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Maaren Ali-Marttila

TOWARDS SUCCESSFUL MAINTENANCE SERVICE NETWORKS – CAPTURING DIFFERENT VALUE CREATION STRATEGIES

Thesis for the degree of Doctor of Science (Technology) to be presented with due permission for public examination and criticism in the Auditorium 2310 at Lappeenranta University of Technology, Lappeenranta, Finland on the 28th of June, 2017, at noon.

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ABSTRACT

Maaren Ali-Marttila

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The field of industrial maintenance management is evolving constantly, as the trend of servitization and outsourcing of support services affect maintenance operations. In-house maintenance organizations have moved at least partly towards inter-organizational relationships in different company networks (consisting of customer companies, service providers and equipment providers). Hand in hand with structural change, new value-creating opportunities have emerged. Equipment providers enter the service market more and more often to level out cyclical changes in equipment sales. In addition, an increasing number of companies that focus primarily on maintenance services have entered the market (often as a result of outsourced in-house operations).

The purpose of this thesis is to clarify the nature of maintenance service value and capture the different value creation strategies in service networks. First, the study identifies what the value creating elements and features in industrial maintenance services are. Second, the study explores how maintenance service operations are currently managed. Thirdly, the thesis studies what the prerequisites for successful maintenance service networks are. The thesis employs the mixed methods approach where both quantitative and qualitative methods are used in the empirical part of the research. The survey method is utilized for quantitative data collection in order to decipher the complex nature of maintenance service value. After quantitative analysis, a qualitative case study is used to explain the identified value creation strategies and the role of networks in value creation further.

The findings of this thesis indicate that successful maintenance service networks are created stagewise by utilizing comprehensive value creation capabilities. The thesis offers three main contributions to the field. First, it presents a framework for successful maintenance service networks where different value creation strategies at different relationship and offering levels in maintenance service networks are identified. Second, it provides a multidimensional value construct where the comprehensive value of maintenance services is presented. Thirdly, the findings highlight that non-financial value elements become critical when aiming at more collaborative maintenance service networks.

Keywords: maintenance management, maintenance services, service value, networks, value creation, collaborative relationships

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This is the most fun but also hardest part to write as there are so many people to thank. Finalizing this project has been teamwork, and therefore my sincere thanks go to all the colleagues, friends and family who have helped and supported me during these 3+ years.

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As most of the empirical data in the thesis was collected during a research project funded by the Finnish Funding Agency for Innovation (Tekes), I would also like to thank all the different stakeholders for their financial support and project participants for the interesting discussions. Special thanks go to the persons I interviewed in the case companies for their time and contribution to the project. I would also like to thank the Erasmus+, Finnish Doctoral Program of Industrial Engineering and Management, and the Research Foundation of Lappeenranta University of Technology (Lappeenrannan Teknillisen Yliopiston Tukisäätiö) for their financial support that allowed me to do research and travel in Sweden, Denmark, the Netherlands, the UK, and China.

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Danke Mama. Kiitos Iskä. You both have taught me that nothing is impossible.

Lappeenranta, June 2017

Maaren Ali-Marttila

It is time for a new adventure.

TABLE OF CONTENTS

LIST OF PUBLICATIONS

This thesis is based on the following publications. The rights to include these publications in this thesis have been granted by the publishers.

Publication 1

Ali-Marttila, M., Tynninen, L., Marttonen, S. and Kärri, T. (2015), 'Value elements of industrial maintenance: verifying the views of the customer and service provider', *International Journal of Strategic Engineering Asset Management,* Vol. 2, No. 2, pp. 136-158.

The author was responsible for conducting the analyses, drawing the conclusions, and writing the article. The co-authors were involved in designing the research, data collection, and the writing process. The main author took primary responsibility for revising the paper during the peer review process. The paper was accepted based on a double blind review of the full paper.

Publication 2

Ali-Marttila, M., Saunila, M., Marttonen-Arola, S., Kärri, T. and Pekkarinen, O. (2017), 'Understand what your maintenance service partners value', *Journal of Quality in Maintenance Engineering,* Vol. 23, No. 2, pp. 144-164.

The author was responsible for conducting the analyses, drawing the conclusions, and writing the article. The co-authors were involved in designing the research, data collection and analysis. The main author took primary responsibility for revising the paper during the peer review process. The paper was accepted based on a double blind review of the full paper.

Publication 3

Pekkarinen, O. and Ali-Marttila, M. (2016), 'Managing Industrial Maintenance – Networked Model', in Koskinen, K. T., Kortelainen, H., Aaltonen, J., Uusitalo, T., Komonen, K., Mathew, J. and Laitinen, J. (Eds.), *Proceedings of the 10th World Congress on Engineering Asset Management (WCEAM 2015),* Lecture Notes in Mechanical Engineering, Springer, ISBN 978-3-319-27062-3, pp. 459-469.

The author was a co-author, who was jointly responsible for collecting the data and analyzing the results. The research was jointly designed, and the author took primary

responsibility for revising the paper during the publication process. The paper was accepted for conference proceedings based on a peer review of the full text.

Publication 4

Ali-Marttila, M., Marttonen-Arola, S., Ylä-Kujala, A., Ukko, J., Rantala, T., Sinkkonen, T., Pekkola, S., Saunila, M., Pekkarinen, O. and Kärri, T. (2016), 'Stagewise Process Towards Collaborative and Value-Driven Decisions in Maintenance Networks', in Koskinen, K. T., Kortelainen, H., Aaltonen, J., Uusitalo, T., Komonen, K., Mathew, J. and Laitinen, J. (Eds.), *Proceedings of the 10th World Congress on Engineering Asset Management (WCEAM 2015)*, Lecture Notes in Mechanical Engineering, Springer, ISBN 978-3-319-27062-3, pp. 41-50.

The author was responsible for conducting the analyses, drawing the conclusions, and writing the publication. The research was jointly designed, and the co-authors were involved in the data collection and the writing process. The main author took primary responsibility for revising the paper during the publication process. The paper was accepted for conference proceedings based on a peer review of the full text.

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

The first chapter presents the background and motives for the research by discussing the development of industrial maintenance services and the actors' interest towards value creation in business and in the academia. After this, the identified research gap and the objectives and research questions are presented, followed by the scope and structure of the thesis.

1.1 Background and motivation

Industrial maintenance management has had a paradigm shift from a cost-centric view towards a more value-centric perspective, where maintenance is not only considered as a cost factor but also as something that can create value (Liyanage and Kumar, 2003; Parida and Kumar, 2006; Pintelon and Parodi-Herz, 2008). In addition, the trend of servitization and outsourcing of support services have affected the maintenance field. In-house maintenance organizations have moved at least partly towards partnerships in different company networks where the actors (i.e. customer companies, service providers and equipment providers) operate (Ahonen et al., 2010; Riis et al., 2007). Maintenance networks are evolving actively, and the aspects of service and relationship are now a common part of maintenance. New value-creating opportunities have emerged hand in hand with structural change. For global equipment providers like Wärtsilä and Konecranes, the service portion counts already for a significant part of the turnover (approx. 40%), and the share keeps increasing also for other major equipment providers like Cargotec, Metso and Valmet (Annual reports, 2016).

"Business Area Service continued to grow its contract base and improve profitability during 2015" (Konecranes, 2016, p. 6)

In addition, an increasing number of companies that focus primarily on maintenance services have entered the market, e.g Efora, Maintpartner, and Botnia Mill Services. In Finland alone, maintenance services employ over 200 000 people, making it the third biggest industry field (Finnish Maintenance Society, 2007).

To be able to capture the emerged value and improve the competitiveness of maintenance service relationships and networks, it is essential for organizations to gain mutual understanding of what the value creating elements in the services are, so that benefits like performance efficiency and reliability can be achieved (e.g. Barry and Terry, 2008; Ojanen et al., 2012A; Ulaga, 2003). Mutual understanding helps to avoid disagreements, lack of quality and sub-optimization between the service partners, and to highlight the positive effects of service collaboration instead. Better understanding of the value elements also helps to improve future service offerings (Klanac, 2013).

The value of maintenance services consists of a wide range of different elements, and it is often very case-specific and in addition diverse for different companies (Toossi et al.,

2013). This makes the identification of the overall value complex, and despite the increasing interest towards the value-centric perspective, the relationships are still in many cases very price-oriented. Industrial customers are more accustomed to evaluate the price than value (Töytäri and Rajala, 2015). When there is uncertainty about the value creating elements, the choices are based on the most certain and explicable element, the price (Anderson et al., 2000). In other words, high uncertainty in the value potential often makes the customer favour low-priced offerings (Keränen, 2014). This can lead to short sighted decisions that can be quite problematic, as many of the benefits in maintenance are created over a long term. For example, when considering the more complex service offerings, relationship learning enabled over the long term is an important part of value creation (Kohtamäki and Partanen, 2016).

Systematic ways to understand and measure what maintenance service value is for each actor are needed, as this would help the building of credible service offerings and realize the long-term value potential through sustainable and successful relationships (Ahonen et al., 2010; Panesar and Markeset, 2008; Reinartz and Ulaga, 2008). To capture the comprehensive value of maintenance services, both financial (e.g. price, cost savings) and non-financial elements (e.g. trained labour, willingness to cooperate, reputation, safety) need to be viewed (Liyanage and Kumar, 2003; Ojanen et al., 2012A; Toossi et al., 2013). However, so far the comprehensive service value of maintenance has been a rather rare topic in scientific studies, as maintenance-related research has focused primarily on technical issues and tactical and operational planning by improving the implementation aspect of the process with for example better planning, scheduling and controlling (e.g. Crespo Márquez, 2007; Pintelon and Parodi-Herz, 2008). The need for a holistic and more strategic perspective on the value creation process has been identified, and further research in the area is needed (Kans and Ingwald, 2016).

In parallel with the trend towards servitization, new value creating possibilities have emerged through the network setting, but they are somewhat hidden. Service networks (e.g. Henneberg et al., 2013) have been studied mostly in the business-to-consumer setting (e.g. Morgan et al., 2007), and also studies on maintenance offerings are still quite rare, with a few exceptions (see e.g. Stremersch et al., 2001). In addition, the existing methods and management tools are mainly used by single companies, as they rarely take the network setting into account. In the industrial context, a more comprehensive understanding of the role of networks in advancing value creation is still lacking. Novel views are needed to support collaborative decision making between the network partners (e.g. Ahonen et al., 2010; MacCarthy and Jayrathe, 2012; Panesar and Markeset, 2008). As Rekola and Haapio (2009, p. 122) state:

"Value is created in networks – and through collaboration"

However, how is the stated value achieved? There is a need to enhance understanding of the value creating elements in industrial maintenance services, and the role of networks in the process. This thesis addresses the identified research gaps by clarifying the nature

of maintenance service value, firstly by an examination of its elements, and secondly by providing insights into different value creation strategies[1] in the networked service context. The findings contribute to the value and industrial service development literature (e.g. Ahonen et al., 2010; Anderson and Wynstra, 2010; Liyanage and Kumar, 2003; Toossi et al., 2013) by providing a multidimensional value construct with the value elements of industrial maintenance services, and by proposing a framework where different value creation strategies in service networks are identified.

[1] The companies were categorized according to seven value elements that were considered to reflect their strategic view towards maintenance management.

1.2 The objectives of the study and research questions

The purpose of this study is to explore and understand different value creation strategies in maintenance service networks. The main objective is further divided into three research questions. Figure 1 presents the linkage between the research objective, research questions, and individual publications of this thesis. In addition, the corresponding research methods are addressed.

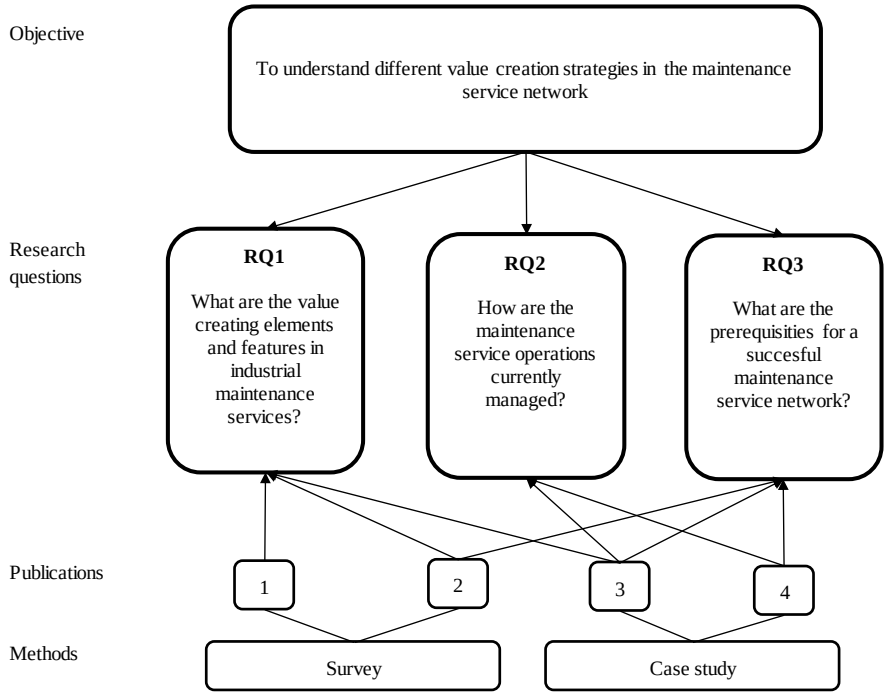

Figure 1. The research objectives, research questions and publications

The first research question (RQ1) is mainly addressed in publications 1, 2 and 3, which use the survey method and case study. The value creating elements and features in maintenance services are identified, and the differences between customers and service providers are analysed. In the service context, it is important to assess the value creating elements both from the financial and the non-financial side. The mentioned publications focus especially on the assessment of the non-financial side, as it is currently considered more complex by the customers and service providers (Toossi et al., 2013; Velmurugan and Dhingra, 2015).

The other two research questions focus on the role of maintenance service networks in advancing value creation. The second research question (RQ2) is addressed in publications 3 and 4 with the case study approach. The publications discuss the current management of maintenance services. Finally, the third research question (RQ3) is addressed in publications 2, 3 and 4, which use the survey and case study methods. In the publications, different prerequisites for a successful maintenance service network are identified. As the inference of the research, different value creation strategies are identified and captured in a framework (see section 4.6).

1.3 Positioning of the research

The focus of this thesis is on the intersection of three constantly evolving research areas: maintenance management, value creation and the development of service networks.

Industrial markets form the context for the research, as the empirical data has been collected mainly from industrial maintenance service networks where other industrial companies are considered as service customers. Another special characteristic of industrial markets is the installed base (e.g. production equipment) of the customers and its relatively long life cycles. While new investments are directed overseas, in Finland and in other western countries the maintenance operators often have to work with ageing capacity (Järviö et al., 2007). Maintenance services provide a stable source of contact for relationships, as they can be built around the existing installed base and are less affected by cyclical changes (Alajoutsijärvi et al., 2012; Ojasalo and Ojasalo, 2008).

Furthermore, the rapid technological progress has opened up new service opportunities in the industrial markets and the maintenance field. For example, cloud computing enables service concepts like monitoring as a service (MaaS) and platform as a service (PaaS) (Rittinghouse and Ransome, 2010). Referring to the data-information-knowledge-wisdom hierarchy presented by Rowley (2006), wisdom as a service (WaaS) is seen as the next developing service level after data as a service (DaaS), information as a service (IaaS), and knowledge as a service (KaaS), as DaaS, IaaS and KaaS encompass the majority of current information services. Alongside the new technologies, the new service opportunities have created buzzing discussions around the possibilities of "Industry 4.0" (Hofmann and Rüsch, 2017; Lasi et al., 2014; Upsani et al., 2017). This is also referred to as the fourth industrial revolution where new technologies and concepts like cyber-physical systems (CPS), industrial internet of things (IIoT), internet of services (IoS),

cloud computing and smart factories shift the existing manufacturing logic by enabling intelligent communication between e.g. products, machines, transportation systems, production facilities, humans and companies. However, in this thesis the more specific implications of Industry 4.0 and the new service opportunities are out of the scope. Instead, they are seen as future research opportunities, discussed more closely in chapter 5.3. The specific scope of the thesis is presented in figure 2.

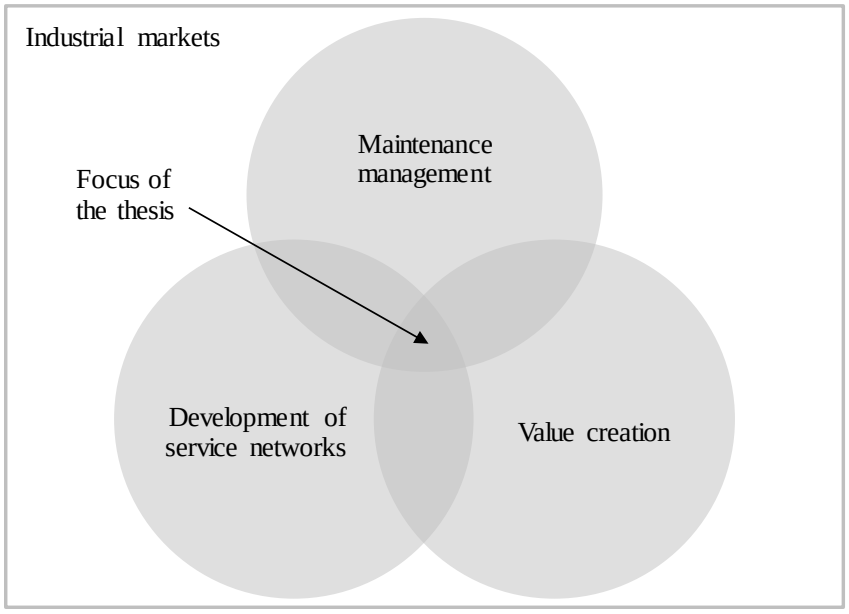

Figure 2. The scope of the thesis

Maintenance management is defined as "*all activities of the management that determine the maintenance objectives, strategies and responsibilities, and implementation of them by such means as maintenance planning, maintenance control, and the improvement of maintenance activities and economics*" (SFS-EN 13306, 2010, p. 9). This thesis focuses especially on the first part: setting the objectives for the maintenance strategy. The majority of maintenance-related research has focused on the implementation part of the management processes (e.g. scheduling) and technical aspects (e.g. fault detection, monitoring) instead on refining the strategic objectives, and further research in this area is needed (Crespo Márquez, 2007; Pintelon and Parodi-Herz, 2008). Furthermore, in this thesis industrial maintenance services are considered to be services that are developed and offered to tackle the various activities around maintenance management.

The literature has traditionally considered value as something that is created by one party and consumed by another (e.g. Anderson and Narus, 2004; Jaakkola and Hakanen, 2013; Mizik and Jacobson, 2003). This is based on a product-centric view and goods-dominant logic. Furthermore, value is often defined as the trade-off between the benefits and the

sacrifices delivered by an offering (Blocker, 2011; Ramsay, 2005; Zeithaml, 1988). The service-dominant logic has challenged the product-centric view, and the literature considers value increasingly as a jointly created phenomenon where the service is the focal point of value creation (Grönroos and Helle, 2010; Jaakkola and Hakanen, 2013; Vargo and Lusch 2008; Ulaga and Eggert, 2006). Furthermore, the servitization trend of equipment providers and outsourcing of support services have affected the maintenance field. Industrial companies have moved towards partnerships in different maintenance service networks, as the maintenance activities and repairs of in-house maintenance organisations are often partly or completely outsourced (Ahonen et al., 2010; Riis et al., 2007). In service networks, different actors such as service providers, original equipment providers and customers operate and contribute to the service offering (Gebauer et al., 2013; Henneberg et al. 2013; Kothandaraman and Wilson, 2001).

By bringing services to the centre emphasizes the role of also non-financial and intangible benefits and resources in relationships (Grönroos, 2001; Vargo and Lusch, 2006). Therefore, in this thesis service value is considered as a trade-off between benefits and sacrifices that can be financial or non-financial by nature, and this trade-off is achieved in interaction with one or multiple actors (i.e. service providers and customers). Value is created within the network by integrating the capabilities of different actors and enabling cooperation and interaction between them. However, in the industrial context a more comprehensive understanding of the role of networks is still lacking, as service networks have been studied mainly in the business-to-consumer context (e.g. Henneberg et al., 2013; Morgan et al., 2007). Novel views are needed to support decision making in the network setting (e.g. Ahonen et al., 2010; MacCarthy and Jayrathe, 2012; Panesar and Markeset, 2008).

1.4 Structure of the thesis

This thesis consists of two main parts. Part I provides an overview of the thesis, and Part II includes four individual publications, which describe the research in closer detail. Figure 3 shows the structure of the thesis, and the inputs and outputs of each chapter. The thesis starts with an introduction in chapter 1, which details the background and motives of the research, the identified research gap and the objectives and research questions of the thesis. In addition, the scope of the research is presented. Chapter 2 summarizes the theoretical background of the thesis, by presenting previous scientific discussion on the relevant topics in the scope of the study: maintenance management, industrial service networks, and value creation. Chapter 3 presents the methodological justification of the research by detailing the methodological choices, research methods, data collection, and analyses related to the empirical data of the thesis. Chapter 4 provides answers to the research questions by summarizing the research results and presenting the objectives and main findings of the individual publications. Chapter 5 presents conclusions of the thesis by discussing the research findings and their theoretical and managerial contribution. Also suggestions for future research directions are presented.

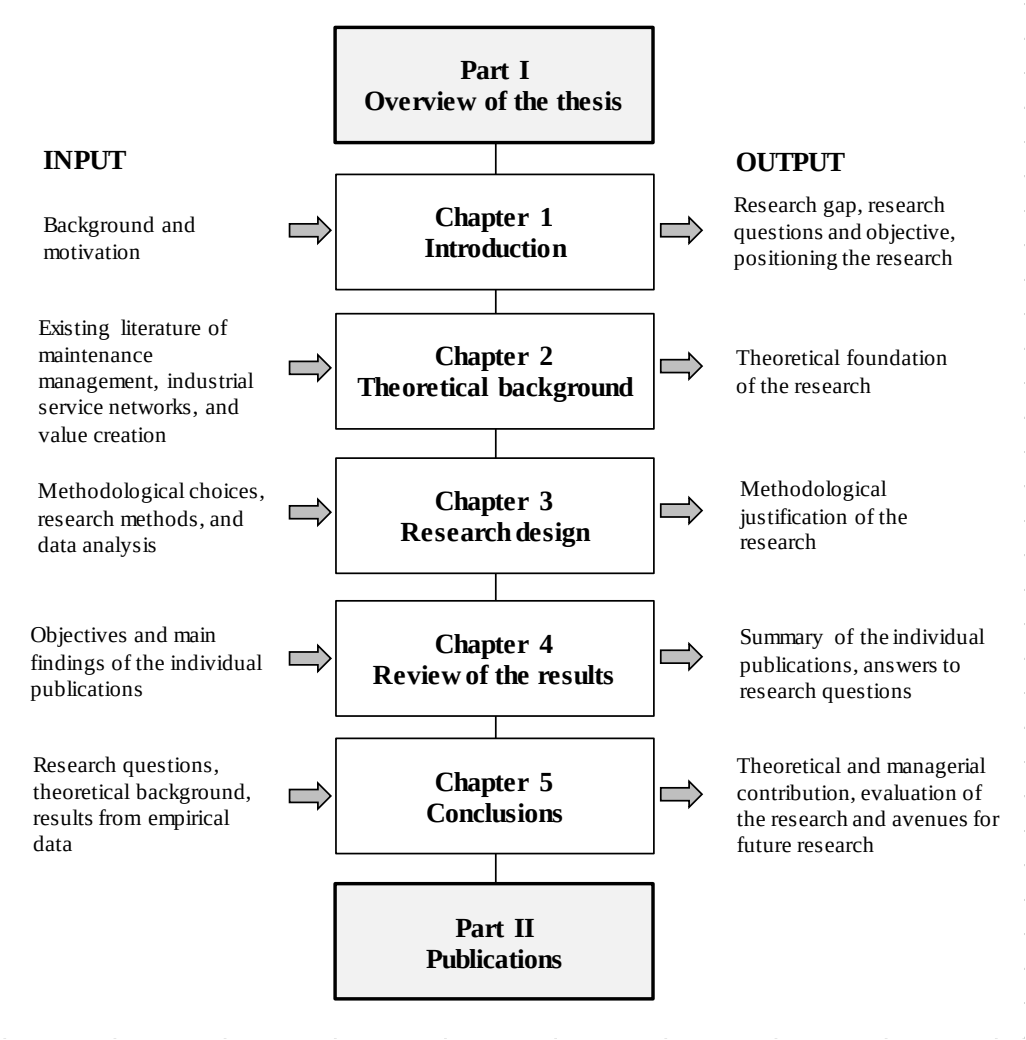

Figure 3. The structure of the thesis.

2 THEORETICAL BACKGROUND

The second chapter describes the research areas defined in the scope of the thesis: maintenance management, industrial service networks and value creation, and presents the theoretical ground for the research. The chapter begins with a description of maintenance management and its development. Also maintenance performance measurement is discussed. The chapter continues with the introduction and definition of the maintenance service network. In addition, different relationship and offering aspects and their development is presented briefly. Finally, the chapter presents concepts related to value and value creation in service relationships and discusses the theme specifically in the industrial and maintenance service context.

2.1 Maintenance management

Maintenance is defined as an activity that keeps or repairs the production items and other assets to the aimed operating condition and controls the environmental and safety risks actively (Järviö et al., 2007; Pintelon and Parodi-Herz, 2008; SFS-EN 13306, 2010). Furthermore, maintenance management is not constricted to technical actions, but it also includes other activities, such as planning and documenting (SFS-EN 13306, 2010).

Maintenance objectives are defined as targets assigned and accepted by the management and the maintenance department, and these targets may include for example product quality, cost reduction, availability, safety and environmental issues (Crespo Márquez, 2007; SFS-EN 13306). The selected maintenance objectives should derive from the corporate strategy and an overall business perspective (e.g. Crespo Márquez et al., 2009; Murthy et al., 2002; Pintelon et al., 2006; Velmurugan and Dhingra, 2015). In order to achieve the maintenance objectives, the responsibilities of maintenance management and the resources need to be defined. The responsibilities are normally divided between the in-house maintenance organisations and outsourced functions, including for example original equipment manufacturers (OEMs) and third party maintenance service providers (Crespo Márquez, 2007; Pintelon and Gelders, 1992). After the responsibilities have been clarified, more specific maintenance plans can be developed where the activities, procedures and the time scale required to carry out maintenance are more specifically defined (SFS-EN 13306). Planning can be further divided into strategic, tactical and operational planning (Pintelon and Gelders, 1992). In order to take the changes in the business environment and changing systems into account, the maintenance management strategy should be revised periodically. This enables continuous improvement and also the utilization of new techniques (Crespo Márquez et al., 2009; Waeyenbergh and Pintelon, 2002). The maintenance management process is depicted in figure 4. This thesis focuses especially on the first part presented in the figure: setting the objectives for the maintenance strategy.

Corrective and preventive maintenance are often also defined as maintenance management strategies (e.g. Pintelon et al., 2006), but here they are allocated under

tactical planning as different maintenance policies, however. Furthermore, widely used concepts like Reliability Centred Maintenance (RCM), Total Productive Maintenance (TPM) and asset management are defined as a set of maintenance interventions that provide a framework for maintenance planning, but they are not considered as independent maintenance management strategies (Velmurugan and Dhingra, 2015). In this thesis, strategy and management are discussed as more comprehensive constructs that influence the decision-making affecting maintenance plans and framework selection.

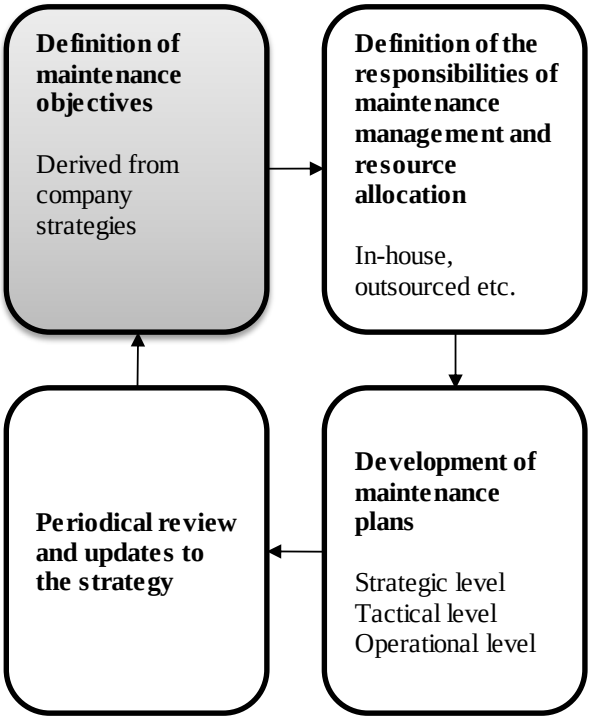

Figure 4. Maintenance management process

Maintenance management focus moving from cost to value

Traditionally, maintenance management has been viewed from a short-term perspective with the focus on issues like manpower and cost, and its role has not been recognized clearly in companies (Alsyouf, 2009; Duffuaa et al., 2002). The role of maintenance management has been changing, however, and long-term goals like sustainability and competitive advantage have been introduced as objectives of the management process (Duffuaa et al., 2002). The role has changed in tow with technology and development in business environments.

In the early 1900s, maintenance was considered a "necessary evil" that "costs what it costs", and the technologies and the management field were not yet very advanced (Parida and Kumar, 2006). Maintenance failures occurred mainly randomly. After the 1950, the technologies developed and new management methods like preventive maintenance and condition monitoring were introduced. This changed the cost-centric view to "it can be planned and controlled". Maintenance management evolved and it became an important support function. This development path has created a paradigm shift in maintenance management from a cost-centric view towards a more value-centric perspective. The strategic role of maintenance is supported in the literature (e.g. Alsyouf, 2009: Liyanage and Kumar, 2003; Parida and Kumar, 2006; Pintelon and Parodi-Herz, 2008; Velmurugan and Dhingra, 2015).

The top management in many companies also recognizes the effectiveness of proper maintenance management in ensuring success in business operations. However, the concrete link between business strategy and maintenance management is often still missing, as more focus is put on tactical and operational planning (Pintelon and Parodi-Herz, 2008). In practice the optimization of maintenance still often means the minimizing of cost in the short term instead of maximizing the value through long-term objectives and continuous improvement (Marais and Saleh, 2008; Murthy et al., 2015). Marais and Saleh (2008) argue that by focusing only on the short-term objectives and cost cutting, an important dimension of maintenance, value, is forgotten, and this can lead to sub-optimal maintenance management. Therefore, both sides: assessment of the benefits of maintenance and assessment of the costs of maintenance should be involved when determining the objectives for maintenance. A multidisciplinary view, where different parties, e.g. finance, operations and maintenance influence the assessment would ensure a comprehensive perspective (ibid.). Also Liyanage and Kumar (2003) promote the value-based view to maintenance. Optimizing maintenance solely from the cost perspective can lead to short-sighted decisions that can eventually add to the total cost. This happened for example when the offshore oil production platform P-36 sunk due to too ambitious cost saving efforts (ibid.).

Moving from the cost-centric view towards a more value-centric perspective also sets the focus from short-term operational planning towards long-term development goals. As Al-Sultan and Duffuaa (1995) and Parida and Kumar (2006) mention, supporting the competitiveness and profitability of the organization in the long term can be considered as one of the key functions of maintenance management. In addition, maintenance management is also a field that affects all three dimensions of sustainability, namely the economic, environmental, and social dimensions, and thus also influences corporate-level sustainability by creating/destroying (if organized badly) long-term shareholder value (Lo, 2010). Therefore, it is important to look at maintenance and its management not only as a plant-based cost centre, but from a long-term business-oriented and more strategic perspective (Liyanage and Kumar, 2003; Panesar and Markeset, 2008; Pintelon and Parodi-Herz, 2008). This way also the long-term benefits of appropriate maintenance (e.g. quality of work, availability, increased safety) can flourish and the business value can be optimized comprehensively in the long run.

Measurement of maintenance performance

Performance measurement is an important part of management, so that gaps between the current and the desired performance can be identified and motivation boosted (Meekings, 1995; Velmurugan and Dhingra, 2015). Swanson (2001) showed in his study that maintenance performance is greatly affected by how well the maintenance objectives and their measurement are aligned with the overall business strategy. Therefore, a well-designed maintenance performance measurement system is an essential part of management to support the decision making and achievement of business goals (Kutucuoglu et al., 2001). To enable powerful decision making, the performance measures need to be accurate and in line with the strategic objectives, up-to-date, forward-looking, and reliable, as well as present the information in an understandable way so that everyone can participate actively in the continuous improvement process (Crespo Márquez, 2007; Meekings, 1995; Muchiri et al., 2010). In addition, the number of indicators should be manageable, and focus on organizational learning and structural change instead of meaningless target-setting (Crespo Márquez, 2007).

However, the selection of appropriate measures for a specific case can in itself be a challenge, as versatile measurement listings are provided by the literature, but not much support in how to select the right ones (Muchiri et al., 2010). For example, the European Standard on Maintenance Key Performance Indicators (EN 15341) lists 75 different indicators including 24 financial measures, 21 technical measures, and 26 organization-related measures (CEN, 2007). Furthermore, standardized measures can be challenging to implement in an organization without previous experience in data collection and analysis (Stenström et al., 2013). Parida and Uday (2009) conclude that measuring maintenance is a complex phenomenon with multiple inputs, outputs and stakeholders. In addition, the service aspect of maintenance adds to the complexity of the measurement process, as intangible elements such as service quality, communication and convenience are involved (Toossi et al., 2013; Velmurugan and Dhingra, 2015).

The complex nature of maintenance measurement has also been acknowledged in practice, as the survey by Muchiri et al. (2010) showed that much of the data collected with performance measurement systems is not adequately used to support maintenance management. Furthermore, performance measurement is dominated by lagging indicators (focus on the achieved outcomes), and leading indicators (focus on the tasks that will lead to the expected outcome) are in the minority. Both are needed for successful management, but leading indicators can be considered even more important in maintenance as they can prevent unfavourable situations and enable proactive decisions (ibid.). The highlighting of lagging indicators is a common feature in management. Tsang et al. (1999, p. 698) conclude that "the majority of management systems are designed around short-term, control-oriented financial frameworks that are fundamentally tactical". Long-term goals, learning and change are often neglected in the measurement systems, and non-financial measures are often not connected to the strategic objectives and short-term action plans (op.cit.). In maintenance the measures are also often misaligned with the company's overall business strategy (Gelders et al., 1994; Crespo Márquez, 2007).

Rosqvist et al. (2009) suggest a value-driven maintenance planning approach (VDMP) to support the alignment of strategic objectives and maintenance measures. In the VDMP, a value-tree approach is used to define the strategic objectives. The performance measures can then be selected on the basis of the selected objectives. However, the framework is based on a single case study example, and further research is needed to refine the approach to a more generic model. As the study of Muchiri et al. (2010) showed, there is dissatisfaction towards the current performance management systems, and in addition to generic models, further understanding is needed to determine the ineffectiveness of performance management systems in maintenance and maintenance service relationships.

2.2 Maintenance service networks

To gain competitive advantage, many companies have outsourced their non-core functions to external service providers and are increasingly dependent on their supply networks (e.g. Cooper and Slagmulder, 1999; Kulmala et al., 2002; Möller et al., 2012). The trend to outsource has also affected maintenance management, and many industrial companies have outsourced their maintenance function at least partly (Ahonen et al., 2010; Al-Turki, 2011; Muchiri et al., 2011; Riis et al., 2007). This has created a new market for maintenance services, and in addition to independent service providers, also OEMs are eagerly developing their service offerings. In-house maintenance organizations have shifted towards partnerships in organization networks where the customers, equipment providers and service providers interconnect in direct or indirect relationships.

