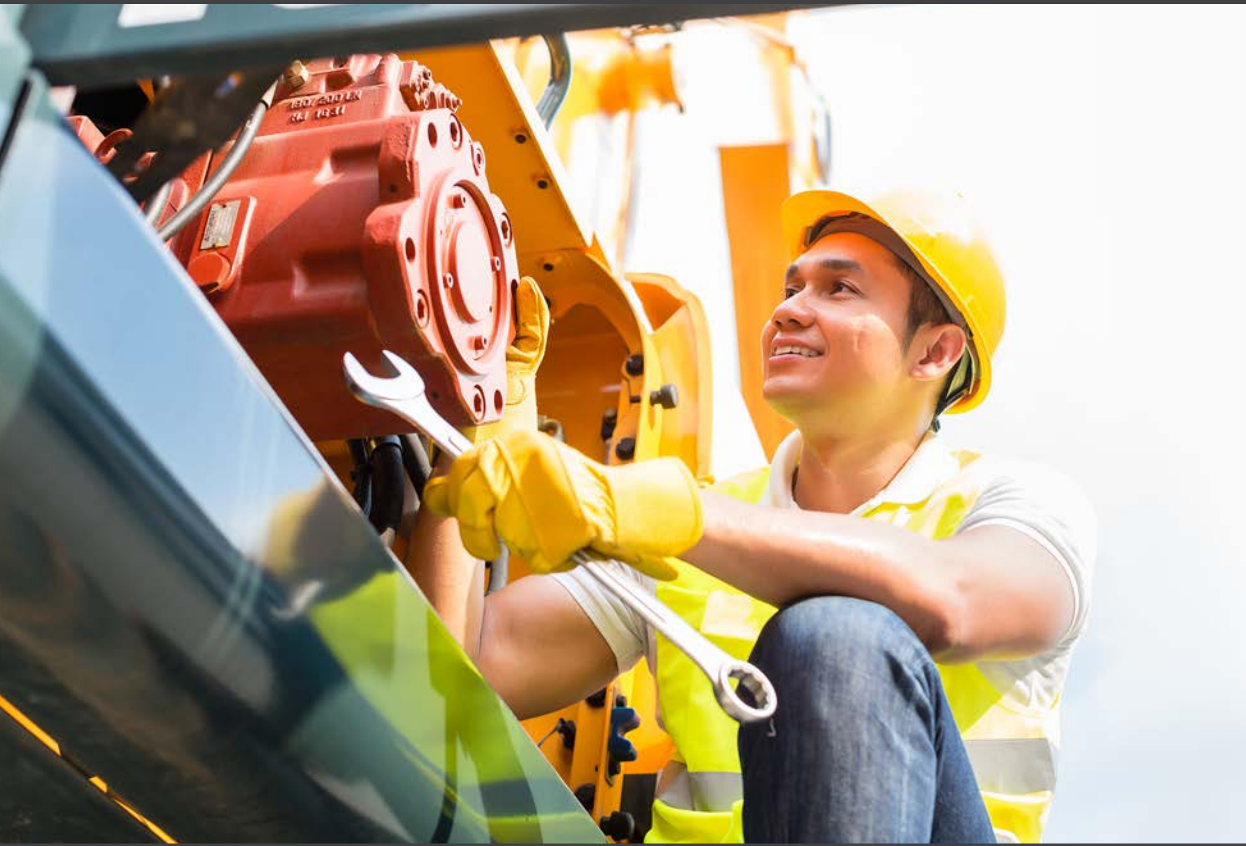
Christoph Schneider

OPEN BOOK ACCOUNTING AND RESOURCE INTERDEPENDENCIES

THE CASE OF CAPITAL EQUIPMENT SALES



STOCKHOLM SCHOOL OF ECONOMICS

OPEN BOOK ACCOUNTING AND RESOURCE INTERDEPENDENCIES

Over the past few decades, firms have arguably become more dependent on each other. On average, purchased products and services account for more than 50 % of the total cost of large firms. In addition, they have become more complex, requiring closer co-operations between buyers and suppliers.

This development has also been reflected in the growing literature on Open Book Accounting (OBA). It deals with the systematic exchange of confidential financial and nonfinancial information that legally independent business partners undertake with the aim to manage their interdependencies. Prior research has observed large differences in OBA depending on whether the exchanged product is standardised or designed by the buyer, the supplier or both parties together. At the same time, limited attention has been paid to how OBA might be used in capital equipment sales. Capital equipment is characterised by its need for support with spare parts and services over its extended life cycles. High opportunity costs might also arise whenever it cannot be used due to scheduled services or unexpected breakdowns.

The thesis analyses consequently how OBA is designed and used in the embedded buyer-supplier relationship between a manufacturer of capital equipment and one of its major customers. With its detailed observations, the study contributes also to an improved general understanding of the interconnection between *inter*-organisational and *intra*-organisational designs and uses of OBA information. Moreover, it challenges current views of OBA as primarily increasing visibility. In contrast, it illustrates how increases and decreases of visibility are simultaneously and continuously negotiated between actors in industrial networks.

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To my mom († 2015)

Foreword

This volume is the result of a research project carried out at the Department of Accounting at the Stockholm School of Economics (SSE).

This volume is submitted as a doctor's thesis at SSE. In keeping with the policies of SSE, the author has been entirely free to conduct and present his research in the manner of his choosing as an expression of his own ideas.

SSE is grateful for the financial support provided by Carl Silfvén stipendiefond, KPMG Bohlin AB:s Stipendiestiftelse and Torsten Söderbergs Stiftelse which has made it possible to fulfill the project.

Göran Lindqvist	*Johnny Lind*
Director of Research Stockholm School of Economics	Professor and Head of the Department of Accounting

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The Department of Accounting at the Stockholm School of Economics has been my "academic home" over the past seven years. I am grateful to all colleagues who have contributed to making the department such a pleasant workplace. I am particularly indebted to Associate Professor Ebba Sjögren who introduced me to the world of teaching, organised and facilitated methodology seminars for us PhD students and stopped by my office many times during evenings and weekends. Your support has been priceless. I am also grateful to Malin Lund who shared her own experiences and contributed with lots of positive energy. I really felt how the sun went up when you entered the office! A big thank you also to Anne Bengtsdotter and Christina Ekelin who make the department a better workplace every day and keep track of us and all administrative matters. Over the time, I have shared office with Tina Sigonius, Gabriel Karlberg, Patrik Tran and Anastasiya Klyuchko along some temporary visitors to the department. Our many discussions and lunches will never be forgotten. I am glad that I will have you around as reliable friends also in the future. Particular gratitude is also due to Péter Aleksziev, Emilia Cederberg, Carl Henning Christner, Florian Eugster, Anna-Stina Gillqvist, Milda Tylaite and Per Åhblom for different forms of interaction over the course of my PhD studies.

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Finally, this book would never have been finished without the encouragement, support and well needed distractions provided by my family and friends. I am particularly glad that I found my soul mate in Gunnel Axman who went through the bumpy ride together with me, hand in hand. I dedicate this thesis to my mother who would have been most glad and proud of all of us, but, unfortunately, died far too early to witness me crossing the finishing line in person.

Stockholm, July 20, 2018

Christoph Schneider

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Chapter 1

Introduction

As a result of globalisation, rapid technological development and an increasing complexity of technical products, firms have become increasingly dependent on each other (Kraus and Lind, 2007). Survey studies have for example found that the 100 largest US firms have increased their spent on purchased products and services to more than 50 percent of their total costs on average. Depending on industry and company, this figure can rise to 70 to 80 percent of total costs (Anonymous, 2002). Similar developments have been reported for other parts of the world, such as Scandinavia (Gadde and Håkansson, 2001, Gadde et al., 2010). In addition to this relative increase in external sourcing, the characteristics of outsourced products and services have also changed, giving rise to a need for closer buyer-supplier interaction. Cooper and Slagmulder (2004) have for example observed a change from mostly purchasing commodity products and processes to purchasing complex products and services based on proprietary supplier technology. According to their studies, those products require a close buyer-supplier interaction to ensure an optimal specification from the perspective of both parties, thereby ensuring an optimal trade-off between quality, functionality and cost.

A common problem constitutes here that firms usually only exchange price information with each other (Kulmala, 2002). This means that a buyer only knows what a certain product or service costs in terms of purchasing price, but not what has caused this price in the form of necessary production steps and related costs in the upstream supply chain. Conversely, the supplier does not know which consequential costs a certain product or service design causes in its customers' and customers' customers' production processes. This lack of insight makes it accordingly difficult to design products and associated processes that are optimal from a total cost perspective.

The exchange of additional, financial and nonfinancial information is accordingly required in order to manage interdependence in complex supply chains and networks (Mouritsen et al., 2001, Agndal and Nilsson, 2010, Caglio and Ditillo, 2012, Alenius et al., 2015). The study of such financial and nonfinancial information exchanges is the subject of the literature on Open Book Accounting (OBA). It can be defined as *the systematic exchange of confidential financial and nonfinancial information that legally independent business partners undertake with the aim to manage their interdependencies* (see Chapter 2.2.1, page 14). OBA has been established as a research field in the accounting literature in the beginning of the 1990s (see e.g. Munday, 1992, Otley, 1994, Hopwood, 1996) and grown since then (for previous reviews see Kulmala, 2002, Hoffjan and Kruse, 2006, Kajüter and Kulmala, 2010).

1.1 The concept of interdependence in the study of Open Book Accounting

The concept of interdependence has been at the heart of OBA since its very beginning (Munday, 1992, Otley et al., 1995, Hopwood, 1996). In one of the first calls for research, Hopwood (1996) for example asked for "a more explicit awareness of the interdependency of action and the role which joint action can play in organizational success" (p. 589).

The meaning of the term *inter*dependence is itself important as it suggests that both the buyer and the supplier are dependent *on each other* rather than one of the partners being solely dependent on the other (Oxford University Press, 2016a, 2016b). In cases of (one-sided) dependence, it has been argued that OBA can usually not be applied successfully for a range of reasons. For example, if the buyer is unilaterally dependent on the supplier, the supplier lacks the incentive to open its books (Kulmala, 2004, Romano and Formentini, 2012, Kumra et al., 2012). In turn, if the supplier is dependent on the buyer, it might be possible for the buyer to force the supplier to open its books. It has, however, been argued that suppliers try to refuse such requests due to the perceived risk of subsequently being pressed in prices (Munday, 1992, Kajüter and Kulmala, 2005, Caglio and Ditillo, 2012) and that, if they cannot refuse these requests, might falsify the provided information (Lamming, 1993, Lamming et al., 2001), exert little effort to save costs in the long-term (Munday, 1992) and/or develop negative attitudes towards the buyer, making future co-operations difficult (Windolph and Möller, 2012).

Interdependence can thus be seen as an important precondition for a mutually beneficial, long-term use of OBA. At the same time, while buyer-supplier relationships are usually characterised by *inter*dependence in a range of areas, they are also characterised by *in*dependence in a range of other areas (see for example Ford et al., 1998, Araujo et al., 1999, 2016). A reason for this lies in that while interdependence provides benefits, entertaining interdependent relationships is also resource consuming and constrains firms in their ability to engage in relationships with third parties (Gadde and Snehota, 2000, Håkansson and Ford, 2002). In consequence, firms usually entertain a range of relationships with external business partners that are characterised by different degrees of interdependence and independence (Ford et al., 1998, Araujo et al., 1999, 2016).

Seen from this perspective, it is not surprising that scholars have observed different forms of OBA being applied in different buyer-supplier relationships, characterised by different kinds of interdependence (see for example Cooper and Slagmulder, 1999a, 2004, Agndal and Nilsson, 2010). Early research has for example focused on OBA in relationships where interdependencies mostly arise from the buyer designing the product, but outsourcing its production to a supplier (see e.g. Munday, 1992, Cooper and Yoshikawa, 1994). In these relationships, detailed financial and nonfinancial information with a focus on manufacturing costs are exchanged. This OBA information is then used to facilitate discussions on potential changes in the specification of the product and its cost consequences at the manufacturer and cost-plus based price negotiations.

As research progressed, it has also considered OBA in other types of relationships, characterised by other kinds of interdependencies. Some researchers have for example studied OBA in relationships where the supplier develops and produces a standardised product that is sold to many different buyers. Examples of such products are pharmaceutical drugs (Dekker and van Goor, 2000), nondurable consumer products (Dekker, 2003, Agndal and Nilsson, 2010) and standardised components and bulk material (Kulmala, 2004). OBA seems here not to include the exchange of detailed financial and nonfinancial information related to the manufacturing of the product, as the respective processes are independent of particular customers and thus managed independently by the buyer. Instead, information exchanges seem to focus on other areas in which interdependencies exist, i.e. the purchasing of raw and packaging material from sub-suppliers (Agndal and Nilsson, 2010, Romano and Formentini, 2012, Kumra et al., 2012), logistics (Dekker and van Goor, 2000, Dekker, 2003) and servicing (Kulmala, 2004).

Some scholars have later on also studied OBA in relationships in which the buyer delegates product development to the supplier based on some overarching technical and interface specifications (Cooper and Slagmulder, 1999a, 2004, Mouritsen et al., 2001). Other scholars have studied relationships in which product development is conducted jointly by the buyer and supplier (Cooper and Slagmulder, 1999a, 2004, Agndal and Nilsson, 2009). In this research, quite fundamental differences in interdependence and OBA have also been found.

Interdependencies might sometimes also stretch beyond focal dyadic relationships, making the involvement of further firms into OBA necessary (Cooper and Yoshikawa, 1994, Carr and Ng, 1995, Dekker and van Goor, 2000, Dekker, 2003, Kulmala, 2004, Agndal and Nilsson, 2009, Romano and Formentini, 2012). Cooper and Yoshikawa (1994) have for example observed that buyers who specify the product, but outsource its production, might include the supplier's sub-suppliers into OBA (see also Munday, 1992, Kajüter and Kulmala, 2005, Agndal and Nilsson, 2008, Alenius et al., 2015). This is so as the supplier itself outsources the manufacturing of some subcomponents to sub-suppliers, which in turn might stand for a large proportion of the product's cost. Likewise, any delivery problems between the sub-supplier and the supplier might ultimately also affect the buyer. The buyer might thus want to discuss the product specification and proactively learn about and manage potential supply chain risks. In addition, the buyer might want to exploit indirect links between its different suppliers and their sub-suppliers to create economies of scale and scope.

As prior research on OBA has thus enquired into a wider array of focal buyer-supplier relationships, characterised by different kinds of interdependencies, differences in OBA have been observed and discussed.

1.2 Problematizing prior research on Open Book Accounting

OBA has thus grown to become an important and varied stream of research within management accounting. At the same time, some theoretical challenges continue to exist in this field of research. One identified gap is that prior research seems to have primarily focused on the interdependencies that arise from the division of product development and manufacturing between buyers and suppliers and their influence on OBA. As I have begun to discuss above, prior research has discerned considerable differences in interdependence and OBA, depending on whether the product is standardised in characteristic or designed by the buyer, the supplier or jointly by both. Significant interdependencies do, however, not only arise during the development and production of products, but also during their use (Baraldi and Strömsten, 2006, Håkansson and Waluszewski, 2007).

This is in particular the case for capital equipment, and, thus, the equipment that firms continuously use in their production (Oxford University Press, 2017). While capital equipment is, like other products, often designed and produced by the supplier on the buyer's specific requirements, it requires frequent maintenance with spare parts, labour and supplementary products and services (Benton, 2010, Burt et al., 2010, Hofmann et al., 2012). In addition, it requires the buyer and supplier to invest into particular supporting facilities, such as maintenance workshops and stocks of spare parts. Moreover, different organisational units of the buyer and supplier are commonly involved in its acquisition, use and maintenance. Burt et al. (2010) observes for example that operations, plant engineering, purchasing and marketing departments of the buyer are often involved in the purchasing and use of the equipment. Similarly, different organisational units of the supplier and indirectly connected relationships might be involved. Significant interdependencies arise accordingly between the buyer and supplier due to its need to not only develop and produce capital equipment, but also maintain it over extended periods.

