued maintenance departments, with few exceptions. These companies are offering usually a variety of maintenance services. There are mainly two types of maintenance companies. Some maintenance companies are highly focused with in-depth knowledge on few specific services, while others offer turnkey maintenance solutions by acting as an integrator towards the customer. These maintenance contracts cover the needed practices in order to avoid production downtimes. However, in some cases the maintenance company handles only customer's auxiliary equipment.

3 Services Networks

Business-to-business services have had significant growth worldwide but the area is still quite underrepresented in service research (e.g. Kunz and Hogreve 2011; Ostrom et al. 2010). Furthermore, as industrial business actions are often formed by a web of multiple actors influencing each other, it is essential to examine also services from a networked perspective. This perspective has also been the topic of a recent special issue in the Industrial Marketing Management (see Henneberg et al. 2013). While competition gets tighter, companies have to collaborate more intensively to be able to meet their customers' needs more effectively and efficiently (Bititci et al. 2012, 2004).

In their article, Henneberg et al. (2013) offer a sort of conceptualization for services network. Their view of services networks involve three layers or dimensions of services networks; first, second, and third order, representing "different intensities of possible service network constellations" (Henneberg et al. 2013, p. 5). While the first order of services networks depicts relationships with more traditional services elements, the second order of services networks carries on the relationship to a deeper level by focusing on solutions which combine products and services more seamlessly. The third order of services networks can occur when the emphasis shifts from products to services as the main contributor of value in offerings. Maintenance offerings can vary within this scale. When an equipment provider takes fully care of the plant, meaning a sort of operation or even leasing plan, and utilizes a network of partners, then maintenance can be a part of third order service networks. However, usually maintenance networks are best described as first or second order services networks.

Ahonen et al. (2010) acknowledge the lack of methods, models and practical business scenarios within maintenance service networks. They propose a type of consortium, maintenance community, to orchestrate maintenance operations in a given plant. In this model, deeper relationships are tied in order to orchestrate the maintenance practices as efficiently as possible. The partners share common development targets and objectives.

4 Research Method and Data

We conducted a classic qualitative case study (Dyer and Wilkins 1991; Yin 2009) with a dialogue between data and theory (see e.g. Eisenhardt and Graebner 2007). We focused on seven Finnish case companies. Among these companies, there are three types of maintenance actors; customers (plants), equipment providers, and maintenance companies. Altogether, nine interviews were conducted, of which four were persons from equipment manufacturers (three separate companies, cases A, B, and C), two from maintenance companies (cases D and E), and three from customer companies (cases F and G). Eight of the interviews were face-to-face, while one

interviewee submitted his answers via email. Interviews were tape-recorded and transcribed for qualitative analysis.

Case A is an equipment manufacturer that offers contract-based maintenance on their own equipment. Their main driver for offering maintenance contract is long-lasting and closer customer relationships during various economic cycles—but also lowered profits from product business. Service business provides also knowledge on how their equipment performs in real life. They see short response times and geographical closeness as their strength. Case A offers different maintenance packages with highly varying content from basic operations to tailor made expert services. In their way, the content of maintenance agreements needs to be strictly negotiated with clear responsibilities. Case A sees challenges in the current business environment, where they often do not possess a straight connection with the customer but need to communicate through separate maintenance companies. This affects information flow on how well the maintained process is actually operating. Case A is developing their services towards an outsourced model, where they would took responsibility of a certain customer process, offering capacity instead of products through a lifecycle service. Case A would like to have a transparent networked model, where the customer has direct connections to each actor. Their responsibilities would be on special equipment knowledge, whereas a maintenance company would take care of basic operations. However, they see that the customer selects the model and they adapt to it. Case A sees contractual aspects as a major key to the success of a networked maintenance model. Transparent operations and clear responsibilities with straight connections among different network partners. However, they fear that if the needed openness level would be reached, the knowledge tranfer would soon make some actors useless some actors useless. Also, current customer's buying procedures often restrict innovative forms of maintenance services—it often neglects the longer perspective but concentrates on more transactional short term value.