From the *customer's* point of view, the development of technologies has created increasingly complex assets, and the knowledge intensity of operations has grown. Maintaining the special resources, know-how, and skills in-house is not always profitable, and therefore outsourcing is a sought-after option in many cases (Al-Turki, 2011). Persona et al. (2007) list the motivation behind outsourcing as the following: focus on core functions (technology-related assets), business improvement through cost reduction and efficiency, and improving the performance of existing lines of business. Lorenzoni and Lipparini (1999) and Kremic et al. (2006) add flexibility and access to new markets, skills and latest technology to the list. In addition, sharing the risks, resources, knowledge, and R&D development (e.g. McDonough et al., 2006), as well as integrated solutions and full service concepts (Stremersch et al., 2001) can motivate organizations to purchase maintenance services from external service providers. However, outsourcing should be handled with care. Outsourcing of technical systems is often not as simple as it looks when considering it only as a row in the financial statement and making the outsourcing decision based on short-term cost savings.

Poorly managed outsourcing introduces also new risks to the organization (Campbell, 1995; Kremic et al., 2006). Benefits and cost savings are often overemphasized in the planning phase, and savings remain unrealized. In worst case examples of outsourcing, the overall costs have actually increased for the customer company. Other risks related to outsourcing are for example power shift and dependence on a certain supplier, knowledge

and competence loss, and issues related to the personnel and their motivation and morale (Bertolini et al., 2004; Kremic et al., 2006). Loss of cross-functional communication (Campbell, 1995) and efficient data management (Murthy et al., 2015) are also potential risks. Badly managed information can cause serious problems between the different parties of outsourced maintenance (Murthy et al., 2015).

From the *equipment provider's (OEM)* point of view, outsourced maintenance provides an opportunity to develop more strategic service elements to differentiate their products. Added services also provide more steady cash flows and increased customer satisfaction besides traditional equipment exchange (e.g. Johansson and Olhager, 2004; Kindström and Kowalkowski, 2009). Basic services, such as spare parts and warranties have traditionally been on the service portfolio of equipment providers. Lately also more value co-creating and solutions for the customer's specific challenges have been introduced e.g. performance contracts (see e.g. Kindström and Kowalkowski, 2009). Many equipment providers see services as a tool towards long-term customer relationships, and their offerings form a continuum (see e.g. Penttinen and Palmer, 2007) from less binding basic services to closer operational relationships. However, services are often still mainly focused around the equipment provided, and the development of turnkey offerings has shown to be challenging (Tuli et al. 2007).

In addition to equipment providers, there is also a growing number of medium and large sized *maintenance companies* that focus on offering a variety of maintenance services and are often specialized in outsourcing (Pintelon and Parodi-Herz, 2008). Many maintenance companies have their roots in discontinued maintenance departments, but there are also exceptions. Some of the actors are highly focused on in-depth knowledge with few specific services, while others offer maintenance service concepts with customized solutions e.g. to avoid production downtimes, as well as complete outsourcing contracts.

The network context of maintenance services provides a fertile ground for value co-creation by integrating the capabilities of different actors and by enabling cooperation and interaction between the actors. Collaborative agreements and partnerships can have positive effects on revenue in the manufacturing industry as e.g. knowledge and other intangible benefits are shared (Grönroos and Helle, 2010; Stuart, 2000). Companies have to collaborate more intensively to be able to meet their customers' needs, as competition is increasingly taking place between networks instead of single companies (Bititci et al., 2012; Muchiri et al., 2011). However, more comprehensive understanding of the role of networks in advancing value creation in the industrial context is still lacking, as service networks have been mainly studied in the business-to-consumer context (Henneberg et al., 2013; Morgan et al., 2007).

To start the discussion, Henneberg et al. (2013) provide a conceptualisation for services networks based on the business network and service systems literature. The view of Henneberg et al. of service networks involves division into three layers of service networks; first, second, and third order networks (see figure 5).

The first order service networks depict relationships with more traditional service elements that are related to product-based exchange, where the product offering is infused with additional services (e.g. spare parts, technical support) (Oliva and Kallenberg, 2003). The second order service networks focus not just on providing additional services, but combining the products and services more seamlessly to form solutions with new resources, activities and actors. Finally, the third order service networks can appear when the tangible aspects of the relationships became secondary and the service offering and knowledge creation become the main contributor of value in the relationship. The prerequisite for joint knowledge creation and third order service networks is a trusting and open culture between the actors (Dyer and Nobeoka, 2000; Möller et al., 2005). Based on case evidence (see publications 3 and 4), maintenance service networks are usually best described as first or second order service networks where services are provided as add-ons.

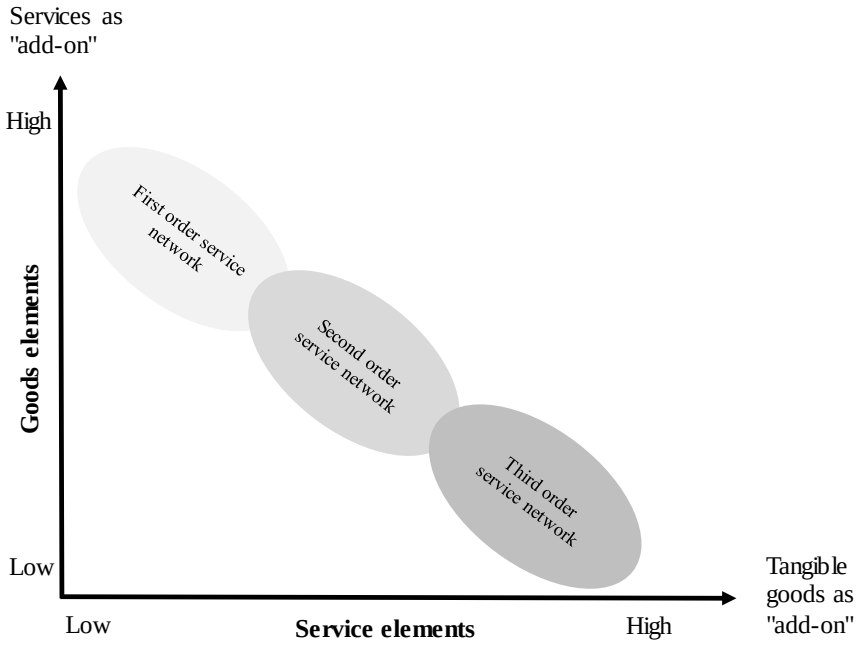

Figure 5. Conceptualization of service networks (Henneberg et al., 2013)

Regardless of the service network layer, each network is comprised of embedded and reciprocal relationships between the different actors, and thus the management issues in the network context can be quite complex (Ford and McDowell, 1999; Håkansson and Ford, 2002; Möller et al., 2005). Each network is unique and requires different management skills and organizational arrangements. As Möller et al. (2005, p. 1280) explain, one key aspect for an organization is to be able to "identify the roles, capabilities and goals of other important actors, and to modify one's strategy to match the network

situation". It all starts from being able to manage bilateral business relationships well before moving to the complex network setting with multiple actors and embedded relationships.

Relationships are often categorized according to the exchange behaviour and what features the partners highlight in the relationship. This exchange behaviour can be considered to form a continuum that has end points from transactional to relational exchange and full collaboration (e.g. Axelsson and Wynstra, 2002; Day, 2000; Lindgreen et al., 2012; Penttinen and Palmer, 2006). The main recognizable features of both perspectives (end points) are presented in table 1. Also here services and their role define the nature of the relationship as one feature.

Table 1. Transactional versus relational exchange (adapted from Axelsson and Wynstra, 2002 and Lindgreen et al., 2012)

Perspective	**Transactional approach**	**Relational approach**
Competition	Many alternatives	One or a few alternatives
Tactical focus	Every deal is a new business, no one should benefit from past performance	A deal is part of a relationship, and the relationship is part of the network context
Relationship attitude	Exploiting the potential of competition; anonymous and efficient market	Exploiting the potential of cooperation; numerous market networks
Time horizon	Short-term; arm's length, avoiding coming close	Long-term with tough demands and joint development
Renewal	Effective renewal through partner changes, choosing the most efficient supplier at any time	Effective renewal through collaboration and teamwork, combining resources and knowledge
Services	Buying "products". Services augment the core product	Buying "capabilities". Services are a basis for differentiation
Orientation	Price orientation, strong in achieving favourable prices in well-specified products	Cost and value orientation, strong in achieving low total costs of supply and developing new values

In transactional relationships, the focus is more on the tangible aspects, and services augment the core product, whereas in relational exchange services are the main contributor of value. Relationships based on full collaboration are still quite rare, and not

everyone has to even aim for them, as they require a great deal of mutual trust and can involve complicated contractual issues (Markeset and Kumar, 2005; Rekola and Haapio, 2009). Axelsson and Wynstra (2002) also discuss that sometimes losing the competitive side of the relationship can result in increasing the cost. It is often a challenge for the service providers to convince the customers of the value potential in integrated solutions (Jaakkola and Hakanen, 2013).

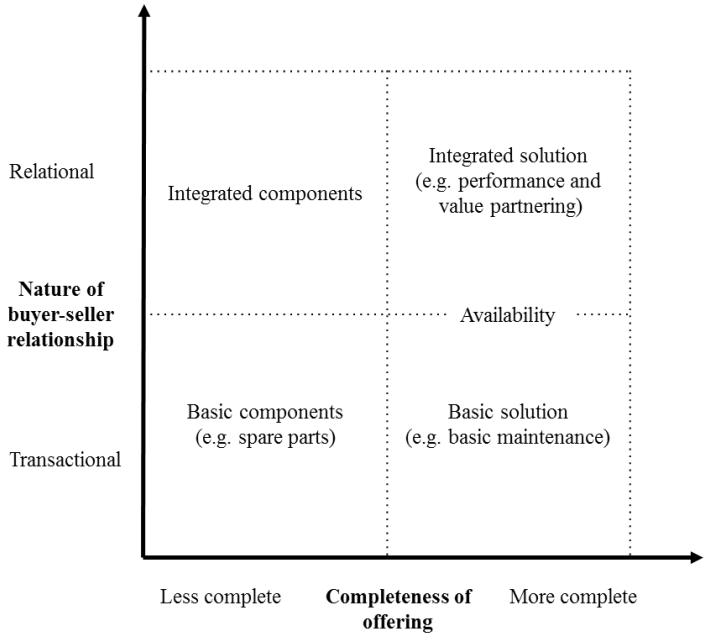

Figure 6. Development of the relationship and the service offering (adapted from Penttinen and Palmer, 2006).

The completeness of services can also be measured on a continuum from less complete (e.g. basic components) to more complete service offerings (e.g. integrated solution) (Oliva and Kallenberg, 2003; Penttinen and Palmer, 2006). The less complete offerings are often simple but also limited in differentiation for the customer. On the other hand, the more complete offerings are extensions in meeting customer needs, but they are also more complex on the relationship side and can require for example more extensive information exchange (Penttinen and Palmer, 2006). In maintenance services, the service offering also often ranges from less complete offerings like spare parts to a complete operation and maintenance contract, where the focus is on the business process and mutual value creation in the long term (Rekola and Haapio, 2009). In basic services the focus is on price and not on long-term contracts or relationship development (e.g. spare parts, basic maintenance). Extended basic services are similar to basic services but are based on a long-term contract (e.g. technical support). Rekola and Haapio (op.cit.) mention availability as the most popular form of maintenance service (full services/

outsourcing), where the focus is on preventive maintenance, and the relationship is based on a service contract (incl. services like maintenance, spare parts, training, and inspections). Maintenance services that would be among the more complete service offerings are performance partnering, where the focus is on OEE (overall equipment effectiveness), and value partnering, where the focus is on the customer's business processes instead of only maintenance. Both service offerings are based on long-term contracts and mutual service development, and will require intimate service relationships.

Based on the continuum of relationship development (from transactional to relational exchange) and the continuum of service offering development (from less complete to more complete), Penttinen and Palmer (2006) have constructed the framework presented in figure 6. The vertical axis describes the nature of the relationship, and the horizontal axis describes the completeness of the service offering.

Every box in the relationship and offering quadrat of Penttinen and Palmer (2006) can be successful, as long as the offering suits the needs of all parties, and the relationship status is on the required level. However, the more the focus is on the service side of the offering, the more the parties should focus on the relationship aspects and realized value (value-in-use) instead of focusing only on the potential value at the point of sales and price (value-in-exchange) (Grönroos and Helle, 2010).

Perceptions of the value created vary typically between individuals from different functions and from different companies, and therefore it is important to discuss and give feedback actively so that the value propositions can be revised, organizational learning can be enhanced, and resources assigned in the most profitable way (Lambert and Enz, 2012). The success of a maintenance service network depends on the actors' ability to collaborate (Bengtsson and Kock, 2000). Overall, in the core of successful relationships is a common view of the objectives, as well as trust and commitment between the actors (Anderson and Narus, 1998; Rosqvist et al., 2009).

2.3 Maintenance service value

The literature has traditionally considered value as something that is created by one party and consumed by another (e.g. Anderson and Narus, 2004; Jaakkola and Hakanen, 2013; Mizik and Jacobson, 2003). This is based on a product-centric view and goods-dominant logic. Furthermore, value is often defined as the trade-off between the benefits and sacrifices delivered by an offering (Blocker, 2011; Ramsay, 2005; Zeithaml, 1988). However, the service-dominant logic has challenged the product-centric view, and the literature considers value increasingly as a jointly created phenomenon in interaction between different actors (e.g. customer and supplier), where value is related to the benefits and solutions created at different relationship facets (Ballantyne and Varey, 2006; La Rocca and Snehota, 2014; Tuli et al., 2007; Vargo and Lusch 2008; Ulaga and Eggert, 2006).

Value creation can be considered to be reciprocal, and services work as a mediating factor in the business relationship (Ballantyne and Varey, 2006; Grönroos, 2011; Grönroos and Ravald, 2009; Jaakkola and Hakanen, 2013). Service is not just a change in the offering but requires also a comprehensive mind-set change by the actors, as service can be considered to be a perspective on value creation (Edvardsson et al. 2005; Lusch and Vargo, 2006). By bringing services to the centre emphasizes the role of also non-financial and intangible benefits and sacrifices in the relationship (Vargo and Lusch, 2006). For example in business-to-business services the value is often related to issues like performance, quality, and relationship-related aspects, like administrative routines and communication (La Rocca and Snehota, 2014; Lindgreen and Wynstra, 2005; Vargo and Lusch, 2008). As a conclusion, relationship value can be considered as a trade-off between benefits and sacrifices that can be financial (e.g. increased revenues) or non-financial (e.g. trust, reputation, safety) by nature, and this trade-off is achieved in interaction with one or multiple actors (i.e. service providers and customers).

However, although companies may work together or as part of a network, in practice the actors often have very varying perceptions of what constitutes value for them in the relationship (Anderson et al., 2006; Corsaro and Snehota, 2010; Möller, 2006; Töytäri and Rajala, 2015; Ulaga and Eggert, 2005). Value is partly subjective, as each actor can have diverging perceptions accompanied by their own strategies and motivation (Ford and McDowell, 1999; Gummerus, 2013). Thus, significant efforts have been put in the literature into understanding the nature and elements of relationship value comprehensively (e.g. Corsaro and Snehota, 2010; Keränen, 2014; Menon et al., 2005; Ulaga and Eggert, 2006). To be able to examine and understand value creation comprehensively, value needs to be made more stable so that the different parties (e.g. the maintenance service customer, the maintenance service provider and/or the equipment provider) can communicate about the interactions in the relationship, as well as the created service benefits and costs. Ulaga (2003) suggests that to capture the comprehensive facets of relationship value, empirical research should rely on multidimensional scales rather than overall measures of the construct. In addition, the value indicators should not be interchangeable (ibid.). Well-defined representations where the value creating elements are identified help to create shared meanings and communicate the value faster between the parties (Corsaro, 2014). Improved communication decreases the ambiguity of value and shifts the focus towards comprehensive decision making and away from looking at the price as the only value criterion (Anderson et al., 2000; Anderson and Wynstra, 2010; Töytäri and Rajala, 2015).

Maintenance services are also often provided as large solution entities where the ambiguity of value is high, as the different partners are uncertain about the value creating elements in the relationship. This often results in solely price-oriented and transactional relationships. This can be quite problematic in maintenance management, however, as there are several different benefits that can be achieved, many of which are created over the long term. For example, the Finnish Maintenance Society Promaint (2007) has identified versatile benefits that well-conducted maintenance can assist organizations to achieve (see figure 7). In the figure, the benefits are categorized into three groups:

increased profit, cost savings, and society factors based on their main value creation potential. It should also be remembered that poorly conducted maintenance does the opposite and has great potential in destroying the value by decreasing profit, increasing costs and neglecting society factors.

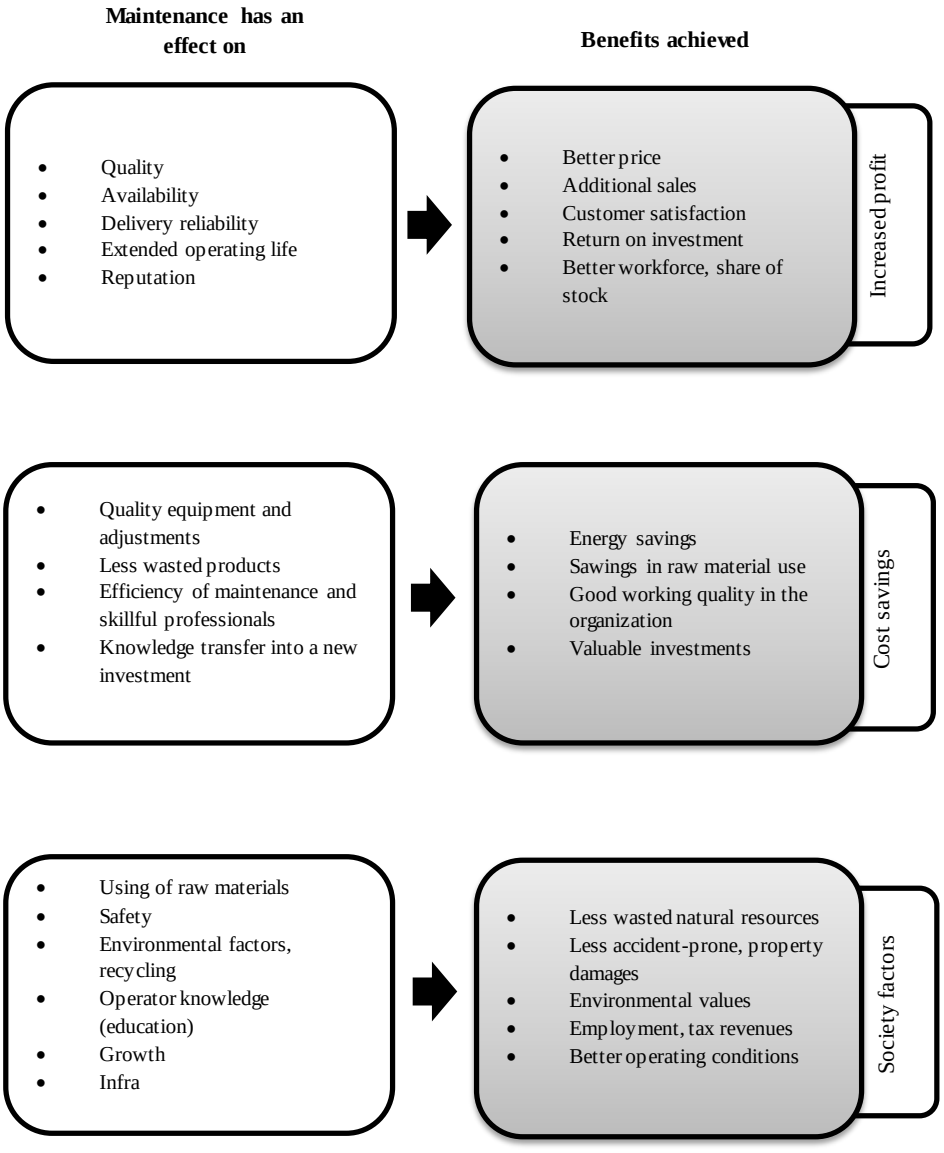

Figure 7. The effects of maintenance on business operations (adapted from the Finnish Maintenance Society Promaint, 2007)

As mentioned above, especially for the more complex offerings, relationship learning (i.e. knowledge sharing, joint sense-making and knowledge integration) enabled over long-term relationships and active feedback is an important part of value creation in knowledge-intensive services (Kohtamäki and Partanen, 2016). More systematic ways to understand and measure the comprehensive value of maintenance service are needed (Ahonen et al., 2010; Lapierre, 2000; Panesar and Markeset, 2008; Reinartz and Ulaga, 2008). The study of Toossi et al. (2013) supports the view, as they identify several intangible and tangible service elements that affect the value assessments of customers in outsourced maintenance service relationships. More comprehensive views should be taken into account in "order to meet customers' needs" (Toossi et al., 2013, p. 355). The most important value dimensions identified by the customers in the study of Toossi et al. (op.cit.) were "specialist knowledge", "accessibility (of service provider)", "relational dynamic", "range of product and service offerings", "delivery", "pricing", and "locality". Toossi et al. (ibid.) define the value dimensions as follows:

Specialist knowledge means that customers value the specialist knowledge of suppliers and often select providers based on their specialized skills. However, at the same time the customers fear the loss of control when outsourcing specialized activities. Therefore, effective feedback and reporting are an important part of the relationship to ensure that customers perceive value.

Accessibility, delivery, and locality refer to the physical presence and interaction between the customer and the service provider. It is important that the service provider has an on-site representative, as this gives a clear point of contact and enhances the perception of accessibility and the customer's feeling of being taken care of.

Relational dynamics means the interpersonal relationships between the customer and the service provider. This is an important dimension especially in the initial phase of the relationship, but should also be acknowledged in a more mature phase. The service provider should have an ongoing strategy for managing the relationship with the customer. Relationships are dynamic by nature, and the strategy should be updated according to changes in the requirements and expectations.

The range of product and service offerings refers to the service providers' ability to respond to new requirements of the customer. A wide offering is considered a key value dimension and especially customers in an established relationship may demand new solutions from the provider in order to consider the relationship as valuable.

Pricing refers to the price orientation of customers. Instead of focusing on cost savings a service contract can deliver, customers are more focused on the exchange price of the service contract or spare parts. However, detailed feedback is expected from the supplier, so that the customer can evaluate the financial aspects and have the feeling of control.

Komonen et al. (2007) identified similar dimensions when they studied the factors that affect customer satisfaction in maintenance services. According to their survey results,

customer satisfaction was affected by the quality of operations and the service level, professional skills of the operators, cost level, feedback to the customer, orderliness of maintenance, and competence.

In the studies of Toossi et al. (2013) and Komonen et al. (2007), the intangible and non-financial aspects of the relationship were also considered an important part of service value. Furthermore, also the price orientation of customers was recognized. Therefore, to capture the comprehensive value of maintenance service relationships, both financial (e.g. cost savings, price) and non-financial (e.g. trained labour, willingness to cooperate, reputation, safety) elements need to be viewed (Liyanage and Kumar, 2003; Ojanen et al., 2012A; Toossi et al., 2013). As Toossi et al. (2013, p. 359) conclude "Customers of outsourced maintenance services need to ensure that they take into account the full range of value contributors when procuring maintenance services and suppliers need to ensure that they address the full range of value dimensions when providing integrated services for their customers".

Because service relationships and value creation can be considered to be reciprocal (see e.g. La Rocca and Snehota, 2014; Tuli et al., 2007; Vargo and Lusch 2008), also understanding the service providers' value elements should be considered to achieve a comprehensive view of the relationship value (Walter et al. 2001). Tynninen et al. (2012) have made a first suggestion of value elements suitable for maintenance services based on a literature review, where both the customer's and service providers' views are considered (see table 2). The suitable elements were selected based on previous service studies where the value phenomena of services had been discussed. The original references used can be seen in parenthesis in the table.

Table 2. An example list of value elements of industrial maintenance services (adapted from Tynninen et al., 2012)

CUSTOMER	SERVICE PROVIDER
Price (e.g. Brito et al. 2007; Lapierre, 2000)	*Price* (e.g. Songailiene et al. 2011)
Technical quality (e.g. Matthyssens, and Vandenbempt, 1998; Ojanen et al. 2012B)	*Flexibility* (e.g. Ojanen et al. 2012B; Barry and Terry 2008; Malleret 2006)
Dependability (e.g. Ma et al. 2005)	*Reliability* (e.g. Songailiene et al. 2011)
Contracts (e.g. McDonough et al., 2006)	*Contracts* (e.g. Ramsay and Wagner 2009; Songailiene et al. 2011)
Relationship (e.g. Barry and Terry 2008; Ojanen et al. 2012B)	*Relationship* (e.g. Ramsay and Wagner 2009)
Reliability (e.g. Ojanen et al. 2012B; Barry and Terry 2008; Lapierre, 2000)	*Total solutions* (e.g. Matthyssens and Vandenbempt, 1998; Stremersch et al. 2001)
Flexibility (e.g. Ojanen et al. 2012B; Barry and Terry 2008; Malleret 2006)	*Operator knowledge* (e.g. Songailiene et al. 2011)
Reputation of service provider (e.g. Ramsay and Wagner 2009)	*Availability* (e.g. SFS-EN Std. 13306, 2010)
Accessibility (e.g. Ma et al. 2005)	*Asset management factors* (e.g. Ojanen et al. 2012B)
Asset management factors (e.g. Ojanen et al. 2012B)	*Access to markets* (e.g. Ramsay and Wagner 2009; Walter et al. 2001)
Total solutions (e.g. Matthyssens and Vandenbempt, 1998; Stremersch et al. 2001)	*Reputation of customer* (e.g. Ramsay and Wagner 2009)
Sustainability (e.g. Ramsay and Wagner 2009)	*Development, R&D* (e.g. Walter et al. 2001)

Tynninen et al. (ibid.) conclude on the basis of the literature review that the discussion on the value element has been more common in the business-to-customer context, but recently also the business-to-business and industrial view have been added to the

discussion. Tynninen et al. define the selected value elements for the maintenance service context as follows:

Dependability means decreased quality costs and availability of the service provider for the customer.

Contracts refer to the risks and guarantee and payment terms defined by the partners.

Relationship describes the level of trust, documentation and information sharing, as well as feedback.

Reliability refers to the relationship and how well promises, forecasted price and quality are kept.

Flexibility describes the level of tailoring and customization for the customer, and on the other hand, it means less special work and more routine operations for the service provider.

Accessibility refers to the availability of spare parts, schedule, and personnel of the service provider.

Asset management factors means discussions related to ownership and investments in fixed assets and working capital, including e.g. spare part inventories.

Operator knowledge describes the employees' experience and training, the training of the operators, and standardization of tasks.

Availability is defined as item reliability, item recoverability, and item maintainability as the standard EN 13306 defines (SFS-EN Std. 13306, 2010).

Access to markets is an element to describe increase in the market share, reputation, and new customers.

The list of Tynninen et al. (2012) has been utilized as a starting point for this thesis when trying to understand and conceptualize the maintenance service value construct. However, as can been seen, the list is somewhat congruent with the views and value dimensions identified by Toossi et al. (2013) and Komonen et al. (2007). The importance of knowledge and financial, quality, relationship and solution aspects are highlighted in all three studies.

3 RESEARCH DESIGN

This chapter presents the overall research design employed in the study. First, the research approach, including the philosophical worldview of the study, is introduced. After this, the chapter continues by discussing the methodological choices, especially from the view of mixed methods research. Thirdly, data collection and analysis methods related to the quantitative and qualitative data used in this research are introduced.

3.1 Research approach

When conducting research, the set of beliefs and values affects how the study is conducted, i.e. what methodologies are used to gather data and how the data is analysed (Guba, 1990). This set of beliefs and values the research relies on, can be called the research philosophy of the researcher. There are two key concepts that help to explain the varying views of research philosophies: epistemology and ontology. *Epistemology* is a way of understanding how we know what we know and what constitutes acceptable knowledge (Crotty, 1998; Saunders et al., 2009). Crotty (1998) presents objectivism, constructionism and subjectivism as the three main epistemological stances. These three stances are not to be seen as watertight compartments, but to help recognize their main differences (ibid.).

Objectivist epistemology holds the view that the reality exists independently of the consciousness of people. In the objectivist view, it is possible to discover the objective truth, if research is going in the right way, as understanding and values are objectified in the studied people. Constructionism, on the other hand, rejects the objectivist view of human knowledge. Constructionism holds the stance that meaning is built in the human mind, and different people may construct meaning in different ways. Meaning is not discovered and there is no objective truth, but it is constructed in and out of our realities. The third epistemological stance, subjectivism, has similarities with constructionism, as it also considers that meaning is not discovered, but meanings to objects come for example from our dreams and unconscious mind. Meanings are imported from anything except the interaction between the subject and the object, as in constructionism (Crotty, 1998). As can be seen, each epistemological stance implies differences that affect the conducted research and presentation of the research outcomes (ibid.). Furthermore, o*ntology*, the study of being or nature of reality, is closely related to epistemological considerations. Ontological beliefs consider whether reality is seen as a phenomenon that is singular or multiple by nature (Burrel and Morgan, 2005). For example, reality can be found in a theory that helps to explain phenomena among a large group of people (reality external to social actors), or reality is determined by varying individual perspectives (reality constructed from the perceptions of social actors) (Bryman, 2008; Creswell, 2015).

Alternating research philosophies are commonly accepted in social sciences. This said, one philosophical view cannot be considered superior to another, as it depends on the

research questions to be answered which research philosophy can be considered the most suitable one (Saunders et al., 2009). In table 3, four key research philosophies and their main concepts that are commonly used in management research are presented; positivism, realism, interpretivism and pragmatism. As can be seen, the epistemological and ontological stances towards research also often influence the selection of either a quantitative, qualitative or mixed methods approach (Creswell, 2009).

Table 3. Four key research philosophies in management research (adapted from Saunders et al., 2009)

	POSITIVISM	REALISM	INTERPRETIVISM	PRAGMATISM
Ontology: the researcher's view of the nature of reality or being	External, objective and independent of social actors	Objective. Exists independently of human thoughts and beliefs or knowledge of their existence (realist), but is interpreted through social conditioning (critical realist)	Socially constructed, subjective, may change, multiple views	External, multiple, view chosen to enable answering the research question best
Epistemology: the researcher's view regarding what constitutes acceptable knowledge	Only observable phenomena can provide credible data, facts. Focus on causality and law like generalisations, reducing phenomena to simplest elements	Observable phenomena provide credible data, facts. Insufficent data means inaccuracies in sensations (direct realism). Alternatively, phenomena create sensations which are open to misinterpretation (critical realism). Focus on explaining within a context or contexts.	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions	Either or both observable phenomena and subjective meanings can provide acceptable knowledge depending upon the research question. Focus on practical applied research, integrating different perspectives to help interpret the data
Data collection techniques most often used	Highly structured, large samples, measurement, quantitative, but can use qualitative techniques	Methods chosen must fit the subject matter, quantitative or qualitative	Small samples, in-depth investigations, qualitative	Mixed or multiple method designs, quantitative and qualitative

The *positivist* research approach is also common in natural sciences, and it is characterized by a focus on observable social reality and facts rather than impressions. Theory testing is common, and the end product of positivist research is often a law-like generalisation (Saunders et al., 2009). For example, gathering data for testing and confirming (and/or refuting) deductively constructed hypothesis, and further developing theory based on the results, is a likely feature in the positivist research approach (Creswell, 2009).

Realism is another research approach where objectivity is emphasized. In addition, the reality is considered to be independent of the mind (Saunders et al., 2009). However, also realism has two different viewpoints to this. The first type, direct realism, considers that

what we experience and see is accurate. The second type, critical realism, argues that our experiences are sensations and representations of what is real, but they might not be accurate (ibid.). Realism is close to positivism, as it also expects a very scientific and often quantitative approach for theory development.

Compared to the two approaches presented above, *interpretivism* is quite the opposite, as it argues that the social business world is too complex to be theorized in law-like generalisations like phenomena in physical sciences (Saunders et al., 2009). The interpretivist approach does not look for an objective truth but for subjective meanings and social phenomena (Easterby-Smith et al., 2002). People are not considered as objects in research, but as "social actors". Interpretations of the social roles of others is based on the researcher's own set of meanings, and mainly qualitative approaches are used to develop theory (Saunders et al., 2009).

The fourth research philosophy presented here, *pragmatism*, is a mixture of the other three. Pragmatism argues that the research question is the most important determinant of the research approach, and the researcher should use all approaches available to understand phenomena (Rossman and Wilson, 1985; Saunders et al., 2009). As a philosophical view, pragmatism arises out of actions, situations and consequences rather than former conditions (as for example in positivism) (Creswell, 2009). Furthermore, Tashakkori and Teddle (1998) suggest that the researcher should think of the philosophies adapted to a particular study more as a continuum instead of opposite positions. Both quantitative and qualitative methods (mixed methods) are highly appropriate to use within one study to derive knowledge of a phenomenon (Creswell, 2009).

Based on the views of Cherryholmes (1992), Morgan (2007) and Creswell (2009), pragmatism provides a philosophical basis for research with the following ideas:

- Pragmatism is not committed to one research philosophy. This applies well to mixed methods research where inquiries are liberally drawn from both quantitative and qualitative assumptions.
- Individual researchers have a freedom of choice. Researchers are free to choose the methods and techniques that meet their needs best.
- In pragmatism, the world is not seen as an absolute unity. Similarly, mixed methods researchers do not subscribe to only one way (e.g. quantitative or qualitative), but look to many approaches for collecting and analyzing data.
- Truth is what works at the time. It is not based in a duality between reality independent of the mind or within the mind. Therefore, researchers use both quantitative and qualitative data because their aim is to provide best understanding of a research problem.
- In the pragmatist approach, the researcher looks to what and how to research, based on the intended consequences and where they want to go with it. The

researcher needs to establish a purpose for the mixing of quantitative and qualitative data.

- Research always occurs in social, political, historical, and other contexts. Studies may include a postmodern turn, reflective of social justice and political aims.
- In summary, pragmatism opens the door to different philosophical approaches, different assumptions, multiple methods, and different forms of data collection and analysis.

This thesis follows the pragmatic research approach and uses a mixed method design. The purpose is to gain understanding of a complex phenomenon, and therefore both qualitative and quantitative research methods are used. The quantitative part follows mainly the positivist approach, as maintenance service value is conceptualized to simple elements. Furthermore, the qualitative part follows mainly the interpretivist view, so that the real-life context between the concepts can been understood.

3.2 Methodological choices

The ability to combine the strengths of both quantitative and qualitative perspectives provides a good rationale for using a mixed methods approach (for example quantitative research methods provide an opportunity for generalization and precision, whereas qualitative research methods offer an in-depth experience of individual perspectives), as strengths and weaknesses can be found in all research methods (Creswell, 2015). Alternatively, the strengths of one perspective make up for the weaknesses of the other (for example quantitative research provides only a limited understanding of the context, whereas qualitative research has limited generalizability) (Creswell, 2015; Rossman and Wilson, 1985). Well-conducted mixed methods research is able to reveal much more relating to a research problem than the use of a single research approach. However, it is important to remember that the mixed methods approach has also its weaknesses, and it cannot be automatically considered superior to a single method approach (Bryman and Bell, 2011). Also the methods selected for the mixed methods approach need to be suitable for the research question, and the findings should be integrated, and not just discussed separately, as qualitative and quantitative findings. Furthermore, there is no need to collect more data simply on the basis that more is better. If the data does not add to our knowledge, it is just a waste of money. When mixed methods research is poorly conducted, the findings might not be valid, no matter how many methods are used.