These interdependencies are also visible financially. Schweiger (2009) observes for example that, depending on the type of capital equipment, the initial purchase price constitutes only 5-50 percent of total cost over its life cycle. Moreover, significant opportunity costs arise whenever the equipment cannot be used due to maintenance or unexpected breakdowns. Schweiger (2009) reports opportunity costs of up to 1,000 Euros per minute for a certain machine, while Burt et al. (2010) estimate the downtime costs due to a failing machine in the production facilities of an automobile assembler to 26,000 dollars per minute.

As most costs arise only during its use, but are intimately related to the initial product design, some authors have suggested to design capital equipment with its complete Life Cycle Cost in mind (LCC; Fabrycky and Blanchard, 1991, Asiedu and Gu, 1998, Wouters and Morales, 2014). Similarly, some scholars have provided the normative advice to evaluate capital equipment purchases from a life cycle cost perspective (see for example Ellram, 1995, Ellram and Siferd, 1998). From a normative standpoint, prior literature has accordingly outlined how LCCs can be calculated by discounting connected future cash flows and making uncertainties visible with the help of Monte Carlo simulations.

At the same time, none of the two literatures have enquired into behavioural aspects related to the potential exchange and use of LCC calculations and other pieces of information between buyers and suppliers of capital equipment. Reviewing the LCC literature from an accounting perspective, Dunk (2004) has thus also concluded:

> "Although significant benefits are attributed to life cycle cost analysis, there is little evidence regarding the extent of its application in organizational settings. Moreover, there is scant systematic evidence available with respect to the array of factors that may influence its use" (p. 403).

A study of the interdependencies and OBA in capital equipment sales might thus be considered an important area along which the literature might be expanded. Capital equipment sales appear to be highly impacted by the outlined maintenance-related resource interdependencies, which in turn might leave a significant imprint on OBA in the respective buyer-supplier relationships. In addition, the study of OBA in capital equipment sales might also highlight new aspects of OBA in general that have not been discussed in prior literature, but might be noticed when studying OBA in this particular setting. A study of OBA in capital equipment sales might accordingly not only help to refine prior theory, but also lead to new discoveries related to the complex empirical phenomenon in general (Keating, 1995, Dubois and Gadde, 2014).

1.3 Aim of the thesis

In line with this identified theoretical challenge, the following research aim can be formulated:

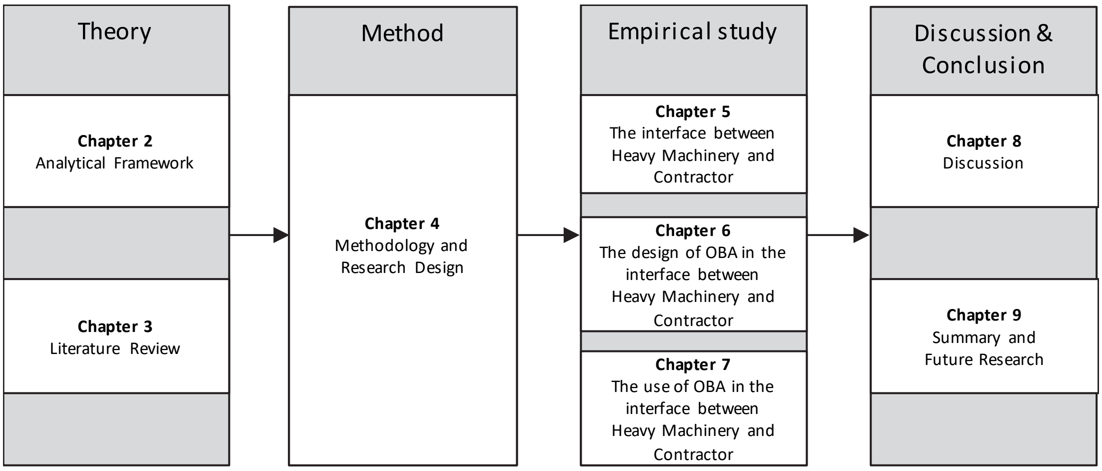
- The aim of the thesis is to understand how the specific interdependencies existing in capital equipment sales impact OBA in this setting. As part of this undertaking, some new, general aspects of OBA might also be discovered.

1.4 Outline of the thesis

With this aim in mind, the thesis is structured into nine chapters (Figure 1, page 8). Chapter 2 develops the analytical framework that is applied in the literature review and the empirical study. The framework further substantiates the link between OBA and interdependence and defines the two terms. It also introduces a further distinction between the design and use of OBA and defines interdependence in the context of the thesis. Chapter 3 summarises extant research from the perspective of this framework. In Chapter 4, the methods applied in the empirical case study of OBA in capital equipment sales are described. Chapters 5 to 7 report the results of the empirical study.

In particular, Chapter 5 describes the observed interdependencies, while Chapters 6 and 7 describe the design and use of OBA in capital equipment sales respectively. Finally, Chapter 8 compares and contrasts the empirical findings with extant literature and Chapter 9 summarises the thesis' theoretical and practical contributions and provides recommendations for future research.

Figure 1 Overview of the thesis' disposition

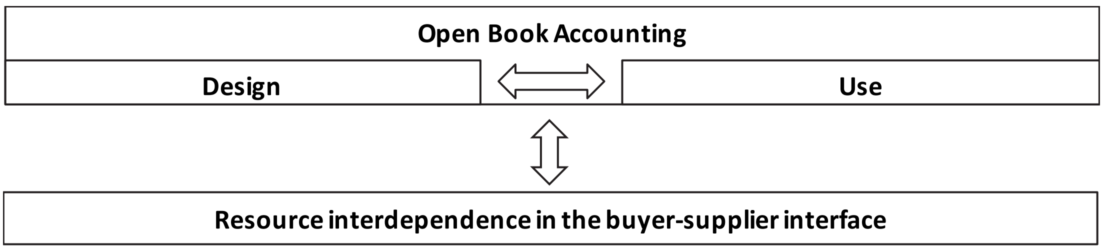


Chapter 2

Analytical framework

This chapter develops and explains the analytical framework on which both the literature review (Chapter 3) and the empirical study on Open Book Accounting (OBA) in capital equipment sales (Chapters 5-7) build. The framework highlights the interrelationship between the design and use of OBA and the interdependencies existing in particular focal, embedded buyer-supplier relationships (Figure 2). Before the individual elements of the framework are discussed, some theoretical arguments for the analytical link between OBA and interdependence are provided next.

Figure 2 Analytical framework



2.1 Motivating the analytical link between Open Book Accounting and interdependence

From the beginning of the literature on OBA, it has been argued that OBA, in particular its design, is not generic, but is interrelated with the interdependencies existing in particular buyer-supplier relationships (see for example Lamming, 1993, Tomkins, 2001, Cooper and Slagmulder, 1999a, Cooper and Slagmulder, 2004). In an early contribution, Lamming (1993) for example observed with regard to the design of OBA:

> "In practice, the customer should only require directly relevant data and should be able to justify any and all requests (i.e. rather than requiring *card blanche* access to the supplier's costing systems)" (ibid, p. 214, emphasis in original)

Similarly, Tomkins (2001) observed that "[t]here is clearly a different emphasis in the detailed information content required for different types of alliances" (pp. 181-2). In the analytical framework (Figure 2), OBA is accordingly linked to the interdependencies existing in particular relationships. Theoretical support for these analytical connections can be found in two complimentary lines of reasoning.

2.1.1 Bounded rationality

One motivation for the analytical link between OBA and interdependence can be found in the argument of bounded rationality (Simon, 1947, Cyert and March, 1963, within the industrial network approach, see e.g. Ford and Håkansson, 2006). While, under full rationality, firms might be seen as fully knowledgeable of all their direct and indirect interdependencies with business partners and having no need to differentiate the kind of information exchanged with different business partners[1], this is not the case under bounded rationality.

[1] Fully rational firms, which are not limited in their perceptual or information processing capabilities, are able to exchange the same information with all firms they are directly or indirectly connected to. Given their information processing capabilities, they can analyse the data in the next step and extract the information they require in particular relationships.

Bounded rationality highlights that firms are limited in their perception and information processing capabilities, which might make it difficult for them to behave completely rational in information exchanges. Firms might for example only be aware of some of their resource interdependencies with certain business partners (Weick, 1969, Pfeffer and Salancik, 1978). In addition, even if they had full information on all their interdependencies, firms might not necessarily be able to fully analyse and understand it. A consequence of this is that too much information from business partners might sometimes be as helpful as no information at all. Within the OBA literature, Lamming et al. (2004) have considered this by stating that providing too much information could even be intentionally used by business partners to "actually blind or dazzle the receiver, or perhaps (…) to hide the fact that critically important parts are missing or false" (p. 299). On a related note, Kulp (2002) has also observed the importance of information precision and reliability in information exchanges.

The argument of bounded rationality can accordingly be seen as providing support for the bidirectional link between OBA and interdependence. First, due to limits in perception and information processing, it is feasible to assume that there is not one single generic form of OBA. Rather, information exchanges might be adapted to the specific interdependencies at hand in particular relationships, and in particular to those that are perceived as "major problems" which business partners wish to manage with each other (Lamming, 1993, Lamming et al., 2001, 2004, Tomkins, 2001). In the light of information processing limits, this increases also the efficiency and effectiveness of OBA (Kulp, 2002, Caglio and Ditillo, 2012).[2] Second, the interdependencies that are considered as important to manage might change over time as firms apply OBA and learn about their different kinds of interdependencies. OBA might thus be expanded over time to additional, already existing interdependencies (see for example Alenius et al., 2015). Likewise, as buyers and suppliers manage their interdependencies with each other, they

[2] This is in particular so as firms might use different accounting systems and definitions, necessitating either the costly development of common definitions or creating an understanding of each other's definitions (Tomkins, 2001, Kulmala, 2004, Kajüter and Kulmala, 2005, Agndal and Nilsson, 2008). Without such definitions, firms are found being unable to understand and draw conclusions from exchanged data (Kulp, 2002).

might also create new interdependencies (Alenius et al., 2015, Ford and Håkansson, 2006).

2.1.2 The coexistence of co-operation and self-interest in business relationships

Complimentary arguments for adapting OBA to the specific interdependencies at hand can be found in the observation that business partners are not only cooperative. In contrast, they also nurture their self-interests, which might lead to conflicts (Johanson and Mattsson, 1987, Håkansson and Snehota, 1995). As Håkansson and Snehota (1995) have for example observed:

> "Elements of cooperation and conflict have been found to coexist in the atmosphere of business relationships. There is an inherent conflict about the division of benefits from a relationship, but other conflicts also can arise over time. A relationship does not mean that all conflicts have been straightened out and resolved once and for all" (p. 9).

Given the natural self-interest of business partners and the potential conflicts that might arise out of it, scholars have cautioned firms to consider that business partners might potentially misuse the conveyed data to their own advantage (see e.g. Gietzmann, 1996, Baiman and Rajan, 2002b). Several ways in which conveyed OBA information might be misused by business partners have been outlined by prior literature. These include buyers subsequently pressing their suppliers in price negotiations (e.g. Munday, 1992, Kajüter and Kulmala, 2005, Windolph and Möller, 2012), buyers changing suppliers based on the gained insights (Seal et al., 2004), buyers exploiting the conveyed ideas on their own (Baiman and Rajan, 2002b) or with direct competitors to the firm that originally conveyed the information, thereby reducing its competitive advantage (e.g. Jarimo and Kulmala, 2008, Cooper and Slagmulder, 2004, Romano and Formentini, 2012). Similarly, suppliers might consciously or unconsciously spread information from a particular buyer to other customers (Cooper and Slagmulder, 1999a, 2004). According to the literature, the risk of potential misuse is particularly high if information disclosure is one-sided and the conveyed information does not become outdated over time (Cooper and Slagmulder, 1999a, Lamming et al., 2001, 2004).

Adapting OBA to the particular interdependencies that are to be managed actively with particular business partners can minimise such behavioural risks (Lamming et al., 2001, Tomkins, 2001, Cooper and Slagmulder, 1999a, 2004). First, the focus on areas of interdependence allows business partners to simultaneously exclude areas in which they might perceive themselves as independent and that thus might be of high importance for their network position (Lamming et al., 2001, 2004). Likewise, the exchange of information on areas of existing interdependence that are not yet to be managed actively might be deferred until later (Lamming et al., 2001).

Second, if information is limited to areas of interdependence, it is usually also specific to at least some degree. If subcontractors for example disclose manufacturing cost information on a particular product, it might be difficult to analyse this information in relation to other products provided by other suppliers, as the configuration of the products manufactured by them might differ (Cooper and Slagmulder, 1999a). This can be seen as reducing the risk of a potential misuse of such information.

Third, as interdependence suggests mutual dependence, it is usually difficult to manage with one-sided OBA information disclosure. Multilateral disclosure might thus become necessary, which in turn can create some trust and substantially reduce the risk of potential misuse of confidential information by business partners (Lamming et al., 2001, Cooper and Slagmulder, 2004). Accordingly, any business partner who misuses information received from others needs to fear that the other firm(s) might retaliate such behaviour, e.g. by releasing equally sensitive data to competitors.

The discussion of firms' natural self-interest provides thus complimentary argumentative support for the assumed connections in the framework. In particular, behavioural risks associated to firms' self-interest might preclude the implementation of a single generic OBA design with all business partners. Rather, firms might consider in a more detailed manner with whom they want to share which kind of information. As discussed, due to the lower associated risks, information on areas of interdependence that are to be managed jointly might be primarily exchanged (Lamming et al., 2001).

Moreover, while the OBA design might be adapted to existing interdependencies between business partners, this might also hold the other way around. Adapting the degree of interdependence might thus be seen as a way to support the implementation of particular OBA designs. Interdependence with particular business partners might for example be increased by removing a directly competing supplier from the supplier portfolio (Romano and Formentini, 2012) or increasing the number of components bought from a particular supplier (Cooper and Slagmulder, 1999a, 1999b, 2004). Reversely, interdependence might also be decreased by establishing relationships with alternative suppliers or customers (Cooper and Slagmulder, 1999a).

Complimentary arguments associated with the concept of bounded rationality and the natural self-interest of business partners lend thus strong support for the conceptual link between OBA and interdependence. Next, these two elements are described in detail.

2.2 Open Book Accounting

2.2.1 Defining Open Book Accounting

Interdependence commonly provides the backdrop for interaction (Håkansson, 1982, Ford and Håkansson, 2006) and thus information exchanges. At the same time, not all information exchanges might be regarded as OBA (see in particular Hoffjan and Kruse, 2006, Caglio and Ditillo, 2012). In the context of this thesis, OBA is defined as *the systematic exchange of confidential financial and nonfinancial information that legally independent business partners undertake with the aim to manage their interdependencies.*

OBA concerns accordingly the exchange of both financial and nonfinancial information between legally independent business partners. In addition to financial information (Hoffjan and Kruse, 2006), nonfinancial information has been pointed out as important to manage interdependencies between firms for several reasons (Kajüter and Kulmala, 2005, Mouritsen et al., 2001, Agndal and Nilsson, 2010, Caglio and Ditillo, 2012, Alenius et al., 2015). To begin with, nonfinancial information, such as production capacity, lead times, set-up times and the rate of inventory turnover, has been found to aid the understanding of financial information (Mouritsen et al., 2001). Moreover, nonfinancial information has been regarded as important for the management of certain risks that are difficult to depict in absolute financial terms, but can potentially lead to severe financial consequences. Agndal and Nilsson (2010) observe for example that buyers working on principles of lean production might be severely impacted by delivery failures or quality problems of their suppliers. Firms seem to manage these risks by systematically monitoring nonfinancial indicators, such as delivery precision and production capacity of their suppliers, and requiring regular updates on the suppliers' financial strength and policies with regards to product development, quality, logistics, purchasing, risk management and ethics (Agndal and Nilsson, 2010, Kumra et al., 2012). Furthermore, buyers often provide different kinds of nonfinancial information to their suppliers, such as access to new product development plans and production schedules. This information is not only particularly valuable to coordinate the work carried out in the different firms (Gulati and Singh, 1998, Tomkins, 2001, Dekker, 2004). The degree of confidentiality of the provided information can also be seen as an expression of trust and important ingredient to furthering mutual interdependence between business partners (Tomkins, 2001, Cooper and Slagmulder, 2004). The inclusion of nonfinancial information is accordingly also important as these important kinds of information might otherwise be missed out.