Case B, a large equipment manufacturer, has developed its maintenance services heavily during the last decade. Their massive organization structure has made the development quite a challenge, but the reasons are familiar: longer customer relationships and smoothening the business cycles. Case B offers as extensive maintenance as the customer demands on their own products. Being a global provider, a major challenge has been to find well-trained work force. Also, their complex palette of different products and services has made the sales phase difficult. Regarding the networked maintenance model, case B sees challenges in contractual agreements and responsibilities—and how the costs and profits should be divided. Opening the books seems too difficult with multiple actors involved.

Case C is an equipment manufacturer that has developed its service operations from repairs to full scale maintenance on their own equipment. They see maintenance as a prerequisite for a successful equipment provider, it provides steady income in turbulent business environment but also enhances customer satisfaction and reputation. The challenge is in ever growing complexity and extent of maintenance operations—it has shown to be difficult to develop the business model and service organization enough before the actual commitment. However, they see that

customers are willing to outsource maintenance more and more extensively. Reasons for this are focusing on core competences, enhancing cost efficiency, retirement of skilful employees, and the grown complexity of modern process equipment. Case C sees that networked maintenance is challenging mainly due to self-centred reasons: sales profits are difficult in a network setting where each actor aims for largest possible share. Also, network level monitoring and development is largely missing. To function, a networked maintenance model would need a strong leader as well as clear division of responsibilities among network actors. Furthermore, willingness to collaborate with each other is a key element.

Case D is a maintenance service provider that was established from an outsourced maintenance function in the beginning of 1990s. It operates mainly locally, doing basic maintenance tasks based on unwritten verbal agreements. Their offering is based on tasks fulfilled through manual labour, they do not offer e.g., planning services. A particular feature has been that their customers are buying personal skills and knowledge rather than a service. Often, a single workman can affect to who will win a maintenance deal. However, they do offer entities that might require subcontracting. They see that maintenance could benefit from more comprehensive agreements framing clearly the mutual goals for all the participants. Lack of information and unclear goals often leads to unnecessary work during maintenance operations. Case D would like to participate closer with their customers' maintenance planning and development. Furthermore, they see that different functions, such as financing and technical, should communicate better with each other. Through better communication, the long-term benefits could be better managed. Regarding future developments, case D believes that maintenance will be managed through close partnerships, if not reverse outsourced back to the plants. Extensive maintenance collaboration among multiple actors each focusing on their core skills interests. However, attempts towards it have proven to fail, mainly because of disagrees on financial issues. With appropriate measurement tools, open books and extensive agreements, a networked maintenance, with clear responsibilities, could be an effective business model. In general, case D sees that maintenance is undervalued—without a major mind-set change regarding maintenance development, customers' process equipment can wear out faster than planned.

Case E is a full maintenance service provider with an extensive offering covering e.g., productivity, cost efficiency, EHSQ (environment, health, safety and quality), and change leadership. The company operates in several countries and has focused on developing different modules or maintenance products. These modules are then selected and used depending on the particular customer need. They strive for open collaboration with their customers with strictly defined maintenance goals. Initial customer negotiations are done with care to ensure mutual understanding of the needs and wishes. During negotiations, it is essential to address your message to a right respondent. This highlights that maintenance cannot be taken as an expenditure, it rather reflects to the overall performance of a customer's industrial process. Also, the more the customer's processes are defined, the better maintenance can be planned and performed. Case E has also developed internal protocols and reporting systems for different tasks to ensure steady quality. Their customer base is

extensive, through which they have learnt that customers' expectations differ a lot. Depending on the customer case, company E leads the maintenance, is an equal partner, or acts as a subcontractor. They see that the maintenance model should be adaptive to customer needs where the most suitable partners perform maintenance operations as a network. While case E has focused on developing maintenance concepts, a general challenge regarding customers is a mind-set change—how to update maintenance from a mandatory cost to a process enhancing service.