There are three basic mixed method designs; convergent design, explanatory sequential design and exploratory sequential design (Creswell, 2015). One of the three basic designs can be identified at the centre of all mixed methods studies. In *convergent design,* first both quantitative and qualitative data are collected and analysed. Then the results of the two datasets are merged and the results compared. Some say that the results of one dataset are validated with the other. In *explanatory sequential design* the process is more straightforward. Here, quantitative methods are used first and after the results of the quantitative methods are available, the results are explained in depth with qualitative

research methods. *Exploratory sequential design* is similar to explanatory design, but it starts with a qualitative process. First an understudied or poorly understood problem is explored with qualitative methods. After this initial exploration, the qualitative findings are used to construct for example an instrument to measure the variables. As the final stage, this quantitative instrument is then used for quantitative data collection and analysis procedure.

The research process of this thesis follows explanatory sequential design and mainly two empirical research methods, the survey method (publications 1-2) and case study (publications 3-4) have been used. The strength of explanatory design lies in the straightforward process where easily recognized stages build upon each other (Creswell, 2015). First, quantitative data was collected and analysed with the survey method to find out what was considered as value creating in maintenance services. Furthermore, the results of the quantitative analysis were examined to see what results needed further explanation in the second, qualitative phase, as Creswell (2015) suggests. The network and relationship aspect affecting the service value was hard to grasp solely with the survey method, and therefore the qualitative data collection focused on these issues in the second stage. In the second phase, qualitative data was collected and analysed with the case study method to explain the phenomena further. Conclusions on how the qualitative results have helped to explain the quantitative results are drawn in the thesis results, where all individual publications are summarized and final inferences considering the thesis are discussed (section 4.5-4.6). The research process is summarized in figure 8.

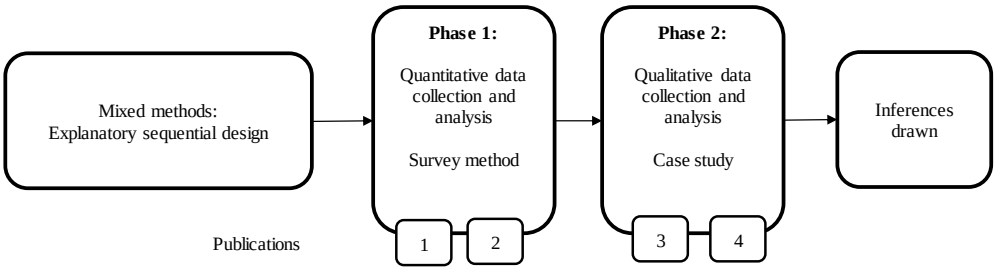

Figure 8. Research process and publications related to each phase

The *survey method* was used in publications 1 and 2 to gather the empirical data for the quantitative phase of the research. The purpose of a survey method is often to find new viewpoints and new phenomena, to develop hypotheses, and decipher phenomena that are little known. Furthermore, the purpose is to generalize or make claims from sample results to a population, so that inferences relating this population's characteristics, attitude, or behaviour can be made (Babbie, 1990; Creswell, 2009). The survey design provides a quantitative numeric description of the characteristics, attitudes, or opinions as propositions are presented with numerical figures and tables to illustrate them. The

quantitative survey data can then be analysed statistically. Quantitative study is good for surveying a phenomenon, but it is often not enough to explain it in detail. A quantitative study needs theory or further qualitative data to be able to explain complex phenomena (Creswell, 2015; Morgan, 2007; Rossman and Wilson, 1985). Therefore, the case study method was also utilized in this study to explain value creation and its characteristics further in maintenance service networks. The case study method has often been a preferred strategy when complex phenomena like company relationships and business networks are studied (Halinen and Törnroos, 2005).

The *case study method* was used in publications 3 and 4 as the primary research method to gather data for the qualitative phase of the research. Yin (2003, p. 13) defines the case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident." Furthermore, case studies are typically used for research questions with a *how* and *why,* but it can also suit as a research strategy for a *what* type of a question (op.cit.). Case studies are widely used in industrial marketing and business-to-business research (Easton, 2010). The case study method allows the researcher to grasp in-depth knowledge and understanding relating to a complex phenomenon and its characteristics. In addition, it provides an opportunity to gain novel insights into a problem by moving flexibly between data and theory (Eisenhardt, 1989).

3.3 Data collection and analysis

3.3.1 Quantitative data collection and analysis

Survey design

As mentioned above, the first phase of the research utilized the survey method to decipher the quite unexplored phenomenon of maintenance service value. The quantitative data was collected with a structured survey questionnaire. The survey design provided a quantitative description of the phenomenon so that it could be analysed statistically and generalizable features could be found, as the first aim of the study was to explore and conceptualize the maintenance service value. The questionnaire consisted of background questions, the main part capturing the service value of maintenance, and a final part where measurement and performance -related questions were asked as additional information. The main part comprised 32 value propositions measuring maintenance services as a multidimensional phenomenon with both financial and non-financial service elements. The value elements behind the propositions were originally selected based on a literature review by Tynninen et al. (2012). To maximize the validity of the construct, the elements were reviewed and revised with a group of researchers and maintenance experts. First a pre-assignment was conducted, where the experts determined the value of different maintenance services without the preliminary list based on the literature review, to avoid guided responses. Secondly, the group was asked to revise critically the lists created on the basis of the literature review and the pre-assignment. Two elements were added on

the basis of the revision: safety at work and environmental safety, as the impact of maintenance on safety issues is brought up repeatedly, and it is also one of the main focus points in specific maintenance literature and forums (e.g. EU-OSH, 2012; EFNMS, 2016; Lind et al., 2008; Finnish Maintenance Society, 2007). In addition, some improvements in wording related to other elements were made. Each element was then turned into two value propositions to communicate the value-creating characteristics behind the element clearly to the respondents (Ballantyne et al. 2011). The elements of maintenance service value and the propositions used in the questionnaire are presented in appendix A. For each of the 32 value propositions, the respondents were asked to indicate their opinion on a five-point Likert scale with end points of 'strongly disagree' (1) to 'strongly agree' (5). The unit of analysis was an individual respondent's perception on maintenance service value at the organizational level, as the respondents were not required to provide absolute values. The questionnaire was pretested among maintenance experts, and some minor improvements were made before sending the questionnaire out.

Construct validity of the measurement scale was ensured by developing pre-understanding of the value elements with a literature review, and building new elements based on theories and expert opinions (Hair et al., 2006). The finalizing of the questionnaire was also done with a group of researchers and maintenance experts to ensure content validity, so that the solution captured the main domain of the maintenance service value construct. Criterion validity was assessed based on correlation coefficients between different value propositions. All the propositions had significant correlations relating to other propositions, which was a good starting point for factor analysis, as the partial correlations were small, based on the measure of sampling adequacy.

The reliability of the results was tested by measuring the internal consistency of the created factors with Cronbach's alpha, so that the items in a scale represented the same phenomenon (Nunnally, 1978). Cronbach's alpha was mainly greater than 0.50. The reliability of the analysis can be concluded to be sufficient when considering these factors, especially as they also included new scales (Nunnally, 1978). In one factor the alpha value was 0.49, which is below the recommended. This indicates that the reliability of the factor can be questioned, and the results concerning this factor should be used with caution. The overall alpha value of the scale with the remaining 29 variables was 0.915, which means that the reliability of the total construct is supported. The created factors formed the base for the multidimensional scale measuring maintenance service value. The reliability of the scale and specific alpha values were discussed in detail in publications 1 and 2.

Data collection procedure

The set of data for the study was collected with an online-questionnaire from Finnish companies that were either customers or service providers (pure service providers or also equipment providers) of maintenance in an industrial context. Overall, the questionnaire link was sent to 345 maintenance service professionals. The primary source for the contacts was a nationwide actor, the Finnish Maintenance Society Promaint, which has a diverse network of companies acting in the maintenance field. Finland is a good testing

ground, as outsourcing of maintenance is quite common, and the maintenance sector is a significant industry overall due to the aging industrial assets (Hatinen et al., 2012; Finnish Maintenance Society, 2007). The survey was conducted in January-March 2013. The contact persons received two reminders at two-week intervals after the first message. The process resulted in a total of 83 completed questionnaires, representing a final response rate of 24%.

To avoid the common method bias of social desirability (Podsakoff et al., 2003), the respondents were encouraged to answer as truthfully as possible from their own viewpoint. The respondents were allowed to answer anonymously. By allowing anonymous responses, the respondents were less likely to edit their responses according to social desirability. In addition, the survey questions were constructed carefully by paying attention to the wording and clarity. The questions were also pretested and revised by a group of researchers and maintenance experts, and this should have also reduced the possibility of common method bias. To check the non-response bias, the differences between different respondent groups were tested. It was assumed that the last group of respondents resembled most closely the non-respondents (Armstrong and Overton, 1977). The respondents were divided into three groups based on their response time: the first respondents, respondents after the first reminder, and respondents after the second and last reminder. The results of the Kruskall-Wallis H test (as the data was not normally distributed) showed that there were no significant differences (at the 0.05 significance level) between the three groups. Based on the test, it can be assumed that the received responses presented the whole sample well.

Respondent demographics

As the background information of the respondents in table 4 shows, 39% of the respondents represented large companies (over 250 workers), and thus the majority represented middle sized or small companies. The majority (57%) of responses was received from middle management, for example from maintenance managers, 20% of the respondents represented senior management, and the rest (23%) represented mainly consultants and supervisors. One third (39%) of the respondents represented companies in the maintenance service customer side and the rest (61%)[2] represented the service provider side. The customers were mainly active in the industrial goods and services industry (69%) but also electricity, gas and heating industry (15%), mining (6%) and chemical industry (6%) and with single responses, port services and defence industry were represented.

[2] As can be seen the respondent group is slightly imbalanced as service providers represented 61% of the responses and service customers 39%. Therefore, a potential bias of the results towards the service provider side should be acknowledged. However, based on the test of non-response the received responses seem to present the whole sample well (non-response bias discussed in more detail under *data collection procedure*). In addition, when concerning the target field (industrial maintenance) it is common that the amount of service providers is higher than the amount of customers. Therefore, the slightly skewed respondent group actually represents the whole population around industrial maintenance quite well.

The majority of customers was working within uniform production (65%) but also serial production (19%) and one-off production (16%) were present. None of the customers claimed to execute the maintenance services completely in-house. The service providers represented mainly mechanical maintenance, automation, consulting, or a combination of different maintenance service types.

Table 4. Background information of the responses

	Number (N=83)	*Percentage*
Number of employees		
under 10	7	8%
10-49	19	23%
50-249	25	30%
over 250	32	39%
Approximate turnover (€)		
under 1 million	9	11%
1-20 million	23	28%
21-100 million	21	25%
over 100 million	30	36%
Position of the respondent		
senior management	17	20%
middle management	47	57%
other	19	23%
Organization unit primarily		
maintenance service customer	32	39%
maintenance service provider	36	43%
equipment and maintenance service provider	15	18%

Analyses

The survey data was first examined for statistically significant differences in publication 1, and secondly, a multidimensional value construct was built with an explorative factor analysis in publication 2. In addition, cluster analysis was conducted (in publication 2) to identify respondent groups characterized by their attitude towards different value creation strategies.

The data of the survey sample was not normally distributed, and therefore the non-parametric tests Mann-Whitney U and Wilcoxon were used to analyse the differences in the value elements (see publication 1). To complete the multidimensional measurement

scale, generalized least squares analysis was conducted to group the propositions into more comprehensive groups and to find possible hidden elements. An exploratory analysis with Oblimin with Kaiser Normalization rotation produced seven factors with an eigenvalue over 1.00. The model explains 60% of the variance (see publication 2). The value of the Keiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.784, which can be considered good. The computed factor scores were further used for cluster analysis. The number of clusters was based on hierarchical cluster analysis, and the final clustering was done with K-mean clustering.

The clustering revealed interesting differences in the respondents' value creation strategies, and therefore the research focused next on exploring and understanding these differences by investigating the networked environment of maintenance more closely with the help of qualitative research.

3.3.2 Qualitative data collection and analysis

The second phase of the research, qualitative data collection, was conducted as a multiple case study within two maintenance service networks. The first network operated in the mining industry and the other one in the energy industry. Overall, seven case companies participated in the research, including maintenance service customers, maintenance service providers and equipment providers. The diversity of companies provided rich data and ensured that different viewpoints of the network participants were considered. For confidentiality reasons, the case companies are referred to with letters. The main characteristics of the case companies are described in table 5.

Case companies

Case company A is an equipment manufacturer that offers contract-based maintenance on their own equipment. Their main driver for offering a 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 the equipment performs in real life. The company sees short response times and geographical closeness as their strength. Company A offers different maintenance packages with highly varying contents from basic operations to tailor-made expert services. In their way of operating, the content of maintenance agreements needs to be strictly negotiated with clear responsibilities.

Case company B, a large equipment manufacturer, has developed its maintenance services strongly 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.

Case company 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, as it provides steady income in a turbulent business environment, but also enhances customer satisfaction and reputation.

Table 5. Main characteristics of the case companies

	Company A	Company B	Company C	Company D	Company E	Company F	Company G
Business	Equipment manufacturer service provider	Supplier of technologies, components, and systems	Equipment manufacturer service provider	Industrial services	Maintenance services, project business	Mining and refining	Production of energy and heat
Primary customers	Process industry	Mineral and metal mining industries	Process and energy industries	Process and other industries, construction	Manufactu-ring, process and other industries	Different end customers for the products e.g. in process, and metal industries	Various companies and consumers
Sales (2011, €M)	125.7	310.5	199.3	2.8	107.2	158.2	1 633
Employees (2011)	495	682	518	38	1105	494	1746
Primary role in the maintenance service network	Equipment manufacturer	Equipment manufacturer	Equipment manufacturer	Service provider	Service provider	Customer company	Customer company

Case company D is a maintenance service provider that was established from an outsourced maintenance function in the beginning of the 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 is that their customers buy personal skills and knowledge rather than a service. Often, a single workman can affect who will win a maintenance deal. However, the company does offer entities that might require subcontracting.

Case company 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. Case E has also developed internal protocols and reporting systems for different tasks to ensure steady quality. Their customer base is extensive, and depending on the customer case, company E leads the maintenance, is an equal partner, or acts as a subcontractor.

Case company F is an industrial supplier operating in the 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 between their sites. One reason for this is the multitude of different monitoring systems used among the companies. For a maintenance service provider, case F expects that the price is in line with quality. Besides their 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.

Case company 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 separate contracts with all individual providers.

Data collection and analysis

The primary method for gathering the qualitative data were open-ended interviews, and altogether 9 semi-structured interviews were conducted in the case companies during autumn 2014. The semi-structured approach allowed active interaction with the interviewees and enabled the possibility to focus ad hoc on interesting topics that emerged during the interviews, while following the interview frame designed beforehand (see Appendix B) (Silverman, 2014; Yin, 2003). The main topics in the interviews were the value of maintenance services (its current state and development suggestions), value assessment issues, development of the maintenance service offering, and networked maintenance service operations. Depending on the interviewee's experience and special knowledge, the use of time for certain topics was adjusted.

Mainly senior-level managers with good experience on the maintenance service offering and interorganizational relationships were invited to participate in the study. In addition, the key informants were also asked to name other candidates that could be knowledgeable about the topic. This "snowball sampling" technique helps to identify hidden populations in a company (Biernacki and Waldorf, 1981; Silverman, 2014). The use of multiple respondents in a company can also help to avoid the single-respondent bias (Kumar et al. 1993). Unfortunately, multiple responses were only gained from two companies, as the suggested interviewees were not available for further interviews. However, the quality of the data was emphasized over quantity in the research setting, and it was concluded that the gathered data allowed making certain assumptions, as similar themes were brought up by the key informants of different companies. The interviewees are listed in table 6.

The interviews were conducted face-to-face, except for one interview, and they lasted between 72 and 103 minutes. One interviewee submitted the answers via email, where the interviewee responded to the same interview frame as the other interviewees, but no further ad hoc questions were presented. The interviews, altogether 11 hours, were audio-taped and transcribed, and resulted in 181 pages of text. In addition, field notes were

written during the interviews to protect against audio-tape failure and to be able to follow the key points arisen in the interviews.

When conducting case studies, it is recommended to use multiple sources of evidence to benefit from data triangulation (Yin, 2003). The opportunity to use many different sources of evidence can be considered as a strength of the case study method, as it allows the researcher to discuss various issues and adds reliability to the study (ibid.). Therefore, in this study, written assignments of the participating companies, documented focus group meetings and seminar discussions, as well as company documents (e.g. annual reports, brochures, plant tours, and web pages) were used as secondary data to reflect and comment on the research results and to understand the business environment better. The written assignments, the documented focus group meeting, and the seminar discussions were part of a three-year academic research project focusing on maintenance service management in a networked company environment. The project gave the possibility to access the case companies and the secondary data.

Table 6. Main characteristics of interviewees

Nr	Date	Company	Participant	Experience	Duration of the interview
1.	13.10.2014	A	Manager, Service Center	28 years	92 min
2.	13.10.2014	A	Service Manager	12 years	87 min
3.	15.10.2014	F	Department Manager, Planning and Projects	20 years	88 min
4.	20.10.2014	F	Purchasing and Technology Director	10 years	85 min
5.	20.10.2014	G	Head of Production	11 years	75 min
6.	21.10.2014	B	Senior Specialist, Service Business Development	8 years	103 min
7.	21.10.2014	E	Vice President, Service Offerings	10 years	79 min
8.	22.10.2014	D	Managing Director	20 years	72 min
9.	02.11.2014	C	Business Unit Executive, Services	24 years	submitted via email

The data was analyzed by employing qualitative content analysis (Silverman, 2014). The field notes and discussions provided the base for the first ideas and more specific analysis. After the first ideas, the transcribed interviews were read and interesting sections marked. The sections were further categorized and combined, and written to the article drafts. The final results presented in the publications were developed iteratively by going back and forth between the findings presented in the literature and the primary and secondary data. In publication 3, the analysis focused especially on understanding the network model requirements and different motivations to develop maintenance, whereas in publication 4 the analysis focused on different collaboration levels in maintenance service relationships.

4 REVIEW OF THE RESULTS

This chapter presents the main findings of the thesis. First, the main objectives, results, and contributions of the four individual publications are introduced. Publications 1 and 2 focus on exploring and conceptualizing the value creating elements of industrial maintenance services, whereas publications 3 and 4 focus on understanding the role of networks in value creation and explaining the quantitative results. Second, the objectives and main results considering the whole thesis and their relationship towards successful maintenance service networks are summarized.

4.1 Publication 1 - Value elements of industrial maintenance: verifying the views of the customer and service provider

Objectives

The objective of the first publication was to verify the most important value elements for the maintenance service customer and provider, and also to recognize where the value elements differ, by using the non-parametric tests Wilcoxon and Mann-Whitney U. The data was collected by an online survey that was sent to maintenance service professionals in Finland. In the survey, the value elements were considered in four different contexts: the customer's high critical and low critical items, and the service provider's core and support service.

Main results

The survey results showed that for the critical items the customers ranked reliability, safety at work, environmental safety, operator knowledge, price, and technical quality as the most important value elements (see appendix A for detailed value propositions). The lowest scores were given to research and development (R&D), access to markets, and asset management factors. When the results of the high and low critical items were compared, the survey results supported the idea that there are differences between the value elements. Statistically significant differences between the value elements were found in availability, technical quality, flexibility, reliability, orderliness, R&D, and access to markets. The customers valued the elements substantially higher when considering critical maintenance. This confirmed the assumption that item criticality affects the customer's decision-making, and the value of maintenance services is case-specific.

The service providers rated operator knowledge, reliability, safety at work, technical quality, environmental safety, and price as the highest value elements. The differences between the core and support services were minor and not supported statistically. The service providers had not clearly differentiated their service offerings, as many named the same service as core and support service. However, when comparing the customer and the service provider, there were differences between the value elements, again not only

in ranks but also statistically. This highlights the importance of communication, so that mutual understanding of the value creating elements can be reached between the service partners.

The results also suggested that the surveyed elements were strongly related, and further research is needed to capture the complex nature of the maintenance service value. However, the value elements and value propositions presented in this paper (*availability, safety at work, environmental safety, technical quality, flexibility, reliability, operator knowledge, orderliness, reputation, relationship, contracts, total solutions, R&D, price, access to markets, and asset management factors*) can be considered as the preliminary value elements of industrial maintenance services. The results also support the view that the value of maintenance services is multidimensional and comprises a value element package. The presented value elements and value propositions make the achieved benefits more concrete and support the value discussions between customers and service providers. One part of the discussions can be the selection of strategic performance measures, and for that the value elements provide great support by making the selection of the measures more value-based. This also supports the strategic shift of maintenance management on the practical level from cost-centric towards more value-centric decisions.

Contribution

The paper contributes to the theories of value and industrial service development by providing a first draft of value elements specific to industrial maintenance services. Until now there has been little understanding of the value-creating elements in maintenance services concerning both the customer and the service provider side. The paper also points out that there are recognizable differences in the preferred value elements, and this should be acknowledged in service negotiations. The value elements provide a base for discussions and a way to present the expected benefits in a service offer. In addition, the identification of value is made more concrete for the managers, so that strategic decision making and value assessment can be supported better in service relationships.

4.2 Publication 2 - Understand what your maintenance service partners value

Objectives

The second publication was a follow-up of publication 1, and the objective was to conceptualize the maintenance service value construct through an examination of its elements, and to provide insight into its actors' (i.e. customer companies, service providers, equipment providers) attitudes towards value creation. The empirical data was collected with an online survey (same as in publication 1). Also here, statistical analysis methods were used. First an explorative factor analysis was conducted to explore the value construct. Second, cluster analysis was conducted to define the actors.

Main results

The empirical findings supported the view that maintenance service value is a multidimensional construct including both financial and non-financial elements. The study identified seven main elements that capture maintenance service value: relationship synergies, reliability of the service partner, development, availability, service solutions and problem solving ability, EHSQ (environment, health, safety and quality), and adaptability to suit different situations. Table 7 is a summary of the created value construct and its elements based on the original value propositions.

Table 7. Maintenance service value as a multidimensional construct

Value element	
Relationship synergies	The previous experiences with the maintenance service partner have been positive.
	The risks and responsibilities considering the maintenance services are shared between the customer and the service provider.
	The maintenance service partner can provide information and knowledge related to the development of R&D activities.
	Maintenance service cooperation enables contact with new customers.
	Maintenance service cooperation enables starting a new type of business.
Reliability of the service partner	The maintenance service operators are professionally skilled and qualified.
	The current reputation of the maintenance service partner is good.
	Information exchange works between the maintenance service partners.
	The maintenance service warranty and terms of payment are kept and executed as promised.
	The price paid for the maintenance service corresponds with the received service.
	The price is negotiated in cooperation with the maintenance service partner.
	The maintenance service partner is responsible for spare part storage so that it does not tie your own resources and capital.
Development	The operational conditions and safety increase along the service.
	The maintenance service cooperation is based on confidentiality.
	Own research and development can be developed with the maintenance service partner.
Availability	The maintenance tasks are appropriate and maintainability and repairs are easy.
	The operators carry out their part of the in-use maintenance operations and enhance the maintainability of the item.
	The resources and timetable of the maintenance service can be planned well in advance.
Service solutions and problem solving ability	The maintenance service provider has the knowledge to solve upcoming problems.
	The maintenance service cooperation covers the whole maintenance services comprehensively (from management to execution).
	The maintenance service covers the whole life span of the item.
EHSQ (environment, health, safety and quality)	Maintenance is performed according to safety policies.
	Maintenance is performed according to environmental safety policies.
	The maintenance service outcome is as expected.
	The maintenance service outcome is sustained for the promised time.
	The maintenance service cooperation is executed on time and as promised.
	The maintenance service cooperation works well considering the conditions of all partners.
Adaptability to suit different situations	The maintenance service partner can suit the needs of the company (e.g. delivery time).
	The maintenance services are tailored based on need.

Relationship synergies refers to the positive synergies of relationships, as it reflects to sharing the risks and responsibilities between the service partners, as well as collaboration

in the R&D activities. Also previous experiences with the maintenance service partner are evaluated, as well as how managers consider that the cooperation enables contact with new customers and starting a new type of business. This element highlights the relational perspective towards exchange and how the potential of cooperation is exploited, as Axelsson and Wynstra (2002) and Lindgreen et al. (2012) suggest.

Reliability of the service partner represents how well the contract is executed and whether the service partner can be considered reliable. The element reflects the professionality and reputation of the service operator, as well as the functionality of the price negotiations, resource and capital arrangements, and information exchange between the service partners. The partners also evaluate how well the price paid for the maintenance service corresponds with the received service and if the warranty and payment terms are kept and executed as promised.

Development refers to different development activities, and highlights the requirement of mutual trust. It measures how well the operational conditions and safety increase along the service and how the possibility to develop own R&D activities with the maintenance service partner is utilized.

Availability highlights the maintainability and planning aspect of maintenance. The element measures the easiness of operations and how maintainability is enhanced. In addition, the element emphasizes the planning aspect. In many cases it adds value to the service if the resources and timetable of the maintenance service can be planned well in advance.

Service solutions and problem solving ability describes comprehensive solutions where the ability to solve and take care of problems is on the partner's side. It reflects how complete the provided service solutions are and what the life span for the service is. This highlights relationship learning enabled over the long term, especially when considering more complex service offerings. Relationship learning ensures that the maintenance service provider has the knowledge to solve upcoming problems, and this is also one of the key features measured by the element.

EHSQ (environment, health, safety and quality) highlights the importance of safety and quality aspects in maintenance services. The element measures how well maintenance is performed according to safety and environmental safety policies, whether the maintenance outcome is as expected and sustained for the promised time, and whether service cooperation is executed on time and as promised. Many of these are interlinked, as the element features a well-functioning working environment. In addition, the element emphasizes cooperation between all partners, as it also measures how well maintenance cooperation works considering the conditions of all partners. The development of safety and quality culture cannot be controlled solely by one organization, as the features are affected and created by several partners. This should be emphasized especially in networked environments.

Availability to suit different situations refers to the flexibility of the services. It concerns how well the service partner can suit the needs of a company (e.g. delivery time) and how well the services are tailored based on need.

Further analysis revealed that the different maintenance service actors (i.e. customer companies, service providers, and equipment providers) can be categorized into three main value creation strategy types based on the seven value elements: basic, quality- and collaboration-oriented partners. The value elements were considered to reflect the company's strategic view towards maintenance management. In addition, the different strategies were discussed in relation to their suitable positioning in the relationship and service offering development quadrat of Penttinen and Palmer (2007). The positioning of the strategies is presented in figure 9.

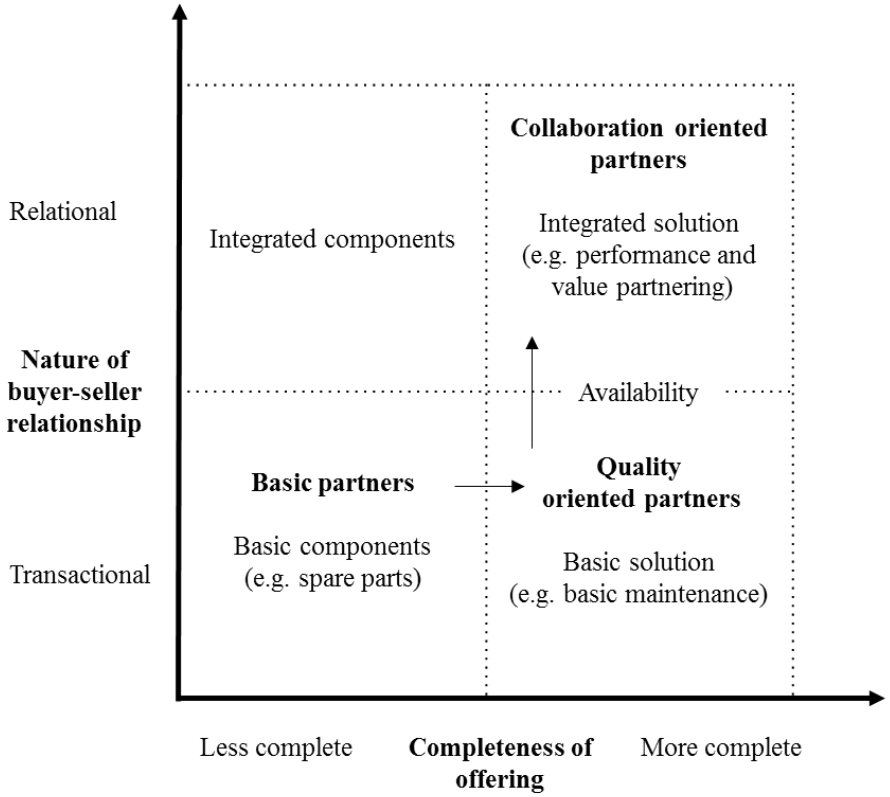

Figure 9. Framework for possible value creation strategies at different relationship and offering levels

Basic partners see maintenance services as a transaction amongst other functions, and no special value is seen in the relationship. This group did not emphasize any particular elements. The maintenance service is ordered and the service provider provides it as

ordered, and not much other expectations than the transaction are had regarding the relationship or service offering. The value-creation strategy of this group is based on the transactional approach (see e.g. Axelsson and Wynstra, 2002). The time horizon is short-term and the relationships exploit the potential of competition and choosing the most efficient supplier at any time. For the basic partners, a less complete offering, like spare parts and basic solutions are suitable.

Quality-oriented partners, on the other hand, have expectations towards the service, but not necessarily towards the relationship behind it. This group is interested in the outcome being as discussed, and the partner trustworthy, working according to safety and environmental policies, but there is not necessarily interest to take the relationship one step further to think of relationship synergies and co-creation of value. However, the more complete the offerings are (like availability and performance partnering), the more the relationship focus of this group should shift from the transactional side towards the relational side (see figure 9). Otherwise the completeness of the offering and the nature of the relationship do not match, and this can cause dissatisfaction among the service partners. The full value potential of comprehensive maintenance services is not achieved.

Collaboration-oriented partners emphasize the comprehensive nature of maintenance service value, as they agree that all the factors of the maintenance service value scale are important. The value creation strategy is based on the relational approach. This group highlights the positive effects of relationships and outsourcing, and aims to exploit the potential of cooperation. Instead of short-term transactions, the focus is on long-term development. For collaboration-oriented partners, more complete offerings, like performance partnering are suitable service models.

Contribution

In previous studies, the comprehensive nature of maintenance service value has received less attention, and the literature has focused on the technical and financial aspects. The results of this paper provide a new conceptualization of the value-creating elements, including also non-financial elements, and offers an integrated measurement scale for the actors to identify the comprehensive value construct around maintenance services. The measurement scale can be used as a base for network- and company-level measurement building, and to communicate and create mutual understanding of the current level of practices and aimed service level. The comprehensive measurement scale helps companies to extend their understanding beyond the cost-centric view towards value-added processes by identifying different cost and benefit aspects they have been unaware of previously. As the findings showed, the actors in the field have still varying strategies when considering value creation; some are very transaction-oriented, whereas others are very relational-oriented. Communication and mutual understanding of the value creating strategies is important, so that right services are carried out and developed with the right partners. The service network can be moved step by step from the traditional arm's length towards value creation through collaboration and joint development.

4.3 Publication 3 - Managing industrial maintenance – networked model

Objectives

The aim of the third publication was to analyse the current maintenance service operations within seven case companies and to develop a networked offering framework. The purpose of this framework was to help to understand the complexity of service networks, which is one of the agendas of service network research of Henneberg et al. (2013). The data was gathered in case companies, and altogether nine interviews were conducted (of which four were on the equipment provider side, two on the maintenance service provider side, and three on the maintenance service customer side). Detailed descriptions of the case companies can be found in chapter 3.3.2 (Qualitative data collection and analysis) and table 5 (main characteristics of the case companies). The main context for the case companies was process, energy and mining industries where the role of maintenance is critical, as stoppages of uniform production lines can be very costly (due to production losses).

Main results

There are at least four ways of maintenance service provisioning at the moment. First, in-house maintenance is still in place at many sites, even though it might not perform the most demanding tasks. In the in-house model, the customer is responsible for maintenance and has workers specialized in maintenance on the payroll. Maintenance services are provisioned in case special knowledge is needed, and in these cases the customer acts mainly as the integrator. Second, maintenance services can be acquired from the original equipment manufacturers that have expanded their product business towards service. The equipment providers usually offer specialized maintenance for their own products, but can serve as main contractors as well and operate as performance partners. Depending of the role of the equipment provider and comprehensiveness of the service offering, also the role of the customer changes from integrator to participant and to bystander. Third, maintenance services can be acquired from mainly locally operating maintenance companies, which are often established as an outsourced maintenance function. They have responsibilities mainly within general maintenance and the customers' role is to act as a participant by providing also their own maintenance specialist to the operations, or act as a bystander in case general maintenance is fully outsourced. The fourth way is to use size-wise larger maintenance companies that cover geographically wide areas. They have often the most advanced offering concepts where the customers' role is to be a bystander and enjoy the service. However, while these actors have functioning concepts and business models, the companies are somewhat restrained resource-wise. Maintenance is labour-intensive, which restricts the growth to some extent. In the end, also in these models (where the maintenance company works as an integrator), an active participant role of the customer and/or equipment provider is often required.

On the basis of the case evidence, the current maintenance field is quite scattered and as a function still somewhat underdeveloped, and in many cases treated as an obligatory cost, e.g. customer companies buying maintenance services use different approaches at different sites. While one site might be fully outsourced, others are still maintained in-house. Maintenance is usually done by combining in-house practices with service provisioning from original equipment manufacturers and maintenance companies, resulting in a complex net of different actors. The case companies saw that there was room for more comprehensive measurement and new kinds of business models. However, the general comment from all respondents was that at least some level of maintenance knowledge should be maintained in-house (at the customer site) also in the future.

The results also suggest that a single service provider is rarely the optimal case for maintenance, as maintenance companies have certain key competencies, but lack knowledge in other areas. With multiple actors, key knowhow on different areas could be utilized better. Therefore, a locally networked maintenance framework is proposed. Within a locally established maintenance network, the actors share their key competencies, individual needs, scheduling information, etc. in order to outperform individual maintenance operations. The local network could have several customer sites in it. This way the workforce could be better organized, and a momentary lack of workforce could be avoided as the customers could also communicate within the network for example about maintenance-intensive operations, e.g. yearly shutdowns, and avoid having them on simultaneously. The difference between the current maintenance networks and the networked maintenance model would be an active organization of tasks and a mutual goal for the network participants where they are committed. The network would not just evolve around the participants (like many current maintenance networks), but in the suggested model the network is built purposefully and managed and developed actively.

Contribution

The study contributes to the business-to-business service and network literature by presenting how maintenance services are currently managed and by discussing the possibility of a networked maintenance offering. The main challenges recognized by the case participants that restrict maintenance development 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. To overcome the challenges, a locally networked maintenance offering model is suggested. In the networked model, multiple actors concentrate on how their core competencies could benefit the mutual goal of the whole network, instead of individual companies developing comprehensive maintenance offerings. The networked model and its participants also need to be led and developed actively. The main question in the networked model is which maintenance practices would be performed by which actor. At least one network integrator is needed in addition to the different participant roles. The locally networked maintenance model requires also a notable change in the

mind-sets of the different actors from cost to process enhancement, as well as mutual value creation.

One of the key issues when developing a networked maintenance offering is the forming of mutual trust and commitment across the network participants. Other local network model requirements pointed out by the case participants were a transparent network with direct connections and clear responsibilities, agreed division of costs and profits, network-level monitoring and development, open communication, and a shared mind-set regarding mutual goals. An ideal case for a networked maintenance offering would be open books -type business. However, to allow the formation of trust and development of mutual practices, it is recommended to first pilot the locally networked model for a sub-process within the customer's operations before launching the model to the whole process. Companies need to work closely together to find the best value creating setting for every participant.