In order to qualify as OBA, the exchanged financial and nonfinancial information needs to be confidential in character and should thus not be available by other means (Lamming, 1993, Hoffjan and Kruse, 2006, Caglio and Ditillo, 2012). In addition, OBA information is usually assumed to be exchanged in a systematic manner rather than on an ad hoc basis (Kajüter and Kulmala, 2005, Hoffjan and Kruse, 2006, Caglio and Ditillo, 2012).

2.2.2 The design of Open Book Accounting

A common problem of prior research is that it has referred to OBA without explicitly stating what it "actually entails" (Agndal and Nilsson, 2010, p. 163, see also Hoffjan and Kruse, 2006). In an attempt to improve conceptual clarity, a distinction between the *design* and the *use* of OBA is made in the context of this thesis (see also Agndal and Nilsson, 2010).

For the conceptualisation of the design of Open Book Accounting, I draw inspiration from the general model of accounting information system design developed by Gordon et al. (1978). Following their model, the design of accounting systems concerns the specification of three elements: preparer(s), recipient(s) and the characteristics of the particular information they exchange.[3] As part of their example, Gordon et al. (1978) note also that individual organisational units might be recipients of information from certain units and preparers of information to other units in the next step. They thus acknowledge that the design needs to take into account that the preparation and receipt of information is a distributed activity that might include several, directly and indirectly involved organisational units.

As Gordon et al.'s (1978) model has been originally developed with intra-organisational accounting systems in mind, in line with its original ideas, it requires some adaptation to the study of OBA. Three points shall be highlighted in particular. A first aspect that might require further consideration is the distinction into preparers and recipients. While this distinction might have been useful for the study of intra-organisational information-flows, it becomes somewhat problematic when discussing inter-organisational information exchanges. In those, individual firms might act as both preparers and recipients at the same point in time and with regard to the same specific interdependencies. At the same time, as Gordon et al. (1978) have highlighted, it is always important to note who exactly is allowed to enter or receive certain kinds of information and who is excluded from it. This has also been highlighted by research on OBA (see for example Lamming et al., 2001). As a result of this contemplation, it is suggested to adopt the term of "*participants in the information exchange*" as a more general term and, at the same time, to consciously discuss for each (group of) participant(s), which information they provide and/or receive.

A second aspect that requires more consideration is Gordon et al.'s (1978) observation that different participants might be directly and indirectly

[3] Gordon et al.'s (1978) model includes also a fourth element concerning the technology employed to transmit the information. They list a number of different technologies, such as written reports, online-computer data, telephone calls and face-to-face meetings. As the way in which OBA information is exchanged has not been discussed extensively in the prior literature (see e.g. Caglio & Ditillo, 2012), this element is sidelined in the analytical framework and the subsequent literature review. We will, however, reconsider it as part of the discussion chapter (Chapter 8.2).

involved in the information exchange. This opens up for the study of the design of accounting systems from a network perspective. Firms participating in OBA usually include the focal buyer and supplier, but might also include indirectly connected firms, such as sub-suppliers or competitors to any of the participants (see e.g. Cooper and Yoshikawa, 1994, Dekker, 2003, Kulmala, 2004).

A third aspect concerns the characteristics of the information that are exchanged. In the context of this thesis on OBA, one characteristic, the financial and nonfinancial information *data items* that are shared, appears particularly relevant. Gordon et al. (1978) observe that different data items might be communicated, such as production rate data or inventory levels. Prior research has found that the OBA design might differ with regard to the data elements that are exchanged (Carr and Ng, 1995, Cooper and Slagmulder, 2004, Hoffjan and Kruse, 2006, Agndal and Nilsson, 2010). It might for example include data on manufacturing operations (see for example Cooper and Yoshikawa, 1994, Mouritsen et al., 2001, Kajüter and Kulmala, 2005) or on logistics only in particular relationships (see for example Dekker and van Goor, 2000, Dekker, 2003).

2.2.3 The use of Open Book Accounting

The design of OBA sets the framework for the use of OBA. While accounting information might be used to several ends, two particular uses of OBA are distinguished in the following.

The attention directing use of Open Book Accounting

The attention directing use of financial and nonfinancial information is well established within the accounting literature (Simon et al., 1954, Gordon et al., 1978). In their classic study, Simon et al. (1954) for example noted:

> "It has been noted that reports are used for their value in directing attention to trends and drifts, to underlying causes of recurrent day-to-day problems, and generally to matters that may escape attention in the course of direct supervision" (ibid, p. 28).

OBA might direct attention to interdependencies with existing and new business partners that are naturally difficult to perceive by direct supervision (e.g. Dekker, 2003, Kajüter and Kulmala, 2005, Alenius et al., 2015). Dekker (2003) has for example observed how the supermarket chain Sainsbury introduces OBA with its existing suppliers and subsequently becomes aware of its interdependencies with those in general and with regards to logistics in particular. It accordingly directs more attention to these areas. Kajüter and Kulmala (2005) observe how an automobile manufacturer uses OBA with new suppliers to direct their attention to important aspects of interdependence right from the start of the relationship. Moreover, OBA might not only direct attention to interdependencies with directly connected business partners, but also indirectly connected ones (e.g. Cooper and Yoshikawa, 1994, Dekker and van Goor, 2000, Kulmala, 2004). Cooper and Yoshikawa (1994) observe for example how OBA can direct the buyer's attention to the indirect interdependencies it has with its supplier's sub-suppliers.

Relationships might include a range of different interdependencies that might be perceived or not depending on the OBA design. The OBA design influences thus to which interdependencies business partners direct their attention. Mouritsen et al. (2001) observe for example how a certain OBA design directs the business partners' attention to functional and interface requirements in one case while another OBA design, used in another relationship, directs the partners' attention to direct and indirect manufacturing costs. The design of OBA and its attention directing use can thus be perceived as closely interrelated.

The decision facilitating use of Open Book Accounting

Calling attention to particular aspects of business is often insufficient. In order to solve concrete problems, firms need to make decisions, which might be facilitated by accounting information (Simon et al., 1954, Gordon et al., 1978). Simon et al. (1954) observed for example that firms often draw on accounting information from standardised reports and particular analyses to understand concrete problems, evaluate alternative solutions and, finally, make decisions.

This use has also been noted for OBA (Tomkins, 2001, Agndal and Nilsson, 2008, 2010). Tomkins (2001) has for example noted the importance of OBA when mastering particular events in a relationship, which includes the consideration of different alternatives and a joint agreement on the actions to be taken. Agndal and Nilsson (2008) identify seventeen decisions that are supported by OBA in the relationship between a large car assembler and a supplier of complicated plastics and rubber parts. Those include supplier selection, decisions on component design, who should carry out certain operations, investments into specialised tools and price revisions.

Decision making in business relationships is of high complexity, providing OBA with a particularly important role. While business partners might for example sometimes take decisions that only affect their own firms based on OBA information, decisions usually affect several, legally independent firms. These firms might possess different kinds of knowledge that is important to consider when forming a decision and might also be affected differently by individual decisions (Dekker and van Goor, 2000, Tomkins, 2001, Baiman and Rajan, 2002a, Dekker, 2003, Cooper and Slagmulder, 2004, Kajüter and Kulmala, 2005, Agndal and Nilsson, 2008). While a decision might for example be beneficial from a total cost perspective, these benefits might be distributed inequitably among the concerned companies. One partner might for example need to invest additional resources and encounter higher costs, while the resulting cost benefits are reaped by the other partner (Dekker, 2003, Agndal and Nilsson, 2008). Decision making is further complicated by that it is non-hierarchical and builds on compromises as to how potential benefits might be shared (Van der Meer-Kooistra and Scapens, 2008). Moreover, relationships are dynamic. Decisions might accordingly be of temporary character only and subject to continuous reassessments (see e.g. Alenius et al., 2015, Håkansson et al., 2010).

OBA can facilitate decision making in such complex settings as it allows business partners to consider "what each party wishes to achieve from the collaboration, how feasible the goals and relative roles are and what actions need to be taken" (Tomkins, 2001, p. 171). OBA thus enables the pro-active consideration of the consequences of particular decisions for the concerned actors, thereby making their introduction more likely (Dekker, 2003).

The decisions made with the help of OBA might differ depending on the interdependencies and the OBA design at hand. Agndal and Nilsson (2010) find for example large differences with regard to the decisions that are supported by OBA in three different kinds of relationships. A vehicle manufacturer uses OBA for example in its supplier relationships to decide on suppliers, component (re-) designs, manufacturing process improvements and the pricing of the purchased components. In contrary, a retail chain uses OBA mainly to decide on changes in logistics and joint purchases of e.g. packaging material. Understanding the particular decision facilitating use of OBA, given certain OBA designs and interdependencies, is thus important.

2.3 Resource interdependence

An important concept that requires further definition is interdependence. In this thesis, the focus lies in particular on the interdependence that arises in specific focal buyer and supplier relationships. At the same time, it is acknowledged that individual business relationships are embedded in other relationships (Granovetter, 1985, Uzzi, 1997) and interdependence as well as OBA might thus sometimes stretch across several relationships.

2.3.1 Interdependence in the industrial network approach

The industrial network approach is one theory that has been developed from several hundred case studies with the aim to understand the interdependencies that accrue in individual, embedded buyer-supplier relationships (Håkansson, 1982, Håkansson and Snehota, 1995, Håkansson et al., 2009, 2010). According to the research perspective, business partners are naturally interdependent with each other to different degrees. This is so as interdependence not only provides benefits, but also involves costs (Gadde and Snehota, 2000, Håkansson and Ford, 2002). Interdependence might for example imply increased coordination costs and constrain the ability to interact with third parties (Gadde and Snehota, 2000). In addition, it might direct innovation efforts into a certain direction, which might lead to problems in the long term when alternative technologies become more important (Håkansson and Ford, 2002, see also Christensen, 1997).

According to the industrial network approach, interdependencies arise as firms interact over time across many different exchange episodes and adapt their activities, resources and actor identities to each other, which provides their relationships with a specific substance (Håkansson and Snehota, 1995, Ford and Håkansson, 2006). Interdependence between *activities* arises as firms coordinate different technical, administrative or commercial activities that are carried out within and between firms. Activities build on resources that business partners invest into and combine with each other. Interdependence between *resources* arises as business partners adapt their resources to each other. Finally, as activities and resources are coordinated and combined, interdependence arises between *actors*. Actors establish bonds and shape each other's identities. According to the industrial network approach, individual relationships are embedded in larger activity patterns, resource constellations and actor webs that might support and/or constrain certain changes within individual relationships (Håkansson, 1982).

2.3.2 Focus on resource interdependence

Empirical studies usually focus on one of the three levels of analysis (Håkansson and Snehota, 1995, Gadde and Håkansson, 2001). In the context of this study, particular focus lies on resource interdependence. According to Ford and Håkansson's (2006) words, "[r]esources are at the heart of interdependence. The interdependencies between actors relate closely to the fact that their respective resources are not isolated but are related to each other" (p. 14). Scholars have applied the perspective in different fields, such as industrial marketing and purchasing (Håkansson and Waluszewski, 2002, 2007, Waluszewski et al., 2009), strategy (Baraldi, 2008) and accounting (Lind and Strömsten, 2006, Baraldi and Strömsten, 2008, 2009, Carlsson-Wall et al., 2009, Alenius et al., 2015), and shown that it captures well this important element of interdependence.[4]

In the context of this thesis, the focus on resource interdependence provides two specific advantages. First, most prior studies on OBA provide details on the resources that are combined within particular relationships. This

[4] For a more complete list of publications and PhD theses building on the resource layer of the industrial network approach, see Baraldi et al. (2012).

makes it possible to cluster this research and to integrate research falling under each type of resource interdependence in the literature review. Second, the perspective is also particularly helpful in the analysis of an empirical case study on the design and use of OBA in capital equipment sales. Capital equipment can be seen as a particularly heavy resource that in itself is made up of many different other resources, sourced from different suppliers (Brusoni et al., 2001, Araujo et al., 2003). The approach allows thus to understand the interdependencies arising in capital equipment sales and their impact on OBA on a general level. At the same time, it also facilitates the study of potential differences in the design and use of OBA that might exist with regard to the particular resources that are combined in capital equipment. Besides a general understanding of the interdependencies and their impact on OBA design, an even more fine-grained analysis is thus supported by the research perspective.

The importance of resource interfaces

According to the resource layer of the industrial network approach, business relationships can be conceptualised as resource interfaces that are created when buyers and suppliers "relate and combine their respective resource bases" (Araujo et al., 2016, p. 3, see also Araujo et al., 1999). Interfaces are "interconnection(s) between two or more entities at a shared boundary" (Dubois and Araujo, 2006, p. 22). The importance of the interface between resources has for example been highlighted by Penrose (1959) and Alchian and Demsetz (1972). They have observed that resources are heterogeneous in character and that their value arises from the interfaces they share with other resources (Penrose, 1959, p. 25, 74-76, Alchian and Demsetz, 1972). Value can accordingly be created by creating new interfaces (Penrose, 1959) or adapting existing interfaces between resources (Alchian and Demsetz, 1972), for example by refining their fit.

According to the industrial network approach, an important function of business relationships is to establish interfaces between the resources business partners own and have access to via other, indirectly connected relationships. Establishing interfaces between resources is an important economic activity as no firm can own all the resources it requires. Access to resources of business partners is thus crucial (Håkansson and Snehota, 1995, Håkansson and Waluszewski, 2002). In addition, no firm can develop the features of its resources on its own. Suppliers might for example design certain features into a resource, but these features are of no value unless they are activated by the buyer and used in an interface with other resources (Håkansson and Waluszewski, 2002, Harrison and Håkansson, 2006). Interaction between the supplier providing resources with certain features and the buyer as a user of these features is thus pivotal (Håkansson and Waluszewski, 2002, Araujo et al., 1999, 2016).

Characterising resources

Buyers and suppliers might combine different kinds of resources in their interface. One conceptualisation distinguishes between technical and organisational resources (Håkansson and Waluszewski, 2002, Dubois and Araujo, 2006). According to this model, organisational resources store the knowledge about technical resources and develop them over time. Technical resources are the artefacts of past interactions as well as the subject of the continuous interaction between business partners (Ford and Håkansson, 2006). Two types of technical resources are facilities and products and two types of organisational resources are business units and relationships (Håkansson and Waluszewski, 2002, Gadde and Håkansson, 2008).

Facilities include the plants, logistics infrastructures, machines, vehicles, information systems and other forms of equipment that are used to develop, produce and distribute products (Gadde and Håkansson, 2008). Facilities might limit the features a certain product resource can take in the short-term. At the same time, facilities might be adapted to make new product features possible. Production facilities are owned by business units.

Products are transferred between different business units. They need thus to be handled by different facilities and business units at the buyer and supplier.

Depending on the level of analysis, *business units* can be "a firm, a part of a firm, or several firms together" (Gadde and Håkansson, 2008, p. 36). The perspective of business units on current and potential resource combinations is highly impacted by the facilities they own, the range of products they use and produce and the business relationships they are part of (Håkansson and Waluszewski, 2002).

Business relationships are the result of continued interaction between business units. They coordinate particular exchanges (Richardson, 1972) and take time and effort to develop (Håkansson and Snehota, 1995, Håkansson and Ford, 2002). As resources might be adapted within these relationships and give them a certain substance, they can over time take on the form of quasi-organisations (Blois, 1972).