Case F is an industrial supplier operating in mining industry with eight sites in Finland. The sites use external maintenance services varyingly, some even do maintenance fully in-house. Developing maintenance is still in its early steps because measuring the results is not systematic, meaning weak comparison ability among their sites. One reason for this is the multitude of different monitoring systems used among companies. Mutually negotiated goals and compatible systems is seen as a main key for better maintenance. For a maintenance service provider, case F expects that the price is in line with quality. Also, previous experiences regarding e.g., scheduling, additional pricing, and quality are decisive. Besides own opinions, they use general purchasing criteria. However, even lower quality in line with price is acceptable if it does not compromise the maintained process. On the other hand, in more demanding tasks the maintenance is often acquired based on individual persons, even though they might have changed the employer. As a challenge, they see limited resources—often many sites have their yearly shutdowns simultaneously. Also, more detailed plans would benefit the site in organizing the maintenance as a whole. This would help also the change towards network-based maintenance. Case F sees that it would be better to have multiple partners instead of a giant one. They emphasize the importance of choosing right partners through common values. Furthermore, a common goal for developing the maintenance should be set. One form of operations was presented—a sort of industrial cluster through which geographically near actors would organize the needed maintenance.

Case G is a large supplier in the energy sector. For them, a producer of energy and heat, reliability is essential. They have outsourced around 80 % of their maintenance to a wide array of different service providers. Usually, they have own contracts with all individual providers. An issue that was raised here relates to efficiency. How can one measure how efficiently maintenance is done? To outsource this dilemma, a different kind of business model could be used: buying capacity instead of hourly-feed based services. A challenge here is to understand what is needed and what it would mean. Hence, maintenance-based knowledge on their processes as a whole should be increased and based on that different maintenance concepts developed. Case G would like to preserve an overall view on the maintenance in-house, but is eager to move towards networked maintenance management. However, greed is seen as a challenge for optimally operating a networked model. A mind-set change is needed to overcome the competition between maintenance operators—not only for companies but also for individuals. Another option would be to outsource large entities for a single operator, who then builds the needed network.

Table 1 Summary of the case data

Case	Type	Motivation for maintenance development	Network model requirements
A	Equipment provider	Feedback on products, new business opportunities, long-term customer relationships	**Transparent** network, direct connections among members, **clear responsibilities**
B	Equipment provider	Long-term customer relationships, smoothening the business cycles	Well-planned contractual **agreements** and responsibilities, agreed **division** of costs and profits. **Open books** too difficult.
C	Equipment provider	Steady income, also enhances customer satisfaction and reputation	From self-centricity to **collaboration**—clear division of profits, network level **monitoring** and development, a strong **leader**
D	Maintenance company	Established from an outsourced maintenance function, local kiosk for maintenance	Appropriate **measuring**, open books, **shared mindset** on mutual goals, **open communication**
E	Maintenance company	How to update maintenance from a mandatory cost to a process enhancing service	**Adaptive** to a customer need, **mindset change** from a cost to a process enhancement
F	Customer	Low maintenance development skills	**Mutually** negotiated goals, efficient **resource distribution**, **local network**
G	Customer	Increasing the maintenance-based knowledge on their processes	**Overcoming greed**, mindset change

Table 1 summarizes the motivations for developing maintenance as well as the requirements for a networked operation. Next, we move on to propose how maintenance could be orchestrated in the future.

5 Maintenance—Present and Future

The current maintenance field is quite scattered, e.g., companies buying maintenance use different approaches in different sites. While one site might be fully outsourced, others are still maintained in-house. This highlights that maintenance as a function is still a bit underdeveloped. In many cases, respondents see that there is room for more comprehensive measurement and new kinds of business models in maintenance. A common problem seems to be how to measure what is the most effective way for a certain maintenance task. Also, communication is seen as a challenge. In cases where there is one main contractor, the subcontractors feel their role too distant towards the end customer. In these settings, mutually beneficial development can be difficult to perform, while the main contractor blocks the

communication. As a result, maintenance development still lags behind compared to other business functions. Maintenance is still considered as an obligatory cost instead of part of process optimization.