4.4 Publication 4 - Stagewise process towards collaborative and value-driven decisions in maintenance networks

Objectives

The main objective of the fourth and final paper was to find out how the value of industrial maintenance services can be identified and modelled, considering the views of each business network member, and how the multiple views can be used in collaborative decision making. The research was conducted as a case study where two maintenance business networks formed the case. The first network operated in mining industries, and the second one in the energy industry. Overall, seven case companies participated in the research, including maintenance service customers, maintenance service providers and equipment providers.

Main results

The findings showed that the existing collaboration level between the actors in a maintenance network affects greatly the value potential that can be realized with different value management tools. By increasing the openness and collaboration level of the actors, the value potential of the created tools and network increases. However, this does not happen overnight, but requires transparency between the actors, as well as long-term network relationships. In addition, initial willingness for collaboration is required. The transition towards collaborative operations occurs step by step, as mutual trust grows within the service network.

A stagewise process was suggested, where it was shown how companies could utilize the created value management tools to support the transition from basic service relationships towards collaborative and value-driven maintenance service networks and network-level service offerings. Value can be co-created through all process stages, but the underlying value potential, especially concerning services, grows as the collaboration level increases.

The first stage is the starting point for network-level value creation. In the first stage the participants explore what the others want from the relationship and whether they are ready to increase their collaboration level in the service network. For example, the Value Profile tool can be utilized for identifying the value perceived by the partners in the service network. With the Value Profile tool, the most important value creating elements for each party are identified and drawn into a radar diagram to enhance development discussions (see publications 1 and 4).

When co-operation between the service partners has been established and trust developed over medium-term collaboration, the network parties have moved to the second stage. Here the parties are ready to share some sensible data, like costs and profits, but the sharing of information can still be quite regulated and controlled, so that the benefits and risks are clearly defined for each party (e.g. in a mutually defined contract). Here for example the life-cycle model (LCM) presented by Sinkkonen et al. (2015) and flexible asset management (FAM)-model presented by Marttonen et al. (2013) can be utilized to model the perceived value. The LCM calculates the cumulative net present value of maintenance and the benefit/cost ratio. If the economic gains have been spread unevenly between the network partners, collaborative actions should be taken to promote the competitiveness of the whole network. The FAM-model, on the other hand, shows the impact of fixed assets and working capital on the return on investment and can be used in strategic decision-making, e.g. in maintenance contract negotiations or investment portfolio planning.

In the third stage of the stagewise process, mutual trust has been developed over the long term, collaborative practices have been established, and the different parties of the maintenance service network have initial willingness to develop mutual goals and network-level performance measurement systems. Openness and trust –related issues are not just regulated with contracts, but there is true interest in doing business together and increasing the competitive advantage of the whole network. When reaching this stage, it is suggested to develop a network level performance measurement system (PMS), as presented by Ukko et al. (2015), so that the perceived value can be managed actively on the network level. However, reaching stage 3 is still quite rare, and currently the maintenance service networks can be considered to be on stages 1 and 2.

It should also be acknowledged that as with poorly managed outsourcing, also poorly managed openness can create potential risks and negative effects. Theft and critical knowledge spill-overs ending in the wrong hands (e.g. a rival's) can be the most extreme ones (Cassiman and Veugelers, 2002; Laursen and Salter, 2014). Legal protection methods like patents and trademarks protect to some level but might be arduous to implement, and it is also often quite easy to invent around existing patents (Mansfield et al., 1981). Therefore, formal or at least informal agreements should be negotiated between the network partners to reach mutual understanding (Laursen and Salter, 2014). In addition, partial information sharing can be one solution when sharing sensitive data.

As legal departments can make the agreements heavy and processes complex, it is of benefit that the network connections are based on relational relationships. This decreases the different parties' opportunistic behaviour and eases the operations (Windolph and Moller, 2012). If the relationships are more at a transactional stage, the heavy legal operations might scare the potential collaborators and lengthen the agreement process unnecessarily. Other challenges, especially related to data openness, can decrease efficiency when the openness practices are built on top of the existing processes instead of renewing the operations, thus wasting already limited resources. Nevertheless, also in the case of successful renewing of practices, modification takes time, and also new system investments are often needed (Accordino, 2013; Herala et al., 2016; Huijboom and Van den Broek, 2011). In some cases, the old organizational culture can be the biggest challenge, as for open operations, change is required in previously known practices (Huijboom and Van den Broek, 2011). This supports the stagewise development of openness in the relationships, so that the development of organizational cultures can be continued in the network setting.

Contribution

Previous research has concluded that network-level management is needed to optimize the maintenance operations on both the strategic and operational level. This publication contributes to the discussion by addressing the prerequisites needed from the actors operating in a maintenance service network. By increasing the collaboration level and openness of the network stagewise, the overall competitive advantage of the network can be increased, and also more complete offerings provided. The network is no longer only sub-optimized from one party's perspective, but comprehensive service value can be developed.

4.5 Summary of the results

The objective of this thesis was to explore and understand different value creation strategies in the maintenance service network. All the four individual publications introduced above have their own contribution to the final conclusions of the thesis. Table 8 summarizes the main findings and presents the contribution of each publication to the overall objective of the thesis.

Publications 1, 2 and 3 are connected to the first research question: *What are the value creating elements and features in industrial maintenance services?* Publication 1 presents a first suggestion of the value creating elements, and publication 2 captures the seven main elements (relationship synergies, reliability of the service partner, development, availability, service solutions and problem solving ability, EHSQ (environment, health, safety and quality), and adaptability to suit different situations), and presents maintenance service value as a multidimensional phenomenon. More specific definitions of the elements can be found above in table 7, section 4.2 (Maintenance service value as a multidimensional construct). Publication 3 supports the idea that service value is considered to be case-specific and complex to assess by different network actors.

Publications 3 and 4 are connected to the second research question: *How are the maintenance service operations currently managed?* Based on the case evidence in publication 3, the current maintenance field is quite scattered, and customer companies buying maintenance services use different approaches at different sites. While one site might be fully outsourced, others are still maintained in-house. Maintenance is still in many cases treated as an obligatory cost, and the case companies see that there is room for more comprehensive measurement and new kinds of business models. There are at least four ways of maintenance service provisioning at the moment: in-house maintenance, acquiring maintenance from original equipment manufacturers that have expanded their product business towards service, acquiring maintenance from mainly locally operating maintenance service companies, or to use size-wise larger maintenance service companies that cover geographically wide areas.

The results suggest that a single service provider is rarely the optimal case for maintenance, as maintenance companies have certain key competencies but lack knowledge in other areas. With multiple actors, key knowhow on different areas could be utilized better. Therefore a locally networked maintenance framework is proposed. Within a locally established maintenance network, the actors share their key competencies, individual needs, scheduling information, etc. in order to outperform individual maintenance operations. The local network could have several customer sites in it. This way the workforce could be organized better and momentary lack of workforce avoided, as the customers could also communicate within the network for example of maintenance-intensive operations e.g. yearly shutdowns, and avoid doing them simultaneously. Publication 4 shows that the current collaboration level is crucial when considering the functionality of a possible maintenance service network. The transition towards collaborative operations occurs step by step as mutual trust grows within the service network.

In addition to the above-mentioned questions, publications 2, 3 and 4 also aim at responding to the third and final research question: *What are the prerequisites for a successful maintenance service network?* Publication 2 shows that the actors operating in the maintenance field are heterogeneous; some actors are very transaction-oriented, whereas others are very relation-oriented in terms of value creation. Communication and mutual understanding of the value creating strategies is important, so that more successful service networks can be built around industrial maintenance.

Publication 3 points out one of the key questions in the networked setting by discussing which maintenance practices would be performed by which actor. At least one network integrator in addition to the different participant roles is needed. One of the key issues in the forming stage of a network-level service offering is mutual trust and commitment across the network participants. Other local network model requirements pointed out by the case participants were a transparent network with direct connections and clear responsibilities, agreed division of costs and profits, network-level monitoring and development, open communication, and a shared mind-set on mutual goals. An ideal case for network-level maintenance offerings would be an open books -type of business. To

allow the operations to develop, it is recommended to first pilot the networked model for a sub-process within the customer's process before launching the model to the whole process. Publication 4 contributes to the discussion by highlighting the importance of openness and collaboration in networked service operations. The required level of collaboration for the service network does not develop overnight, but requires transparency between the actors and long-term network relationships. In addition, initial willingness for collaboration is required. By increasing the collaboration level and openness of the network stagewise, the overall competitive advantage of the network can be increased, and also more complete offerings provided.

Table 8. Summary of the individual publications and their main results

	Publication 1	Publication 2	Publication 3	Publication 4
Title	Value elements of industrial maintenance: verifying the views of the customer and service provider	Understand what your maintenance service partners value	Managing industrial maintenance – networked model	Stagewise process towards collaborative and value-driven decisions in maintenance networks
Objectives	To verify the most important value elements for the maintenance service customer and provider and also to recognise where the value elements differ	To conceptualize the maintenance service value construct through an examination of its elements, and to provide insight into its actors' (i.e. customer companies, service providers, equipment providers) attitudes towards value creation	To analyse the current maintenance operations within seven case companies and to develop a networked offering framework	To find out how the value of industrial maintenance services can be identified and modelled considering the views of each business network member and how the multiple views can be used in collaborative decision making
Research methods	Survey	Survey	Case study	Case study
Empirical data	83 questionnaires (collected in Finland)	Survey data (same as in publication 1)	Nine interviews of case company representatives and support material	From two maintenance business networks (seven case companies)
Main results	First suggestion of the value creating elements in industrial maintenance services. The results also point out that there are case specific features in the value elements and this should be acknowledged in service negotiations	Seven main elements that capture maintenance service value. Further analysis revealed that the actors can be divided into three main strategy types: basic, quality and collaboration - oriented partners.	Requirements for networked maintenance. The results suggest that a single service provider is rarely the optimal case for maintenance.With multiple actors, key knowhow on different areas could be better utilized.	Three stages towards collaborative and value-driven maintenance service networks are identified. The transition towards collaborative operations occurs step by step as mutual trust grows within the service network.
Main contribution to the thesis	The value elements provide a base for discussions and a way to present the expected benefits in a service offer. The identification of value is made more concrete for managers so that value can be better managed in service relationships.	Conceptualization of the value creating elements in industrial maintenance services. Value creation strategy types.	Presents how maintenance services are currently managed and discusses the possibilities of a locally networked maintenance offering model.	Addresses the prerequisites needed for a succesful maintenance service network. By increasing the collaboration level and openness of the network stagewise, the overall competitive advantage of the network can be increased, and also more complete offerings provided.
RQ adressed	RQ1	RQ1, RQ3	RQ1, RQ2, RQ3	RQ2, RQ3

4.6 Capturing different value creation strategies in a framework

As described in the literature review (section 2.2) on value creating services and service networks, existing studies have identified that the nature of service relationships varies and can be considered to form a continuum from transactional to relational exchange and full collaboration (e.g. Axelsson and Wynstra, 2002; Lindgreen et al., 2012; Penttinen and Palmer, 2007). In addition, the completeness of a service offering can be measured on a continuum from less complete (e.g. basic components) to more complete offerings (e.g. integrated solution) (Oliva and Kallenberg, 2003; Penttinen and Palmer, 2007). In service networks, the tangible aspects (i.e. products) are of primary importance in the beginning, but as the service relationship develops the intangible aspects (i.e. service) become more important, and the network can be formed around capabilities (Henneberg et al. 2013). The inference of this mixed methods study has been created by combining these dimensions and the findings of the quantitative and qualitative studies summarised in table 8. More specifically, different value creation strategies and their main features are captured in a framework (figure 10). The framework presents the identified value creation strategies at different relationship and offering levels. The path towards successful maintenance service networks can be characterized as a stagewise process moving from stage 1 (less complete/transactional) to stage 2 (more complete/transactional or less complete/relational), and eventually to stage 3 (more complete/relational) service networks. The framework presents the findings of the thesis as value elements and development possibilities that can advance the value creation and competitiveness of a maintenance service network.

Each strategy (box in the quadrat) can create value, as long as the offering suits the needs of all parties and the collaboration level of the network is on the required level. However, the more complex the offerings become (e.g. performance partnering), the more the network should shift to the upper right corner. To achieve the best value in a maintenance service network, the value-creating elements need to be communicated actively between the actors, so that the collaboration level of the network and the offering level can be developed to the most suitable box in the quadrat. The conceptualized value elements (see publication 2) and the value profile (see publication 1) can be utilized to identify the current collaboration level and to communicate the non-financial and intangible benefits of the service relationship more concretely to the different partners.

Stage 1 represents the starting point of a maintenance service network, where value creation is based on transactional relationships. For basic service networks, the service offerings focus on the delivery and maintenance of basic components (e.g. delivering spare parts), and no specific value elements or value propositions are emphasized.

Stage 2 represents two different value creation strategies. If the companies emphasize the service offering aspects in the network, they represent a quality-oriented service network where value elements like EHSQ, adaptability to suit different situations, and reliability of the service partner are highlighted. The quality-oriented service networks should focus on basic solutions (e.g. basic maintenance), as the collaboration level between the service

partners is still quite low. If the firms develop highly specified and differentiated offerings on a transactional basis, the coordination cost may be a challenge, as Penttinen and Palmer (2007) suggest.

However, if the companies are able to control the coordination costs, this can also be a successful strategy even with complex solutions. The second value creation strategy on stage 2 is to emphasize the relationship aspects in the network. In this case, a relational service network is represented, where relationship synergies are highlighted by the actors. The success in this stage comes from higher market shares and easiness in operations. For example, integrated components with long-term service contracts can be a suitable offering. However, also here Penttinen and Palmer (ibid.) identify challenges in keeping the relationship costs at a decent level. Stage 2 can create value to the actors, but the operations need to be managed carefully, so that the coordination or relationship costs do not surpass the achieved benefits. There are many examples of outsourced maintenance where high coordination costs have destroyed the value (e.g. through lack of information management), and the original intention to save costs through outsourcing has resulted instead in cost increase for the maintenance service customer and other actors in the network (e.g. Kremic et al. 2006; Liyanage and Kumar 2003; Murthy et al. 2015).

Stage 3 represents a capability and cooperation -driven service network, where the combination of different value elements is considered important, and especially elements like relationship synergies, development, availability, service solutions, and problem solving ability are highlighted. This is the stage for integrated and complex solutions (e.g. performance and value partnering,) as the relational view also supports relationship learning enabled over the long term. At this stage the focus is on the business processes, and value creation is based on active development of the relationship and service offerings. However, as the results suggest, stage 3 and its success potential are not reached overnight, but it requires openness and mutual trust between the actors. In addition, the more complex the network offerings are, the more likely it is for the actors to become dependent on each other (Windahl and Lakemond, 2010).

The framework suggests two different paths that enable the networks to evolve from stage 1 to stage 3, depending on whether the service offering or relationship aspects are emphasized first. The first path suggests developing the service solutions provided first, and then progressing towards more relational relationships in the network as the offerings become more complex. As stated above, this is not compulsory, but developing the relationship synergies and mutual goals can help to gain competitive advantage on the network level. For example, the case networks in publication 3 recognized that to truly engage in the locally networked maintenance offering model requires the development of relational aspects and coordination. The skills were considered to be there already.

The second path towards stage 3 is suggested to begin by developing the relationship synergies in the service network first and still operating with less complete service offerings. After the cooperation activities have been established (e.g. knowledge is shared in the network) and mutual trust exists between the actors, and service solutions and

problem solving ability can be emphasized more. The capabilities of each actor are known, and more complete offerings can be built. Based on the case evidence, the maintenance service networks were currently mainly at stage 1 or 2, but the actors were clearly interested in the next stage by identifying the benefits and development possibilities of a capability and cooperation -driven network. As the results in publication 2 showed, some of the maintenance service actors were already very collaboration-oriented. They just need to find their counterparts, and the development of successful maintenance service networks can begin.

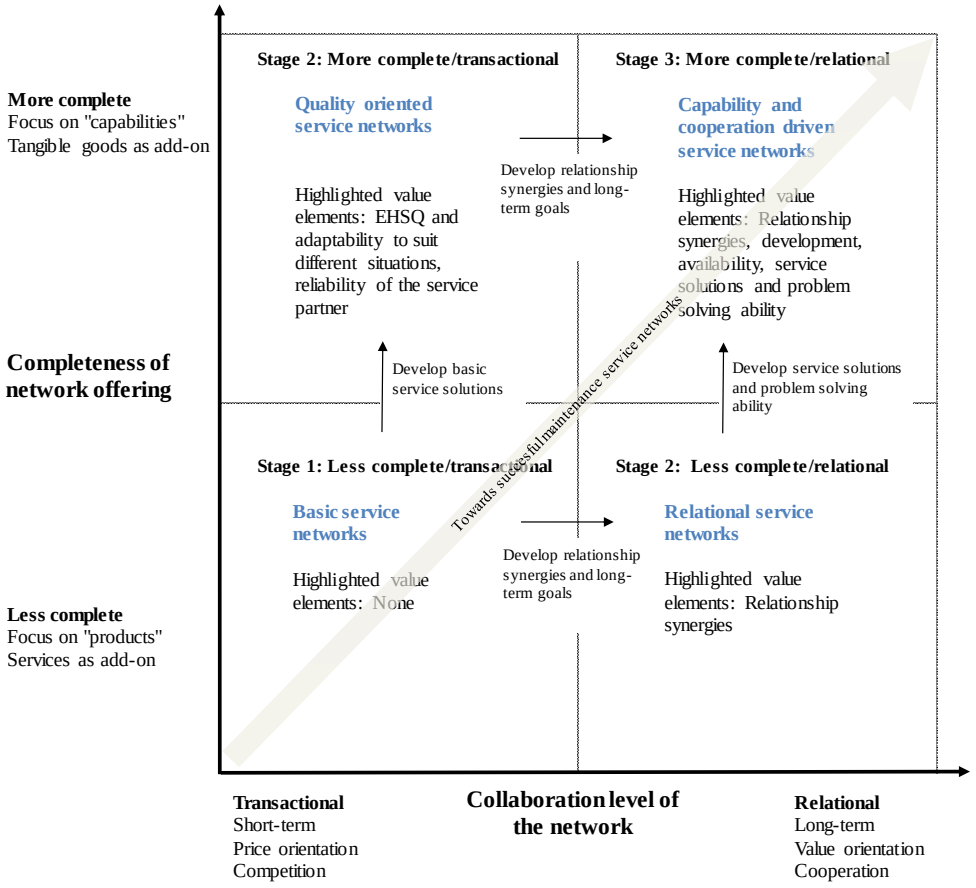

Figure 10. Different value creation strategies in a maintenance service network

5 CONCLUSIONS

This chapter presents the overall conclusions of the thesis in terms of theoretical and managerial implications. In addition, future research directions are discussed. The purpose of the study was to understand different value creations strategies in maintenance service networks. On the basis of the inferences drawn from the results of the individual publications and the synthesised research process in the form of exploratory sequential design, the study suggests that four main value creation strategies with different development paths can be identified in maintenance service networks. The study makes three main contributions: first, it conceptualizes the value-creating elements of maintenance services. Second, it gives empirical evidence of the varying value-creation strategies and heterogeneity amongst the network actors. Thirdly, it builds understanding by presenting a framework where the varying value creation strategies and possible development paths in maintenance service networks are identified.

5.1 Theoretical implications

This study has connected maintenance research with value and industrial service development research. The theoretical ground of this thesis was built mainly on literature concerning strategic maintenance management, industrial service networks, and value creation in business-to-business relationships. The research provides the following insights especially considering the maintenance management and service network literature.

Firstly, the research contributes to the current literature by conceptualizing the value-creating elements of industrial maintenance services. The study shows the value of maintenance services as a multidimensional phenomenon where value is captured with seven main aspects: relationship synergies, reliability of the service partners, development, availability, service solutions and problem solving ability, EHSQ (environment, health, safety and quality), and adaptability to suit different situations. In previous studies, the comprehensive nature of maintenance service value has received less attention, and the literature has focused more on the technical and financial aspects. The findings of this research highlight that the non-financial elements (mentioned e.g. by Liyanage and Kumar, 2003; Ojanen et al., 2012A; Toossi et al., 2013) become critical when aiming at more collaborative relationships in service networks.

Secondly, the research supports the performance measurement of maintenance service relationships. The conceptualized value elements provide a multidimensional measurement construct for value assessment (presented in table 7), with specific focus on maintenance service value. As brought up in the literature (Murthy et al., 2015; Pintelon et al., 2008), more comprehensive value assessment is needed. The conceptualized elements support this view, as also non-financial aspects are incorporated in the measurement scale to help translate the company strategy into long-term maintenance

objectives. If companies aim at creating value through collaboration, the collaboration needs to be managed and measured to avoid organisation-level sub-optimization.

Thirdly, this research identified great heterogeneity among the different actors in maintenance service networks, and the actors were divided into three main value creation strategy types. The actors of the first strategy type "Collaboration-oriented partners" agreed that all the factors of the maintenance service value scale are important. This means that instead of a single value proposition, a combination of different elements is considered meaningful. In the second strategy type "Basic partners", the actors valued certain service aspects less than the first cluster, but still the combination of different elements was considered at least somewhat important. The third strategy type "Quality-oriented partners" emphasized especially quality factors and adaptability. Financial and operative performance were considered as good within the Collaboration-oriented partners. This could indicate that if the business is running smoothly, there is also time to think of development ideas and common projects with the service partners to gain positive synergies. On the other hand, if these do not function well, there is no time and/or desire to consider the other elements around value than the financial one. All the energy goes into running the operative business, and results in basic partners. The big actors were a major group in the basic cluster, and it seemed that they had not yet adopted the value-centric view of maintenance, and the medium and small sized actors were the majority in the two others. For the big companies, maintenance service can be just another function besides the main functions of the company, and cost-centricity is still emphasized.

Fourthly, the research sheds light into the complexity of maintenance service network development. Henneberg et al. (2013) clarify that understanding the complexity of service network development is crucial to understanding the service networks better. This thesis provides a framework (figure 10) for maintenance service actors to identify different value creation strategies and their development paths in the networked environment. Varying routes are presented as possible success strategies. The framework provides a good starting point for studying the development of maintenance service and other industrial networks and their success factors.

5.2 Managerial implications

The principal focus of the thesis is on increasing the understanding of value creation strategies, and therefore the practical side concerns mainly how the theory development should be understood by the managers. Thus, concrete implications may be limited. However, the results provide understanding on what should be considered when managerial tools and models for optimization are built in the industrial service context. The main managerial implications of the research are as follows.

To proceed from transactional networks towards more collaborative ones, mutual understanding of the comprehensive maintenance service value needs to be attained.

First, although research and practice have moved from cost- to value-centric, the findings show that the actors in the maintenance field still have very varying strategies towards value creation: some actors are very transaction-oriented, whereas others are very relation-oriented, and outsourcing is done for multiple reasons (e.g. some aim for cost savings and some for special know-how). Especially a lot of customers seem to consider maintenance as a cost, and prefer transaction-based service relationships as a value creating strategy, like Murthy et al. (2015) suggest. Considering the value creation potential of maintenance, the cost-centric view may be harmful, as it guides the decisions towards the short term. Maintenance and other knowledge-intensive business services should be managed with a long-term business -oriented view to enable a learning process in the relationship and see the value achieved in the long run (Kohtamäki and Partanen, 2016; Liyanage and Kumar, 2003; Parida and Kumar, 2006). This emphasizes the role of communication between the service actors.

The multidimensional value construct built in this study can be used as a base for network- and company-level value measurement building and for communicating and creating mutual understanding of the value-creating elements between the service partners.

Second, maintenance service value is considered complex to manage, but by using the created factors presented in table 7, some systematics can be brought into the process. Integrated measures are needed by the customers and the service providers, as they will help the building of sustainable relationships and networks (Ahonen et al., 2010; Panesar and Markeset, 2008; Reinartz and Ulaga, 2008). The value construct makes also the soft values more concrete and supports the development of a common language by identifying the non-financial side of the service. The service providers need to ensure that they address all the most important value-creating elements when providing complete offerings like performance partnering. The value construct can be used to benchmark the current level of practices and aimed service level. Also the customers need to ensure that they consider the value-creating elements comprehensively when procuring maintenance services, and that their partner is capable of providing the needed service level (Toossi et al., 2013). The core of successful service relationships between different service partners, as Rosqvist et al. (2009) highlight, is a common view of the maintenance objectives that arise from strategic objectives and key performance indicators (KPIs). The multidimensional construct of the value creating factors could be used as a base to determine suitable performance measures and objectives for the maintenance service. The service network can be moved step by step from the traditional arm's length towards collaborative value creation. The comprehensive value construct helps the companies to extend their understanding beyond the cost-centric view towards the value-added processes, which is emphasized e.g. by Liyanage and Kumar (2003) and Parida and Kumar (2006), and to see maintenance management from a more strategic perspective.

Often the offerings and the nature of the relationship do not match, and this causes conflicts and dissatisfaction between the service partners.

Third, communication and mutual understanding of the value-creating elements is also important when considering the development of the relationships and service offerings in a maintenance service network. For transaction-oriented actors, less complete service offerings, like spare parts and basic solutions are suitable (Penttinen and Palmer, 2006; Rekola and Haapio, 2009). However, the more complete the offerings are (like availability and performance partnering), the more the relationship focus of the network should shift to the relational side and take the value-creating aspects of maintenance services into consideration comprehensively. Heterogeneity among the customers and service providers is probably one reason why the building of successful service networks is considered complex. To achieve the best value in service networks, the value-creating elements need to be communicated actively between the actors so that the relationship levels and offerings will match. Basic, quality- and collaboration -oriented partners will find their counterparts.

Successful maintenance service networks are built stagewise.

Fourth, the framework presented in figure 10 identifies possible value-creation strategies for maintenance service actors. The framework provides a tool for understanding and identifying the different network stages: basic service networks, quality-oriented service networks, relational service networks, and capability- and cooperation -driven service networks. By increasing the collaboration level and openness of the network stagewise, the overall competitive advantage of the network can be increased, and also more complete offerings provided. With the framework, the actors see what relationship style their current or aimed offering level requires and what are the development paths towards more complete offerings and increased collaboration in the network. For example, if the network actors are currently operating with basic services and desire to move towards availability or performance partnering, a strategy shift towards more relational relationships is required to be able to move on the continuum. The transition towards collaborative operations occurs step by step as mutual trust grows within the service network. In addition, the capability- and cooperation -driven service networks require a notable change in the mindset 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. However, it should be remembered that as each stage of the framework can create value to the different parties as long as the offering and collaboration levels match, not all networks need to aim at the highest stage (capability and cooperation driven service networks) in the framework.

5.3 Suggestions for future research

The findings of this thesis provide some particularly interesting avenues for future research. *Firstly* the framework towards successful maintenance service networks needs to be verified in an empirical context. The framework is presented as the inference of this study, and even though parts of it have been tested in an empirical context, the complete

framework and its verification still needs future research. As the relationship level of the network and its development is an important factor in the framework, the different value creation strategies and their development over the long term should be followed with a longitudinal study. Relational relationships are often built over several years, and in addition the true value created with appropriate maintenance services can often be hidden in short-term follow-ups (e.g. no breakdowns versus breakdown of a critical item due to poor maintenance operations three years after the official contract termination). Therefore, a more in-depth research strategy would support the verification of the complete framework and add further dimensions to the different value creation strategies.

Secondly, closely related to the first research avenue, it would be interesting to focus future research on company performance compared to its value creation strategy. Would more comprehensive value creation strategies with relational aspects also foster better operational and/or financial performance? The cluster analysis suggested that the collaboration-oriented partners slightly outperformed the other clusters in operative and financial performance, but this might also be a statistical curiosity. Future research would require a bigger sample within the different clusters, so that the statistical findings could be considered as significant.

Thirdly, there are possibly country- and/or industry -specific features that affect the selected value creation strategy. Therefore, future research is required to identify these possible factors. As the sample size of the study was limited, industry-specific features were not identified in the sample.

Fourthly, development of performance measures that would support comprehensive value assessment should receive future research attention. The multidimensional value construct presented in this study provides a good base for a measurement framework. However, functionality should be tested in an empirical setting, for example with a case study. A functioning measurement framework that incorporates both non-financial and financial elements could be used to support the discussions between the different actors in a maintenance service network. In addition, by including also non-financial elements in the performance measures, the mutual development objectives and target values could be followed more comprehensively.

Fifthly, future research is needed to identify the possibilities of IoT (Internet of Things) and other information system possibilities that would support the network context. Data management was not in the focus of this thesis. However, it is acknowledged that to support decision making as effectively as possible, also information technology and its different solutions should support the management practices (e.g. Bitici et al., Franco-Santos et al., 2007). Especially in relational value creation strategies, information systems, and more specifically smart factory approaches could support openness, easiness of operations and straightforward communication, e.g. with different platforms for information and data sharing. It should be acknowledged throughout that the selected solutions should enhance the current operations and not just add one system to the network. Non-purposeful information systems will not add to the functionality of the

service network, just the opposite. Therefore, the emerging opportunities of the Industry 4.0 context should be used carefully in attempts to optimize value creation. Intelligent maintenance planning as proposed by Upasani et al. (2017) could be one good example of purposeful optimization. In their work, a distributed algorithm is created to shorten the planning time of preventive maintenance and its scheduling significantly by utilizing the capabilities of Cyber-Physical Systems (CPS).

Finally, future development of the industrial field and its effects on maintenance is seen as the *sixth* future research target. How will the digitalization of the business affect for example the value elements? Will accessibility, delivery and locality be valued in the future as well, or will virtual presence replace these elements? In addition, will companies utilize the value potential created by networks or will the outsourcing trend turn and result in more in-house solutions? Furthermore, what is the influence of policy development, towards or against network level collaboration of different companies? At least recent news support the development interests to be still on more comprehensive and strategic partnerships that also provide a fruitful base for network-level cooperation (see e.g. Metso, 2016; Wärtsilä, 2017).

REFERENCES

Accordino, F. (2013), "The Futurium – a Foresight Platform for Evidence-Based and Participatory Policymaking", *Philosophy & Technology*, Vol. 26, No. 3, pp. 321-332.

Ahonen, T., Reunanen, M., Pajari, O. and Ojanen, V. (2010), "Maintenance communities – a new model for the networked delivery of maintenance services", *International Journal of Business Innovation and Research*, Vol. 4, No. 6, pp. 560-583.

Alajoutsijärvi, K., Mainela, T., Ulkuniemi, P., and Montell, E. (2012), "Dynamic effects of business cycles on business relationships", *Management decision*, Vol. 50, No.2, pp. 291-304.

Al-Sultan, K.S. and Duffuaa, S.O. (1995), "Maintenance control via mathematical programming", *Journal of Quality in Maintenance Engineering*, Vol. 1 No. 3, pp. 36-46.

Alsyouf, I. (2009), "Maintenance practices in Swedish industries: Survey results", *International Journal of Production Economics*, Vol. 121, No. 1, pp. 212-223.

Alsyouf, I. (2006), "Measuring maintenance performance using a balanced scorecard approach", *Journal of Quality in Maintenance Engineering*, Vol. 12, No. 2, pp. 133-149.

Al-Turki, U. (2011), "A framework for strategic planning in maintenance", *Journal of Quality in Maintenance Engineering*, Vol. 17, No. 2, pp. 150-162.

Anderson, J. C., Narus, J.A. and Van Rossum, W. (2006), "Customer value propositions in business markets", *Harvard Business Review*, Vol. 84, No. 3, pp. 90-99.

Anderson, J. C. and Narus, J. A. (2004), *Business market management: Understanding, creating and delivering value*, Upper Saddle River: Pearson Education.

Anderson, J.C. and Narus, J.A. (1998), "Business marketing: Understand what customers value", *Harvard Business Review*, (November–December), pp. 53–65.

Anderson, J.C., Thomson, J.B.L. and Wynstra, F. (2000), "Combining price and value to make purchase decisions in business markets", *International Journal of Research in Marketing*, Vol 17, No. 4, pp. 307-329.

Anderson, J.C. and Wynstra, F. (2010), "Purchasing higher-value, higher-price offerings in business markets", *Journal of Business-to-Business Marketing*, Vol. 17, No. 1, pp. 29-61.

Annual reports (2016):

Cargotec (2016), "Annual review 2015", [online] http://www.cargotec.com/en-global/investors/materials/financial-reports/Pages/default.aspx [accessed 20.10.2016].

Konecranes (2016), "The direction is clear – Konecranes Annual report 2015", [online] http://www.konecranes.com/raportit-ja-presentaatiot [accessed 20.10.2016].

Metso (2016), "Metso 2015 – Annual Review", [online] http://www.metso.com/company/investors/reports-and-presentations/ [accessed 20.10.2016].

Valmet (2016), Annual review – Valmet's operations and sustainability in 2015 [online] http://www.valmet.com/investors/reports-and-presentations/annual-reports/ [accessed 20.10.2016].

Wärtsilä (2016), "Wärtsilä Corporation – Annual report 2015" [online] http://www.wartsila.com/investors/reports-presentations/annual-report-material [accessed 20.10.2016].

Armstrong, J.S. and Overton, T.S. (1977), "Estimating non-response bias in mail surveys", *Journal of Marketing Research*, Vol. 14, No. 3, pp. 396-402.

Axelsson, B. and Wynstra, F. (2002), *Buying business services*, Chichester: John Wiley & Sons.

Babbie, E. (1990), *Survey research methods*, 2nd edition, Belmont California: Wadsworth.

Ballantyne, D. and Varey, R.J. (2006), "Creating value-in-use through marketing interaction: the exchange logic of relating, communicating and knowing", *Marketing Theory*, Vol. 6 No. 3, pp. 335-348.

Ballantyne, D., Frow, P., Varey, R.J. and Payne, A. (2011), "Value propositions as communication practice: Taking a wider view", *Industrial Marketing Management*, Vol. 40, Iss. 2, pp. 202-210.

Barry, J. and Terry, T. (2008), "Empirical study of relationship value in industrial services", *Journal of Business & Industrial Marketing*, Vol. 23, No. 4, pp. 228–241.

Bengtsson, M. and Kock, S. (2000), "Coopetion' in business networks – to cooperate and compete simultaneously", *Industrial Marketing Management*, Vol. 29, No. 5, pp. 411–426.

Bertolini, M., Bevilacqua, M., Braglia, M. and Frosolini, M. (2004), "An analytical method for maintenance outsourcing service selection", *International Journal of Quality & Reliability Management*, Vol. 21 No. 7, pp. 772-88.

Bititci, U., Garengo, P., Dörfler, V. and Nudurupati, S. (2012), "Performance measurement: Challenges for tomorrow", *International Journal of Management Reviews*, Vol. 14, No. 3, pp. 305–327.

Blocker, C.P. (2011), "Modeling customer value perceptions in cross-cultural business markets", *Journal of Business Research*, Vol. 64, No. 5, pp. 533-540.

Brito, E.P.Z., Beneduzzi, R.L. and Brito, A.L.A.L. (2007), "Customer choice of a car maintenance service provider: A model to identify service attributes that determine choice", *International journal of Operations & Production Management*, Vol. 27, Iss. 5, pp. 464-481.

Bryman, A. (2008), *Social research methods*, 3rd edition, New York: Oxford University Press.

Bryman, A. and Bell, E. (2011), *Business Research Methods*, 3rd edition, New York: Oxford University Press.

Burrell, G. and Morgan, G. (2005), *Sociological paradigms and organisational analysis*, England: Ashgate Publishing.

Campbell, J.D. (1995),"Outsourcing in maintenance management", *Journal of Quality in Maintenance Engineering*, Vol. 1, Iss. 3, pp. 18-24.

Cassiman, B. and Veugelers, R. (2002), "R&D Cooperation and Spillovers: Some Empirical Evidence from Belgium", *The American Economic Review*, Vol. 92, No. 4, pp. 1169-1184.