According to the industrial network approach, resources usually share interfaces with several other resources at any point in time (Håkansson and Snehota, 1995, Håkansson and Waluszewski, 2002, 2007, Baraldi and Strömsten, 2006, Gadde and Håkansson, 2008). Buyer-supplier interfaces and the resources that are combined therein develop thus not in isolation, but are *embedded into larger structures* (Granovetter, 1985, Uzzi, 1997). Accordingly, it is sometimes important to extent the study beyond individual buyer-supplier interfaces to understand the connection with other, directly and indirectly connected, resources and resource interfaces.

2.3.3 Interdependence in four buyer-supplier interfaces

Interdependence arises in buyer-supplier interfaces when the resources that are combined at a particular interface are *adapted* to each other. Through adaptation, a better fit between the respective resources can be established. However, adaptations might make it also more difficult to use the respective resources in other interfaces. The standardisation of some resources within a buyer-supplier interface might thus often be necessary (Håkansson and Waluszewski, 2002). When the interface between two or more resources is not adapted, but standardised, these resources are seen as independent of each other (Håkansson et al., 2009). Accordingly, the following definition of interdependence is proposed for the thesis: *Interdependence exists when different kinds of resources (in particular facilities, products, organisational units and business relationships) are adapted to each other at specific buyer-supplier interfaces.*

Araujo et al. (1999) have conducted an empirical study on buyer-supplier interfaces. According to their study, products, facilities, business units and relationships are often combined and adapted in similar ways at specific buyer-supplier interfaces (see also Araujo et al., 2016). In particular, they distinguish between four generic kinds of buyer-supplier interfaces that are characterised by different kinds of resource adaptations and thus degrees of interdependence (see Table 1, page 26).

Standardised buyer-supplier interfaces

Standardised buyer-supplier interfaces build on the idea of standardisation of both technical and organisational resource interfaces (Araujo et al., 1999, 2016). Products might be standardised by engineering norms, such as those set by the International Organization for Standardization (ISO), or by the supplier who develops and produces them in an undifferentiated form for a large set of customers. Manufacturing facilities are usually also not adapted to particular customers. Standardisation of technical interfaces enables economies of scale to be reaped. At the downside, standardisation might require the buyer to adapt other components of its end products to the standardised components.

In standardised interfaces, organisational resource interfaces are also highly standardised. There is generally no need for the supplier nor the buyer to adapt their organisational resources to each other. Suppliers only need to know about the general demand and the most important variations in component design, as those are not specific to individual buyers. They usually drive innovation without reference to particular customers and publish catalogues from which buyers order. Small adaptations of organisational routines, e.g. with regard to order scheduling and logistics, might nevertheless occur (see also Ford et al., 1998, Dubois, 2003). Internal business units at the buyer and supplier are in general also not adapted to the specific counterpart. At the supplier, buyer-contact is limited to the sales function. As component design is standardised, the purchasing department at the buyer might manage the supplier relationship without much involvement of technical departments. Purchasers might reside over databases with potent suppliers and conduct regular commercial assessments.

Specified buyer-supplier interfaces

Specified buyer-supplier interfaces are characterised by some limited adaptation of both technical and organisational resources (Araujo et al., 1999, 2016). The product is for example specified by the buyer, but its production is outsourced to suppliers which become part of the buyer's expanded production

Table 1 Four buyer-supplier interfaces

	Standardised	Specified	Translation	Interactive
Technical interfaces				
Ex-changed product	Standardized, e.g. by engineering norm or supplier	Adapted, component based on buyer's own design	Adapted, designed by supplier based on functional and interface requirements by the buyer	Highly adapted, larger group of components outsourced; component design and design of the end product and other, connected components are adapted to each other iteratively
Facilities	Standardized	Generally standardised with some minor adaptations, e.g. investments into dies	Generally standardised with some minor adaptations, e.g. investments into dies	More adaptations; facilities might on the one hand pose restrictions on component design, but specific investments into dies and smaller machinery and specifically designed testing equipment might also be made
Organisational interfaces				
Relation-ship	Standardized, possibly some limited adaptations in order handling and logistics	Limited adaptation to ensure manufacturability and on-time production and delivery	Adapted to align technology strategies, conduct parallel engineering and ensure on-time production and delivery	Highly adapted to support simultaneous engineering and ensure on-time production and delivery; supplier responsible for large number of sub-suppliers
Business units	Standardized, relatively limited contact	Limited adaptation: Purchasing, Sales, Operations, R&D might be involved	Some adaptation, for example with regards to marketing, purchasing, operations, quality, finance R&D units; co-location of engineers	Adapted, in particular deep ties between engineering units; supplier might co-locate engineers at buyer; buyer's engineers visit supplier regularly

Own illustration based on Araujo et al. (1999, 2016) structure. By pooling together orders for similar products from several buyers, suppliers can achieve economies of scale and scope that none of its buyers might be able to reach on their own. In order to achieve those, it uses highly standardised facilities. Some smaller adaptations of the facilities, such as the investment into dies, might, however, be necessary.

While still standardized to some degree, organisational resource interfaces become also more adapted. Coordination is required before and during production. While specifying the product, the buyer might need to take into account the supplier's facilities and some of its parallel relationships with other buyers. In this way, the buyer can support the supplier in creating economies of scope among orders from different buyers. In order to make some practical suggestions on how the product specification might be improved in terms of its manufacturability, the supplier might also require some general understanding of the product that the buyer produces and of which the component forms a part of. During production, order schedules need to be coordinated in order to ensure that the supplier can use its facilities as efficiently as possible and the buyer receives high quality, on-time deliveries to avoid any standstills of its manufacturing facilities. Some organisational adaptations are thus necessary and specific to the relationship. A higher number of business units might also be involved in the relationship. The supplier might have key account managers assigned to specific buyers. In addition, some contact between engineers and operations staff of the business partners might be necessary to find optimal product configurations and coordinate production.

Translation buyer-supplier interfaces

In translation interfaces, the buyer delegates product development to the supplier based on some functional and interface requirements (Araujo et al., 1999, 2016). The supplier is accordingly relatively free in how it "translates" these requirements into concrete products, given its own technical and organisational resources and orders from other customers. This flexibility provides it with the possibility to generate economies of scale and scope. It might for example mainly change the interfaces of the product while leaving its "technical core" unchanged and/or use the same subcomponents in several products developed and produced for different customers. The buyer benefits from the supplier's ability to invest into research and development and innovate with regard to the component. At the same time, as those innovations are also available to its competitors, the buyer might not be able to differentiate its products with the component it sources through translation interfaces. As the supplier develops and manufactures similar products for different buyers, the adaptation of facilities is usually also limited to dies.

The organisational resources adapted on the relationship-level differ from standardised and specified interfaces. While the supplier can change the product's specifications quite freely as long as she adheres to the functional and interface requirements set by the buyer, regular design review meetings to synchronise development efforts might be necessary. As the supplier owns the product specification and components might be difficult to replace due to their technical interfaces with other components in the buyer's end product, switching supplier during production is almost impossible. Accordingly, tight coordination of production is required. As the supplier is responsible for both the development and production of the product, the buyer is less involved in the supplier's relationships to sub-suppliers (see also Håkansson and Snehota, 1995). The supplier requires also some flexibility in order to benefit from its connections to other buyers. Several business units might be involved in the interface. Cross-functional teams at the buyer might for example define functional and interface requirements and need to work together with teams from different functions at the buyer (Araujo et al., 2016).

Interactive buyer-supplier interfaces

Interactive interfaces are characterised by an open-ended dialogue in which buyers and suppliers develop product specifications interactively (Araujo et al., 1999, 2016). Compared to translation interfaces, the buyer's technical and interface requirements are thus seen as more flexible. Technical adaptations might for example occur both with regard to both the supplier's or buyer's products and facilities. Accordingly, both buyer and supplier require in-depth knowledge of each other's technical resources. Araujo et al. (2016) observe also that the products exchanged via interactive interfaces often take the form of larger systems and that innovation with regard to these is important due to their importance for the buyer's end customers. Examples include electric powertrains or active safety systems that automobile manufacturers might source from their suppliers (Araujo et al., 2016). Existing facilities might limit the choice of product specifications. Maximum size restrictions for components might for example be set out of the need to produce it on a certain high volume manufacturing line. At the same time, some larger investments into dies, production equipment and testing equipment might be necessary due to the innovative character of the product. These investments might sometimes be also customer-specific as proprietary technologies and product specifications might be developed with and for particular customers. The benefits of these adaptations might often be uncertain, materialise only after several periods and have no value outside the particular buyer-supplier interface (Araujo et al., 1999, 2016).

The interactive interface warrants also a large number of organisational resources. As the concept of the buyer's end product has not been finalised from the outset, frequent coordination meetings, routines and guest engineer programmes might be necessary to avoid the work on conflicting ideas. Accordingly, deep ties might exist in particular between the engineering units of the buyer and supplier. Araujo et al. (2016) observe also that coordination between several cross-functional teams of the buyer and supplier, working on different product development projects in parallel, might become necessary. As the supplier is responsible for larger systems, it becomes also responsible for a larger number of sub-suppliers compared to specified interfaces. Suppliers might sell to other customers in order to recoup the investment into product development carried out with specific customers and to create economies of scale and scope (Araujo et al., 2016).

2.3.4 Maintenance-related resource interdependencies in capital equipment sales

Building on the industrial network approach's resource layer (Håkansson and Snehota, 1995, Håkansson and Waluszewski, 2002), Araujo et al.'s (1999, 2016) typology describes accordingly four buyer-supplier interfaces in terms of the resource interdependencies they give rise to. As production is always performed by the supplier, differences between the interfaces arise mainly based on the distribution of product development responsibilities between the buyer and the supplier. Depending on the interface, the product design is either standardised or established by the buyer, the supplier or jointly by both. Technical and organisational interdependencies increase accordingly along a continuum from standardised to interactive interfaces.

Maintenance-related resource interdependencies in capital equipment sales

While Araujo et al.'s (1999, 2016) typology is accordingly useful to characterise different kinds of buyer-supplier interfaces in terms of their interdependencies in product development and production, it falls short of describing interdependencies that arise during the use and maintenance of products. Such interdependencies appear particularly significant in the purchase and sale of capital equipment and thus the "equipment intended for continuing use by a business" and identified as capital asset (Oxford University Press, 2017). As observed within the purchasing and supply management literature (Burt et al., 2010, Benton, 2010, Hofmann et al., 2012), capital equipment gives rise to additional, *maintenance-related* resource interdependencies between products, facilities, business units and indirectly connected relationships.

Capital equipment requires for example the subsequent exchange of a large number of spare parts and other maintenance-related *products* and services over its extended life cycle in the buyer's operations (Hofmann et al., 2012). The connected cost usually exceed the initial investment by many times (Burt et al., 2010, Schweiger, 2009, Hofmann et al., 2012). Schweiger (2009) observes for example that the initial purchase price might only constitute 5-50 percent of the total cost over the life cycle of a certain machine.

Capital equipment requires also the adaptation of interfaces between additional *facility* resources of the buyer and the supplier. In order to support smooth maintenance and operations, investments into maintenance workshops and spare part stocks might become necessary. As significant opportunity costs arise whenever capital equipment cannot be used, these investments are seen as an important subject of buyer-supplier interaction (Burt et al., 2010).

Moreover, Burt et al. (2010) and Hofmann et al. (2012) observe that additional *business units* might be involved in the purchasing and subsequent maintenance of capital equipment. Plant engineering and marketing units of the buyer might for example be involved to evaluate the fit of the equipment with existing and future production process and product portfolios. In addition, the buyer's operations department might coordinate maintenance-related questions (see also Hofmann et al., 2012) and its finance unit might draw up budgets for maintenance and replacements for the years following the initial purchase (Burt et al., 2010). As capital equipment constitutes complicated products, the involvement of different units of the supplier and *indirectly connected relationships* might also be assumed. Due to its focus on the buyer's organisation, these are, however, not discussed in the reviewed purchasing literature (Burt et al., 2010, Benton, 2010, Hofmann et al., 2012).

Relating Araujo's (1999, 2016) typology to capital equipment sales

Capital equipment is accordingly connected to significant maintenance-related interdependencies that have not been described in Araujo et al.'s (1999, 2016) typology before. The typology remains at the same time nevertheless relevant for the description of the different interdependencies that can arise with regard to the initial development and production of capital equipment. Burt et al. (2010) observes for example that the design of capital equipment is often highly adapted to the buyer's specific requirements. As it forms part of the buyer's larger facilities, it shares for example technical interfaces with other equipment the buyer owns and the products the buyer develops and produces. Adaptations of the design of capital equipment might accordingly be necessary and performed by the supplier alone based on the buyer's functional and interface requirements as in translation interfaces or jointly by the buyer and supplier as in interactive interfaces. As the adaptation of capital equipment takes time and consumes significant resources, substantial lead-times of several months or even years might also apply (Burt et al., 2010), similar to the time it takes to develop and manufacture other products. At the same time, Burt et al. (2010) notes also that the design of capital equipment might occasionally be standardised. The chemical and petroleum industry might for example require a large number of standardised pumps, which it regularly maintains and exchanges. Accordingly, capital equipment seems to lead to additional, maintenance-related resource interdependencies that might be added to Araujo et al.'s (1999, 2016) existing four generic interfaces.

Chapter 3

Literature review

3.1 Open Book Accounting in standardised buyer-supplier interfaces

Standardised buyer-supplier interfaces are associated with a low degree of adaptation of technical and organisational resources and, accordingly, limited interdependence (see Chapter 2.3.3). The product and manufacturing facilities are standardised and only some limited adaptation of organisational resources, for example with regard to order handling and logistics, might be expected.

Several studies illustrate how OBA might be used in standardised interfaces.[5] At a closer look, these studies discuss three specific areas in which OBA might be used in standardised interfaces and to which the design and use is adapted accordingly.[6] Some studies primarily discuss adaptations with regards to the supplier's purchasing of standardised raw material from sub-suppliers (Romano and Formentini, 2012, Kumra et al., 2012), while other studies observe adaptations of logistics facilities and related organisational resources (Dekker and van Goor, 2000, Dekker, 2003, Agndal and Nilsson,

[5] A list of the individual studies and the buyer-supplier interfaces they fall under is provided in Appendix 1.
[6] Agndal and Nilsson (2010) note also a fourth area in which OBA might be designed and used in standardised interfaces. According to their contribution, retailers and manufacturers might discuss joint profit sharing models for sales increases and test marketing of new products with the help of OBA. However, they note problems in implementing OBA in this area due to potential competition with the retailer's white label products and do not discuss it in any further detail. I therefore exclude it from my discussion.

2010) or the establishment of network sales deals (Kulmala, 2004). In consequence, these three groups of studies on OBA in standardised interfaces are discussed separately before a short synthesis is provided.

3.1.1 Open Book Accounting in standardised buyer-supplier interfaces with focus on purchasing from sub-suppliers

Some studies observe how buyers and suppliers design and use OBA in standardised interfaces mainly with regard to suppliers' purchasing from sub-suppliers. Romano and Formentini (2012) report evidence from the relationship between a kitchen manufacturer and its supplier of semi-finished metal components that the buyer orders from catalogues and sources in parallel from several suppliers. Kumra et al. (2012) discusses the case of a construction company and its suppliers of expensive, but standardised building materials (e.g. steel, bricks). In both cases, the cost of the material purchased by the supplier from sub-suppliers is substantial, making the application of OBA interesting in this area.

Design of OBA in standardised interfaces with regards to purchasing

The *participants* of the information exchange are accordingly usually the buyer, its supplier(s) and, to some degree, the suppliers' sub-suppliers. In the case described by Kumra et al. (2012), OBA involves several suppliers, while in the case discussed by Romano and Formentini (2012), the buyer needs to pledge to not involve competing suppliers. Sub-suppliers to the supplier become involved when the buyer provides bargaining support to a specific supplier (Romano and Formentini, 2012) or consolidates the purchasing needs of several suppliers and then places single bulk orders in order to realise quantity discounts (Kumra et al., 2012).