Currently there are four categories of maintenance providers. First, the in-house maintenance is still in place in many sites, even thought it might not perform the most demanding tasks. The general comment from all the respondents was also that at least some level of knowledge should be maintained in-house in the future. Second, there are equipment providers that have expanded their product business towards service. Usually they offer specialized maintenance for their own products, but can as well serve as a main contractor. Third, there are mainly locally operating maintenance companies, which are often established as an outsourced maintenance function. Their main responsibilities are within general maintenance. The fourth category are maintenance companies that cover geographically wide areas. While these are low in number, they are considerably larger size-wise. Also, they have usually put effort on maintenance development. As a downside, while having functioning concepts and business models, these companies are somewhat restrained resource-wise. Maintenance is massively labour intensive, which restricts the growth in some extent.

The main challenges that restrict maintenance development, based on our case evidence, were insufficient measuring, lack of development, lack of mutual trust, lack of communication, timing problems for larger maintenance breaks, and a primitive mind-set in understanding and organizing maintenance. Hence, we would like to suggest two different business models for organizing maintenance in industrial settings: *a capacity-based maintenance* and *a locally networked maintenance framework*. The first option would be optimal for companies that have let go most of their maintenance personnel and lack a will and/or knowledge on efficient maintenance operations. Here, two options prevail (see the roles in Table 2). An equipment provider could offer a capacity deal instead of plain hardware when new investments are made. This way the equipment provider puts the needed network together but the customer communicates only with the main contractor. Also, especially with current machinery a suitable maintenance company could offer a capacity agreement, where they would take the responsibility of the whole process. As a downside, while simpler, the main contractor model might be more expensive for the customer.

Table 2 Possible roles within two maintenance models

Maintenance model	Customer	Equipment provider	Maintenance provider
Capacity-based maintenance	Participant bystander	Integrator/capacity-based investment sub-contractor	Integrator/capacity agreement
Networked maintenance	Integrator participant	Integrator participant—core equipment	Integrator participant—auxiliary equipment

However, our data suggests that a single service provider is rarely the optimum case for maintenance. Often, maintenance companies have certain key competencies but lack knowledge on other areas. Customers are aware of this. With multiple actors, key knowhow on different systems could be better utilized. Due to these characteristics, we propose a locally networked maintenance framework which benefits all the parties within the maintenance network. Within a locally established maintenance network, actors share their key competencies, individual needs, scheduling information, etc., in order to outperform the traditional way of individual maintenance operations. Also, the local network could have several customer sites in it. Many customers have their yearly shutdowns simultaneously, which causes momentary lack of maintenance workforce. A smarter way for organizing maintenance operations locally could enhance the timing challenges.

The aim in networked maintenance is to develop a setting where the added value is distributed evenly enough for the whole network. The main question is that which maintenance practices would be performed by which actor. This leads to different roles actors can possess, see Table 2. One of the key issues when developing a maintenance network is forming of mutual trust and commitment across network participants. Companies need to work closely together to find the most profitable setting for every participant. Quite unusual way to accomplish this could be that the participants open their books to reveal cost structures and value creating potential to each other (see Grönroos and Helle 2010, 2012). By doing this the network can then organize itself so that the value is maximized and shared between participants in an acceptable manner. Furthermore, a networked model could be first piloted for a sub-process within customer's processes. This would allow the operations to develop before launching a networked maintenance model to the whole process. As a conclusion, the networked maintenance model requires a notable change in the mind-sets of each actor. Instead of individual companies developing comprehensive maintenance offerings, a networked offering with multiple actors concentrating on their core competencies could result in a better outcome.

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