CEN (2007) 'Maintenance - Maintenance key performance indicators', *CEN - European Committee for Standardization*, Brussel, Belgium, EN 15341:2007.

Cherryholmes, C. H. (1992), "Notes on pragmatism and scientific realism", *Educational Researcher*, Vol 21, No. 6, pp. 13-17.

Cooper, R. and Slagmulder, R. (1999), *Supply Chain Development for the Lean Enterprise: Interorganisational Cost Management*. Productivity Press, Portland.

Corsaro, D. (2014), "The emergent role of value representation in managing business relationships", *Industrial Marketing Management*, Vol. 43, Iss. 6, pp. 985-995.

Corsaro, D., and Snehota, I. (2010), "Searching for relationship value in business markets: Are we missing something?," *Industrial Marketing Management*, Vol. 39, No. 6, pp. 986–95.

Crespo Márquez, A. (2007), *The maintenance management framework: Models and methods for complex systems maintenance*. - Springer series in reliability engineering, London: Springer.

Crespo Márquez, A., Moreu de León, P., Gómez Fernández, J.F., Parra Márquez, C. and López Campos, M. (2009), "The maintenance management framework – A practical view to maintenance management", *Journal of Quality in Maintenance Engineering*, Vol. 15, No. 2, pp. 167-178.

Creswell, J. (2009), *Research design: Qualitative, quantitative and mixed methods approaches*, 3rd edition, Thousand Oaks, California: SAGE Publications.

Creswell, J. W. (2015), *A concise introduction to mixed methods research*, Thousand Oaks, California: SAGE Publications.

Crotty, M. (1998), *The foundations of social research - Meaning and perspective in the research process*, London: SAGE Publications.

Day, G.S. (2000), "Managing market relationships", *Journal of the Academy of Marketing Science*, Vol. 28, No. 1, pp. 24–30.

Duffuaa, S.O., Al-Ghamdi, A.H. and Al-Amer, A. (2002), "Quality function deployment in maintenance work planning process", *The 6th Saudi Engineering Conference, KFUPM*, Dhahran, 21-23 October.

Dyer, J.H. and Nobeoka, K. (2000), "Creating and managing a high-performance knowledge-sharing network: the Toyota case", *Strategic Management Journal*, Vol. 21, No. 3, pp. 345-367.

Easterby-Smith, M., Thorpe, R. and Lowe, A. (2002), *Management research*, 2nd edition, London: SAGE Publications.

Easton, G. (2010), "Critical realism in case study research," *Industrial Marketing Management*, Vol. 39, No. 1, pp. 118–28.

Edvardsson, B., Gustafsson, A. and Roos, I. (2005), "Service portraits in service research: a critical review", *International Journal of Service Industry Management*, Vol. 16, No. 1, pp. 107-121.

EFNMS (2016), "Details of the safety and environment committee", [online] http://www.efnms.org/European-Health-Safety-and-Environment-Committee/m27l2/European-Health-Safety-and-Environment-Committee-EHSEC.html [accessed 20.5.2016].

Eisenhardt, K. M. (1989), "Building theories from case study research," *Academy of Management Review*, Vol. 14, No. 4, pp. 532–50.

EU-OHS (2012), "Procurement of maintenance services and health and safety at work, E-fact 63" [online] https://osha.europa.eu/en/publications/e-facts/e-fact-63-procurement-of-maintenance-services-and-health-and-safety-at-work (accessed 27 June 2013).

Finnish Maintenance Society (2007), "Maintenance in national economy of Finland", [online, in Finnish] http://www.promaint.net/instancedata/prime_product_yhdistys/kp-media/embeds/promaintwwwstructure/kunnossapito_2007_180407.pdf [accessed 20.5.2016].

Ford, D. and McDowell, R. (1999), "Managing business relationships by analyzing the effects and value of different actions", *Industrial Marketing Management,* Vol. 28, No. 5, pp. 429-442.

Gebauer, H., Paiola, M. and Saccani, N. (2013), "Characterizing service networks for moving from products to solutions", *Industrial Marketing Management*, Vol. 42, No. 1, pp. 31-46.

Gelders, L., Mannaerts, P., and Maes, J. (1994), "Manufacturing strategy, performance indicators and improvement programmes", *International Journal of production Research,* Vol 32, No. 4, pp. 797-805.

Grönroos, C. (2011), "Value co-creation in service logic: A critical analysis", *Marketing Theory*, Vol 11, No. 3, pp. 279–301.

Grönroos, C. (2001) *Service Management and Marketing: A Customer Relationship Management Approach*, 2nd edition, New York: Wiley.

Grönroos, C. and Helle, P. (2010), "Adopting a service logic in manufacturing: Conceptual foundation and metrics for mutual value creation, *Journal of Service Management*, Vol. 21, No. 5, pp. 564-590.

Grönroos, C. and Ravald, A. (2009), "Marketing and the logic of service: value facilitation, value creation and co-creation and their marketing implications", Working Paper 542, Hanken School of Economics, Helsinki.

Guba, E. G. (1990), "The alternative paradigm dialog". In E. G. Guba (Ed.), *The paradigm dialog* (pp. 17-30). Newbury Park, CA: Sage.

Gummerus, J. (2013), "Value creation process and value outcomes in marketing theory: Strangers or siblings?", *Marketing Theory*, Vol. 13, No. 1, pp. 19-46.

Hair, J.F., Black, W.C., Babin, R.E., Anderson, R.E. and Tatham, R.L. (2006), *Multivariate data analysis*, Upper Saddle River: Prentice Hall.

Halinen, A. and Törnroos, J.-Å. (2005), "Using case methods in the study of contemporary business networks", *Journal of Business Research*, Vol. 58, No. 9, pp. 1285–1297.

Hatinen, L., Pirttilä, M., Viskari, S. and Kärri, T. (2012), "The investment logics of Finnish industrial maintenance service providers", *International Journal of Strategic Engineering Asset Management*, Vol. 1, No. 1, pp. 33–48.

Henneberg, S. C., Gruber, T. and Naudé, P. (2013), "Services networks: Concept and research agenda", *Industrial Marketing Management*, Vol. 42, No. 1, pp. 3–8.

Herala, A., Porras, J. and Kärri, T. (2016), "Experiences about opening data in private sector: A systematic literature review", *Proceedings of the IEEE SAI Conference (SAI 2016),* London, UK, July 13-15, 2016, pp. 715-724.

Hofmann, E. and Rüsch, M. (2017), "Industry 4.0 and the current status as well as future prospects on logistics", *Computers in Industry*, Vol. 89, pp. 23-34.

Huijboom, N. and Van den Broek, T. (2011), "Open data: an international comparison of strategies", *European journal of ePractice,* Vol. 12, No. 1, pp. 4-16.

Håkansson, H. and Ford, D. (2000), "How should companies interact in business networks?", *Journal of Business Research*, Vol. 55, No. 2, pp. 133-139.

Jaakkola, M. and Hakanen, T. (2013), "Value co-creation in solution networks", *Industrial Marketing Management*, Vol. 42, No. 1, pp. 47-58.

Johansson, P. and Olhager, J. (2004), "Industrial service profiling: Matching service offerings and processes", *International Journal of Production Economics*, Vol. 89, No. 3, pp. 309-320.

Järviö, J., Piispa, T., Parantainen, T. and Åström, T. (2007), *Maintenance*, Helsinki: KP-Media [in Finnish].

Kans, M. and Ingwald, A. (2016), "Business models for after sales services – Current state and future directions", *Proceedings of the 10th World Congress on Engineering Asset Management (WCEAM 2015),* Lecture Notes in Mechanical Engineering, Springer, pp. 333-346.

Keränen, J. (2014), *"Customer value assessment in business markets"*, Acta Universitatis Lappeenrantaensis 579, Dissertation, Lappeenranta University of Technology, Lappeenranta, ISBN 978-952-265-605-6.

Kindström, D. and Kowalkowski, C. (2009), "Development of industrial service offerings: a process framework", *Journal of Service Management*, Vol. 20, No. 2, pp. 156–172.

Klanac, N. G. (2013), "An integrated approach to customer value: A comprehensive-practical approach", *Journal of Business Market Management*, Vol 6, No. 1, pp. 22-37.

Kohtamäki, M. and Partanen, J. (2016), "Co-creating value from knowledge-intensive business services in manufacturing firms: The moderating role of relationship learning in supplier-customer interactions, *Journal of Business Research*, Vol. 69, Iss. 7, pp. 2498-2506.

Komonen, K., Suominen, S. and Kupi, E. (2007), "Interaction between customer satisfaction, server satisfaction and effectiveness within industrial maintenance", *Conference proceedings, The 2nd World Congress on Engineering Asset Management*, June, 11-14, 2007, Harrogate, UK.

Kothandaraman, P. and Wilson, D. T. (2001), "The future of competition: Value-creating networks", *Industrial Marketing Management*, Vol. 30, No. 4, pp. 379–389.

Kremic, T., Tukel, O.I. and Walter, O.R. (2006), "Outsourcing decision support: a survey of benefits, risks, and decision factors", *Supply Chain Management: An International Journal*, Vol. 11, No. 6, pp. 467-482.

Kulmala, H.I., Paranko, J. and Uusi-Rauva, E. (2002), "The role of cost management in network relationships", *International Journal of Production Economics*, Vol. 79, pp. 33–43.

Kutucuoglu, K.Y., Hamali, J., Irani, Z. and Sharp, J.M. (2001), "A framework for managing maintenance using performance measurement systems", *International Journal of Operations & Production Management*, Vol. 21 No. 1/2, pp. 173-195.

Lambert, D.M. and Enz, M.G. (2012), "Managing and measuring value co-creation in business-to-business relationships", *Journal of Marketing Management*, Vol. 28, Nos. 13-14, pp. 1588-1625.

Lapierre, J. (2000), "Customer-perceived value in industrial contexts", *Journal of Business & Industrial Marketing*, Vol. 15, No. 2, pp. 122–145.

La Rocca, A. and Snehota, I. (2014), "Value creation and organizational practices at firm boundaries, *Management Decision*, Vol. 52, No. 1, pp. 2-17.

Lasi, H., Fettke, P., Kemper, H.-G., Feld, T. and Hoffman, M. (2014), "Industry 4.0", *Business and Information Systems Engineering*, Vol. 6, No. 4, pp. 239-242.

Laursen, K. and Salter, A.J. (2014), "The paradox of openness: Appropriability, external search and collaboration", *Research Policy*, Vol. 43, No. 5, pp. 867-878.

Lind, S., Nenonen, S. and Kivistö-Rahnasto, J. (2008), "Safety risk assessment in industrial maintenance", *Journal of Quality in Maintenance Engineering*, Vol. 14, No. 2, pp. 205–217.

Lindgreen, A., Hingley, M.K., Grant, D.B. and Morgan, R.E. (2012), "Value in business and industrial marketing: Past, present, and future", *Industrial Marketing Management*, Vol. 41, No. 1, pp. 207-214.

Lindgreen, A. and Wynstra, F. (2005), "Value in business markets: what do we know? Where are we going?", *Industrial Marketing Management*, Vol. 34, No. 7, pp. 732-748.

Liyanage, J.P. and Kumar, U. (2003), "Towards a value-based view on operations and maintenance performance management", *Journal of Quality in Maintenance Engineering*, Vol. 9, No. 4, pp. 333-350.

Lo, S-H. (2010), "Performance evaluation for sustainable business: a profitability and marketability framework", *Corporate Social Responsibility and Environmental Management*, Vol. 17, No. 6, pp. 311–319.

Lorenzoni, G. and Lipparini, A. (1999), "The leveraging of interfirm relationships as a distinctive organizational capability: a longitudinal study", *Strategic Management Journal*, Vol. 20, No. 4, pp. 317–338.

Lusch, R.F. and Vargo, S.L. (Eds.) (2006), *The service-dominant logic of marketing: dialog, debate, and directions*, Armonk, N.Y.: M.E. Sharpe.

Ma, Q., Pearson, M.J. and Tadisina, S. (2005), "An exploratory study into factors of service quality for application service providers", *Information & Management*, Vol. 42, Iss. 8, pp. 1067-1080.

MacCarthy, B. L. and Jayarathne, P. G. S. A. (2012), "Sustainable collaborative supply networks in the international clothing industry: A comparative analysis of two retailers", *Production Planning & Control*, Vol. 23, No. 4, pp. 252–268.

Malleret, V. (2006), "Value creation through service offers", *European Management Journal*, Vol. 24, No. 1, pp. 106–116.

Mansfield, E., Schwartz, M and Wagner, S. (1981), "Imitation costs and patents: an empirical study", *The Economic Journal*, Vol. 91, No. 364, pp. 907-018.

Marais, K. and Saleh, J. (2008), "Beyond its cost, the value of maintenance: an analytical framework for capturing its net present value", *Journal of Reliability Engineering and System Safety*, Vol. 94, No. 2, pp. 644-657.

Markeset, T. and Kumar, U. (2005), "Product support strategy: conventional versus functional products", *Journal of Quality in Maintenance engineering*, Vol. 11, No. 1, pp. 53-67.

Marttonen, S., Monto, S. and Kärri, T. (2013), "Profitable working capital management in industrial maintenance companies, *Journal of Quality in Maintenance Engineering*, Vol. 19, No. 4, pp. 429-446.

Matthyssens, P. and Vandenbempt, K. (1998), "Creating competitive advantage in industrial services", *Journal of Business & Industrial Marketing*, Vol. 13, Iss. 4, pp. 339-355.

McDonough, E.F.III, Athanassiou, N. and Barczak, G. (2006), "Networking for global new product innovation", *International Journal of Business Innovation and Research*, Vol. 1, Nos. 1/2, pp. 9–26.

Meekings, A. (1995), "Unlocking the potential of performance measurement: a practical implementation guide", *Public Money and Management*, October-December, pp. 5-12.

Menon, A., Homburg, C. and Beutin, N. (2005), "Understanding customer value in business-to-business relationships", *Journal of Business-to-Business Marketing*, Vol. 12, No. 2, pp. 1-38.

Metso (2016), "Metso solmii pitkäaikaisen strategisen elinkaaripalvelusopimuksen Pohjois-Amerikassa maailman toiseksi suurimman soodan tuottajan kanssa" [online, in Finnish] http://www.metso.com/fi/uutiset/2016/5/metso-solmii-pitkaaikaisen-strategisen-elinkaaripalvelusopimuksen-pohjois-amerikassa-maailman-toiseksi-suurimman-soodan-tuottajan-kanssa/ [accessed 8.2.2017].

Mizik, N. and Jacobson, R. (2003), "Trading off between value creation and value appropriation: The financial implications of shifts in strategic emphasis", *Journal of Marketing*, Vol. 67, No. 1, pp. 63-76.

Morgan, D. (2007), "Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods", *Journal of Mixed Methods Research*, Vol. 1, No. 1, pp. 48-76.

Morgan, F., Deeter-Schmelz, D. and Moberg, C. R. (2007), "Branding implications of partner firm-focal firm relationships in business-to-business service networks", *Journal of Business & Industrial Marketing*, Vol. 22, No.6, pp. 372–382.

Murthy, D.N.P., Atrens, A. and Eccelston, J.A. (2002), "Strategic maintenance management", *Journal of Quality in Maintenance Engineering,* Vol. 8, No. 4, pp. 287-305.

Murthy, D.N.P., Karim, M.R. and Ahmadi, A. (2015), "Data management in maintenance outsourcing", *Reliability Engineering and System Safety,* Vol. 142, pp. 100-110.

Muchiri, P., Pintelon, L., Gelders, L., and Martin, H. (2011), "Development of maintenance function performance measurement framework and indicators", *International Journal of Production Economics,* Vol. 131, No. 1, pp. 295–302.

Muchiri, P.N., Pintelon, L., Martin, H. and De Meyer, A.M. (2010), "Empirical analysis of maintenance performance measurement in Belgian industries", *International Journal of Production Research,* Vol 48, No, pp. 5905-5924.

Möller, K. (2006), "Role of competences in creating customer value: A value-creation logic approach", *Industrial Marketing Management,* Vol. 35, No. 8, pp. 913–24.

Möller, K., Rajala, A. and Svahn, S. (2005), "Strategic business nets - their type and management", *Journal of Business Research,* Vol. 58, No. 9, pp. 1274-1284.

Nunnally, J.C. (1978), *Psychometric Theory*, 2nd edition, New York: McGraw-Hill.

Ojanen, V., Ahonen, T., Reunanen, M. and Hanski, J. (2012A), "Towards availability and sustainability in customer value assessment of asset management services", *International Journal of Innovation and Sustainable Development,* Vol. 6, No. 4, pp. 368-391.

Ojanen, V., Hatinen, L., Kärri, T., Kässi, T. and Tuominen, M. (2012B), "Flexible investment planning and collaborative maintenance management", in van der Lei, T., Herder, P. and Wijnia, Y. (Eds.): *Asset Management: The State of the Art in Europe from a Life Cycle Perspective,* pp. 65-77, Springer, Dordrecht.

Ojasalo, J. and Ojasalo, K. (2008), *Kehitä teollisuuspalveluja*, Helsinki: Talentum Media [in Finnish].

Oliva, R. and Kallenberg, R. (2003), "Managing the transition from products to services", *International Journal of Service Industry Management,* Vol. 14, No. 2, pp. 160-172.

Panesar, S.S. and Markeset, T. (2008), "Development of a framework for industrial service innovation management and coordination", *Journal of Quality in Maintenance Engineering,* Vol. 14, No. 2, pp. 177–193.

Parida, A. and Kumar, U. (2006), "Applications and case studies: maintenance performance measurement (MPM): issues and challenges*", Journal of Quality in Maintenance Engineering,* Vol. 12, No. 3, pp. 239-251.

Parida, A. and Uday, K. (2009), "Maintenance performance measurement-methods, tools and application", *Journal of Maintenance World*, Vol. 1 No. 1, pp. 50-53.

Penttinen, E. and Palmer, J. (2007), "Improving firm positioning through enhanced offerings and buyer-seller relationships", *Industrial Marketing Management*, Vol. 36, No. 4, pp. 552-564.

Persona, A., Regattieri, A., Pham, H. and Battini, D. (2007), "Remote control and maintenance outsourcing networks and its applications in supply chain management", *Journal of Operations Management*, Vol. 25, Iss. 6, pp. 1275–1291.

Pintelon, L.M. and Gelders, L.F. (1992), "Maintenance management decision making", *European Journal of Operational Research*, Vol. 58, pp. 301-317.

Pintelon, L. and Parodi-Herz, A. (2008), *Maintenance: An Evolutionary Perspective. Complex System Maintenance Handbook*, Springer series in reliability engineering, London: Springer.

Pintelon, L., Pinjala, S.K. and Vereecke, A. (2006), "Evaluating the effectiveness of maintenance strategies", *Journal of Quality in Maintenance Engineering*, Vol. 12, No. 1, pp. 7-20.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y. and Podsakoff, N.P. (2003), "Common method biases in behavioral research: a critical review of the literature and recommended remedies", *Journal of Applied Psychology*, Vol. 88, No. 5, pp. 879-903.

Ramsay, J. (2005), "The real meaning of value in trading relationships", *International Journal of Operations & Production Management*, Vol. 25, No. 5, pp. 549-565.

Ramsay, J. and Wagner, B. (2009), "Organisational supplying behaviour: Understanding supplier needs, wants and preferences", *Journal of Purchasing & Supply Management*, Vol. 15, Iss. 2, pp. 127–138.

Reinartz, W. and Ulaga, W. (2008), "How to sell services more profitably", *Harvard business review*, Vol. 86, No. 5, pp. 90-96.

Rekola, K. and Haapio, H. (2009), *Industrial Services and Service Contracts: A Proactive Approach*, The Federation of Finnish Technology Industries, Helsinki.

Riis, J., Johansen, J., Waehrens, B. and Englyst, L. (2007), "Strategic roles of manufacturing", *Journal of Manufacturing Technology Management*, Vol. 18, No. 8, pp. 933–948.

Rittinghouse, J.W. and Ransome, J.F. (2009), *Cloud Computing: Implementation, Management and Security*, CRC Press, Taylor & Francis Group, FL.

Rosqvist, T., Laakso, K. and Reunanen, M. (2009), "Value-driven maintenance planning for a production plant", *Reliability Engineering and System Safety*, Vol. 94, No. 1, pp. 97-110.

Rossmann, G. B. and Wilson, B. L. (1985), "Number and words: Combining quantitative and qualitative methods in a single large-scale evaluations study", *Evaluation Review*, Vol. 9, No. 5, pp. 627-643.

Rowley, J. (2007), "The wisdom hierarchy: representations of the DIKW hierarchy", *Journal of Information Science*, Vol. 33, No. 2, pp. 163-180.

Saunders, M., Lewis, P. and Thornhill, A. (2009), *Research methods for business students*, 5th edition, Harlow, England: Prentice Hall.

SFS-EN Std. 13306. (2010), *Maintenance, Maintenance terminology*, Finnish Standard Association SFS.

Silverman, D. (2014), *Interpreting qualitative data*, 5th edition, Thousand Oaks, California: SAGE Publications.

Sinkkonen, T. (2015), *"Item-Level Life-Cycle Model for Maintenance Networks – From Cost to Additional Value"*, Acta Universitatis Lappeenrantaensis 673, Dissertation, Lappeenranta University of Technology, Lappeenranta, ISBN 978-952-265-882-1.

Songailiene, E., Winklhofer, H. and McKechnie, S. (2011), "A conceptualisation of supplier-perceived value", *European Journal of Marketing*, Vol. 45, Iss. 3, pp. 383-418.

Stenström, C., Parida, A., Kumar and Galar, D. (2013), "Performance indicators and terminology for value driven maintenance", *Journal of Quality in Maintenance Engineering*, Vol. 19, Iss. 3, pp. 222-232.

Stremersch, S., Wuyts, S. and Frambach, R.T. (2001), "The purchasing of full-service contracts: an exploratory study within the industrial maintenance market", *Industrial Marketing Management*, Vol. 30, No. 1, pp.1–12.

Stuart, T.E. (2000), "Interorganizational alliances and the performance of firms: a study of growth and innovation rates in a high-technology industry", *Strategic Management Journal*, Vol. 21, No. 8, pp.791–811.

Swanson, L. (2001), "Linking maintenance strategies to performance", *International Journal of Production Economics*, Vol. 70, No. 3, pp. 237-244.

Tashakkori, A and Teddlie, C. (1998), *Mixed methodology: Combining qualitative and quantitative approaches*, Thousand Oaks, California: SAGE Publications.

Toossi, A., Lockett, L., Raja, J.Z. and Martinez, V. (2013), "Assessing the value dimensions of outsourced maintenance services", *Journal of Quality in Maintenance Engineering*, Vol. 19 No. 4 pp. 348–363.

Tsang, A.H.C., Jardine, A.K.S. and Kolodny, H. (1999), "Measuring maintenance performance: a holistic approach", *International Journal of Operations & Production Management*, Vol. 19, No. 7, pp. 691 – 71.

Tuli, K., Kohli, A. and Bharadwaj, S. G. (2007), "Rethinking customer solutions: From product bundles to relational processes", *Journal of Marketing*, Vol. 71, No. 3, pp. 1–17.

Tynninen, L., Sinkkonen, T., Marttonen, S. and Ojanen, V. (2012), "Framework for the value elements of maintenance services", *The 2nd International congress on Maintenance Performance Measurement & Management*, September, 12-13, Sunderland, UK.

Töytäri, P. and Rajala, R. (2015), "Value-based selling: An organizational capability perspective", *Industrial Marketing Management*, Vol. 45, pp. 101-112.

Ukko, J., Pekkola, S., Saunila, M. and Rantala, T. (2015), "Performance measurement approach to show the value for the customer in an industrial service network", *International Journal of Business Performance Management*, Vol. 16, Issue 2-3, pp. 214-229.

Ulaga, W. (2003), "Capturing value creation in business relationships: A customer perspective", *Industrial Marketing Management*, Vol. 32 No. 8, pp. 677-693.

Ulaga, W. and Eggert, A. (2006), "Value-based differentiation in business relationships: Gaining and sustaining key supplier status", *Journal of Marketing*, Vol 70, No. 1, pp. 119-136.

Ulaga, W. and Eggert, A. (2005), "Relationship value in business markets: The construct and its dimensions", *Journal of Business-to-Business Marketing*, Vol. 12, No. 1, pp. 73-99.

Upsani, K., Bakshi, M., Pandhare, V. and Lad, B.K. (2017), "Distributed maintenance planning in manufacturing industries", *Computers and Industrial Engineering*, Vol. 108, No. 1, pp. 1-14.

Vargo, S.L and Lusch, R.F. (2006), "Evolving to a new dominant logic for marketing" in: Lusch, R.F. and Vargo, S.L. (Eds.) *The service-dominant logic of marketing: dialog, debate, and directions*, Armonk, N.Y.: M.E. Sharpe, pp. 3-28.

Vargo, S.L. and Lusch, R.F. (2008), "Service-dominant logic: Continuing the evolution", *Journal of the Academy of Marketing Science*, Vol. 36, No. 1, pp. 1-10.

Velmurugan, R.S. and Dhingra, T. (2015), "Maintenance strategy selection and its impact in maintenance function", *International Journal of Operation & Production Management*, Vol. 35, No. 12, pp. 1622-1661.

Waeyenbergh, G. and Pintelon, L. (2002), "A framework for maintenance concept development", *International Journal of Production Economics*, Vol. 77, No. 3, pp. 299-313.

Walter, A., Ritter, T., Gemünden, H.G. (2001), "Value-creation in buyer-seller relationships: theoretical considerations and empirical results from a supplier's perspective", *Industrial Marketing Management*, Vol. 30, No. 4, pp. 365-377.

Windahl, C. and Lakemond, N. (2010), "Integrated solutions from a service-centered perspective: Applicability and limitations in the capital goods industry", *Industrial Marketing Management*, Vol. 39, No. 8, pp. 1278-1290.

Windolph, M. and Moeller, K. (2012), "Open-book accounting: Reason for failure of inter-firm cooperation?", *Management Accounting Research*, Vol. 23, pp. 47-60.

Wärtsilä (2017), "Wärtsilä and Carnival Corporation announce strategic performance-based partnership" [online] http://www.wartsila.com/media/news/25-01-2017-wartsila-and-carnival-corporation-announce-strategic-performance-based-partnership [accessed 8.2.2017].

Yin, R. K. (2003), *Case study research: Design and methods*, 3rd edition, Thousand Oaks, California: SAGE Publications.

Zeithaml, V. (1988), "Consumer perceptions of price, quality, and value: A means-end model and synthesis of evidence", *Journal of Marketing*, Vol. 52, No. 3, pp. 2-22.

APPENDIX A: Value propositions and original references used in the questionnaire

Value element	Proposition	
Availability (Ma et al. 2005)	P1	"The maintenance tasks are appropriate and maintainability and repairs are easy."
	P2	"The operators carry out their part of the in-use maintenance operations and enhance the maintainability of the item."
Safety at work	P3	"The operational conditions and safety increase along the service."
	P4	"Maintenance is performed according to safety policies"
Environmental safety	P5	"The maintenance service performer recognizes the environmental safety hazards."
	P6	"Maintenance is performed according to environmental safety policies."
Technical quality (Matthyssens, and Vandenbempt, 1998; Ojanen et al. 2012B)	P7	"The maintenance service outcome is as expected."
	P8	"The maintenance service outcome is sustained for the promised time."
Flexibility (Ojanen et al. 2012B; Barry and Terry 2008; Kremic et al., 2006; Malleret 2006)	P9	"The maintenance service partner can suit the needs of the company (e.g. delivery time)"
	P10	"The maintenance services are tailored based on need."
Reliability (Ojanen et al. 2012B; Barry and Terry 2008)	P11	"The maintenance service cooperation is executed on time and as promised."
	P12	"The maintenance service cooperation is based on confidentiality."
Operator knowledge (Songailiene et al. 2011; Brito et al. 2007)	P13	"The maintenance service provider has the knowledge to solve upcoming problems."
	P14	"The maintenance service operators are professionally skilled and qualified."
Orderliness (Matthyssens and Vandenbempt, 1998; Barry and Terry 2008)	P15	"The resources and timetable of the maintenance service can be planned well in advance."
	P16	"The maintenance service operations are developed in cooperation."
Reputation (Ramsay and Wagner 2009)	P17	"The current reputation of the maintenance service partner is good."
	P18	"The previous experiences with the maintenance service partner have been positive."
Relationship (Ramsay and Wagner 2009; Barry and Terry 2008; Ojanen et al. 2012B)	P19	"The maintenance service cooperation works well considering the conditions of all partners."
	P20	"Information exchange works between the maintenance service partners."
Contracts (McDonough et al., 2006; Ramsay and Wagner 2009; Songailiene et al. 2011)	P21	"The maintenance service warranty and terms of payment are kept and executed as promised."
	P22	"The risks and responsibilities considering the maintenance services are shared between the customer and the service provider."

Total solutions (Matthyssens and Vandenbempt, 1998; Stremersch et al. 2001)	P23	"The maintenance service cooperation covers the whole maintenance services comprehensively (from management to execution)."
	P24	"The maintenance service covers the whole life span of the item."
R&D (McDonough et al., 2006; Ojanen et al., 2012B;Walter et al. 2001)	P25	"Own research and development can be developed with the maintenance service partner."
	P26	"The maintenance service partner can provide information and knowledge related to the development of R&D activities."
Price (Songailiene et al. 2011; Brito et al. 2007)	P27	"The price paid for the maintenance service corresponds with the received service."
	P28	"The price is negotiated in cooperation with the maintenance service partner."
Access to markets (Kremic et al., 2006; Ramsay and Wagner 2009; Walter et al. 2001)	P29	"Maintenance service cooperation enables contact with new customers."
	P30	"Maintenance service cooperation enables starting a new type of business."
Asset management (Ojanen et al. 2012B)	P31	"The maintenance service partner is responsible for spare part storage so that it does not tie your own resources and capital."
	P32	"The maintenance service partner owns the fixed assets, for example the maintained items, so that they do not stress your own balance sheet."

APPENDIX B: Interview frame

Background information – Name, position, work history

Identifying the value of maintenance services – Current state and development of operations

- What do you value in maintenance services?
- Importance of value identification
- How are the value elements identified and measured?
- Challenges in value assessment
- How would you develop the current state of operations?

Value profile tool

- Benefits of value identification in a maintenance service relationship
- Accountable number of elements, time management
- How to use a value profile tool as a support for decision-making?
- Who is responsible for the usage?
- At which points of the relationship should the tool be utilized?
- How would you develop the tool?

Maintenance service offering

- Questions presented especially for the maintenance service customer
    - How do you evaluate different offerings?
    - Challenges when comparing different offerings?
    - Criteria used to select appropriate maintenance services?
    - A wish list to the maintenance service providers, development directions
- Questions presented especially to the equipment and service providers
    - Why do you want to offer maintenance services?
    - Reasons behind the development of maintenance service offering
    - Elements of the current maintenance service offering
    - Challenges in developing the offering
    - Development directions

Networked maintenance service operations

- Why outsource maintenance? Reasons behind different operation models
- First steps towards networked maintenance operations
- Challenges and obstacles towards true networking (vs. traditional relationships)
- How should the networked maintenance service offering be built?
- How to ensure mutual value creation in the network?
- Scenario for the future

Publication 1

Ali-Marttila, M., Tynninen, L., Marttonen, S. and Kärri, T.
Value elements of industrial maintenance: verifying the views of the customer and service provider

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Value elements of industrial maintenance: verifying the views of the customer and service provider

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Abstract: To maximise the total value in a maintenance business relationship it is important to know what the partner values. The value of industrial maintenance service can be considered to consist of value elements, and the perceived total value for the customer and service provider is the sum of these value elements. The specific objectives of this paper are to verify the most important value elements for the maintenance service customer and provider and also to recognise where the value elements differ, by using the non-parametric tests Wilcoxon and Mann-Whitney U. The data has been collected by an online survey sent to 345 maintenance service professionals in Finland. In the survey, four different types of value elements were considered: the customer's high critical and low critical items and the service provider's core and support service. The most valued elements by the respondents were reliability, safety at work, environmental safety, and operator knowledge.

Keywords: maintenance services; customer; service provider; supplier; value creation; value profile; collaboration; win-win; survey; Mann-Whitney U; Wilcoxon; value element; industrial maintenance; asset management.

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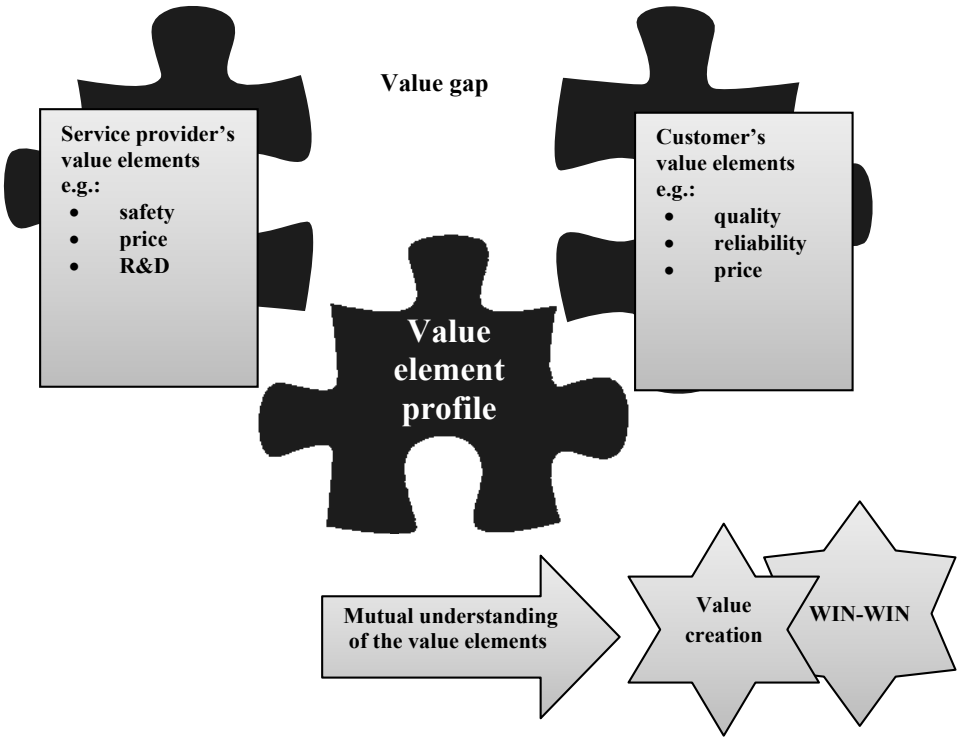
This paper is a revised and expanded version of a paper entitled 'Solving the value puzzle of the customer and service provider in industrial maintenance services' presented at Maintenance Performance Measurement and Management Conference, Lappeenranta, Finland, 12th–13th September 2013.

1 Introduction

Value, adding value and shared value in services have been a major focus in service literature and are often highlighted to the customers and providers. However, the definitions of value are vague. *Customer value* is generally defined as the tradeoff between the give (sacrifices) and get (benefits) components (Zeithaml, 1988). The benefits can include, for example, quality, whereas price can be seen as a sacrifice (Dumond, 2000). Customer value can also be viewed as customer desired value and customer perceived value, where the desired value is what the customer wants to receive and the perceived value what has happened (Flint et al., 1997). Customer value can also be split into perceived value and exchange value, where the exchange value is the amount the customer is prepared to pay for the service (Ramsay, 2005). *Supplier value* is seen as the benefit the supplier receives from acting with the customer, for example, profit (Purchase et al., 2009; Ramsay and Wagner, 2009). The marketing literature focuses mainly on the customer, and supplier value is hence studied notably less than customer value (e.g., Purchase et al., 2009; Ramsay and Wagner, 2009). In addition, relationship value has been studied because value is created more and more in collaborative relationships (Smals and Smits, 2012; Ulaga, 2003). For a customer and service provider, the creation of value can be considered as essential when engaging in a collaborative relationship (Walter et al., 2001). Payne (2006) explains that the *value creation* process consists of what value the customer receives, what value the service provider receives, and how the value exchange can be successfully managed to maximise the received total value. Value can also be considered to be equal to the sum of all future cash flows discounted to today. For example, in maintenance this would mean the future cash flow from asset utilisation, cost control, resource allocation and the safety, health and environment (SHE) factors (Jonker and Haarman, 2006). From the point of view of industrial maintenance, there is relatively little literature considering its value or value elements, and this strengthens the need to formulate and assess the value of maintenance services based on customer collaboration (Ojanen et al., 2012; Tynninen et al., 2012).