The *supplier* might share a "detailed specification of all the phases of its purchasing and supply management processes and the quantification of the related costs" as *data items* (Romano and Formentini, 2012, p. 76). In addition, the supplier provides access to the cost of individual materials purchased from sub-supplies. No information on the suppliers' manufacturing processes is shared (Romano and Formentini, 2012, Kumra et al., 2012). This is motivated by the buyer's lack of understanding of the manufacturing process

(Kumra et al., 2012), the supplier's interest to protect its know-how (Romano and Formentini, 2012) and the rather low amount of costs connected to internal manufacturing (Romano and Formentini, 2012). Eighty percent of the costs of the supplier of semi-finished metal components are for example made up by materials purchased from sub-suppliers, such as copper alloys and stainless steel (Romano and Formentini, 2012).

The *buyer* provides its supplier mainly with feedback on the collected data, e.g. on how purchasing processes might be improved and on cheaper sources for material and logistics providers (Kumra et al., 2012, Romano and Formentini, 2012). It seems to thus not provide any information related to its own firm-level resources and related costs.

The two case studies do not provide any detailed description of the information buyers and suppliers receive from and provide *sub-suppliers* with when negotiating the price of the suppliers' inputs. Based on the buyer's involvement in the negotiations and the standardised character of the purchased products, one can, however, assume that buyers and suppliers mostly receive price information from sub-suppliers as data items. The exchange of detailed cost breakdowns has at least not been reported in prior research.

Use of OBA in standardised interfaces with regards to purchasing

OBA *directs the attention* to purchasing-related issues at the supplier. Different kinds of *decisions* might be supported with OBA with regards to the suppliers' purchasing. First, the supplier's internal purchasing-related organisational resources might be adapted (Romano and Formentini, 2012). Second, suppliers and sub-supplier's might be asked to keep certain exclusive stocks and might be compensated when raw material prices fluctuate to the supplier's disadvantage (Kumra et al., 2012). Third, the buyer might get involved in its supplier's sourcing decisions, either by providing bargaining support to its supplier (Romano and Formentini, 2012) or by taking over and thus centralising the negotiations from several of its suppliers requiring similar raw material, thereby realising quantity discounts (Kumra et al., 2012).

3.1.2 Open Book Accounting in standardised buyer-supplier interfaces with focus on logistics

Some studies contribute with illustrations on how OBA might be designed and used in standardised interfaces to manage the adaptation of logistics resources. The exchanged standardised products discussed in these studies are drugs (Dekker and van Goor, 2000) and nondurable consumer products (Dekker, 2003, Agndal and Nilsson, 2010), which are both developed and produced by their manufacturers for a large number of undifferentiated buyers.

Design of OBA in standardised interfaces with focus on logistics

The information exchange between the supplier of the standardised product and the buyer as *participants* of the information exchange is the main subject of these contributions (Dekker and van Goor, 2000, Dekker, 2003, Agndal and Nilsson, 2010). In the specific studies, the buyer is either a retail chain with own distribution network (distributor-retailer, Agndal and Nilsson, 2010, Dekker, 2003) or a wholesaler who distributes the products in a next step onwards to retailers (Dekker and van Goor, 2000). As investments into logistics resources are costly and directly and indirectly affect several other firms, additional participants might also be included in OBA. Dekker (2003) and Agndal and Nilsson (2010) observe for example that not one, but several large and strategically important suppliers are included in the OBA design. In the case reported by Dekker (2003) 36 key suppliers (of in total 4,000 suppliers) delivering products in six different product categories (produce, main ambient, slow moving ambient, bulky goods, chilled and frozen) to the British distributor-retailer Sainsbury are included. These large suppliers are seen as possessing the necessary resources to implement individual changes in logistics on their own with the buyer as well as together with other suppliers. In addition, Dekker and van Goor (2000) observe that the pharmaceutical wholesaler includes four retail outlets that belong to the same retail chain in order to collect information on how logistics can be improved both up- and downstream. Somewhat less expected, Dekker (2003) observes that a distributor-retailer sometimes even involves direct competitors into OBA. Competing distributor-retailers are included as they source from the same suppliers and any larger change in logistics resources with those suppliers is dependent on them implementing similar changes with their other buyers.

The distributor-retailers (Dekker, 2003, Agndal and Nilsson, 2010) and the wholesaler (Dekker and van Goor, 2000) are the main drivers of the OBA information exchange. They specify which *data items* the other participants, and thus their *suppliers and retailing customers*, should provide and collect similar information about their own operations. In all three cases, suppliers and customers provide Activity Based Cost information related to logistics. This data is at the same time limited to the product category and not detailed out on the level of individual products. The number of activities that are considered varies between the cases. The cost model deployed by the British distributor-retailer Sainsbury (Dekker, 2003) is most extensive. It distinguishes between 20 standard activities that occur at each of three stages: the supplier, in distribution and in retailing. The model is flexible as it encompasses all possible activities, but not all activities might be carried out in all relationships. Likewise, as the focus is on activity costs, how the activities might be carried out can vary. Picking might for example be performed automatically or manually. In addition, the product category, the way of distribution (to primary or regional distribution centres or directly to stores), the concerned geographical region, the retail store category as well as individual cost elements are recorded in the cost model. Agndal and Nilsson (2010) observe that buyers might occasionally also ask their suppliers for some general information related to safety, risks, ethics, quality and environmental concerns, which they might need in their supplier qualification process. Information on manufacturing processes or costs of inputs is excluded from the data exchange in all cases. Likewise, the influence of other resources and related processes (e.g. internal production planning) on logistics costs is deliberately ignored (Dekker and van Goor, 2000, Dekker, 2003). The OBA exchange is accordingly kept focused on logistics resources. Larger differences that might exist between suppliers in other areas are deliberately ignored.

Distributor-retailers and *wholesalers* appear to primarily provide feedback on the information they receive (Dekker, 2003, Agndal and Nilsson, 2010). The data items seem to mirror the information collected from their suppliers and customers. The focus lies on logistics costs. Dekker (2003) for example observes that suppliers are informed about their own logistics costs and the average costs of suppliers falling under the same product category. This includes also logistics costs related to their products accruing at the buyer. In particular cases and with the explicit consent of two suppliers, the buyer might also share specific cost information from these suppliers. Additional information provided by the buyer include information on current and future change initiatives and connected experiences, delivery performance metrics and planned promotional campaigns (Dekker, 2003, Agndal and Nilsson, 2010). Occasionally, the buyer might also indicate cheaper sources for raw and packaging materials to their suppliers (Agndal and Nilsson, 2010).

The data items that distributor-retailers share with their *direct competitors* are equally focused on logistics, but of more general character. The distributor-retailer Sainsbury explains for example *which* changes it considers implementing with suppliers, but not *how* it intends to implement these changes itself (Dekker, 2003).

Use of OBA in standardised interfaces with focus on logistics

OBA appears to help the involved participants to *direct their attention* to several important issues. On a general level and parallel to the introduction of OBA, all three studies note that the participants become aware of their interdependence in logistics, which they had not perceived before in their standardised interface, which is otherwise characterised by adversarial, small number price negotiations (Dekker, 2003, Agndal and Nilsson, 2010) and manual ordering (Dekker and van Goor, 2000). Considering the high volume of standardised product exchanges, small efficiency improvements in logistics are regarded as leading to large absolute differences and a competitive advantage for the involved participants (Dekker, 2003). Before OBA, the individual firms seem to have not been aware of this part of their interface and how it could be improved by means of adaptation. As Dekker and van Goor (2000) and Dekker (2003) for example note, buyers had only access to their own, total logistics costs and no ability to assess how efficient they themselves and their business partners were in logistics. The implemented activity-based cost models increase transparency within and between firms. Dekker (2003) observes for example that the distributor-retailer Sainsbury can now analyse how its internal logistics costs differ between different kinds of products, logistics setups, geographic regions and store categories. In addition, it can understand how they differ between suppliers and trace their development across time.

Within logistics, this increased transparency directs attention to at least three aspects. First, for each individual dyadic relationship, differences in individual cost driver rates become apparent (Dekker and van Goor, 2000, Dekker, 2003, Agndal and Nilsson, 2010). This lays the foundation for discussions about shifting resources within individual dyadic relationships. Second, through benchmarking, differences and similarities between individual supplier relationships within the same and/or different product categories can be uncovered (Dekker and van Goor, 2000, Dekker, 2003). Dekker (2003) discusses for example that different picking methods might be used and leave their imprint in the activity cost drivers. Attention can thus be directed to learning about why differences between relationships exist and how certain, similar resource adaptations could be replicated in other relationships. Third, given their apparent similarities, certain relationships can be analysed as a group. Dekker and van Goor (2000) provide the example of retail outlets that are served by the wholesaler. The wholesaler collects data from four retailers, but averages the data and extrapolates it to see the effect with regard to the larger group of retailers it serves.

This increased attention, leaves also its imprint on *decision making*. In particular, two areas in which decisions are made can be discerned. First, buyers and suppliers need to agree on what constitutes an adequate level of performance before they can make decisions as to how they can achieve these levels in the most cost efficient way. Dekker and van Goor (2000) observe that these discussions about what constitutes "effective logistics" are mostly qualitative in nature. This is probably to be understood in terms of the opportunity costs connected to non-deliveries and empty shelves in pharmacies and supermarkets. Second, buyers and suppliers use OBA information to jointly make decisions about efficiency improvements. OBA serves here an important function when brainstorming about potential changes and analysing different alternatives in terms of their impact on total costs and the costs of each individual partner (Dekker and van Goor, 2000, Dekker, 2003, Agndal and Nilsson, 2010). Concrete decisions reported in the literature include the transfer of particular logistics processes and related resources from one partner to the other (Dekker and van Goor, 2000) as well as the adaptation of logistics facilities (Dekker, 2003). Dekker (2003) discusses for example the investment into plastic crates for a more efficient handling of chilled products. This change might lead to a decrease in total cost, but an increase in handling costs at the supplier, and requires a high investment outlay. OBA helps the business partners to negotiate an agreement as of which the manufacturer is allowed to increase its price to cover for the cost increase, while the distributor-retailer invests into the crates and reaps the larger part of the financial benefits. Interestingly, in none of the three cases, OBA is used for making decisions about the selection of suppliers. This is explained by that retailer-distributors need to stock certain brands due to consumer demand (Agndal and Nilsson, 2010). In addition, Dekker (2003) argues that such a use might stand in contrast to the voluntary character of the information exchange and the cooperative atmosphere required for it to take place.

3.1.3 Open Book Accounting in standardised buyer-supplier interfaces with focus on network sales deals

Design of OBA in standardised interfaces with regards to network sales deals

Kulmala (2004) provides evidence on the use of OBA to establish a network sales deal. *Participants* of the information exchange are the focal buyer, the focal supplier and five of the focal buyer's other suppliers, which later decide to become additional customers to the focal supplier. The other suppliers sell different kinds of products to the focal buyer in the production of which they can use the focal supplier's standardised products as subcomponents. One of the other suppliers produces for example subassemblies and an end product bought by the focal buyer through a specified interface.

In the specific interface, the *supplier* is the only participant providing *data items*. Servicing costs are identified as important cost elements. Accordingly, the data items provided by the supplier include the "actual service process and all related activity-based cost information" (Kulmala, 2004, p. 73), including information on its profit margin, for one product category.

Use of OBA in standardised interfaces with regards to network sales deals

Before OBA, the business partners seem to have had limited knowledge of each other's business models and processes. The relationship between the focal buyer and supplier is described as adversarial with interaction limited to annual price negotiations, the communication of technical specifications and specific orders (Kulmala, 2004). Subsequently, *attention is directed* to each other's businesses, their underlying resources and related costs. The buyer learns about the impact of business volume on the supplier's servicing cost structure and the supplier learns about the possibility to sell its products to the buyer's other suppliers.

Several *decisions* are also supported by OBA. First, the buyer selects the supplier for an additional category of products even though its price for this category lies in line with the one quoted by its prior supplier. Second, the buyer's other suppliers transfer their purchases to the focal supplier. This change takes more than a year to implement and is therefore seen as quite difficult to reverse. As a result, the business volume of the supplier with the focal buyer and its other suppliers increases from 9 to 15 percent of its total sales. Third, the supplier invests into a new facility close to the buyer and adapts the layout of a production line. As a result of these adaptations and the re-use of the same service concept with the buyer's other suppliers, the supplier can reduce the price charged to the focal buyer by 20 % without reducing its own profitability.

3.1.4 Synthesis: Open Book Accounting in standardised interfaces

Table 2 (page 42) summarises the discussion of OBA in standardised interfaces. As expected, the reviewed studies illustrate that even generally standardised buyer-supplier interfaces are characterised by some limited technical and organisational resource adaptations (Araujo et al., 1999, 2016). These adaptations are at the same time limited to resources required in processes prior (purchasing) or subsequent to product development and manufacturing (logistics, network sales) while resources connected to product development and manufacturing are naturally not touched upon.

Table 2 Design and use of Open Book Accounting in standardised interfaces

Area of interdependence	Design	Use
Purchasing of suppliers from sub-suppliers	*Participants:* Buyer, supplier(s), sub-supplier to supplier *Data items provided by supplier to buyer:* information on purchasing and supply management processes and purchased material *Data items provided by sub-supplier to supplier and buyer:* Price information *Data items provided by buyer to supplier:* N/A	*Direction of attention:* • Supplier's purchasing-related organisational resources and associated costs • Costs of standardised material purchased by supplier *Facilitated decisions:* • Adaptation of purchasing and supply management resources at supplier • Minimum stock requirements and compensation in case of raw material price fluctuations • Supplier selection

Area of interdependence	Design	Use
Logistics	*Participants:* distributor-retailer or wholesaler as buyer, one or several manufacturer(s) of standardised products as supplier, retailers (if buyer is a wholesaler), competitors to the buyer *Data items provided by suppliers and retail customers to distributor-retailers or wholesalers:* logistic costs in form of ABC calculations, general information for supplier qualification process (safety, risks, ethics, quality, environmental concerns) *Data items provided by distributor-retailers and wholesalers to suppliers and retail customers:* own and average logistics costs of other suppliers, additional information on changes in logistics, delivery performance metrics, promotional campaigns, cheaper sources for raw materials and packaging material *Data items provided by distributor-retailers to competitors:* general information on resource adaptations that require parallel changes of competitors	*Direction of attention:* • Interdependence in logistics in general • Differences in cost between different logistics set-ups, also over time, possibility to optimise these within and across dyadic relationships and across groups of suppliers and customers *Facilitated decisions:* • Targeted level of logistics performance • Adaptations of / investments into logistics facilities
Network sales deals	*Participants:* Buyer, supplier, other suppliers to the buyer *Data items provided by supplier to buyer and the buyer's other suppliers:* information on servicing-related resources and connected costs	*Direction of attention:* • Understanding each other's business • Servicing-related resources and connected costs *Facilitated decisions:* • Supplier selection • Adaptations of / investment into production/servicing facilities

As the specific resource interdependencies differ so does the specific design and use of OBA. Prior research has accordingly outlined three sub-variants of OBA implemented in standardised interfaces. The review has highlighted existing coherence between studies on these sub-variants. This does at the same time not mean that smaller differences in implementation do not exist. In the context of logistics, the number of involved participants depends for example on whether the distributor is also a retailer or whether retailing is conducted by a legally independent firm. In the former case, different manufacturers and distributor-retailers might be involved; in the latter case, retailers might become a different group of participants, too.

3.2 Open Book Accounting in specified buyer-supplier interfaces

In specified interfaces, more significant adaptations of technical and organisational resources can be observed, based on the buyer specifying the product, but outsourcing its production to suppliers (see Chapter 2.3.3). The interface and the design and use of OBA therein has received most scholarly attention of all interfaces. Qualitative and quantitative studies have studied specified interfaces in different industries, such as the plastic moulding industry (Munday, 1992), the automotive industry (Cooper and Yoshikawa, 1994, Cooper and Slagmulder, 2004, Seal et al., 1999, Kajüter and Kulmala, 2005, Agndal and Nilsson, 2009, Kumra et al., 2012), the global equipment manufacturing industry (Kulmala, 2004), the communication equipment industry (Mouritsen et al., 2001), the kitchen industry (Romano and Formentini, 2012), the knitwear industry (Caglio and Ditillo, 2012) and the white-label meat production industry (Alenius et al., 2015). While differences in implementation naturally exist, these studies provide an overall highly concurrent picture of the design and use of OBA in specified interfaces.