In this paper, we consider industrial maintenance service value to consist of value elements (e.g., price, flexibility and quality) like Ojanen et al. (2012) present, and value is created with the right combination of these elements. When defining and discussing value and finding the value-creating areas, the term value element offers a suitable perspective to value and to presenting the trade-off between the different elements. The total value of maintenance service can be considered to be the sum of the value elements. Figure 1 presents the aim of this paper, which is to verify the most valued elements for the customer and service provider of maintenance services and to solve the value puzzle; how value can be created by profiling the value elements and the intended win-win situation. The value gap in the figure presents the difference of the customer's and service provider's value elements, which has been tested with the non-parametric tests Wilcoxon and Mann-Whitney U. The value gap is closed with the value element profile that provides a base for value discussions in negotiation situations. In addition to value creation, the win-win situation is highlighted because it is essential that both parties gain benefits from the provided maintenance service. In order to improve the competiveness of the relationship, organisations need to understand what elements create value in maintenance service collaboration (Lapierre, 2000).

Figure 1 Value creation in maintenance services with the help of value elements



Many companies have outsourced their maintenance services wholly or partially, and this underlines the need to evaluate the value of maintenance services and contracts to avoid disagreement and inadequate performance (Kumar et al., 2006; Tynninen et al., 2012). The value discussion is important also from the service provider's point, so that the

provider is able to price the services correctly and develop trust between the parties based on common understanding of the value creating elements (Ojanen et al., 2012). With the value element approach we offer one way to find out how the value of industrial maintenance services is modelled and created for each partner. The specific objective of this paper is: 'to verify the most important value elements of industrial maintenance from the service customer's and service provider's perspective, and to find out the differences between the parties'.

The paper is structured as follows. First, the theory and the hypotheses are described. Then, the research methodology is described in detail. Next, the achieved results are shown and discussed. Finally, a summary of the paper and conclusions with future research objectives are presented.

2 Theory and hypotheses

There is not much literature considering the value and value elements of industrial maintenance services. Value has been considered more in b-to-c businesses, and the focus in the value literature concerning services has been on the customer side (Purchase et al., 2009; Ramsay and Wagner, 2009). When articles related to the value elements of services were reviewed, 14 articles considering the customer view and only four articles considering the supplier view were found (Tynninen et al., 2012). None of the reviewed articles considered the value elements of industrial maintenance services. Komonen et al. (2007) have not studied value or the total value of a maintenance network directly, as their research concerns especially customer and supplier satisfaction in industrial maintenance, and how customer and job satisfaction are related to each other. But their research supports the fact that maintenance service value can be considered as summed elements, as they also recognise different dimensions and groups of maintenance operations that are included in customer and job satisfaction (e.g., quality of operations, professional skills, cost level and orderliness).

To get a starting point for the possible value elements of industrial maintenance, Tynninen et al. (2012) gathered the value elements suitable for industrial maintenance services from the reviewed service literature. Then, the recognised elements were discussed and modified in a workshop of company representatives as Sinkkonen et al. (2013) describe. The idea was to test if the value elements of the literature research were even close to the ones the operators consider as value elements of industrial maintenance service.

2.1 Industrial maintenance service customer's value elements

Price, technical quality, dependability, contracts, relationship, reliability, flexibility, reputation of the service provider, accessibility, asset management factors, total solutions, and sustainability were chosen as the industrial maintenance service customer's value elements. Sinkkonen et al. (2013) presented safety at work and environmental safety as new elements in addition to the preliminary list Tynninen et al. (2012) had made. Adding safety to the list makes sense, because the impact of maintenance work on safety issues comes up repeatedly in maintenance literature (e.g., Gulati, 2009; Järviö et al., 2007; Márquez, 2007). Also, the increased amount of outsourcing emphasises the safety at work-element in procurement situations (EU-OSH, 2012; Lind et al., 2008).

The value elements of the customer can be reviewed also from a more specific view at the item level, comparing the value elements from the point of a high critical and a low critical item. At the operational level in maintenance planning, item criticality has to be categorised to make sure how the maintained items have to be prioritised and that the right maintenance method is identified (Márquez, 2007). The items can be categorised with a criticality matrix where item criticality is presented as depending on the failure frequency of the item and the severity of failure or fault (SFS-EN Std. 13306, 2010). For example, a critical pump can be considered as a critical item, and the maintenance should focus on continuous condition-based maintenance. Conversely, the maintenance of the company garden can be considered as a low critical item and the maintenance strategy could be weekly predetermined maintenance. These different maintenance methods will also affect the value elements highlighted in each situation. For example, with a high critical item, availability could be the most important value element, while for a low critical item it could be price (Tynninen et al., 2012). Also, the workshop results suggested that there would be differences in the most important value elements depending on item criticality and occasion (Sinkkonen et al., 2013). Based on the literature it is predicted that the value elements of the customer differ according to the item criticality, and we posit

Hypothesis 1 The customer's value elements differ depending on the item criticality.

2.2 Industrial maintenance service provider's value elements

As the maintenance service provider's value elements Tynninen et al. (2012) suggest price, flexibility, reliability, contracts, relationship, total solutions, operator knowledge, availability, asset management factors, access to market, reputation of customer and R&D. Sinkkonen et al. (2013) presented as elements also safety at work, service ability and orderliness. To be successful in marketing, service providers need to differentiate their service offerings through people and processes that add value, in other words, choose the right value elements. When the customer is correctly assessed, the maintenance service company can offer customised services to each customer and at the same time increase the revenues of the company (Liang, 2010). The theory also suggests that companies that create superior customer value and regularly introduce innovations in service offerings will gain competitive advantage over their competitors (Guenzi and Troilo, 2007).

Like the value elements of the customer, also the value elements of the service provider can be analysed from a more specific view when comparing the value elements of core and support services. Grönroos (2000) notes that for managerial reasons, services should be distinguished into three groups: core, facilitating and support services. The core service is the service for which the company is on the market. Facilitating services are the services customers need to use the core service, for example, a bank card for an ATM. Support services, on the other hand, are services that are not essential for the company but are used to increase the value of the service or to differentiate the service from competitors' service offerings. However, for this paper we consider core and support services to be a wide enough separation to see possible differences in the value elements of maintenance service providers. In industrial maintenance services a core service could be, for example, mechanical maintenance, and a support service would be gardening outdoors. According to Sinkkonen et al. (2013), differences between the core and support

service elements of the service provider were recognised, but the differences were not as clear as with the item criticality. Based on the theory we suggest

Hypothesis 2 The service provider's value elements differ between core and support service.

2.3 Differences between industrial maintenance service customer's and service provider's value elements

For example, Smith et al. (2012) emphasised that value should always be considered from both sides, how much value can be derived by a company from its customers and also the derived value to the customers from the company. Value also depends upon the participants' perceptions, and even though the companies may work in a network, each of the customers and suppliers has their own motivations, problems and strategies (Ford and McDowell, 1999). This, in addition to the vague definition of value, results in versatile value element listings. In order to create value and improve the competiveness of the maintenance service relationship, the customer and the service provider need to understand what elements create value for each party (Lapierre, 2000).

As presented above as well as by Sinkkonen et al. (2013), when the item criticality and provided service are discussed, there are some significant differences in the listings when comparing the customer and the service provider. For example, the service providers do not list environmental safety or asset management factors as value elements like the customers do. It seems that the value elements are partly similar, partly different between the customer and the service provider, but also depend strongly on the occasion, and therefore we posit as our concluding hypothesis

Hypothesis 3 There are differences (a value gap) between the customer's and the service provider's preferred value elements.

3 Research methodology

Because no previous research was found considering the value elements of industrial maintenance services, the survey method was chosen to verify the preliminary elements found by Tynninen et al. (2012) and to identify possible new value elements. The final elements used in the survey were chosen on the basis of the preliminary studies of Tynninen et al. (2012) and Sinkkonen et al. (2013) (Appendix 1). The identification and verification of the most important value elements for the customer and service provider in industrial maintenance services and their differences are the primary objective of this study, and are part of a wider research project MaiSeMa (Industrial Maintenance Services in a Renewing Business Network: Identify, Model and Manage Value).

3.1 Sample

In Finland, outsourcing has increased the demand for industrial maintenance services, and nowadays maintenance is a significant industry (Hatinen et al., 2012). Due to the developed and organised maintenance industry, Finland is a good testing ground for value element research. An online-survey link was sent to 345 Finnish industrial maintenance professionals. The primary source for the contacts was the Finnish

Maintenance Society Promaint, which is an important nationwide actor and has a diverse network of corporations in the maintenance field. The survey was conducted between January–March 2013, and the contact persons received two reminders after the first message. 83 completed questionnaires were received, representing a response rate of 24%. Thirty two responses were received from maintenance customers and 51 from maintenance service providers.

The most common position (56%) of the respondent was working in middle management, for example, as a maintenance manager, 21% of the respondents represented top management, and the rest (23%) represented mainly consultants and supervisors. In the responder group, 39% represented large companies (over 250 workers), and thus the majority represented small or middle sized companies. The customer side represented mainly the industrial goods and services industry (69%), but also the electricity, gas and heating industry (15%). None of the customers executed the maintenance services wholly by themselves. The service providers represented mainly mechanical maintenance (58%) and electricity (33%), or a combination of different maintenance types.

3.2 Survey instrument

Because value can be interpreted in many ways, in the survey instrument the 16 tested value elements were decided to represent two propositions each (shown in Appendix 1). The customer and service provider were thus asked to value 32 propositions on a five-point Likert scale with end points of ‘strongly disagree’ (= 1) to ‘strongly agree’ (= 5). The customers responded first considering a high critical item to be maintained and after that the same claims were presented for a low critical item to be maintained. To be able to compare the differences of the customer and the service provider it was decided to present the same value elements and claims for both sides in the questionnaire, and so the service provider responded to the same propositions but considering a core service and support service it provided to the customers. It was emphasised to the service provider to respond from their own point of view, not the customer’s. The survey instrument was pre-tested by a panel of experts which consisted of company representatives participating in the MaiSeMa-research project.

3.3 Data analysis

The data in the survey sample was not normally distributed, and therefore the non-parametric tests Mann-Whitney U and Wilcoxon were used to examine the statistically significant differences in the value elements (Devore and Berk, 2012). The reliability of the sum variables was tested by computing the Cronbach’s alpha. The values were mainly above the recommended 0.700 or close to it, which indicates that the sum variables were reliable and could be used for further analysis with some regard (Cortina, 1993).

Table 1 Value elements depending on item criticality

Value element	*α HCI*	*Mean HCI*	*SD HCI*	*Rank HCI*	*α LCI*	*Mean LCI*	*SD LCI*	*Rank LCI*	*Z score/sig. level*	*Hypothesis 1*
Availability	0.798	4.11	1.10	9	0.455	3.76	0.80	11	–2.102/0.036*	Supported
Safety at work	0.407	4.45	0.58	2	0.696	4.41	0,67	2	–0.618/0.537	Not supported
Environmental safety	0.816	4.39	0.76	3	0.819	4.45	0.64	1	–0.479/0.632	Not supported
Technical quality	0.874	4.26	0.85	6	0.821	4.03	0.95	7	–2.385/0.017*	Supported
Flexibility	0.563	4.09	0.67	10	0.384	3.76	0.69	11	–2.226/0.026*	Supported
Reliability	0.656	4.55	0.49	1	0.737	4.21	0.80	4	–2.644/0.008***	Supported
Operator knowledge	0.830	4.31	0.67	4	0.751	4.29	0.66	3	–0.534/0.593	Not supported
Orderliness	0.667	4.13	0.82	8	0.890	3.77	1.17	10	–2.067/0.039*	Supported
Reputation	0.596	4.18	0.54	7	0.881	4.02	0.78	8	–1.907/0.057	Not supported
Relationship	0.923	3.98	0.87	11	0.803	4.05	0.87	6	–0.087/0.931	Not supported
Contracts	0.700	3.87	0.88	12	0.545	3.84	0.80	9	–0.378/0.706	Not supported
Total solutions	0.714	3.72	0.89	13	0.294	3.68	0.77	13	–0.383/0.701	Not supported
R&D	0.813	3.22	1.01	14	0.959	2.50	1.01	15	–3.089/0.002**	Supported
Price	0.327	4.27	0.64	5	0.682	4.20	0.77	5	–0.915/0.360	Not supported
Access to markets	0.907	3.06	1.13	15	0.912	2.45	1.10	16	–3.593/0.000***	Supported
Asset mgmt. factors	0.698	2.53	1.13	16	0.674	2.69	1.11	14	–0.793/0.428	Not supported

Notes: Two-tailed test *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, SD = standard deviation.
HCI = high critical item, LCI = low critical item.

4 Results and discussion

4.1 Results regarding the customer's value elements

Descriptive statistics and the results of the Wilcoxon test between the high critical and low critical items can be seen in Table 1. For the critical items the customers ranked as the most important value elements *reliability, safety at work, environmental safety, operator knowledge, price, and technical quality,* which all had means above 4.2. The lowest scores with means below 3.0 were given to R&D, access to markets and asset management factors. When considering the low critical items to be maintained, the customers valued most *environmental safety, safety at work, operator knowledge, reliability, and price.* The value elements with the lowest means were asset management factors, R&D and access to markets. In addition to the presented propositions, the customers suggested the rapidity of the maintenance service as a factor they value (open-ended question).

As can be seen in the table, when comparing the high and low critical items, the survey results support the idea that there are differences between the value elements. It is interesting to see that with the high critical items, reliability is valued even higher than safety at work. Overall safety is valued very high, though, and it seems that companies value the safety risk assessment methods that also Lind et al. (2008) emphasise. For the high critical items, the value elements have substantially higher means. This is understandable because a high critical item is something that can stop the whole production, so the maintenance strategy is overall valued more for a high critical item than for a low critical item (Järviö et al., 2007; Márquez, 2007).

Statistically significant differences ($p < 0.05$) between the value elements based on the Wilcoxon test can be seen in availability, technical quality, flexibility, reliability, orderliness, R&D, and access to markets. Of all the statistically differentiating value elements, the customers valued higher the element of the high critical maintenance items than of the low critical items. This confirms the assumption that item criticality affects the importance and prioritising of maintenance strategy (Márquez, 2007). Because Hypothesis 1 is supported in almost half of the value elements and there are recognisable differences in what the customer's value within a high critical item versus a low critical item, it can be stated that the value elements differ depending on item criticality, and this should be considered when profiling the value elements. It is also important that the service provider sees the difference to make the right offering for each item to be maintained and be successful, as Liang (2010) suggests.

The correlation matrix for the high and low critical items can be seen in Appendix 2. There are a lot of strong correlations of even 0.700 and above. This suggests that the elements are strongly related, and in future research factor analysis would be beneficial to see if some or even all value elements could be merged into bigger groups and complexes.

Table 2 Value elements depending on provided service

Value element	*α CS*	*Mean CS*	*SD CS*	*Rank CS*	*α SS*	*Mean SS*	*SD SS*	*Rank SS*	*Z score/sig. level*	*Hypothesis 2*
Availability	0.672	4.26	0.74	9	0.639	4.32	0.62	7	–1.306/0.192	Not supported
Safety at work	0.602	4.60	0.44	3	0.730	4.53	0.53	1	–0.708/0.479	Not supported
Environmental safety	0.682	4.43	0.59	5	0.877	4.48	0.61	4	–0.443/0.658	Not supported
Technical quality	0.793	4.48	0.56	4	0.916	4.47	0.67	5	0.000/1.000	Not supported
Flexibility	0.440	3.98	0.75	13	0.676	3.98	0.75	14	0.000/1.000	Not supported
Reliability	0.502	4.63	0.46	2	0.555	4.52	0.51	2	–1.882/0.060	Not supported
Operator knowledge	0.678	4.65	0.47	1	0.812	4.52	0.61	2	–2.072/0.038*	Supported
Orderliness	0.801	4.26	0.78	9	0.791	4.20	0.72	10	–0.291/0.771	Not supported
Reputation	0.628	4.28	0.57	8	0.674	4.28	0.56	8	–0.759/0.448	Not supported
Relationship	0.758	4.39	0.61	7	0.785	4.33	0.66	6	–0.041/0.967	Not supported
Contracts	0.429	4.19	0.62	11	0.382	4.05	0.71	12	–1.148/0.251	Not supported
Total solutions	0.586	4.08	0.78	12	0.767	4.11	0.85	11	–0.186/0.852	Not supported
R&D	0.799	3.93	0.82	15	0.865	4.00	0.87	13	–0.041/0.967	Not supported
Price	0.580	4.40	0.59	6	0.497	4.27	0.63	9	–0.984/0.325	Not supported
Access to markets	0.812	3.94	0.85	14	0.889	3.87	0.98	15	–1.040/0.298	Not supported
Asset mgmt. factors	0.352	3.35	0.70	16	0.584	3.30	0.98	16	–0.447/0.655	Not supported

Notes: Two-tailed test *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, SD = standard deviation.
CS = core service, SS = support service.

4.2 Results regarding the service provider's value elements

The descriptive statistics and the results of Hypothesis 2 testing done by Wilcoxon relating the value elements of core and support services are presented in Table 2. The service providers rated the highest in core services *operator knowledge, reliability, safety at work, technical quality, environmental safety, and price*, which all had mean values 4.40 or higher. The service providers valued least in core services flexibility, access to markets, R&D, and asset management factors. They all had means above 3.30, so still quite high. When looking at the support services, the providers rated highest *safety at work, reliability, operator knowledge, environmental safety, and technical quality*. The least valued elements were flexibility, access to markets and asset management factors. In addition to the presented propositions, the service providers mentioned perseverance and domestic content as factors they value in maintenance services (open-ended question).

Based on the theory, we predicted that the core and support services would differ, and overall there were differences in the ranking of value elements between the core and support services, but they were minor and the most important and least valued elements were almost identical. That there were only minor differences was also supported by the Wilcoxon test. The only statistical significant difference ($p < 0.05$) was in operator knowledge. A potential reason comes up when looking at the survey respondents' open-ended responses. Only a few of the respondents had differentiated the core and support services from each other. It seems that the clear definition in theory had not yet reached the practice.

The correlation matrix for the core and support services can be seen in Appendix 2. Within the core service there are not nearly as much strong correlations as within the support service, but it can still be seen that the value elements are related to each other. As with the customer's value elements also here factor analysis would be beneficial for identifying more complex value elements.

4.3 Results regarding the differences between the customer's and service provider's value elements

The identification of the differences between the maintenance service customer's and service provider's value elements was executed by comparing how the preferred value elements differed when the service provider would wish to maintain the customer's high and low critical items with its core service. Comparison of the provider's support service and customer's preferred value elements was left out because there were no statistically significant differences between the service provider's core and support services, and also the respondents' separation between the services was questionable, because many of the respondents named the same service as core and support one. Table 3 shows the Mann-Whitney U test scores and the test results concerning hypothesis 3.

Hypothesis 3 is supported ($p < 0.05$) when comparing the customer's critical items and service provider's core services in operator knowledge, relationship, total solutions, R&D, access to markets, and asset management factors. When the customer's low criticality items and service provider's value elements are compared, there are in addition statistically significant differences ($p < 0.05$) in availability, technical quality and reliability. There are statistically significant differences especially when considering the customer's low criticality items and the service provider's core services. Compared to the customer, the service provider values the different value elements substantially higher.

The service providers did not value any elements under 3.30, and, for example, one of the least valued elements, asset management factors, was still valued notably higher than at the customers' side (3.35 versus 2.54).

Table 3 Value element differences between the customer and the service provider

Value element	*Z score/sig .level when comparing the differences between the high critical item and core service*	*Hypothesis 3*	*Z score/sig. level when comparing the differences between the low critical item and core service*	*Hypothesis 3*
Availability	–0.295/0.768	Not supported	–3.225/0.001**	Supported
Safety at work	–1.000/0.317	Not supported	–0.972/0.331	Not supported
Environmental safety	–0.166/0.868	Not supported	–0.972/0.331	Not supported
Technical quality	–0.871/0.384	Not supported	–2.118/0.034*	Supported
Flexibility	–0.811/0.418	Not supported	–1.390/0.165	Not supported
Reliability	–0.731/0.465	Not supported	–2.442/0.015*	Supported
Operator knowledge	–2.539/0.011*	Supported	–2.587/0.010*	Supported
Orderliness	–0.752/0.452	Not supported	–1.656/0.098	Not supported
Reputation	–0–756/0.450	Not supported	–1.320/0.187	Not supported
Relationship	–2.082/0.037*	Supported	–1.645/0.100	Not supported
Contracts	–1.435/0.151	Not supported	–1.878/0.060	Not supported
Total solutions	–1.903/0.057	Supported	–2.250/0.024*	Supported
R&D	–3.090/0.002**	Supported	–6.743/0.000***	Supported
Price	–0.804/0.422	Not supported	–1.037/0.300	Not supported
Access to markets	–3.544/0.000***	Supported	–5.251/0.000***	Supported
Asset mgmt. factors	–3.804/0.000***	Supported	–3.336/0.001**	Supported

Note: Two-tailed test *p < 0.05, **p < 0.01, ***p < 0.001.

The biggest value gaps seem to be in the least valued elements R&D, access to markets and asset management factors, and the difference is also supported statistically. The low valuation of R&D was expected at least from the customer side, because R&D in industrial services has many contract-related issues and cooperation is considered complicated (Panesar and Markeset, 2008). In the service providers' side this was slightly surprising, because Sinkkonen et al. (2013) discussed it to be one of the most important value elements in support services. To be able to gain competitive advance it would be important for the customer and service provider to work on this value gap and identify innovation activities that would create value for both parties (Guenzi and Troilo, 2007).

The low score of asset management is also interesting, because asset management has been emphasised in current research and it has been shown that with asset management the customers and service providers can affect the company's operation and capital greatly (Kärri, 2007; Ojanen et al., 2012). The service providers seemed to have recognised this slightly better than the customers, at least they valued it with a notably

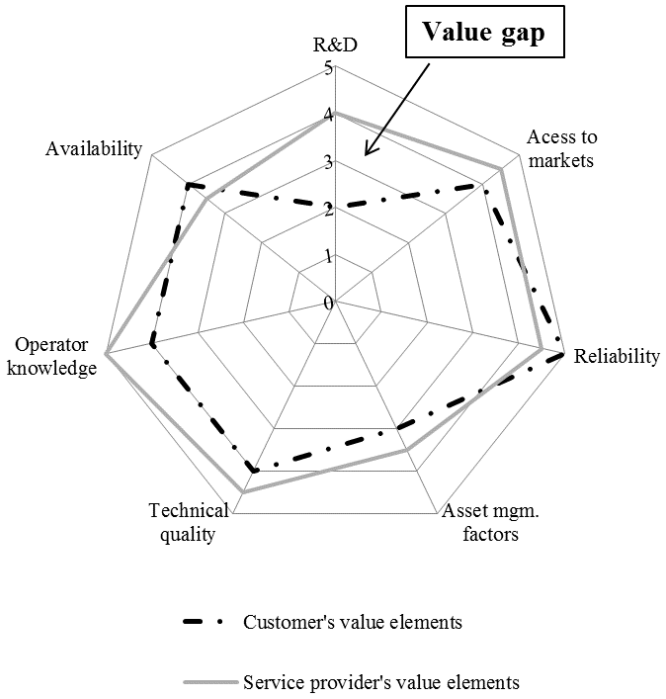
higher score. The low level of top manager respondents probably had some influence on the score because normally top managers have a broader view of total asset management within the company than middle managers.

4.4 Value element profile

There were a lot of strong correlations (above 0.700, see Appendix 2) within the value elements at all levels and all the suggested value elements got quite high valuations. This supports the view that the presented value elements can be considered at some levels as industrial maintenance service value elements, and that the value of maintenance services would consist of a value element package. It can also be seen that there are differences between the value elements of the customer and the service provider not only in ranks but also statistically. Especially in b-to-b relations the differences show more clearly because the deviations are not evened out as in this kind of a survey sample. Like Tynninen et al. (2012) suggest, there is a need for a value element profile that the service provider and the customer can use to recognise differences in their value elements while making contracts and measuring the service, and most importantly, discussing issues that create value for each party. With the value element profile there is a base for discussions and suggestions for adequate measures that can be used. The identification of the right value elements for each situation is made more concrete for managers. Also the expected benefits and value can be made clear in the total offer for the customer (Payne, 2006). The service provider would work as a co-creator of value and offer solutions instead of just a service, like Grönroos (2008) emphasises. For example, if the service provider rates operator knowledge as the most important value element and the customer places it as the fourth element, there are three elements that the customer values higher than the service provider. When the service provider is aware of this difference, they can pay attention to this and provide the best combination of value elements, and make a better offer.

In practice the customer and service provider would go through the different value elements in different situations and rank the values according to their importance for them. Then, the responses would be reviewed and the most differing elements chosen and put into a radar diagram (Figure 2, the chosen elements in Figure 2 are based on the survey results, and the elements with statistically significant differences between the customer and service provider were chosen into the diagram). Then, the maintenance service customer and service provider would recognise where the biggest gaps are, and they could negotiate about these key differences more specifically before making the final contract, and also consider this in the overall decision making, for example, pricing related to improved safety or possible R&D cooperation in exchange for better technical quality. In the best scenarios this would result in a situation where both parties would gain more value of the contract than originally expected. The organisations would understand what elements create value in the maintenance service collaboration (Lapierre, 2000), and this would result in a win-win situation where the overall value of the relationship would grow and also the competitiveness of the relationship would improve. It should not be forgot, however, that contract-related issues are complicated and require openness and mutual trust (Panesar and Markeset, 2008; Rekola and Haapio, 2009).

Figure 2 Draft of the value element profile for identifying the right value elements and the 'value gap'



5 Conclusions and suggestions for future research

The objective of this paper was to verify the most important value elements from the customer's and service provider's perspective, and to find the differences between the parties of industrial maintenance services as well. Overall, all the suggested value elements got quite high valuations with means between 3.0 and even 4.60 (not agreeing nor disagreeing to strongly agreeing), so they can be considered to be elements that at least somehow affect the experienced value of maintenance services. It also shows that value is constituted of different elements. On the basis of the survey results, there are clearly maintenance service value elements that arise above others in all categories, namely reliability, safety at work, environmental safety, and operator knowledge. Also technical quality and price were rated high. Fastness, perseverance and domestic content of the maintenance service were suggested as new factors that would also affect the experienced value. On the other hand, there were also value elements that were constantly rated as less important value elements in all categories. These were access to markets, asset management factors and R&D. Especially, the low valuation of asset management factors was surprising, because there has been a lot of discussion and research regarding the importance of asset management factors, but it seems that the customers and service provides have not yet understood their profit potential. Overall, comprehensive value elements like total solutions, asset management factors, access to markets, and R&D were rated lower, and this is understandable due to their complex

nature. The possible win-win potential and development of these elements should be emphasised. The survey results suggested also that there are differences between the value elements of the customer and the service provider, and also different situations affect the value elements preferred. The statistically significant differences were not as great as expected on the basis of theory, but because there were at least some statistical differences in a big population like this, in business-to-business relations the differences are probably even greater because the means are not evened out.

The paper contributes to the theoretical value discussion of industrial maintenance services and provides value elements that can be considered as the value elements of industrial maintenance services. Until now there has been a lack of knowledge about the specific value elements concerning the industrial maintenance service customer and service provider. The paper also points out that there are differences in maintenance service value elements that should be considered in negotiations. The paper also provides a first draft of a value element profile, which could be used in negotiation situations. Now the profile is rather theoretical because the value elements were verified for the first time and they are also strongly situational. In the future the value element profile will provide also a practical side by offering a negotiation method for assessing and discussing value and making it more concrete for the customer and the service provider by visualising a possible gap in the value elements of the customer and the service provider. Also performance measurement can be value-based, and therefore the value discussion also helps in finding the correct performance measures used in the contract. By successfully closing the gap, the customer and the service provider can reach their maximum value creation potential, and an overall win-win situation in the cooperation can be reached. Of course profiling and discussing the value elements would require openness and interest in honest cooperation.

There are also limitations in the study that should be taken into account in future research. The propositions behind the value elements are compromises that are situation-specific and service-related, and there are probably as many views behind the responses as there are respondents. Also it is a weakness of a survey method like this that unconscious preferences cannot be known because the responses are not based on clear measurable values. However, the research did not aim at absolute value, the aim was to add and verify the theoretical knowledge related to the value elements of maintenance services that can be used for discussional purposes (e.g., the value element profile, the function of which is situation-specific and the theory only constructs a starting point for the use). The mean values and sum variables had a high weight in this paper to get an overall view of the situations, but for future research also the value elements should be reviewed in closer detail because in some cases Cronbach's alpha was considerably low. Possible dividing and regrouping of elements should be considered. In the future also the list of elements should be modified and updated. Correlations received little attention because the focus was on finding differences. But, because there was a great amount of significant correlations, it would be interesting to test the correlations further and also make a factor analysis to see whether some value elements could be merged.

A major future research target is the building and focusing of the maintenance service value analyser based on the value element profile. The analyser should be studied in different situations, like preventive and corrective maintenance, and also specified for different customers, for example, according to size or maintenance service area. Later, the analyser could be added with weights to the life-cycle model developed by Sinkkonen

et al. (2013) and also included in service offering discussions and presented as a comprehensive manager tool.

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References

Cortina, J.M. (1993) 'What is coefficient alpha? An examination of theory and applications', *Journal of Applied Psychology*, Vol. 78, No. 1, pp.98–104.

Devore, J.L. and Berk, K.N. (2012) *Modern Mathematical Statistics with Applications*, 2nd ed., Springer, New York, NY.

Dumond, E. (2000) 'Value management: an underlying framework', *International Journal of Operations & Production Management*, Vol. 20, No. 9, pp.1062–1077.

EU-OHS (2012) *Procurement of Maintenance Services and Health and Safety at Work*, E-fact 63 [online] https://osha.europa.eu/en/publications/e-facts/e-fact-63-procurement-of-maintenance-services-and-health-and-safety-at-work (accessed 27 June 2013).

Flint, D., Woodruff, R. and Gardial, S. (1997) 'Customer value change in industrial marketing relationships: a call for new strategies and research', *Industrial Marketing Management*, Vol. 26, No. 2, pp.163–175.

Ford, D. and McDowell, R. (1999) 'Managing business relationships by analyzing the effects and value of different actions', *Industrial Marketing Management*, Vol. 28, No. 5, pp.429–442.

Grönroos, C. (2000) *Service Management and Marketing: A Customer Relationship Management Approach*, Wiley, Chichester.

Grönroos, C. (2008) 'Service logic revisited: who creates value? And who co-creates?', *European Business Review*, Vol. 20, No. 4, pp.298–314.

Guenzi, P. and Troilo, G. (2007) 'The joint contribution of marketing and sales to the creation of superior customer value', *Journal of Business Research*, Vol. 60, No. 2, pp.98–107.

Gulati, R. (2009) *Maintenance and Reliability Best Practices: With Contributions by Ricky Smith*, Industrial Press, New York.

Hatinen, L., Pirttilä, M., Viskari, S. and Kärri, T. (2012) 'The investment logics of Finnish industrial maintenance service providers', *International Journal of Strategic Engineering Asset Management*, Vol. 1, No. 1, pp.33–48.

Järviö, J., Piispa, T., Parantainen, T. and Åström, T. (2007) *Maintenance*, KP-Media, Helsinki, in Finnish.

Jonker, R. and Haarman, M. (2006) 'Value driven maintenance: what is the actual added value of maintenance?', *Uptime Magazine*, 6 November [online] http://www.reliabilityweb.com/art07/value_driven_maintenance_uptime.pdf (accessed 13 May 2013).

Kärri, T. (2007) *Timing of Capacity Change: Models for Capital Intensive Industry*, Acta Universitatis Lappeenrantaensis 287, Dissertation, Lappeenranta University of Technology, Finland.

Komonen, K., Suominen, S. and Kupi, E. (2007) 'Interaction between customer satisfaction, server satisfaction and effectiveness within industrial maintenance', *Conference Proceedings, the 2nd World Congress on Engineering Asset Management*, June, pp.11–14, Harrogate, UK.

Kumar, R., Markeset, T. and Kumar, U. (2006) 'Implementation and execution of industrial service strategy: a case study from the oil and gas industry', *Journal of Quality in Maintenance Engineering*, Vol. 12, No. 2, pp.105–117.

Lapierre, J. (2000) 'Customer-perceived value in industrial contexts', *Journal of Business & Industrial Marketing*, Vol. 15, No. 2, pp.122–145.

Liang, Y. (2010) 'Integration of data mining technologies to analyze customer value for the automotive maintenance industry', *Expert Systems with Applications*, Vol. 37, No. 12, pp.7489–7496.

Lind, S., Nenonen, S. and Kivistö-Rahnasto, J. (2008) 'Safety risk assessment in industrial maintenance', *Journal of Quality in Maintenance Engineering*, Vol. 14, No. 2, pp.205–217.

Márquez, A.C. (2007) *The Maintenance Management Framework: Models and Methods for Complex Systems Maintenance*, Springer series in reliability engineering, Springer-Verlag, London.

Ojanen, V., Hatinen, L., Kärri, T, Kässi, T. and Tuominen, M. (2012) 'Flexible investment planning and collaborative maintenance management', in van der Lei, T., Herder, P. and Wijnia, Y. (Eds.): *Asset Management: The State of Art in Europe from a Life Cycle Perspective*, pp.65–77, Springer, Dordrecht.

Panesar, S.S. and Markeset, T. (2008) 'Industrial service innovation through improved contractual relationship', *Journal of Quality in Maintenance Engineering*, Vol. 14, No. 3, pp.290–305.

Payne, A. (2006) *Handbook of CRM: Achieving Excellence in Customer Management*, 438pp, Elsevier, Oxford.

Purchase, S., Goh, T. and Dooley, K. (2009) 'Supplier perceived value: differences between business-to-business and business-to-government relationships', *Journal of Purchasing & Supply Management*, Vol. 15, No. 1, pp.3–11.

Ramsay, J. (2005) 'The real meaning of value in trading relationships', *International Journal of Operations & Production Management*, Vol. 25, No. 5, pp.549–565.

Ramsay, J. and Wagner, B. (2009) 'Organisational supplying behavior: understanding supplier needs, wants and preferences', *Journal of Purchasing & Supply Management*, Vol. 15, No. 2, pp.127–138.

Rekola, K. and Haapio, H. (2009) *Industrial Services and Service Contracts: A Proactive Approach*, The Federation of Finnish Technology Industries, Helsinki.

SFS-EN Std. 13306 (2010) *Maintenance*, *Maintenance terminology*, Finnish Standard Association SFS, 53pp.

Sinkkonen, T., Kivimäki, H., Marttonen, S. and Kärri, T. (2013) 'A value-based life-cycle framework for networks of industrial maintenance services', *The 26th International Congress of Condition Monitoring and Diagnostic Engineering Management*, 11–13 June, Helsinki, Finland.

Smals, R. and Smits, A. (2012) 'Value for value – the dynamics of supplier value in collaborative new product development', *Industrial Marketing Management*, Vol. 41, No. 1, pp.156–165.

Smith, L., Ng, I. and Maull, R. (2012) 'The three value proposition cycles of equipment-based service', *Production Planning & Control: The Management of Operations*, Vol. 23, No. 7, pp.553–570.

Tynninen, L., Sinkkonen, T., Marttonen, S. and Ojanen, V. (2012) 'Framework for the value elements of maintenance services', *The 2nd International Congress on Maintenance Performance Measurement & Management*, 12–13 September, Sunderland, UK.

Ulaga, W. (2003) 'Capturing value creation in business relationships: a customer perspective', *Industrial Marketing Management*, Vol. 32, No. 8, pp.677–693.

Walter, A., Ritter, T. and Gemunden, H.G. (2001) 'Value creation in buyer-seller relationships: theoretical considerations and empirical results from a supplier's perspective', *Industrial Marketing Management*, Vol. 30, No. 4, pp.365–377.

Zeithaml, V. (1988) 'Consumer perceptions of price, quality, and value: a means-end model and synthesis of evidence', *Journal of Marketing*, Vol. 52, No. 3, pp.2–22.

Appendix 1

Appendix 1 shows the proposed value elements and defining propositions based on the previous literature research of Tynninen et al. (2012) and the workshop results of Sinkkonen et al. (2013).

Availability:	
1	The target of the maintenance work functions as expected, its maintainability and repair is easy.
2	The users look after their part of the in use maintenance operations and enhance the maintainability of the item.
Safety at work:	
3	The operational conditions and safety increase along the service.
4	The maintenance is performed according to safety policies.
Environmental safety:	
5	The maintenance service performer recognises the environmental safety hazards.
6	The maintenance is performed according to environmental safety policies.
Technical quality:	
7	The maintenance service outcome is as expected.
8	The maintenance service outcome is sustained for the promised time.
Flexibility:	
9	The maintenance service partner bends from its claims (e.g., delivery time)
10	The maintenance services are tailored based on need.
Reliability:	
11	The maintenance service cooperation is executed on time and as promised.
12	The maintenance service cooperation is based on confidentiality.
Operator knowledge:	
13	The maintenance service provider has the knowledge to solve upcoming problems.
14	The maintenance service operators are professionally skilled and qualified.
Orderliness:	
15	The resources and timetable of the maintenance service can be planned well in advance.
16	The maintenance service operations are developed in cooperation.
Reputation:	
17	The current reputation of the maintenance service partner is good.
18	The previous experiences with the maintenance service partner have been positive.
Relationship:	
19	The maintenance service cooperation works well considering the conditions of all partners.
20	The information exchange works between the maintenance service partners.

Contracts:	
21	The maintenance service warranty and terms of payment are kept and executed as promised.
22	The risks and responsibilities considering the maintenance services are shared between the customer and the service provider.
Total solutions:	
23	The maintenance service cooperation covers comprehensively the whole maintenance services (from management to execution).
24	The maintenance service covers the whole life span of the item.
R&D:	
25	Own research and development can be developed with the maintenance service partner.
26	The maintenance service partner can provide information and knowledge related to the development of R&D activities.
Price:	
27	The price paid for the maintenance service corresponds with the received service.
28	The price is negotiated in cooperation with the maintenance service partner.
Access to markets:	
29	The maintenance service cooperation enables contact with new customers.
30	The maintenance service cooperation enables starting a new type of business.
Asset management factors:	
31	The maintenance service partner is responsible for the spare part storage so that it does not tie your own resources and capital.
32	The maintenance service partner owns the fixed assets, for example, the maintained items so that they do not stress your own balance sheet.

Appendix 2

Appendix 2 shows the correlation coefficients between the value elements.

	Value element (high critical item)	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	Availability															
2	Safety at work	.571**														
3	Environmental safety	.500**	.577**													
4	Technical quality	.806**	.635**	.574**												
5	Flexibility	.116	.236	.379*	.268											
6	Reliability	.228	.305	.352	.454*	.376*										
7	Operator knowledge	.688**	.542**	.367*	.687**	.386*	.553**									
8	Orderliness	.656**	.539**	.550**	.699**	.318	.526**	.673**								
9	Reputation	.412*	.486**	.696**	.446*	.644**	.466**	.545**	.496**							
10	Relationship	.609**	.600**	.491**	.708**	.596**	.623**	.843**	.645**	.694**						
11	Contracts	.327	.389*	.469**	.367*	.441*	.497**	.591**	.401*	.699**	.632**					
12	Total solutions	.064	–.142	.263	.166	.162	.197	.189	.312	.380*	.160	.286				
13	R&D	.193	.191	.572**	.172	.315	.318	.171	.457**	.567**	.326	.462**	.478**			
14	Price	.669**	.619**	.712**	.767**	.312	.421*	.636**	.730**	.546**	.536**	.397*	.246	.325		
15	Access to markets	–.219	–.229	.156	–.190	.040	–.086	–.208	–.020	.152	–.039	.069	.090	.469**	–.135	
16	Asset management factors	.400*	.371*	.363*	.514**	.141	.194	.400*	.265	.312	.556**	.275	.186	.328	.326	.269

Notes: **Correlation is significant at the 0.01 level (two-tailed).
*Correlation is significant at the 0.05 level (two-tailed).

Value element (low critical item)		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	Availability															
2	Safety at work	.579**														
3	Environmental safety	.437*	.585**													
4	Technical quality	.483**	.499**	.453*												
5	Flexibility	.197	.170	.410*	.135											
6	Reliability	.442*	.221	.465**	.458**	.528**										
7	Operator knowledge	.507**	.303	.359	.762**	.213	.548**									
8	Orderliness	.344	.244	.468**	.456**	.421*	.791**	.593**								
9	Reputation	.415*	.322	.530**	.421*	.468**	.494**	.408*	.539**							
10	Relationship	.524**	.248	.459*	.588**	.439*	.731**	.676**	.707**	.676**						
11	Contracts	.289	.310	.454*	.379*	.659**	.544**	.369*	.457**	.545**	.582**					
12	Total solutions	.274	.270	.309	.256	.163	.308	.236	.111	.242	.303	.394*				
13	R&D	.193	–.139	.284	–.088	.311	.347	–.063	.373*	.223	.293	.353	.003			
14	Price	.429*	.458*	.508**	.774**	.084	.610**	.578**	.424*	.424*	.579**	.357	.348	–.047		
15	Access to markets	.160	–.151	.329	–.224	.319	.135	–.167	.228	.250	.203	.342	–.056	.812**	–.114	
16	Asset management factors	.165	.030	.139	.146	.122	.285	.145	.131	.187	.229	.243	.288	.358*	.236	.252

Notes: **Correlation is significant at the 0.01 level (two-tailed).
*Correlation is significant at the 0.05 level (two-tailed).

Value element (core service)		*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	Availability															
2	Safety at work	.589**														
3	Environmental safety	.421**	.441**													
4	Technical quality	.482**	.636**	.573**												
5	Flexibility	.337*	.278	.292	.297											
6	Reliability	.448**	.650**	.628**	.586**	.324*										
7	Operator knowledge	.576**	.611**	.456**	.685**	.426**	.668**									
8	Orderliness	.410**	.335*	.550**	.475**	.593**	.432**	.629**								
9	Reputation	.474**	.507**	.397**	.534**	.471**	.420**	.616**	.704**							
10	Relationship	.322*	.493**	.439**	.611**	.442**	.490**	.614**	.684**	.728**						
11	Contracts	.286	.236	.435**	.473**	.602**	.413**	.500**	.637**	.561**	.624**					
12	Total solutions	.175	.215	.366*	.333*	.351*	.299*	.333*	.473**	.306*	.249	.255				
13	R&D	.314*	.379**	.137	.316*	.478**	.285*	.389**	.504**	.509**	.483**	.433**	.344*			
14	Price	.362*	.223	.298*	.261	.584**	.261	.497**	.588**	.455**	.540**	.611**	.135	.220		
15	Access to markets	.203	.177	.201	.261	.343*	.204	.351*	.494**	.502**	.508**	.537**	.030	.440**	.417**	
16	Asset management factors	–.028	–.112	.171	.129	.000	–.128	.093	.149	.258	.220	.428**	–.028	.125	.162	.228

Notes: **Correlation is significant at the 0.01 level (two-tailed).
*Correlation is significant at the 0.05 level (two-tailed).

	Value element (support service)	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	Availability															
2	Safety at work	.579**														
3	Environmental safety	.540**	.738**													
4	Technical quality	.724**	.706**	.702**												
5	Flexibility	.459**	.461**	.361*	.407**											
6	Reliability	.521**	.679**	.639**	.674**	.525**										
7	Operator knowledge	.543**	.566**	.501**	.699**	.442**	.699**									
8	Orderliness	.547**	.539**	.521**	.715**	.495**	.662**	.711**								
9	Reputation	.581**	.670**	.531**	.659**	.504**	.655**	.692**	.716**							
10	Relationship	.719**	.571**	.572**	.783**	.370*	.758**	.811**	.749**	.707**						
11	Contracts	.515**	.484**	.593**	.624**	.501**	.561**	.578**	.538**	.648**	.611**					
12	Total solutions	.369*	.446**	.342*	.494**	.324*	.420**	.471**	.460**	.725**	.437**	.474**				
13	R&D	.579**	.485**	.440**	.648**	.411**	.598**	.699**	.610**	.722**	.812**	.696**	.522**			
14	Price	.499**	.597**	.627**	.594**	.529**	.548**	.521**	.515**	.507**	.478**	.472**	.382*	.498**		
15	Access to markets	.506**	.409**	.363*	.585**	.246	.381*	.529**	.435**	.494**	.627**	.545**	.402*	.805**	.566**	
16	Asset management factors	.236	.166	.128	.315*	.054	.031	.231	.080	.279	.177	.444**	.104	.150	.103	.162

Notes: **Correlation is significant at the 0.01 level (two-tailed).
*Correlation is significant at the 0.05 level (two-tailed).

Publication 2

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Understand what your maintenance service partners value

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Understand what your maintenance service partners value

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Abstract

Purpose – The purpose of this paper is to identify what is currently valued in maintenance services. The study first conceptualizes the value construct through an examination of its elements, including both financial and non-financial elements, and second provides insight into its actors' (i.e. customer companies, service providers, equipment providers) attitudes toward value creation.

Design/methodology/approach – The study uses data collected from maintenance service professionals by an online survey. First an explorative factor analysis is conducted to examine the value construct. After this cluster analysis is conducted to define the actors.

Findings – The empirical findings suggest seven main elements that capture maintenance service value: relationship synergies, reliability of the service partner, development, availability, service solutions and problem solving ability, environment, health, safety and quality, and adaptability to suit different situations. Further analysis reveals that the actors can be divided into three main strategy types: basic, quality- and collaboration-oriented partners.

Originality/value – In previous studies the comprehensive nature of maintenance service value has received less attention, and the literature has focused on the technical and financial aspects. This paper provides a new conceptualization of the value creating elements, including also non-financial elements, and offers an integrated measure for the actors to identify the comprehensive value construct around maintenance services. In addition, the findings show that the actors in the field still have varying strategies when considering value creation. Communication and mutual understanding of the value creating elements are important so that right services are carried out and developed with the right partners.

Keywords Collaboration, Value creation, Relationship value, Maintenance services, Value element

Paper type Research paper

1. Introduction

Maintenance management has moved from a cost-centric view toward a more value-centric perspective where the service is not only considered as a cost factor but it can also create additional value (Liyanage and Kumar, 2003; Parida and Kumar, 2006; Pintelon and Parodi-Herz, 2008). In addition, the maintenance field is constantly evolving, as in-house maintenance organizations have moved partly toward partnerships in different company networks where the actors (i.e. customer companies, service providers and equipment providers) operate (Ahonen et al., 2010; Riis et al., 2007). The service aspect is now a common part of maintenance. In order to improve the competitiveness of the service relationships, it is essential for the organizations to gain mutual understanding of what the value creating elements in the service network are, so that benefits like performance efficiency and reliability can be achieved (e.g. Barry and Terry, 2008; Lapierre, 2000; Ulaga, 2003). Mutual understanding helps to avoid disagreements, lack of quality and sub-optimization between the service partners and highlight the positive

effects of service collaboration instead, so that all parties can benefit from the service relationship.

Maintenance service value consists of a diverse range of different elements, and it is also very maintenance case -specific, which makes the identification of the overall value complex (e.g. Toossi et al., 2013). Despite the increasing recognition of comprehensive maintenance value, the relationships are still often price-oriented. This often results in short-term decisions which can be quite problematic in maintenance, as many of the benefits are created over a long term. Especially for the more complex offerings, relationship learning enabled over long-term is an important part of value co-creation (Kohtamäki and Partanen, 2016). Systematic ways to understand and measure what maintenance service value is for each actor are needed, as this would help the building of sustainable and successful relationships (Ahonen et al., 2010; Lapierre, 2000; Panesar and Markeset, 2008; Reinartz and Ulaga, 2008). To capture the comprehensive value of maintenance services, both financial (e.g. cost savings, price) and non-financial (e.g. trained labor, willingness to cooperate, reputation, safety) elements need to be viewed (Liyanage and Kumar, 2003; Ojanen, Ahonen, Reunanen and Hanski, 2012; Toossi et al., 2013).

This research focuses on the comprehensive service value of maintenance, which has been a rather rare topic in earlier studies, as the literature has focused more on the technical and financial aspects. The paper aims to clarify the nature of maintenance service value, first by an examination of its elements, and second by providing insights into the different value creation strategies of the actors.

On one hand, the research supports the multidimensional and complex nature of maintenance service value, as the empirical findings show that value creation is characterized by multiple elements. On the other hand, the findings show that the actors in the field are very heterogeneous when considering the attitudes toward value. Some do not emphasize any particular elements and keep the service relationship more on the transactional side, whereas others emphasize the relational aspects and non-financial elements of the service. Therefore, when designing and evaluating value creating maintenance services, academics and managers should keep in mind the heterogeneity of the actors and the possible differences in the evaluation criteria. When aiming at more collaborative relationships, also non-financial elements have to be considered and measured. Communication is the key in developing right offerings with the right partners.

The paper is structured as follows. In Section 2, value creation is described in the context of maintenance services. Next (Section 3), the methods and data used in the study are presented. The results are reported in Section 4. The overall results with managerial implications and future research are discussed in Section 5, and final conclusions in Section 6.

2. Value creation in maintenance services

Maintenance focus moving from cost-centric to value-centric

Parida and Kumar (2006) describe that maintenance management has had a paradigm shift from being viewed as a cost to being looked as a service that can create value. In the early 1900s, maintenance was considered as a "necessary evil" that "costs what it costs." The technologies were not very advanced yet and failures occurred randomly. After the 1950s, the technologies advanced and methods like preventive maintenance and condition monitoring were introduced. This changed the cost-centric view to "it can be planned and controlled," and maintenance became an important support function. Value thinking within companies has emerged, and maintenance is treated more and more as a strategic issue instead of a purely technical one (Pintelon and Parodi-Herz, 2008). As Rosqvist et al. (2009) suggest in their Value Driven Maintenance Planning model, the maintenance objectives should derive from the strategic objectives and key performance indicators (KPIs) of the company. Now maintenance

can be treated as an integral part of the business process, and e.g. Liyanage and Kumar (2003) suggest that it can create additional value to companies.

However, for companies the optimization of maintenance still often means the minimizing of cost in the short term instead of maximizing the value through long-term objectives and continuous improvement (Marais and Saleh, 2008; Murthy et al., 2015). Marais and Saleh (2008) argue that by focusing only on the cost-centric views, an important dimension of maintenance, value, is forgotten, and this can lead to sub-optimal maintenance strategies. Therefore both sides: assessment of the value of maintenance and assessment of the costs of maintenance should be involved when determining the maintenance strategy. A multidisciplinary view involving e.g. finance, marketing and operations within companies should be included to guide the operations in a comprehensive and value-optimized way (Marais and Saleh, 2008). Also Liyanage and Kumar (2003) promote the value-based view to maintenance. A more comprehensive view and overall results should be looked at, rather than focusing only on cost cutting and controlling operational expenses (which has led to companies optimizing maintenance as a cost center). Pure cost-centric views can lead to short-sighted decisions that can add to the total cost. This happened for example as the offshore oil production platform P-36 sunk due to too ambitious cost saving efforts (Marais and Saleh, 2008). Companies should extend their understanding beyond the financial and cost-centric view and elaborate the value-added processes (Liyanage and Kumar 2003; Parida and Kumar, 2006).

Moving from the cost-centric view toward more value-centric views also sets the focus on long-term development aspects. Supporting the long-term development and profitability of the organization is one of the key functions of maintenance (Al-Sultan and Duffuaa, 1995; Parida and Kumar, 2006). Maintenance is also a field that affects all three dimensions of sustainability, namely, the economic, environmental, and social dimensions and thus also influences corporate level sustainability by creating/destroying (if organized badly) long-term shareholder value (Lo, 2010). Therefore it is important to look at maintenance not only as a plant-based cost center but from a long-term business-oriented view (Liyanage and Kumar, 2003; Panesar and Markeset, 2008; Pintelon and Parodi-Herz, 2008). This way also the long-term benefits of appropriate maintenance (e.g. quality of work, availability, safety incidents) can be seen and the value creation optimized comprehensively in the long run.

Maintenance outsourcing and service relationships

Maintenance operations are often at least partly outsourced, which emphasizes the role of the inter-organizational relationship. The nature of the business has changed; maintenance service suppliers are now an important part of the business landscape. Also equipment providers are eager to provide added value through services besides traditional equipment exchange, as they can reach more steady cash flows and better customer satisfaction with the added services (e.g. Johansson and Olhager, 2004; Kindström and Kowalkowski, 2009). In-house maintenance organizations have shifted toward partnerships in different company networks where the customer, service providers and equipment providers operate (Ahonen et al., 2010; Riis et al., 2007).

From the customer's point of view, increasingly complex assets have grown the knowledge intensity of operations, making the maintaining of special know-how, resources and required skills in-house not always profitable. This has attracted specialization in the service provider field, and outsourcing is now a sought-after option in many cases (e.g. Al-Turki, 2011). Persona et al. (2007) list the possible benefits of outsourcing as the following: business improvement through cost reduction and efficiency, improving the performance of existing lines of business, and focus on core functions (technology-related assets). Also flexibility and access to new markets, skills and latest

technology (Lorenzoni and Lipparini, 1999; Kremic et al., 2006), as well as sharing the risks, resources, knowledge, and R&D development (e.g. McDonough et al., 2006) can motivate partnerships in maintenance. Stremersch et al. (2001) add integrated solutions and full service concepts to the list as being behind the motivation to purchase maintenance services from external service or equipment providers.

Outsourcing and service relationships can also have a positive effect on company growth and innovativeness when the ability to integrate the company's own knowledge with the partnering outside company's successes. It should be remembered that complex company networks engage in more than just transactions around services, goods and revenue (Allee, 2000). Also knowledge value and intangible value or benefits are shared (Grönroos and Helle, 2010). Some studies suggest that collaborative agreements and partnerships can have positive effects on revenue and profit in the manufacturing industry (e.g. Stuart, 2000). Even though versatile benefits have been acknowledged in service relationships, for many companies the decisions related to the outsourcing of maintenance operations and their management is still made on possible short-term cost savings (Murthy et al., 2015). The discussion focuses on the transactions around services and goods instead of improving the processes in the long term and creating mutual development objectives.

If the outsourcing process is poorly managed, the results of outsourcing are not always positive, as also new risks are included (Campbell, 1995; Kremic et al., 2006). Benefits are often overemphasized in the planning phase and the savings remain unrealized, and in the worst case scenarios result in increased overall cost. Other risks are for example issues related to the personnel and their motivation and morale, unsatisfied customers, power shift and dependence on a supplier, and knowledge and competence loss (Bertolini et al., 2004; Kremic et al., 2006). In addition, Campbell (1995) mentions as one concern the potential loss of cross-functional communication, which can lead to less flexible processes. With more and more complex technologies, one part of communication is efficient data management. This is often ignored in contracts, which can cause serious problems in the information flow and management of operations between the different parties of outsourced maintenance (Murthy et al., 2015).

Value creating service relationships

Value creation has two sides: the value created for the customer and the value created for the company offering the service (Gupta and Lehmann, 2005). This means that in a business relationship value creation is reciprocal, and the services offered work as a mediating factor in the process where the parties involved should achieve value (Ballantyne and Varey, 2006; Grönroos, 2011; Grönroos and Ravald, 2009). When considering business-to-business services, in most cases the value will be interactional and dependent on issues like performance and quality, as well as relationship-related aspects like e.g. administrative routines and communication (La Rocca and Snehota, 2014; Lindgreen and Wynstra, 2005; Vargo and Lusch, 2008). Value is related to the solutions created at different relationship facets and therefore it is created in interaction between the customer and supplier rather than unilaterally by one party (Ballantyne and Varey, 2006; La Rocca and Snehota, 2014; Tuli et al., 2007).

The nature of service relationships varies and can be considered to form a continuum on the range from transactional to relational exchange and full collaboration (e.g. Axelsson and Wynstra, 2002; Day, 2000; Lindgreen et al., 2012; Penttinen and Palmer, 2006). Table I lists the recognizable features of the end points of the continuum.

Together with the nature of the relationship and related interactions, also the service offering changes (Oliva and Kallenberg, 2003). The completeness of a service offering can also be measured on a continuum from less complete (e.g. basic components) to more

Perspective	Transactional approach	Relational approach
Competition	Many alternatives	One or a few alternatives
Tactical focus	Every deal is a new business, no one should benefit from past performance	A deal is part of a relationship and the relationship is part of the network context
Relationship attitude	Exploiting the potential of competition; anonymous and efficient market	Exploiting the potential of cooperation; numerous market networks
Time horizon	Short-term; arm's length, avoiding coming close	Long-term with tough demands and joint development
Renewal	Effective renewal through partner changes, choosing the most efficient supplier at any time	Effective renewal through collaboration and teamwork, combining resources and knowledge
Services	Buying "products." Services augment the core product	Buying "capabilities." Services are basis for differentiation
Orientation	Price orientation, strong in achieving favorable prices in well-specified products	Cost and value orientation, strong in achieving low total costs of supply and developing new values

Table I.
Transactional vs relational exchange

Sources: Adapted from Axelsson and Wynstra (2002), Lindgreen et al. (2012)

complete offerings (e.g. integrated solution) (Oliva and Kallenberg, 2003; Penttinen and Palmer, 2006). Based on the continuum of relationship development and the continuum of service offering development, Penttinen and Palmer (2006) have constructed a framework presented in Figure 1. The horizontal axis describes the nature of the relationship based on the continuum from the transactional to the relational approach, and the vertical axis describes the continuum of the service offering and its completeness.

The less complete offerings are often simple but also limited in differentiation for the customer. On the other hand, the more complete offerings are extensions in meeting customer needs but they are also more complex on the relationship side and can require for example more

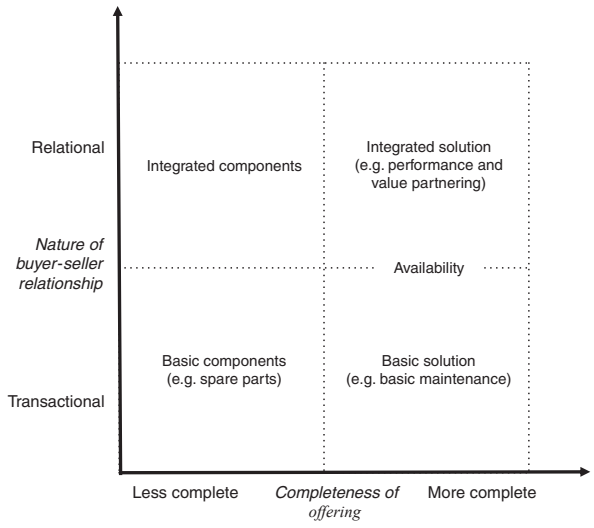

Figure 1.
Development of the relationship and service offering

Source: Adapted from Penttinen and Palmer (2006)

extensive information exchange (Penttinen and Palmer, 2006). In maintenance services the service offering also often ranges from less complete offerings like spare parts to a complete operation and maintenance contract, where the focus is on the business process and mutual value creation in the long term (Rekola and Haapio, 2009). In basic services the focus is on price and not on long-term contracts or relationship development (e.g. spare parts, basic maintenance). The extended basic services are similar to the basic services but are based on a long-term contract (e.g. technical support). Rekola and Haapio (2009) mention availability as the most popular form of maintenance service (full services/outsourcing), where the focus is on preventive maintenance and the relationship is based on a service contract (incl. services like maintenance, spare parts, training and inspections). Availability services are located in the middle of basic maintenance and performance partnering in Figure 1. Maintenance services that would fall more on the relational side are performance partnering, where the focus is on OEE (overall equipment effectiveness), and value partnering, where the focus is on the customer's business processes instead of only maintenance. Both service offerings are based on long-term contracts and mutual service development, and will require intimate service relationships. In knowledge-intensive business service offerings, the co-creation of value is also characterized by the positive moderating role of relationship learning (Kohtamäki and Partanen, 2016). Even though value partnering sounds profitable, not all need to aim at it. It can involve complicated contractual issues and other costs associated to the close relationship, and in addition it requires a great deal of mutual trust. Axelsson and Wynstra (2002) also discuss that sometimes losing the competitive side of the relationship can result in increasing the cost.

Every box in the relationship and offering quadrat of Penttinen and Palmer (2006) can be profitable, as long as the offering suits the needs of all parties and the relationship status is on the required level. However, the more the focus is on the service side of the offering, the more the parties should focus on realized value (value-in-use) instead of focusing only on the potential value at the point of sales (value-in-exchange) (Grönroos and Helle, 2010). Perceptions of the value created vary typically between individuals from different functions and from different companies, and therefore it is important to discuss and give feedback actively so that the value propositions can be revised, organizational learning can be enhanced, and resources assigned in the most profitable way (Lambert and Enz, 2012). The success of a maintenance service network depends on the partners' ability to collaborate (Bengtsson and Kock, 2000). Overall, the core of successful relationships between different service partners is a common view of the objectives, trust and commitment (Anderson and Narus, 1998; Rosqvist et al., 2009).

3. Methodology

Design and procedure

The present study is based on a questionnaire that consisted of background questions, the main part capturing the service value of maintenance, and a final part where measurement and performance-related questions were asked as additional information. The main part comprised 32 value propositions measuring maintenance services as a multidimensional phenomenon with both financial and non-financial service elements. The value elements behind the propositions were selected originally based on a literature review. To maximize the validity of the construct, the elements were reviewed and revised with a group of researchers and maintenance experts. First a pre-assignment was conducted, where the experts determined the value of different maintenance services without the preliminary list based on the literature review, to avoid guided responses. Second, the group was asked to revise critically the lists created on the basis of the literature review and pre-assignment. Based on the revision, two elements were added: safety at work and environmental safety, as the impact of maintenance on safety issues is brought up repeatedly and it is also one of the main focus points in specific maintenance literature and forums (e.g. EU-OSH, 2012;

EFNMS, 2016; Lind et al., 2008; The Finnish Maintenance Society, 2007). In addition, some improvements in wording related the other elements were made. Each element was then turned into two value propositions to communicate the value-creating characteristics behind the element clearly to the respondents (Ballantyne et al., 2011). The elements of maintenance service value and their propositions are presented in Table II. For each of the 32 value propositions, the respondents were asked to indicate their opinion on a five-point Likert scale with end points of "strongly disagree" (1) to "strongly agree" (5). The unit of analysis was an individual respondent's perception on maintenance service value at the organizational level, as the respondents were not required to provide absolute values. The questionnaire was pretested among maintenance experts, and some minor improvements were made before sending out the questionnaire.

Participants and data collection

The data for the study was collected with an online-questionnaire from Finnish companies that were either customers or service providers (pure service providers or also equipment providers) of maintenance in an industrial context. Overall, the questionnaire link was sent to 345 maintenance service professionals. The primary source for the contacts was a nationwide actor, the Finnish Maintenance Society Promaint, which has a diverse network of companies acting in the maintenance field. Finland is a good testing ground, as outsourcing of maintenance is quite common and the maintenance sector is overall a significant industry due to the aging industrial assets (Hatinen et al., 2012; The Finnish Maintenance Society, 2007). The survey was conducted in January-March 2013. The contact persons received two reminders after the first message at two-week intervals. The process resulted in a total of 83 completed questionnaires, representing a final response rate of 24 percent.

To avoid the common method bias of social desirability (Podsakoff et al., 2003), the respondents were encouraged to answer from their own viewpoint as truthfully as possible. The respondents were allowed to answer anonymously. By allowing anonymous responses, the respondents were less likely to edit their responses according to social desirability. In addition, the survey questions were constructed carefully by paying attention to the wording and clarity. The questions were also pretested and revised by a group of researchers and maintenance experts, and this should have also reduced the possibility of common method bias. To check the non-response bias, the differences between different respondent groups were tested. The respondents were divided into three groups based on their response time: the first respondents, respondents after the first reminder, and respondents after the second and last reminder. The results of the Kruskall-Wallis H test (as the data were not normally distributed) showed that there were no significant differences (at the 0.05 significance level) between the three groups. Based on the test, it can be assumed that the received responses present the whole sample well.

Description of the data

As the background information of the respondents in Table III show, 39 percent of the respondents represented large companies (over 250 workers), and thus the majority represented middle sized or small companies. The majority (57 percent) of the responses were received from middle management, for example from maintenance managers, 20 percent of the respondents represented senior management, and the rest (23 percent) represented mainly consultants and supervisors. One-third (39 percent) of the respondents represented companies on the maintenance service customer side and the rest (61 percent) represented the service provider side.

Value element	Proposition
Availability (Ma *et al.*, 2005)	P1: "The maintenance tasks are appropriate and maintainability and repairs are easy"
	P2: "The operators carry out their part of the in-use maintenance operations and enhance the maintainability of the item"
Safety at work	P3: "The operational conditions and safety increase along the service"
	P4: "Maintenance is performed according to safety policies"
Environmental safety	P5: "The maintenance service performer recognizes the environmental safety hazards"
	P6: "Maintenance is performed according to environmental safety policies"
Technical quality (Matthyssens, and Vandenbempt, 1998; Ojanen, Hatinen, Kärri, Kässi and Tuominen, 2012)	P7: "The maintenance service outcome is as expected"
	P8: "The maintenance service outcome is sustained for the promised time"
Flexibility (Ojanen, Hatinen, Kärri, Kässi and Tuominen, 2012; Barry and Terry, 2008; Kremic *et al.*, 2006; Malleret, 2006)	P9: "The maintenance service partner can suit the needs of the company (e.g. delivery time)"
	P10: "The maintenance services are tailored based on need"
Reliability (Ojanen, Hatinen, Kärri, Kässi and Tuominen, 2012; Barry and Terry, 2008)	P11: "The maintenance service cooperation is executed on time and as promised"
	P12: "The maintenance service cooperation is based on confidentiality"
Operator knowledge (Songailiene *et al.*, 2011; Brito *et al.*, 2007)	P13: "The maintenance service provider has the knowledge to solve upcoming problems"
	P14: "The maintenance service operators are professionally skilled and qualified"
Orderliness (Matthyssens and Vandenbempt, 1998; Barry and Terry, 2008)	P15: "The resources and timetable of the maintenance service can be planned well in advance"
	P16: "The maintenance service operations are developed in cooperation"
Reputation (Ramsey and Wagner, 2009)	P17: "The current reputation of the maintenance service partner is good"
	P18: "The previous experiences with the maintenance service partner have been positive"
Relationship (Ramsey and Wagner, 2009; Barry and Terry, 2008; Ojanen, Hatinen, Kärri, Kässi and Tuominen, 2012)	P19: "The maintenance service cooperation works well considering the conditions of all partners"
	P20: "Information exchange works between the maintenance service partners"
Contracts (McDonough *et al.*, 2006; Ramsey and Wagner, 2009; Songailiene *et al.*, 2011)	P21: "The maintenance service warranty and terms of payment are kept and executed as promised"
	P22: "The risks and responsibilities considering the maintenance services are shared between the customer and the service provider"
Total solutions (Matthyssens and Vandenbempt, 1998; Stremersch *et al.*, 2001)	P23: "The maintenance service cooperation covers the whole maintenance services comprehensively (from management to execution)"
	P24: "The maintenance service covers the whole life span of the item"
R&D (McDonough *et al.*, 2006; Ojanen, Hatinen, Kärri, Kässi and Tuominen, 2012; Walter *et al.*, 2001)	P25: "Own research and development can be developed with the maintenance service partner"
	P26: "The maintenance service partner can provide information and knowledge related to the development of R&D activities"
Price (Songailiene *et al.*, 2011; Brito *et al.*, 2007)	P27: "The price paid for the maintenance service corresponds with the received service"
	P28: "The price is negotiated in cooperation with the maintenance service partner"

Table II.
Value propositions and original references

(*continued*)

Value element	Proposition
Access to markets (Kremic *et al.*, 2006; Ramsey and Wagner 2009; Walter *et al.*, 2001)	P29: "Maintenance service cooperation enables contact with new customers"
	P30: "Maintenance service cooperation enables starting a new type of business"
Asset management (Ojanen, Hatinen, Kärri, Kässi and Tuominen, 2012)	P31: "The maintenance service partner is responsible for spare part storage so that it does not tie your own resources and capital"
	P32: "The maintenance service partner owns the fixed assets, for example the maintained items, so that they do not stress your own balance sheet"

Table II.

	Number (n=83)	%
Number of employees		
Under 10	7	8
10-49	19	23
50-249	25	30
over 250	32	39
Approximate turnover (€)		
Under 1 million	9	11
1-20 million	23	28
21-100 million	21	25
Over 100 million	30	36
Position of the respondent		
Senior management	17	20
Middle management	47	57
Other	19	23
Organization unit primarily		
Maintenance service customer	32	39
Maintenance service provider	36	43
Equipment and maintenance service provider	15	18

Table III. Descriptive statistics of the sample

Proposition P4 "Maintenance is performed according to safety policies" had the highest mean (4.74) on the scale from 1 to 5 (see Table IV). It seems that safety awareness is still highlighted in organizations. Also P7 "The maintenance service outcome is as expected" (4.55), P11 "The maintenance service cooperation is executed on time and as promised" (4.54), P12 "The maintenance service cooperation is based on confidentiality." (4.66) and P14 "The maintenance service operators are professionally skilled and qualified" (4.56) were valued very high (above 4.5). This emphasizes the role of well-functioning relationships. It is important that the partners are reliable and do what they promise.