Design of Open Book Accounting in specified interfaces

In specified interfaces, the information exchange appears to include a wide array of *participants*. Buyers usually conduct OBA with several, directly competing suppliers at any given point of time (see for example Munday, 1992, Cooper and Yoshikawa, 1994, Cooper and Slagmulder, 1999a, Kajüter and Kulmala, 2005). This can be explained by that buyers generally source products of a given category from multiple suppliers. At the same time, they use, however, single sources for particular product specifications. Moreover, as the supplier might outsource the production of certain sub-components to sub-suppliers and their sub-sub-suppliers, these are also often included, either by asking the first tier supplier to collect information from these and passing it on to the buyer (Kajüter and Kulmala, 2005) or through direct involvement of the buyer with these sub-suppliers (Munday, 1992, Cooper and Yoshikawa, 1994, Kulmala, 2004, Alenius et al., 2015). Furthermore, suppliers and sub-suppliers that belong to different, complementary supply chains might also be included. Alenius et al. (2015) provide the example of a complex supply network for meat products. The buyer, a supermarket chain, initially conducts OBA only with its supplier of packaged, white-label pork meat products and its supplier's sub-supplier of pork meat cuts. However, as it perceives possibilities to use pork parts that cannot be sold as meat cuts in its parallel supply chain of white-label processed meat products, it extends OBA to suppliers in this complimentary, indirectly connected supply chain. In contrast to OBA in standardised interfaces, competing buyers appear to be not actively involved into OBA. The only reference to competitors of the buyer is found with regard to teardown analyses of competitive products that buyers might undertake to learn about competing product's specifications and related costs (Cooper and Slagmulder, 1997, 1999a, Kajüter and Kulmala, 2005).

At a closer look, it seems that *suppliers and sub-suppliers* (from the same as well as competing and complementary supply chains) provide and receive the same kind of *data items* to/from focal buyers, which, in turn, are those specifying the product. Accordingly, they can be discussed together. Several data items are provided by these participants as part of OBA. Taken together, this information might provide buyers with even more detailed insights than when they conducted production in-house before and managed associated processes informally (Mouritsen et al., 2001). First, suppliers and sub-suppliers provide their buyers usually with highly detailed breakdowns of direct and indirect costs related to the production of a particular product (Munday, 1992, Cooper and Yoshikawa, 1994, Mouritsen et al., 2001, Kajüter and

Kulmala, 2005, Kumra et al., 2012, Alenius et al., 2015). The exact way of calculating cost appears to be negotiated at the outset of the relationship (Seal et al., 1999, Kumra et al., 2012) and only revisited when particular questions arise (Agndal and Nilsson, 2009). The supplier prepares cost breakdowns often on the buyer's templates that are adapted to the specific product category (see for example Cooper and Yoshikawa, 1994, Kajüter and Kulmala, 2005, Alenius et al., 2015). Cooper and Yoshikawa (1994) describe the example of a supply chain consisting of an automotive manufacturer, a supplier of automotive components and its sub-supplier of forged components. The sub-supplier breaks down its product costs on the buyer's template into eight categories: material cost, mould cost, facility fees, labour hours, heat treatment costs, shot blast costs, profit and management fees. As facility fees represent the majority of these costs, those are further broken down into four categories (depreciation charge for the used equipment based on the expected machine life and the hours required for the product, conversion costs including utilities, cost for machine operators, machine operating costs). The management fee and profit margins are pre-negotiated and fixed across all products the supplier manufactures for the buyer in order to secure the supplier's long-term viability. Additional cost categories that might be disclosed are transportation, warranty and research and development costs (Kajüter and Kulmala, 2005, Alenius et al., 2015).The price paid by the buyer is accordingly established by cost-plus pricing.

Second, suppliers might provide additional information that aids understanding of the cost breakdowns. Mouritsen et al. (2001) observe the exchange of information on intermediary product inventory, inventory turnover and adjustment times for machines. Similarly, Kajüter and Kulmala (2005) observe that the buyer asks its suppliers to state the overall capacity utilisation of its machines in order to not only understand the calculation of indirect costs, but to also further analyse how they might be optimised at the supplier.

Third, suppliers provide information on necessary facility investments. In specified interfaces, these are usually limited to investments into dies (Cooper and Yoshikawa, 1994, Kumra et al., 2012). Larger adaptations of manufacturing facilities are rare and, if they are considered, they are unspecific from particular buyers and their products, such as the introduction of lean manufacturing techniques or improvements in purchasing and supply chain management (Agndal and Nilsson, 2009, Romano and Formentini, 2012). Exceptions from this rule occur only when the production volume requires the designation of a particular production line to the buyer (Kulmala, 2004, Alenius et al., 2015). Additional contracts might then be drawn up to secure capacity utilisation over a certain period.

Fourth, suppliers might provide several kinds of general information. Kumra et al. (2012) observe for example that the buyer collects data on process quality, existing and expandable plant capacity, financial strength and reputation in the market and delivery terms. Kajüter and Kulmala (2005) observe that the buyer asks its suppliers also to disclose the distance and means of transport between all of their sub-suppliers further up in the supply chain.

Buyers provide suppliers mostly with feedback on the *data items* these provide. This feedback can come in different forms. First, buyers might provide their suppliers with anonymised cost calculations from other supplier relationships (Alenius et al., 2015) and best practice reference values on production processes, technologies and quality standards (Kumra et al., 2012). Second, buyers might deploy lean manufacturing (Kulmala, 2004) or purchasing specialists (Romano and Formentini, 2012) to give feedback on how to improve particular resource combinations. Third, buyers might hold technical exchange meetings with several of their suppliers (Cooper and Yoshikawa, 1994). During those, they might ask suppliers to present their resource combining efforts in front of their direct competitors. As a result, suppliers are supported in quickly matching each other's costs. Being part of the buyer's network might accordingly be advantageous for suppliers, which might exploit this knowledge in their parallel relationships. In addition, buyers might provide their suppliers with short- and medium order forecasts (Romano and Formentini, 2012). In none of the cases do buyers provide suppliers with information on their own internal cost or strategic information on upcoming new development projects (Cooper and Slagmulder, 2004, Agndal and Nilsson, 2009). This might be explained by that the product design is mostly specified by the buyer.

Use of OBA in specified interfaces

The exchanged information is quite broad in terms of data items and participants, allowing for a broader use than in standardised interfaces. At the same time, it is important to observe that, apart from investments into dies, there is also usually no scope for customer-specific adaptations of manufacturing facilities in specified interfaces. One important area of interdependence to which OBA *directs attention* are the individual product specifications set by the buyer and their cost consequences at suppliers and sub-suppliers (Munday, 1992, Cooper and Yoshikawa, 1994, Mouritsen et al., 2001, Kajüter and Kulmala, 2005, Alenius et al., 2015). Buyers, suppliers and sub-suppliers might be able to contribute with knowledge on how the buyer's product specifications can be improved, given their own and others' technical and organisational resources.

Furthermore, OBA draws attention to that resource interdependence extends over time and that cost and quantity changes might occur over such more extended periods (Cooper and Yoshikawa, 1994, Cooper and Slagmulder, 1999a, 2004, Kajüter and Kulmala, 2005, Agndal and Nilsson, 2009, Alenius et al., 2015). OBA can be regarded as a communication tool that allows buyers and suppliers to sensitise their counterparts for the cost pressures they are subject to and to stimulate efficiency improvements and price adaptations over time. Buyers can be seen as subject to cost pressures from their end customers and competitors, making efficiency improvements important (Cooper and Yoshikawa, 1994, Cooper and Slagmulder, 1999a, 2004). Supplier's profitability can at the same time be regarded as highly dependent on the product volumes ordered by buyers as well as changes in raw material prices. Alenius et al. (2015) observe for example how the supplier of packaged meat cuts provides updated information every four-week period on achieved volumes and costs. Fluctuations in volumes, pig prices and other costs become thus visible and are rendered manageable within the specified buyer-supplier interface.

Another major area into which attention is directed is interdependence within and between complimentary supply chains the buyer is part of (Munday, 1992, Cooper and Yoshikawa, 1994, Kajüter and Kulmala, 2005, Romano and Formentini, 2012, Alenius et al., 2015). Cooper and Yoshikawa (1994) and Alenius et al. (2015) observe for example how OBA is used with different suppliers and sub-suppliers in the same and complimentary supply chains and thereby sensitises the buyer for cost differences among its suppliers. Buyers become accordingly interested in understanding the root causes of these differences and to transfer the most efficient production techniques between their suppliers. In addition, interconnections between different supply chains might become apparent through OBA and lead to new ideas on how economies of scale and scope might be created. Munday (1992) observes for example that customers of plastic injection moulders often specify the plastic grade, price and source company that these should use. On a similar note, Alenius et al. (2015) observes how OBA information sensitises the supermarket chain as buyer of white-label packaged pork meat cuts not only for its connections to the packaging provider, but also to slaughterhouses which supply the meat cuts. Moreover, the OBA calculation sensitises the supermarket chain for that some of the meat of a slaughtered pig cannot be used as meat cuts and therefore comes up as "waste" in the OBA calculation. The OBA calculation thus initiates a search for different alternative uses of these parts. The business partners finally settle for their use in white-label processed meat products manufactured by other suppliers.

Compared to standardised interfaces, less attention seems to be directed to interdependencies in logistics. Kajüter and Kulmala (2005) is the only study observing the exchange of information related to logistics (name and location of suppliers and sub-suppliers, distance and means of transport and transportation cost), but does not provide any information on how this information is actively referred to and used. Agndal and Nilsson (2009) observe that buyers might undertake supplier development programs with regards to logistics with their suppliers, but that "[t]he costing of the supplier apparently plays no major role in regard to this activity" (p. 96). An explanation for this might be that logistics costs are of lower relative importance and that buyers accordingly are primarily concerned about the vulnerability of their lean supply chains rather than their efficiency. Compared to standardised interfaces, buyers cannot swap suppliers as easily in specified interfaces. Problems in the supplier's extended supply network might thus impact the buyer quite drastically and, accordingly, become subject of proactive risk assessments.[7]

The literature observes also a range of concrete *decisions* that are facilitated by OBA in specified interfaces. To begin with, in specified interfaces, suppliers seem to be selected with reference to OBA information (Cooper and Yoshikawa, 1994, Kumra et al., 2012). Buyers seem to always contact several of their current, pre-qualified suppliers and asked them for tenders based on the specifications of particular new products. The focus on established suppliers is explained by the ability to directly build on and reap the benefits from prior resource adaptations and the understanding of each other's processes (Kumra et al., 2012). Based on the detailed cost disclosures and pre-negotiated overhead allocation rates and profit margins, competing tenders are evaluated and the final price is negotiated, usually in the form of cost-plus pricing.

Second, buyers, suppliers and sub-suppliers seem often to analyse the buyer's product specifications and form decisions about their adaptation. Given competitive pressure and the transparency through OBA, coming up with suggestions on how to improve the product specification is crucial for suppliers and sub-suppliers to secure their own profitability and long-term survival (Cooper and Yoshikawa, 1994, Cooper and Slagmulder, 1999a, 2004). As the buyer has finalised its specification to the largest degree, the room for changes is at the same time limited. Decisions mentioned in the literature relate to limiting the number of variants and subcomponents, increasing surface tolerances that do not impact the end product's functionality, changing the production technique and altering raw material choices (Cooper and Yoshikawa, 1994, Mouritsen et al., 2001, Cooper and Slagmulder, 2004, Alenius et al., 2015). Mouritsen et al. (2001) observe for example how a communication equipment firm decides to reduce the number of subcomponents used in its products from 15,000 to 5,000 based on OBA data illustrating the excessive costs connected to the high variety in subcomponents. As the buyer is the one specifying the product, she needs to

[7] Breakdowns of transport systems might for examples be caused by strikes by train drivers and weather incidences. These have in the past led to serious production standstills in the German automobile industry as car bodies, a type of specified component, are usually transported by train and could not be delivered on time by their suppliers, see for example Budras and Schwenn (2007) and Thomson Reuters (2013).

verify and approve any suggested changes by suppliers and sub-suppliers (Cooper and Yoshikawa, 1994, Cooper and Slagmulder, 1999a). As the benefits of changing product specifications might be divided inequitably across firms in supply chains, the buyer might also be involved in decision making about the distribution of benefits across different tiers of suppliers (Cooper and Yoshikawa, 1994).

Third, given the product design and supplier, decisions about investments into dies and other manufacturing facilities are taken. The buyer usually owns or at least finances dies, irrespective of whether they are produced by the supplier or a third party (Munday, 1992, Kumra et al., 2012).

Fourth, as products might be produced over larger time periods, OBA is drawn upon to make decisions about supplier changes and quantity and price adaptations. Cooper and Yoshikawa (1994) observe for example that the quantity of outsourced products might change over the product life cycle. In particular, they observe that during launch phases, the demand is often low and production might thus be outsourced to suppliers with specialised resources for low volume manufacturing. Later, when volumes increase, buyers might consider changing to other suppliers or in-house production in order to benefit from lower costs based on large scale automated production resources that the first group of suppliers does not have at its disposal. In addition, production quantities might differ compared to forecasts on which original cost and price calculations have been based. Buyers and suppliers might thus need to make decisions about how other partners should be compensated (Agndal and Nilsson, 2009, Alenius et al., 2015). Price changes might be negotiated in different ways. One way is to negotiate upfront as to how changes of raw material prices that suppliers are subject to should be reflected in the prices of intermediary products (Agndal and Nilsson, 2009, Alenius et al., 2015). In addition, general efficiency improvement rates might be negotiated according to which the prices for larger product portfolios are adapted annually (Cooper and Yoshikawa, 1994, Cooper and Slagmulder, 1999a, Agndal and Nilsson, 2009, Kumra et al., 2012). Setting such efficiency targets does not require the buyer to become engaged in the ongoing manufacturing processes of its suppliers as the achievement of these targets is delegated to those (Kumra et al., 2012). The definition of such targets is at the same time not unproblematic as it ignores efficiency improvements that might be created by the two partners together and thus lead to cost increases in the suppliers organisation followed by larger cost decreases at the buyer (Seal et al., 1999). As efficiency improvements are easiest to implement in early years of production, older products might also become unprofitable when certain rates are applied across products (Agndal and Nilsson, 2009). This might make it necessary to update cost information at regular times whereby the profit margin is reduced for the most profitable products and increased for the least profitable products, while profitability for the product portfolio remains constant (Kulmala, 2004). OBA might be used to facilitate such decisions. Otherwise, the risk might arise that the buyer makes decisions in its on-going product development based on "old" cost information (see also Kulmala, 2002). An alternative to general efficiency improvement rates is the negotiation of target achievement plans. In these, buyers and suppliers might for example specify the projects they want to undertake in order to reduce costs over a four year period (Kajüter and Kulmala, 2005).

Fifth, decisions might be made about changes in the wider and complimentary supply chains (Munday, 1992, Romano and Formentini, 2012, Kumra et al., 2012, Alenius et al., 2015). Munday (1992) observes for example that buyers centralise the purchasing needs of raw material from several of their suppliers and negotiate framework contracts. Alenius et al. (2015) observe how a supermarket chain negotiates its combined demand for pork meat cuts and branded meat products with slaughterhouses and explores possibilities to use pork meat that cannot be sold as meat cuts in the complimentary supply chain of processed meat.

3.2.1 Synthesis: Open Book Accounting in specified interfaces

Table 3 (page 53) summarises the discussion of OBA in specified interfaces, characterised by buyer-specific product designs and a connected need for more organisational coordination (Araujo et al., 1999, 2016). While differences in implementation naturally exist, a highly coherent picture of the design and use of OBA in these interfaces can be noted. The design can be characterised as broad in terms of both participants and data items. In specified interfaces, suppliers and several of their sub-suppliers in different tiers might be involved from the same, competing and complimentary supply

Table 3 Design and use of Open Book Accounting in specified interfaces

Design	**Use**
Participants: buyer, several competing suppliers and their sub-suppliers belonging to the same, similar or complimentary supply chains *Data items provided by suppliers and sub-suppliers to buyers:* Breakdowns of direct and indirect costs, information that aids understanding of cost breakdowns (intermediary product inventory, inventory turnover, adjustment times for machines, capacity utilisation of machines), die costs and other facility investments, general information (process quality, existing and expandable plant capacity, financial strength, reputation, delivery terms, distance and means of transport between suppliers and sub-suppliers) *Data items provided by buyers:* Feedback in the form of anonymised cost calculations from competitors, best practices on production processes, technologies and quality standards or the deployment of production engineers, technical exchange meetings, short- and medium order forecast information	*Direction of attention:* • Facility investments in the form of dies • Product specification • Cost changes over time • Cost differences between suppliers and sub-suppliers • Interfaces between suppliers and sub-suppliers that are part of same, similar or complementary supply chains and economies of scale and scope that might be created here • Vulnerability of supply chains *Facilitated decisions:* • Supplier selection • Smaller adaptations of product specifications • Investments into dies • Supplier, quantity and price changes over time • Design of similar and complimentary supply chains to create economies of scale and scope

chains. Manufacturing-related cost data is exchanged along with information on investments into dies, general information on the supply network further upstream and complimentary data that aids understanding. The detailed and broad data exchange directs the participants' attention to many, primarily manufacturing-related areas of interdependence and supports concrete decision making within these. The attention is for example directed to the specification of the product, potential cost changes over time, cost differences between suppliers and sub-suppliers, the possibility to create economies of scale and scope across similar and complimentary supply chains and the vulnerability of their supply chains to disruptions in logistics. The design and use of OBA in specified interfaces differs accordingly from that reported for standardised interfaces before.

3.3 Open Book Accounting in translation interfaces

In translation interfaces, the buyer specifies functional and interface requirements of the purchased product, but outsources its development *and* production to the supplier (see Chapter 2.3.3, Araujo et al., 1999, 2016). The supplier has accordingly more freedom to adapt the product to its own technical resources. Organisational resources are adapted to coordinate product development and production.

OBA in translation buyer-supplier interfaces has been the subject of several studies. When analysing these studies more closely, two groups of studies can be discerned, which differ as to whether they concern tangible products (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2008, 2009, 2010) or intangible services (Agndal and Nilsson, 2010, Kumra et al., 2012). The different designs and uses of OBA are described for each group next before a synthesis is provided.

3.3.1 Open Book Accounting in translation buyer-supplier interfaces with focus on tangible products

The first group of studies observes OBA in translation interfaces in which a tangible product is exchanged. Examples of products exchanged are individual components of engine cooling systems (Cooper and Slagmulder, 1999a, 1999b, 2004)[8], rubber and plastic subassemblies (Agndal and Nilsson, 2008), gearshift systems (Agndal and Nilsson, 2009), and other, not further specified complex automotive components (Agndal and Nilsson, 2010).

Design of Open Book Accounting in translation buyer-supplier interfaces with focus on tangible products

Buyers, suppliers and sub-suppliers are also identified as the *participants* of the OBA information exchange in this group of studies. At the same time, some differences emerge compared to specified interfaces. A first difference is that the number of parallel competing suppliers involved in OBA seems to be lower than in specified interfaces. One reason for this is that, due to the increased complexity of the product and the need to technically integrate resources relying on different technologies, a lower number of potent suppliers is observed in general (Cooper and Slagmulder, 1999a, 2004). A second reason is related to the benefits that accrue from continued relationships with the same business partner across several products and product generations. Such benefits accrue for example in terms of quality, cost and a reduced likelihood of delays when new products are developed based on the specification of prior products and their subcomponents (Agndal and Nilsson, 2008, 2009). Moreover, several intra-organisational units are involved in the exchange and the creation of interfaces among those takes time and resources to develop (Agndal and Nilsson, 2008, 2009, 2010, Cooper and Slagmulder, 1999a, 2004). Nevertheless, as the function might be realised with different resource combinations, buyers have an interest to compare *occasionally* the

[8] Cooper and Slagmulder (1999a, 1999b, 2004) describe the buyer-supplier interface between Komatsu, a Japanese manufacturer of construction equipment, and Toyo Radiator, a Japanese supplier of cooling systems. During their study, the interface through which the exchange is organised changes from a translation to an interactive interface, which is also connected to a corresponding change in OBA design. Accordingly, I refer to the case study in both interfaces, limited to the observations made during the respective time periods/interfaces.

technical designs and related costs from different competing suppliers. This is in particular the case when interface and functional requirements differ more drastically and the reuse of former component and subcomponent designs accordingly appears less useful (Agndal and Nilsson, 2008, 2009, 2010).

A second difference compared to specified interfaces seems to be that buyers are less involved in the relationships that suppliers entertain with sub-suppliers. Accordingly, the information that buyers exchange with suppliers and sub-suppliers differs and requires separate consideration.

Suppliers appear to provide their buyers with *data items* similar to those shared in specified interfaces. This includes cost breakdowns for the purchased products, necessary investments into dies and general information on their product development and manufacturing facilities and the structure of their supply chain. As in specified interfaces, the purchase price is also established in a cost plus manner with guaranteed profit margins (Agndal and Nilsson, 2008, 2009, 2010). At the same time, several differences with regard to the exchanged data elements can be noted.

Some differences concern the structure and information contained in the exchanged cost breakdowns (Agndal and Nilsson, 2008, 2009, 2010, Cooper and Slagmulder, 1999a, 2004). First, cost breakdowns appear to be organised around the different subcomponents combined within the product. As the product exchanged in translation interfaces might consist of subcomponents with different technical complexity (see for example Cooper and Slagmulder, 1999a, 1999b, 2004, and on multi-technology products in general for example Brusoni et al., 2001, Araujo et al., 2003), different profit margins might be applied for the subcomponents (Agndal and Nilsson, 2008). The applied profit margins appear at the same time generally higher than in specified interfaces in order to cover for product development and associated risks (Cooper and Slagmulder, 1999a, 2004). In addition, when subcomponents are re-used in other products, their known costs can be used as cost targets (Agndal and Nilsson, 2008, 2009).

Second, in contrast to specified interfaces, manufacturing-related costs are only occasionally detailed out, if related to particular product specification choices (Agndal and Nilsson, 2008, 2009). Otherwise, the supplier is seen as responsible for all related questions. Overhead costs are also allocated outside of OBA and only full costs are presented (Agndal and Nilsson, 2009).

Third, costs become detailed out throughout the buyer's product life cycle (Agndal and Nilsson, 2008, 2009, 2010). The buyer's product life cycle expands usually across several years during which volumes and raw material prices might change and efficiency improvements might become realised. Accordingly, suppliers seem to forecast their costs per year based on the buyer's volume forecasts and provide information on the sensitivity of their products to raw material price changes (Agndal and Nilsson, 2008, 2009). Compensations for quantity and raw material price changes are accordingly negotiated at the beginning of the supply relationship. In addition, as in specified interfaces, the buyer and supplier consider efficiency improvement rates. However, these rates appear to be adapted to both the year and the subcomponent level (Agndal and Nilsson, 2008). This is motivated by that most of the efficiency gains are realised during the first years of production of new product specifications while these are produced throughout longer time periods. "Old" subcomponents that are re-used might accordingly already have seen most of their efficiency gains being realised, making the negotiation of realistic efficiency improvement rates important (Agndal and Nilsson, 2008).

Fourth, the format in which cost breakdowns are presented seems to differ. On the one hand, as in specified interfaces, cost breakdowns seem to be also provided in a standardised format. On the other hand, these standardised forms seem to receive a new function and are complemented by cost calculations in a "hundred different ways" (Agndal and Nilsson, 2008, p. 159, see also Agndal and Nilsson, 2009). While suppliers might provide a preliminary product specification and cost breakdown early on, based on prior product and subcomponent exchanges and estimates, these are usually subject to fundamental changes. Adaptations of the product specification are considered in special purpose calculations and documented in the form of additions and subtractions in the original cost breakdown, which becomes a resource for justifying the specification should questions occur at later points in time.

Other differences are connected to additional data items being presented by the supplier. The supplier provides for example additional data elements on end customers' preferences and new technologies that become available for the products they supply the buyer with (Agndal and Nilsson, 2009, Cooper and Slagmulder, 1999a). As the supplier develops the product, he naturally has better insights into these matters than the buyer. In addition, the supplier might discuss different "translations" of functional and interface requirements in the form of conceptual studies before settling for a particular technical concept and detailing it out.

The structure and information provided by suppliers differ thus compared to specified interfaces. Information is organised around subcomponents, does not encompass detailed manufacturing-related cost information, is forecasted for several years in advance and presented in many different ways. In addition, suppliers might provide additional information on customer preferences and new product technologies and provide insights into different technical concepts and related costs in translation interfaces.

As in specified interfaces, *buyers* provide suppliers with cost targets for the purchased products and feedback on the information these supply. Some differences can, however, be observed with regard to these data items, too. First, the supplier seems to influence cost targets to a great degree. The buyer might for example base the cost information in requests for tenders on information received from the supplier before or on prior products' cost breakdowns supplied by the supplier (Agndal and Nilsson, 2008, 2009). Second, while feedback might be provided in the form of reference values, suggestions for improvement and alternative suppliers (Agndal and Nilsson, 2010) or the deployment of supplier development teams (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2008, 2009, 2010) as in specified interfaces, additional information in the form of weekly supplier performance metrics seem to be exchanged and follow-up reports demanded. In addition and in contrast to specified interfaces, buyers do not provide specific suppliers with cost information obtained from competing suppliers (Agndal and Nilsson, 2010). This is motivated by that product designs and manufacturing facilities differ to a larger extent and are more difficult to compare with each other (Agndal and Nilsson, 2008, 2009, 2010). In addition, buyers seem to fear a negative influence on trust and future collaboration if they conveyed such data (Cooper and Slagmulder, 2004, Agndal and Nilsson, 2010).

Moreover, buyers seem to provide their suppliers with additional information related to their long-term end product development plans (Cooper and Slagmulder, 1999a, 2004), concrete upcoming development projects (Cooper and Slagmulder, 1999a, 2004, Agndal and Nilsson, 2008, 2009) and long-term sales forecasts (Agndal and Nilsson, 2008, 2009, 2010). Cooper and Slagmulder (1999a, 2004) observe for example how the construction equipment supplier Komatsu informs its supplier for engine cooling equipment on the plan to increase the engine capacity of its future products several years ahead of time. In addition, Agndal and Nilsson (2008) observe that the buyer and the supplier meet formally three to six times over a period of two months to discuss technical concepts for new products and their cost consequences already before an official invitation to tender is issued. Buyers seem to provide their suppliers also with sales forecasts across the product life cycle of new products so that the supplier in turn can provide its detailed cost breakdowns (Agndal and Nilsson, 2008, 2009, 2010).

As suppliers might purchase raw materials and outsource the production of certain parts, *sub-suppliers* might also become involved in OBA in translation interfaces (Agndal and Nilsson, 2008, 2009). Agndal and Nilsson (2009) observe that sub-suppliers might share cost information related to raw materials and investments into tools as *data items* with suppliers and buyers. At the same time, no information on individual manufacturing processes and related costs is shared. Prior contributions do not provide any details as to the information that sub-suppliers receive from buyers and/or suppliers.

Use of Open Book Accounting in translation buyer-supplier interfaces with focus on tangible products

The OBA design in translation interfaces differs thus from that in specified interfaces in some important points. This leaves also its imprint on the use of OBA. In translation interfaces, similar to specified interfaces, *attention is directed* to questions related to product specification, volume and cost changes that might arise over time and the vulnerability of the supply network. The nature of the related questions differs, however, in important aspects.

First, in translation interfaces, OBA draws the attention of buyers and suppliers to that the purchased function can potentially be accomplished by different resource combinations (Agndal and Nilsson, 2008, 2009, 2010). While different suppliers might only occasionally be asked to compete for particular orders, an important use of OBA in these instances is that it sensitises the buyer to differences in suggested resource combinations and related costs. Agndal and Nilsson (2008) observe that already very small differences, e.g. in the choice of material, can lead to large cost differences and that these differences might remain undetected without OBA. In addition, in translation interfaces, both product specification and related costs are likely to change dramatically during product development (Agndal and Nilsson, 2008, 2009, 2010). OBA makes it possible for buyers and suppliers to commit to overarching cost targets already when developing the basic technical concept, while allowing for some flexibility in how these might be achieved in the final product specification. In this way, attention is also directed to further cost reductions in the ensuing product development process. This contrasts to specified interfaces, where the OBA sensitises buyers and suppliers mostly to how the buyer's existing design can be improved in terms of its manufacturability with some limited adaptations.

Second, OBA seems to also direct more attention to the impact of volume and raw material price changes as well as possible efficiency gains (Agndal and Nilsson, 2008, 2009). In translation interfaces, the supplier usually owns the product specifications and the buyer's possibility to change supplier or take production back in-house is accordingly limited. Much focus lies thus on *pro-actively* finding solutions on how the interdependencies arising over the whole life cycle of the end buyer's product can be managed. Long-term volume forecasts, sensitivity tests and discussions about efficiency improvement rates support such a focus.

Third, OBA directs also attention to the business partner's vulnerability not only in production, but also in product development. Agndal and Nilsson (2010) observe for example that changing suppliers in on-going product development projects can be very costly and risk-filled. The buyer therefore asks suppliers to not only provide data on their resources and policies related to manufacturing, but also a specification of all costs connected to new product development projects. In that way, it attempts to sensitise itself and the supplier to the involved risks in product development and manufacturing and to manage those in a pro-active manner.

Moreover, compared to specified interfaces, less focus seems to be directed to generating synergies within similar and complimentary supply chains in translation interfaces (Agndal and Nilsson, 2008, 2009, 2010, Cooper and Slagmulder, 1999a, 2004). Buyers appear to be involved in discussions about raw material choices and some other product specification-related issues, but the choice of business partners and cost-related issues seem to be taken by the supplier with its sub-supplier without the involvement of the buyer.

A new area to which attention is directed is the coordination of future product concepts and larger investments into product development and manufacturing resources that go beyond those into dies. With the help of OBA, the supplier communicates the particular knowledge she possesses on the buyer's end customers' preferences with regards to its component and new resource combinations and technologies that might become available. The buyer benefits from these insights as she can include these in the concept of future end products and functional and interface requirements for its externally procured components (Agndal and Nilsson, 2009). Reversely, the buyer might sensitise the supplier to adaptations of its end products and needs for adapted product development and manufacturing resources. Cooper and Slagmulder (1999a, 1999b, 2004) note for example how a manufacturer of construction equipment informs its supplier on that it requires engine cooling systems with much increased capacity, but the same cost over its next product models. Based on the information, the supplier dedicates product development resources to making this possible. Agndal and Nilsson (2009) observe that the supplier likewise values insights on future needs with regard to manufacturing-related resources.

OBA does not only direct the attention of buyers and suppliers into these areas, but also helps them to form specific *decisions* (see, in particular, Agndal and Nilsson, 2008, 2010). Several alternatives might for example be considered and decisions made with the help of OBA information when suppliers are selected. In translation interfaces, decision making with regard to supplier selection occurs at the same time less frequently than in specified interfaces where it might be done with each purchase of a new component. Such comparisons occur in particular when different resource combinations, which all might solve the functional requirements, are occasionally evaluated or the component specification differs more significantly, making the reuse of prior used specifications less useful. Concrete decisions include whether the product should be based on old subcomponents or on completely new specifications, whether alternative suppliers and their technical concepts should be included and which supplier and basic concept should be chosen (Agndal and Nilsson, 2008, 2009). In addition, applicable profit margins for different subcomponents are negotiated, based on which the price is calculated later on (Agndal and Nilsson, 2008, 2009, 2010).