Interestingly, the propositions related to relationships and collaboration were mainly valued below average (4.15), as P9 "The maintenance service partner can suit the needs of the company (e.g. delivery time)" (3.72), P22 "The risks and responsibilities considering the maintenance services are shared between the customer and the service provider" (3.85), P24 "The maintenance service covers the whole life span of the item" (3.83), P25 "Own research and development can be developed with the maintenance service partner" (3.69), P26 "The maintenance service partner can provide information and knowledge

Table IV.
Factor analysis results

Variable	Mean	SD	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Comm.
P18	4.198	0.66	0.354							0.672
P22	3.850	0.90	0.370							0.757
P26	3.627	1.02	0.487							0.892
P29	3.780	1.14	0.994							0.867
P30	3.427	1.09	0.851							0.851
P14	4.563	0.63		0.553						0.850
P17	4.280	0.65		0.501						0.764
P20	4.272	0.84		0.711						0.923
P21	4.268	0.88		0.625						0.838
P27	4.329	0.82		0.395						0.862
P28	4.363	0.68		0.448						0.563
P31	3.415	1.12		0.438						0.668
P3	4.337	0.72			0.583					0.719
P12	4.659	0.55			0.444					0.730
P25	3.687	1.05			0.464					0.888
P1	4.205	0.95				0.725				0.836
P2	4.185	1.05				0.430				0.773
P15	4.012	0.94				0.511				0.738
P13	4.470	0.65					0.481			0.857
P23	4.060	0.93					0.395			0.746
P24	3.829	1.03					0.744			0.735
P4	4.738	0.47						0.847		0.771
P6	4.481	0.70						0.676		0.764
P7	4.554	0.65						0.578		0.889
P8	4.238	0.82						0.503		0.777
P11	4.542	0.57						0.353		0.739
P19	4.146	0.79						0.408		0.842
P9	3.723	0.87							0.739	0.643
P10	4.241	0.73							0.525	0.683
Cronbach's α			0.812	0.830	0.574	0.593	0.659	0.874	0.498	
Eigenvalue			6.840	5.593	1.476	1.926	1.241	1.083	1.076	
Percentage of variance explained			21.375	17.477	4.612	6.017	3.877	3.384	3.362	
Cumulative			21.375	38.857	43.464	49.481	53.358	56.742	60.104	

Notes: Generalized Least Squares. Oblimin with Kaiser Normalization rotation. Loadings above 0.35 are shown (Costello and Osborne, 2005). KMO measure of sampling adequacy 0.784; variables P5, P16 were removed from the final results as they loaded on separate factors as the only ones. In addition variable P32 was removed as it loaded negatively on the fourth factor

related to the development of R&D activities" (3.63), P29 "Maintenance service cooperation enables contact with new customers" (3.78), P30 "Maintenance service cooperation enables starting a new type of business" (3.43) and P31 "The maintenance service partner is responsible for the spare part storage so that it does not tie your own resources and capital" (3.42) were valued below (4.00). It can be concluded that well-functioning relationships are valued, but the elements behind them are mainly not identified to actually get positive synergies of relationships.

Based on the survey results, an explorative factor analysis was conducted first to capture the scale to measure the value of maintenance services comprehensively. After that a cluster analysis was conducted to identify respondent groups characterized by their attitude toward different value creation strategies and readiness to collaborate.

4. Findings

Factor analysis

To complete the multidimensional measurement scale, generalized least squares analysis was conducted to group the propositions into more comprehensive groups and to find possible hidden elements. An exploratory analysis with Oblimin with Kaiser Normalization rotation produced seven factors with an eigenvalue over 1.00. The model explains 60 percent of the variance (see Table IV). The value of the Keiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.784, which can be considered good.

Factor 1. The first factor explains 21.4 percent of the total variance of the data. It received five loadings ranging from 0.354 to 0.994. "Maintenance service cooperation enables contact with new customers" had the strongest loading (0.994). The other propositions "Maintenance service cooperation enables starting a new type of business" (0.851), "The maintenance service partner can provide information and knowledge related to the development of R&D activities" (0.487), "The risks and responsibilities considering the maintenance services are shared between the customer and the service provider" (0.370) and "The previous experiences with the maintenance service partner have been positive" (0.354) describe the positive synergies of relationships, and therefore the first factor represents "relationship synergies."

Factor 2. The second factor explains 17.5 percent of the total variance of the data. Altogether seven propositions loaded on this factor, ranging from 0.395 to 0.711. "The information exchange works between the maintenance service partners" had the strongest loading (0.711). The others were "The maintenance service warranty and terms of payment are kept and executed as promised" (0.625), "The maintenance service operators are professionally skilled and qualified" (0.553), "The current reputation of the maintenance service partner is good" (0.501), "The price is negotiated in cooperation with the maintenance service partner" (0.448), "The maintenance service partner is responsible for the spare part storage so that it does not tie your own resources and capital" (0.438) and "The price paid for the maintenance service corresponds with the received service" (0.395). These features represent how well the contract is executed and if the service partner can be considered reliable. Altogether they represent the second factor "reliability of the service partner."

Factor 3. The third factor explains 4.6 percent of the total variance. Three items loaded on the factor, ranging from 0.444 to 0.583. The strongest loading was on the item "The operational conditions and safety increase along the service" (0.583). The others were "Own research and development can be developed with the maintenance service partner" (0.464) and "Maintenance service cooperation is based on confidentiality" (0.444). The propositions describe development activities, and especially if done together, mutual trust is required. Therefore the third factor represents "development."

Factor 4. The fourth factor explains 6.0 percent of the total variance of the data, and three items loaded on it. The loadings ranged from 0.725 to 0.430. “The maintenance tasks are appropriate and maintainability and repair are easy” (0.725) had the strongest loading. Also “The resources and timetable of the maintenance service can be planned well in advance” (0.511) and “The operators carry out their part of the in use maintenance operations and enhance the maintainability of the item” (0.430) describe the easiness of operations and maintainability. Altogether these features represent “availability.”

Factor 5. The fifth factor explains 3.9 percent of the total variance. Three value propositions loaded on the factor, ranging from 0.395 to 0.744. “The maintenance service covers the whole life span of the item” (0.744) had the strongest loading. The others were “The maintenance service provider has the knowledge to solve upcoming problems” (0.481) and “Maintenance service cooperation covers the whole maintenance services comprehensively (from management to execution)” (0.395). The propositions describe comprehensive solutions where the ability to solve and take care of problems is on the partner’s side. Altogether the fifth factor can be considered as the “service solutions and problem solving ability.”

Factor 6. The sixth factor explains 3.4 percent of the total variance of the data, and six propositions loaded on it. The loadings ranged from 0.353 to 0.847. The strongest loading was on the proposition “Maintenance is performed according to safety policies” (0.847). Also “Maintenance is performed according to environmental safety policies” (0.679), “The maintenance service outcome is as expected” (0.578), “The maintenance service outcome is sustained for the promised time” (0.503), “Maintenance service cooperation works well considering the conditions of all partners” (0.406) and “Maintenance service cooperation is executed on time and as promised” (0.353) are part of the sixth factor. As the items represent safety and environmental and quality aspects, and also consider reliability, the sixth factor represents the elements of “environment, health, safety and quality (EHSQ).”

Factor 7. The seventh factor explains 3.4 percent of the total variance of the data. It received two loadings ranging from 0.525 to 0.739. The strongest loading was on “The maintenance service partner can suit the needs of the company (e.g. delivery time)” (0.739) and also the second item “The maintenance services are tailored based on need” (0.525) concern flexibility of the services, and therefore “adaptability to suit different situations” represents the seventh factor.

Construct validity of the measurement scale was assured by developing pre-understanding of the value elements with a literature review and building new elements based on theories and expert opinion. The finalizing of the questionnaire was also done with a group of researchers and maintenance experts to ensure content validity, so that the solution captured the main domain of the maintenance service value construct. Criterion validity was assessed based on correlation coefficients between different value propositions. All the propositions had significant correlations relating to other propositions, which is a good starting point for factor analysis, as the partial correlations were small, based on the measure of sampling adequacy.

The reliability of the results was tested by measuring the internal consistency of the created factors with Cronbach’s α. As can be seen in Table IV, Cronbach’s α is greater than 0.50 in factors 1-6. The reliability of the analysis can be concluded to be sufficient when considering these factors, especially as they also included new scales. In the seventh factor the alpha value is 0.49, which is below the recommended. This indicates that the reliability of the factor can be questioned, and the results concerning this factor should be used with caution. The overall alpha value of the scale with the remaining 29 variables is 0.915, which means that the reliability of the total construct is supported. The created factors form the base for the multidimensional scale measuring maintenance service value.

Cluster analysis

The computed factor scores were further used for cluster analysis. The number of clusters was based on hierarchical cluster analysis, and the final clustering was done with K-mean clustering. The cluster analysis revealed that based on what elements the actors emphasize, they could be divided into three main strategy types (Table V):

(1) collaboration-oriented partners;

(2) basic partners; and

(3) quality-oriented partners.

The first cluster consisted of 28 respondents. All the created factors got positive values (higher than the average), and especially Factor 1 "relationship synergies"(0.65), Factor 3 "development" (0.53), Factor 4 "availability" (0.56) and Factor 5 "service solutions and problem solving ability" (0.43) got high values compared to the other clusters. The respondents seemed to highlight the positive effects of relationships and outsourcing, which can be achieved better by doing things together. They identified that there are multiple elements that affect the maintenance service value in addition to the short-term transaction of the service. Therefore the cluster was named collaboration-oriented partners.

The second cluster consisted of 20 respondents. Compared to the other two clusters, this one got negative values in all factors. The respondents in this group did not see special value in any of the value propositions, and especially Factor 4 "availability" got low values compared to the other clusters. Easiness of operations was not considered important, and overall maintenance services were considered as a transaction amongst other functions and no special value was seen in the relationship. Therefore this cluster was named basic partners. The service is ordered and the service provider provides it as ordered and not much other expectations than the transaction are had.

The third cluster was the biggest one and it consisted of 34 respondents. Factor 7 "adaptability to suit different situations" and Factor 6 "EHSQ" got positive values, and in addition factor 4 "availability" and Factor 2 "reliability of the service partner" got slightly higher values than the average. Interestingly, Factor 1 "relationship synergies" received negative values, it was expected less than on average. Therefore the respondents in this cluster could be characterized as interested in the outcome being as discussed and the partner trustworthy working according to policies, but there is not necessarily interest to take the relationship one step further to think of co-creation of maintenance services or relationship synergies. There are expectations toward the service but not necessarily toward the relationship behind it. This cluster was named quality-oriented partners.

In addition, the descriptive statistics were analyzed together with the cluster membership (Appendix). Medium sized service providers were the biggest group in the first cluster "Collaboration-oriented partners." Most of the customers were in the

Table V. Cluster analysis results

		Clusters		
	Mean	1 ($n = 28$)	2 ($n = 20$)	3 ($n = 34$)
Factor 1: relationship synergies	3.7293	0.65	−0.28	−0.37
Factor 2: reliability of the service partner	4.1481	0.40	−0.61	0.02
Factor 3: development	4.2114	0.53	−0.63	−0.06
Factor 4: availability	3.7348	0.56	−0.80	0.01
Factor 5: service solutions and problem solving ability	4.1341	0.43	−0.55	−0.03
Factor 6: EHSQ	4.3699	0.34	−0.68	0.12
Factor 7: adaptability to suit different situations	3.9939	0.06	−0.34	0.15

third cluster "Quality-oriented partners," and in the second cluster "Basic partners" the respondents were from bigger companies both on the customer and service provider side. Interestingly, the first cluster outperformed slightly the other two clusters in operative and financial performance according to the respondents' own estimates. The respondents may have been overly positive or did the positive synergies form an advantage? It should be noted, though, that the group was rather small to make definite assumptions.

The analysis identified clear differences between the clusters, and this was also supported statistically. When comparing the clusters, statistically significant differences were found also between the factors. They were very significant (0.000) in the first six factors and significant (0.02) in the seventh factor "adaptability to suit different situations."

5. Discussion

Value creation

This research contributes to the value creation and industrial service development literature by providing insight into the value creating elements of maintenance services. In previous studies the comprehensive nature of maintenance service value has received less attention, and the literature has focused more on the technical and financial aspects. The nature of business has changed, as service suppliers and equipment providers are now bringing the service aspect into maintenance, and this underlines the need to evaluate the value of maintenance services. To capture the comprehensive nature of maintenance service value, both financial and non-financial elements need to be considered (e.g. Liyanage and Kumar, 2003; Ojanen, Ahonen, Reunanen and Hanski, 2012; Toossi et al., 2013). To improve the current understanding of the value creating elements in maintenance services, this study explored the value creating propositions behind maintenance comprehensively and identified relationship synergies, reliability of the service partner, development, availability, service solutions, problem solving ability, EHSQ, and adaptability to suit different situations as factors that capture the value creating aspects of services. The building and testing of the multidimensional maintenance service value scale provides a new conceptualization of the value creating elements and extends the systematic ways to understand and measure service value. Integrated measures are needed by customers and service providers, as they will help the building of sustainable relationships and networks (Ahonen et al., 2010; Panesar and Markeset, 2008; Reinartz and Ulaga, 2008).

This research also examined how the different factors of the service value scale are affected when considering different actors in industrial maintenance. Based on the findings, the actors were divided into three strategy types. The actors of the first strategy type "Collaboration-oriented partners" agreed that all the factors of the maintenance service value scale are important. This means that instead of a single value proposition, a combination of different elements is considered meaningful. In the second strategy type "Basic partners," the actors valued certain service aspects less than the first cluster, but still the combination of different elements was considered at least somewhat important. The third strategy type "Quality-oriented partners" emphasized especially quality factors and adaptability. Financial and operative performances were considered as good within the Collaboration-oriented partners (Appendix). This could indicate that if the business is running smoothly, there is also time to think of development ideas and common projects with the service partners to gain positive synergies. On the other hand, if these are not functioning well, there is no time and/or desire to consider the other elements around value than the financial one. All the energy goes into running the operative business and results in basic partners. The big actors were a major group in the basic cluster, and the medium and small sized actors were the majority in the two others. For the big companies, maintenance service can be just another function besides the main functions of the company, but

the smaller organizations have to aim at value partners. The big companies can dictate the relationship and keep it transaction based. Also Hallikas et al. (2014) have received similar results regarding the division of respondents when considering industrial services. It seems to be common that the respondents are divided into groups based on the importance of the relationship level maintained and its positive effects.

Although research and practice have moved from cost- to value-centric, the findings show that the actors in the maintenance field still have very varying strategies toward value creation: some actors are very transaction-oriented vs others who are very relation oriented. Especially a lot of customers seem to consider maintenance as a cost and prefer transaction-based service relationships as a value creating strategy like Murthy et al. (2015) suggest. Considering the value creation potential of maintenance, the cost-centric view may be harmful as it guides the decisions toward the short term. Maintenance and other knowledge-intensive business services should be managed with a long-term business-oriented view to enable a learning process in the relationship and see the value achieved in the long run (Kohtamäki and Partanen, 2016; Liyanage and Kumar, 2003; Parida and Kumar, 2006). To proceed from transactional relationships toward more collaborative ones, mutual understanding of the comprehensive maintenance service value needs to be attained. This emphasizes the role of communication between the service actors.

Communication and mutual understanding of the value creating elements is also important when considering the development of the relationship and service offering. For transaction-oriented actors, the less complete service offerings like spare parts and basic solutions are suitable (Penttinen and Palmer, 2006; Rekola and Haapio, 2009). However, the more complete the offerings are (like availability and performance partnering), the more the relationship focus should shift to the relational side and take the value creating aspects of maintenance services into consideration comprehensively. The development path is illustrated in Figure 2. The heterogeneity among customers and service providers is

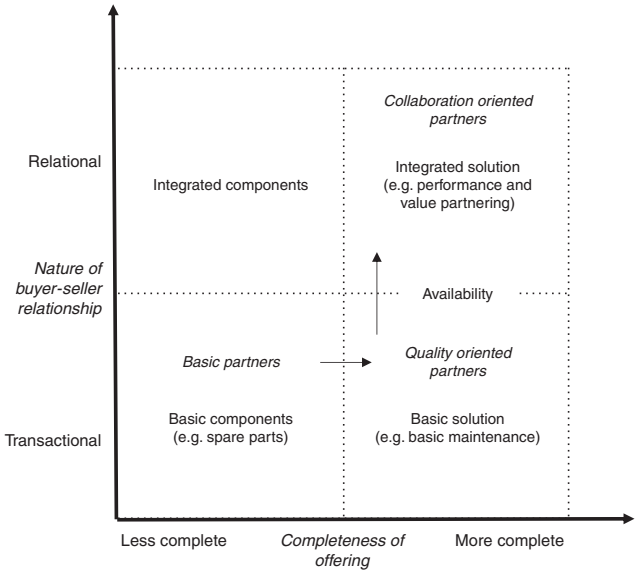

Figure 2. Framework for possible value creation strategies at different relationship and offering levels

Source: Adapted from Penttinen and Palmer (2006)

probably one reason why the building of successful service networks is considered complex. Often the offerings and relationship nature do not match, and this causes conflicts and dissatisfaction between service partners. To achieve the best value in relationships, the value creating elements need to be communicated actively between actors so that the relationship levels and offerings will match. Basic, quality- and collaboration-oriented partners will find their counterparts.

Managerial implications

Outsourcing is done for multiple reasons (e.g. some aim for cost savings and some for special know-how), and therefore open communication is important in defining the goals of the service relationship. Service providers need to consider what the customer's needs are and also what the readiness of the customer is to collaborate when aiming at more complete offerings and also other than cost saving benefits (e.g. flexibility, special know-how, R&D). In addition, the service providers need to ensure that they address all the value-creating elements when providing complete offerings like performance partnering. The measurement scale can be used to benchmark the current level of practices and aimed service level. Also the customers need to ensure that they consider the value creating elements comprehensively when procuring maintenance services and that their partner is capable of providing the needed service level (Toossi et al., 2013). It is important that right maintenance services are created with the right partners so that the best value can be achieved in the relationship. The framework presented above (Figure 2) helps the service provides to see what relationship style their offering requires and the customers to identify how complete they want their maintenance services and relationships to be and what this will require. For example if they are currently operating with basic services and desire to move toward availability or performance partnering, a strategy shift toward more relational relationships is required to be able to move on the continuum.

Maintenance service value is complex to manage, but by using the created factors some systematics can be brought into the process. The scale can be used as a base for network-and company-level value measurement building to communicate and create mutual understanding of the value-creating elements between the service partners. The core for successful service relationships between different service partners, as Rosqvist et al. (2009) highlight, is a common view of the maintenance objectives that arise from strategic objectives and KPIs. The multidimensional scale of the value creating factors could be used as a base to determine suitable performance measures and objectives for the maintenance service. Assessment of the value and cost of the service could be based on this. The comprehensive measurement scale helps the companies to extend their understanding beyond the cost-centric view toward the value-added processes, which is emphasized e.g. by Liyanage and Kumar (2003) and Parida and Kumar (2006). Identifying the value elements helps the parties to understand different cost and benefit elements they have possibly been unaware of previously (Anderson and Narus, 1998). The service network can be moved step by step from the traditional arm's length toward collaborative value creation.

Limitations and future research

There are some limitations to the study that should be taken into account. The data used in the study was based on subjective responses of company managers and other employees. It is possible that the subjectivity biased the results of the study. However, the aim of this study was not to find absolute values, but more importantly, to support comprehensive value discussion, and therefore the possibility of somewhat biased responses should not be a major issue. It is also a limitation that the survey was conducted anonymously, which hindered the possibility to backtrack the respondents' cluster membership and company's current operations style to validate whether the collaboration-oriented partners already

worked in long-term business relationships with different actors or whether it was a development goal. Because quantitative methods are unable to capture the complexity of maintenance service value fully, future research should investigate the relationship between current operations and the cluster membership and mind-set toward value creation with more in-depth case studies. In addition, it would be interesting to focus future research on improved performance. Does acknowledging the value creating elements comprehensively foster also better performance on the financial and operational side of a company? The idea was supported somewhat already in this study, but the sample size inside the clusters was not big enough to verify this statistically.

This study focused on value creation in maintenance services in the industrial context, which is often very case-specific. Therefore it would be interesting to validate the multidimensional value creation scale in another maintenance service field (e.g. logistics) to see which of the value elements are generalizable in other maintenance services and which are specific to the industrial context. For example will EHSQ, development and reliability of the service partner be as highly valued as in the industry, or will some other factors get emphasized even more? Finally, the development of performance measures that support comprehensive value assessment should receive future research attention. This would support the discussion between the different actors in a maintenance service network and also make the value created and mutual development objectives more concrete.

6. Conclusions

This paper contributes to the value creation and industrial service development literature by providing insight into the value-creating elements of maintenance services. The study shows the value of maintenance services as a multidimensional phenomenon where value is captured with different aspects of relationship synergies, reliability of the service partners, development, availability, service solutions and problem solving ability, EHSQ (environment, health, safety and quality) and adaptability to suit different situations. However, what elements are highlighted varies between the actors in the field; some actors are very transaction-oriented, whereas others are very relation oriented. Therefore, academics and managers should pay attention to the heterogeneity of the actors operating in the field in terms of value creation. Communication and mutual understanding of the value creating strategies is important, so that more complete offerings can be built in industrial service networks.

References

Ahonen, T., Reunanen, M., Pajari, O. and Ojanen, V. (2010), "Maintenance communities – a new model for the networked delivery of maintenance services", *International Journal of Business Innovation and Research*, Vol. 4 No. 6, pp. 560-583.

Allee, V. (2000), "Reconfiguring the value network", *Journal of Business Strategy*, Vol. 21 No. 4, pp. 36-39.

Al-Sultan, K.S. and Duffuaa, S.O. (1995), "Maintenance control via mathematical programming", *Journal of Quality in Maintenance Engineering*, Vol. 1 No. 3, pp. 36-46.

Al-Turki, U. (2011), "A framework for strategic planning in maintenance", *Journal of Quality in Maintenance Engineering*, Vol. 17 No. 2, pp. 150-162.

Anderson, J.C. and Narus, J.A. (1998), "Business marketing: understand what customers value", *Harvard Business Review*, Vol. 76 No. 6, pp. 53-65.

Axelsson, B. and Wynstra, F. (2002), *Buying Business Services*, John Wiley & Sons, Chichester.

Ballantyne, D. and Varey, R.J. (2006), "Creating value-in-use through marketing interaction: the exchange logic of relating, communicating and knowing", *Marketing Theory*, Vol. 6 No. 3, pp. 335-348.

Ballantyne, D., Frow, P., Varey, R.J. and Payne, A. (2011), "Value propositions as communication practice: taking a wider view", *Industrial Marketing Management*, Vol. 40 No. 2, pp. 202-210.

Barry, J. and Terry, T. (2008), "Empirical study of relationship value in industrial services", *Journal of Business & Industrial Marketing*, Vol. 23 No. 4, pp. 228-241.

Bengtsson, M. and Kock, S. (2000), "Coopetion' in business networks – to cooperate and compete simultaneously", *Industrial Marketing Management*, Vol. 29 No. 5, pp. 411-426.

Bertolini, M., Bevilacqua, M., Braglia, M. and Frosolini, M. (2004), "An analytical method for maintenance outsourcing service selection", *International Journal of Quality & Reliability Management*, Vol. 21 No. 7, pp. 772-788.

Brito, E.P.Z., Beneduzzi, R.L. and Brito, A.L.A.L. (2007), "Customer choice of a car maintenance service provider: a model to identify service attributes that determine choice", *International Journal of Operations & Production Management*, Vol. 27 No. 5, pp. 464-481.

Campbell, J.D. (1995), "Outsourcing in maintenance management", *Journal of Quality in Maintenance Engineering*, Vol. 1 No. 3, pp. 18-24.

Costello, A.B. and Osborne, J.W. (2005), "Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. Practical Assessment", *Research and Evaluation*, Vol. 10 No. 7, pp. 1-9.

Day, G.S. (2000), "Managing market relationships", *Journal of the Academy of Marketing Science*, Vol. 28 No. 1, pp. 24-30.

EFNMS (2016), "Details of the safety and environment committee", available at: www.efnms.org/European-Health-Safety-and-Environment-Committee/m2712/European-Health-Safety-and-Environment-Committee-EHSEC.html (accessed May 20, 2016).

EU-OSH (2012), "Procurement of maintenance services and health and safety at work, e-fact 63", available at: https://osha.europa.eu/en/publications/e-facts/e-fact-63-procurement-of-maintenance-services-and-health-and-safety-at-work (accessed June 27, 2013).

Grönroos, C. (2011), "Value co-creation in service logic: a critical analysis", *Marketing Theory*, Vol. 11 No. 3, pp. 279-301.

Grönroos, C. and Helle, P. (2010), "Adopting a service logic in manufacturing: conceptual foundation and metrics for mutual value creation", *Journal of Service Management*, Vol. 21 No. 5, pp. 564-590.

Grönroos, C. and Ravald, A. (2009), "Marketing and the logic of service: value facilitation, value creation and co-creation and their marketing implications", Working Paper No. 542, Hanken School of Economics, Helsinki.

Gupta, S. and Lehmann, D.R. (2005), *Managing Customers as Investments – The Strategic Value of Customers in the Long Run*, Wharton School Publishing, Upper Saddle River, NJ.

Hallikas, J., Immonen, M., Pynnönen, M. and Mikkonen, K. (2014), "Service purchasing and value creation: towards systemic purchases", *International Journal of Production Economics*, Vol. 147, Part A, pp. 53-61.

Hatinen, L., Pirttilä, M., Viskari, S. and Kärri, T. (2012), "The investment logics of Finnish industrial maintenance service providers", *International Journal of Strategic Engineering Asset Management*, Vol. 1 No. 1, pp. 33-48.

Johansson, P. and Olhager, J. (2004), "Industrial service profiling: matching service offerings and processes", *International Journal of Production Economics*, Vol. 89 No. 3, pp. 309-320.

Kindström, D. and Kowalkowski, C. (2009), "Development of industrial service offerings: a process framework", *Journal of Service Management*, Vol. 20 No. 2, pp. 156-172.

Kohtamäki, M. and Partanen, J. (2016), "Co-creating value from knowledge-intensive business services in manufacturing firms: the moderating role of relationship learning in supplier-customer interactions", *Journal of Business Research*, Vol. 69 No. 7, pp. 2498-2506.

Kremic, T., Tukel, O.I. and Walter, O.R. (2006), "Outsourcing decision support: a survey of benefits, risks, and decision factors", *Supply Chain Management: An International Journal*, Vol. 11 No. 6, pp. 467-482.

La Rocca, A. and Snehota, I. (2014), "Value creation and organizational practices at firm boundaries", *Management Decision*, Vol. 52 No. 1, pp. 2-17.

Lambert, D.M. and Enz, M.G. (2012), "Managing and measuring value co-creation in business-to-business relationships", *Journal of Marketing Management*, Vol. 28 Nos 13/14, pp. 1588-1625.

Lapierre, J. (2000), "Customer-perceived value in industrial contexts", *Journal of Business & Industrial Marketing*, Vol. 15 No. 2, pp. 122-145.

Lind, S., Nenonen, S. and Kivistö-Rahnasto, J. (2008), "Safety risk assessment in industrial maintenance", *Journal of Quality in Maintenance Engineering*, Vol. 14 No. 2, pp. 205-217.

Lindgreen, A. and Wynstra, F. (2005), "Value in business markets: what do we know? Where are we going?", *Industrial Marketing Management*, Vol. 34 No. 7, pp. 732-748.

Lindgreen, A., Hingley, M.K., Grant, D.B. and Morgan, R.E. (2012), "Value in business and industrial marketing: past, present, and future", *Industrial Marketing Management*, Vol. 41 No. 1, pp. 207-214.

Liyanage, J.P. and Kumar, U. (2003), "Towards a value-based view on operations and maintenance performance management", *Journal of Quality in Maintenance Engineering*, Vol. 9 No. 4, pp. 333-350.

Lo, S.-H. (2010), "Performance evaluation for sustainable business: a profitability and marketability framework", *Corporate Social Responsibility and Environmental Management*, Vol. 17 No. 6, pp. 311-319.

Lorenzoni, G. and Lipparini, A. (1999), "The leveraging of interfirm relationships as a distinctive organizational capability: a longitudinal study", *Strategic Management Journal*, Vol. 20 No. 4, pp. 317-338.

McDonough, E.F. III, Athanassiou, N. and Barczak, G. (2006), "Networking for global new product innovation", *International Journal of Business Innovation and Research*, Vol. 1 Nos 1/2, pp. 9-26.

Ma, Q., Pearson, M.J. and Tadisina, S. (2005), "An exploratory study into factors of service quality for application service providers", *Information & Management*, Vol. 42 No. 8, pp. 1067-1080.

Malleret, V. (2006), "Value creation through service offers", *European Management Journal*, Vol. 24 No. 1, pp. 106-116.

Marais, K. and Saleh, J. (2008), "Beyond its cost, the value of maintenance: an analytical framework for capturing its net present value", *Reliability Engineering and System Safety*, Vol. 94 No. 2, pp. 644-657.

Matthyssens, P. and Vandenbempt, K. (1998), "Creating competitive advantage in industrial services", *Journal of Business & Industrial Marketing*, Vol. 13 No. 4, pp. 339-355.

Murthy, D.N.P., Karim, M.R. and Ahmadi, A. (2015), "Data management in maintenance outsourcing", *Reliability Engineering and System Safety*, Vol. 142, October, pp. 100-110.

Ojanen, V., Ahonen, T., Reunanen, M. and Hanski, J. (2012), "Towards availability and sustainability in customer value assessment of asset management services", *International Journal of Innovation and Sustainable Development*, Vol. 6 No. 4, pp. 368-391.

Ojanen, V., Hatinen, L., Kärri, T., Kässi, T. and Tuominen, M. (2012), "Flexible investment planning and collaborative maintenance management", in van der Lei, T., Herder, P. and Wijnia, Y. (Eds), *Asset Management: The State of the Art in Europe from a Life Cycle Perspective*, Springer, Dordrecht, pp. 65-77.

Oliva, R. and Kallenberg, R. (2003), "Managing the transition from products to services", *International Journal of Service Industry Management*, Vol. 14 No. 2, pp. 160-172.

Panesar, S.S. and Markeset, T. (2008), "Development of a framework for industrial service innovation management and coordination", *Journal of Quality in Maintenance Engineering*, Vol. 14 No. 2, pp. 177-193.

Parida, A. and Kumar, U. (2006), "Applications and case studies: maintenance performance measurement (MPM): issues and challenges", *Journal of Quality in Maintenance Engineering*, Vol. 12 No. 3, pp. 239-251.

Penttinen, E. and Palmer, J. (2006), "Improving firm positioning through enhanced offerings and buyer-seller relationships", *Industrial Marketing Management*, Vol. 36 No. 4, pp. 552-564.

Persona, A., Regattieri, A., Pham, H. and Battini, D. (2007), "Remote control and maintenance outsourcing networks and its applications in supply chain management", *Journal of Operations Management*, Vol. 25 No. 6, pp. 1275-1291.

Pintelon, L. and Parodi-Herz, A. (2008), *Maintenance: An Evolutionary Perspective Complex System Maintenance Handbook*, Springer series in reliability engineering, Springer, London.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y. and Podsakoff, N.P. (2003), "Common method biases in behavioral research: a critical review of the literature and recommended remedies", *Journal of Applied Psychology*, Vol. 88 No. 5, pp. 879-903.

Ramsey, J. and Wagner, B. (2009), "Organisational supplying behaviour: understanding supplier needs, wants and preferences", *Journal of Purchasing & Supply Management*, Vol. 15 No. 2, pp. 127-138.

Reinartz, W. and Ulaga, W. (2008), "How to sell services more profitably", *Harvard Business Review*, Vol. 86 No. 5, pp. 90-96.

Rekola, K. and Haapio, H. (2009), *Industrial Services and Service Contracts: A Proactive Approach*, The Federation of Finnish Technology Industries, Helsinki.

Riis, J., Johansen, J., Waehrens, B. and Englyst, L. (2007), "Strategic roles of manufacturing", *Journal of Manufacturing Technology Management*, Vol. 18 No. 8, pp. 933-948.

Rosqvist, T., Laakso, K. and Reunanen, M. (2009), "Value-driven maintenance planning for a production plant", *Reliability Engineering and System Safety*, Vol. 94 No. 1, pp. 97-110.

Songailiene, E., Winklhofer, H. and McKechnie, S. (2011), "A conceptualisation of supplier-perceived value", *European Journal of Marketing*, Vol. 45 No. 3, pp. 383-418.

Stremersch, S., Wuyts, S. and Frambach, R.T. (2001), "The purchasing of full-service contracts: an exploratory study within the industrial maintenance market", *Industrial Marketing Management*, Vol. 30 No. 1, pp. 1-12.

Stuart, T.E. (2000), "Interorganizational alliances and the performance of firms: a study of growth and innovation rates in a high-technology industry", *Strategic Management Journal*, Vol. 21 No. 8, pp. 791-811.

The Finnish Maintenance Society (2007), "Maintenance in national economy of Finland", (in Finnish), available at: www.promaint.net/instancedata/prime_product_yhdistys/kp-media/embeds/promaintwwwstructure/kunnossapito_2007_180407.pdf (accessed May 20, 2016).

Toossi, A., Lockett, L., Raja, J.Z. and Martinez, V. (2013), "Assessing the value dimensions of outsourced maintenance services", *Journal of Quality in Maintenance Engineering*, Vol. 19 No. 4, pp. 348-363.

Tuli, K.R., Kohli, A.K. and Bharadwaj, S.G. (2007), "Rethinking business solutions: from product bundles to relational processes", *Journal of Marketing*, Vol. 71 No. 3, pp. 1-17.

Ulaga, W. (2003), "Capturing value creation in business relationships: a customer perspective", *Industrial Marketing Management*, Vol. 32 No. 8, pp. 677-693.

Vargo, S.L. and Lusch, R.F. (2008), "Service-dominant logic: continuing the evolution", *Journal of the Academy of Marketing Science*, Vol. 36 No. 1, pp. 1-10.

Walter, A., Ritter, T. and Gemünden, H.G. (2001), "Value creation in buyer-seller relationships: theoretical considerations and empirical results from a supplier's perspective", Vol. 30 No. 4, pp. 365-377.

Further reading

Baba, M.L. (1988), "Two sides to every story: an ethnohistorical approach to organizational partnerships", *City and Society*, Vol. 2 No. 2, pp. 71-104.

Appendix

	All clusters ($n = 82$) Number	%	Cluster 1 ($n = 28$) Number	%	Cluster 2 ($n = 20$) Number	%	Cluster 3 ($n = 34$) Number	%
Number of employees								
Under 10	7	9	4	14	1	5	2	6
10-49	19	23	6	21	3	15	10	29
50-249	24	29	10	36	4	20	10	29
over 250	32	39	8	29	12	60	12	35
Approximate turnover (€)								
Under 1million	9	11	5	18	1	5	3	9
1-20 million	23	28	6	21	4	20	13	38
21-100 million	20	24	8	29	5	25	7	21
Over 100 million	30	37	9	32	10	50	11	32
Position of the respondent								
Senior management	17	21	4	14	2	10	11	32
Middle management	46	56	19	68	12	60	15	44
Other	19	23	5	18	6	30	8	24
Organization unit primarily								
Customer	31	38	5	18	9	45	17	50
Service provider	36	44	16	57	7	35	13	38
Equipment and service provider	15	18	7	25	4	20	4	12
Financial performance of unit								
Bad	1	1	0	0	0	0	1	3
Sufficient	15	19	5	19	4	21	6	18
Good	45	56	12	44	11	58	22	65
Excellent	19	24	10	37	4	21	5	15
No response	2							
Operative performance of unit								
Bad	1	1	0	0	1	5	0	0
Sufficient	11	14	1	4	7	37	3	9
Good	54	68	19	70	9	47	26	76
Excellent	14	18	7	26	2	11	5	15
No response	2							

Table AI. Descriptive statistics of the clusters

Publication 3

Pekkarinen, O., and Ali-Marttila, M.
Managing Industrial Maintenance – Networked Model

in Koskinen, K. T., Kortelainen, H., Aaltonen, J., Uusitalo, T., Komonen, K., Mathew, J. and Laitinen, J. (Eds.), *Proceedings of the 10th World Congress on Engineering Asset Management (WCEAM 2015),* Lecture Notes in Mechanical Engineering, Springer, ISBN 978-3-319-27062-3, pp. 459-469, 2016

Publication 4

Ali-Marttila, M., Marttonen-Arola, S., Ylä-Kujala, A., Ukko, J., Rantala, T., Sinkkonen, T., Pekkola, S., Saunila, M., Pekkarinen, O., and Kärri, T.
Stagewise Process Towards Collaborative and Value-Driven Decisions in Maintenance Networks

in Koskinen, K. T., Kortelainen, H., Aaltonen, J., Uusitalo, T., Komonen, K., Mathew, J. and Laitinen, J. (Eds.), *Proceedings of the 10th World Congress on Engineering Asset Management (WCEAM 2015),* Lecture Notes in Mechanical Engineering, Springer, ISBN 978-3-319-27062-3, pp. 41-50, 2016

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