Furthermore, several decisions are supported by OBA during product development (Agndal and Nilsson, 2008, 2009, 2010). To begin with, the buyer and supplier agree on a basic technical concept and a related cost platform to which they commit themselves. The buyer concretises the product specification independently and presents design alternatives and related costs to the buyer at meetings so that joint decisions can be made. In addition, decisions are made with regard to the investment into dies and manufacturing processes. The final price, based on the cost and negotiated profit margins, and potential price adjustment clauses are also agreed upon.

Another area in which decision making is supported are changes that might occur over time (Cooper and Slagmulder, 1999a, 2004, Agndal and Nilsson, 2008, 2009, 2010). These might include price revisions due to quantity and raw material price changes. In addition, suppliers might re-negotiate prices if they cannot meet pre-negotiated efficiency improvement rates with the help of OBA (Agndal and Nilsson, 2008). The buyer and supplier might also evaluate the consequences of and decide upon the change of location of certain resources and connected activities, additional investments into facilities and product redesigns that require the involvement of both partners (Agndal and Nilsson, 2008, 2009, 2010).

A final area is connected to decision making with regards to long-term investments in product development and facilities (Agndal and Nilsson, 2009, Cooper and Slagmulder, 1999a, 1999b, 2004). Based on the information received from buyers, suppliers might adapt their product development plans and investment decisions into facilities (Agndal and Nilsson, 2009, Cooper and Slagmulder, 1999a, 2004). In addition, buyers might make decisions about new features of their products and externally purchased components (Agndal and Nilsson, 2009).

3.3.2 Open Book Accounting in translation buyer-supplier interfaces with focus on intangible services

Two studies observe OBA in interfaces in which services rather than tangible products are exchanged. Agndal and Nilsson (2010) discuss the purchase of network maintenance services by a multinational telecom provider and Kumra et al. (2012) discuss the subcontracting of IT services by an Indian IT company. Buyer-supplier interfaces related to the exchange of intangible services share some similarities with purchasing of tangible products through translation interfaces. For example, the purchasing of such intangible services usually includes the definition of a problem and interfaces with existing resource interfaces (e.g. data centres, databases, computer applications) by the buyer. Suppliers might receive some freedom of how they translate these requirements and might offer different technical solutions (Agndal and Nilsson, 2010, Kumra et al., 2012). While tangible components, such as network components (Agndal and Nilsson, 2010), might sometimes also be exchanged, they play a minor role. This appears to leave its imprint on the design and use of OBA as observed by the two studies.

Design of Open Book Accounting in translation buyer-supplier interfaces with focus on intangible services

The buyer and several of its suppliers constitute the *participants* of the OBA exchange in the two reviewed studies (Agndal and Nilsson, 2010, Kumra et al., 2012). Invitations to tender are usually distributed to several competing suppliers with which framework agreements might exist (Agndal and Nilsson, 2010). No sub-suppliers are considered.

Suppliers are expected to provide buyers with a breakdown of man hours per project stage (e.g. pre-study, platform development, testing,), monthly salaries or hourly wages and competence levels of involved employees, overhead costs and profit margin as data items (Agndal and Nilsson, 2010, Kumra et al., 2012). In addition, general data concerning supplier's resources and strategies might be collected (Agndal and Nilsson, 2010). In case the exchange includes also a tangible product, such as a network component, the buyer does not require detailed cost breakdowns for these components. However, it might require extensive technical documentation in order to be able to buy connected services from other suppliers in the future (Agndal and Nilsson, 2010).

Buyers appear to generally not provide any data items to their suppliers. Only in rare cases, when suppliers do not provide any cost information themselves, they might confront these with price indices collected from offers of competing suppliers (Agndal and Nilsson, 2010). By reacting to this price information, suppliers naturally reveal most of their cost structures. According to Kumra et al. (2012), the buyer might in very rare cases also consider the transfer of some knowledge related to the production of IT services to suppliers.

Use of Open Book Accounting in translation buyer-supplier interfaces with focus on intangible services

This OBA design seems to *direct attention* to several issues. First, differences in complex service offers become visible as these are split up in their different parts and compared (Agndal and Nilsson, 2010, Kumra et al., 2012). To this end, Kumra et al. (2012) note also that buyers use the competence level of the supplier's employees as an indicator of the quality of the provided services. Offers from different suppliers can accordingly be compared with each other (Agndal and Nilsson, 2010, Kumra et al., 2012) as well as with the cost of similar internally produced services (Kumra et al., 2012). Second, potential mistakes in tender documents that might lead to delays at later project stages become visible (Agndal and Nilsson, 2010). Third, extensive documentation highlights the need to take into account that the produced services might need to be comprehended and adapted by other suppliers at later point in times (Agndal and Nilsson, 2010). The studies do not contain any information as to whether the data is also referred to during the provision of the intangible services or when conducting ex post evaluations. Accordingly, the *decision facilitating* use is also limited to supplier selection and price negotiation (Agndal and Nilsson, 2010, Kumra et al., 2012).

3.3.3 Synthesis: Open Book Accounting in translation interfaces

Table 4 (p. 65) summarises the discussion of OBA in translation interfaces. The two designs share similarities in that sub-suppliers are involved to a

Table 4 Design and use of Open Book Accounting in translation interfaces

Kind of product	Design	Use
Tangible product	*Participants:* Buyer, (sometimes several competing) supplier(s), sub-suppliers *Data items provided by suppliers:* cost break-downs by subcomponent and across life cycle of buyer's end product, investment needs into dies, general information on product development and manufacturing facilities and structure of supply chain, preferences of buyer's end customers and new resource combinations/technologies that have become available, different resource combinations that might fulfil the function *Data items provided by buyers:* cost targets for component and its subcomponents, feedback (reference values, supplier development teams), supplier performance metrics, long-term product development plans, volume forecasts *Data items provided by sub-suppliers to buyers:* cost information related to raw materials and dies/tools	*Direction of attention:* • Different possible product specifications and related costs • Cost and quantity changes over time • Efficiency improvements over time • Risks in product development and manufacturing • Coordination of investment into product development and manufacturing resources *Facilitated decisions:* • Supplier selection: whether product should be based on old or completely new specifications, whether to include different suppliers, which suppliers to choose; applicable profit margins • Product development: basic technical concept and cost platform, adaptations of the specification, investments into dies, manufacturing processes, price • Price revisions, transfer of resources between business partners, changes in facilities, product redesigns • Decisions about long-term investments in product development and manufacturing facilities

Ex-changed product	**Design**	**Use**
Intangible services	*Participants:* Buyer, several competing suppliers *Data items provided by suppliers:* man-hours per part of the project, salaries and competence level of involved employees, overhead costs, profit margin, some general information on resources, strategies, documentation of tangible components if part of the exchange *Data items provided by buyers:* confront buyers in very rare cases with price indices and transfer knowledge	*Direction of attention:* • Differences in provided services and related costs • Detection of mistakes in tenders • Need to adapt services at later point in time *Facilitated decisions:* • Supplier selection & price negotiation

lower degree and that complex offers are unbundled into their different components and related costs. The information that is exchanged differs, however, depending on whether the focus lies on tangible products or on intangible services. In the case of tangible product exchanges, costs are broken down per physical subcomponents and a large number of additional data items are required. In the case of intangible products, mostly labour costs arise. These are accordingly broken down by the qualification level of the involved staff and the project stage.

Similarities and differences exist also with regard to the use of OBA in the two cases. Enabling comparability between the resource combinations and their related costs, offered by different suppliers to solve functional and interface requirements is noted in both cases. Differences exist however with regard to the use of OBA over time. In the case of tangible components, interdependence over long time periods appears to be inescapable. In consequence, the focus lies on managing cost and volume changes, managing proactively potential risks in product development and manufacturing and aligning investments into long-term product development and manufacturing resources. In the case of intangible services, firms seem rather to try to avoid long-term interdependence by documenting the executed work so that it can be comprehended and reproduced by other service providers in the future. Future research might need to clarify which role OBA information exchanges can play in long-term IT projects, in particular during the provision of intangible services and follow-up evaluations.

3.4 Open Book Accounting in interactive buyer-supplier interfaces

Interactive buyer-supplier interfaces are characterised by an open-ended dialogue as part of which business partners might discuss considerable adaptations of their technical and organisational resources to each other (see Chapter 2.3.3). Product specifications are for example jointly established rather than "dictated" by the buyer, as a result of which larger adaptations of facilities might also become necessary. Organisational resources are adapted to significant degrees to coordinate the exchange.

Considerably fewer studies have considered OBA in interactive buyer-supplier interfaces. Cooper and Slagmulder (1999a, 1999b, 2004) study the relationship between the construction equipment manufacturer Komatsu and its supplier of engine cooling systems, Toyo Radiator.[9] Agndal and Nilsson (2009) studies the relationship between a vehicle producer and a manufacturer of load carrier systems. Overall, the two studies provide a coherent picture of OBA in interactive buyer-supplier interfaces.

Design of Open Book Accounting in interactive buyer-supplier interfaces

Both case studies observe OBA only in the relationship between the buyer and the supplier as *participants* (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2009). Accordingly, competing suppliers and buyers and sub-suppliers are not included in the OBA design. Competing suppliers seem to be almost never involved, irrespective of whether similar or different product and subcomponent specifications are used for new products. As in translation interfaces, this can be explained by adaptations of organisational and technical resources, which lead to interdependence and complicate potential switches of business partners. Additional reasons are connected to the further increase in purchasing level on the side of the buyer. Cooper and Slagmulder (1999a, 1999b, 2004) note for example how the buyer outsources the production of the whole engine cooling system via interactive interfaces. Before, it had only bought individual components and integrated these itself in engine cooling systems. The higher purchasing level makes it possible for the supplier to innovate by altering the order of the included components and excluding a motor and fan. The larger purchasing level reduces at the same time the number of potent alternative suppliers. Comparisons with other suppliers become also less relevant as the focus is on creating "unique", "new" resource combinations (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2009, see also Araujo et al., 2016). This contrasts with translation interfaces where the buyer mainly "follows" the supplier's devel-

[9] Cooper and Slagmulder (1999a, 1999b, 2004) have published some book chapters (1999a), a case study (1999b) and a paper (2004) on their observations from the relationship between Komatsu and Toyo Radiator. As the publications partially differ in the depth of information provided, they are analysed together.

opment efforts and needs to ensure that it uses the best resource combination to provide the required function by comparing suppliers. Contacts the supplier might have to other, competing buyers might accordingly also be problematized in interactive interfaces. Cooper and Slagmulder (1999a, 1999b, 2004) observe that the supplier is leading in its field and sells to competitors of the buyer, too. However, product specifications and simulation software developed in interaction with the buyer are considered as proprietary to the relationship. The supplier is accordingly not allowed to reapply these resources in engine cooling systems supplied to competitors.

The buyer and supplier might *talk about* sub-suppliers, compare the cost of articles purchased from them with similar products purchased by the respective other party and consider joint purchasing with regard to standardised products, such as bolts (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2009). However, sub-suppliers themselves appear not to be actively involved in OBA.

As in translation interfaces, the *supplier* appears to provide information on costs, profit margins, necessary investments, the product's sensitivity to volume and raw material price changes, assumed general efficiency improvement rates, customer preferences and new resource combinations available for the component as *data items*. As in translation interfaces, cost information is provided formally at stage gate meetings, but calculated in many different forms during product development (Agndal and Nilsson, 2009). Likewise, detailed manufacturing-related data is only provided if directly connected to changes in product specification (Agndal and Nilsson, 2009). No information on how overhead costs are allocated is provided in the reviewed case studies. A major difference compared to specified and translation interfaces is also that, despite the availability of actual cost information, the final price is not established in a cost plus manner (Cooper and Slagmulder, 1999a, 1999b, 2004). Rather, it is set based on the initial cost target negotiated between the buyer and supplier, adjusted for potential changes in product specification that are decided upon during product development. Even if, based on exchanged cost breakdowns, the supplier's profits are known to be high, prices are not adapted to reduce the supplier's margin.

As in translation interfaces, the *buyer* provides its supplier with cost targets and feedback on product specifications and related costs, including suggestions of potentially cheaper suppliers, in particular for standardised products (Cooper and Slagmulder, 1999a, 1999b, 2004). It also discusses its own long-term product portfolio plan with the supplier. At the same time, some major differences with regard to the provided information can be noted. First, cost targets are not established on the subcomponent level, but only at the level of the purchased component (Cooper and Slagmulder, 1999a, 1999b, 2004). Cooper and Slagmulder (1999b) illustrate how the buyer establishes these component-level cost targets by collecting information on its end customer preferences regarding engine power and preparedness to pay. Based on this information, it draws conclusions about the required engine cooling capacity. As engine cooling capacity is correlated with radiator size as the main performance and cost driver, it establishes the required radiator size. In a next step, it tabulates all radiators it currently purchases and their connected prices and establishes a linear correlation between the three most efficient radiator designs. Based on these correlations, it sets the cost target for the desired radiator size. This cost target is then provided to the supplier. As a consequence of using such cost targets bundled on the component-level, the buyer also loses its ability to set sub-component cost targets over time (Cooper and Slagmulder, 1999a, 1999b).

An additional major difference compared to translation interfaces is that the buyer provides the supplier with drawings on its own end product, in particular with regard to the parts interfacing the purchased product (Cooper and Slagmulder, 1999a, 1999b, 2004). Furthermore, the buyer provides the supplier with prototypes of its products, lends testing equipment to the supplier and explains its testing procedures (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2009).

Use of Open Book Accounting in interactive buyer-supplier interfaces

As in translation interfaces, OBA helps to *direct the attention* to product development, efficiency improvements, cost and quantity adjustments over time, long-term resource plans and the vulnerability of the supply chain. Manufacturing-related questions are also less of a concern, as in translation interfaces. At the same time, some differences can be noted.

First, a shift in attention from reapplying prior product and subcomponent specifications to considering larger adaptations of resource combinations can be noted. This shift is aligned by interacting with one instead of several competing suppliers and further supported by the move from sub-component-level to component-level cost targets, longer time intervals during which product development and connected information exchanges are carried out and the exchange of testing equipment and information on testing procedures. The shift from sub-component to component-level cost targets enables for example more radical changes in the resource combination, such as the elimination or integration of individual subcomponents or the balancing of cost increases connected to certain subcomponents by decreasing the cost of other subcomponents. A detailed illustration of this is provided for the interface between Komatsu and Toyo Radiator by Cooper and Slagmulder (1999b). For example, by changing the placement of the condenser and radiator in the engine cooling system, one fan and motor can be eliminated by Toyo Radiator. A fan pushing the air horizontally is also exchanged with a newly designed mixed-flow fan that pushed air sideways around the engine, thereby achieving a higher cooling capacity. In addition, a new system to control heat generation is developed and certain parts are redesigned to reduce their manufacturing cost and increase parts commonality across the buyer's end products. The time period of individual development projects is also increased. Load carrier systems are for example jointly developed over a time period of three years (Agndal and Nilsson, 2009) and engine cooling systems over a period of five years (Cooper and Slagmulder, 1999a, 1999b, 2004). As product specifications might change more drastically, testing becomes important. These tests are carried out by the supplier on testing equipment and prototypes borrowed from the buyer and specialised computer-based simulations as the component is developed (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2009).

Second, the early and open-ended exchange of drawings and other technical information on the buyer's end product directs also attention to how the interface between the component and the end product can be improved.

An example is the development of a different mounting approach for engine cooling equipment developed for all of Komatsu's products (Cooper and Slagmulder, 1999b).

Third, additional attention is directed to the risk of incompatible designs by the buyer and supplier that might arise as a result of simultaneous engineering. Engineers work accordingly co-located and directly analyse the influence of potential changes of the product and the component on each other. In addition, simultaneous rather than sequential testing reduces the risks connected to the larger changes in resource combinations (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2009).

Fourth, while cost information appears not to be used for cost plus pricing, it creates attention for the ability to find synergies in purchasing, in particular with regard to standardised sub-components (Cooper and Slagmulder, 2004).

In interactive interfaces, OBA facilitates also *decision making* in several areas. As in translation interfaces, the main focus lies on decision making during product development, including potential investments into manufacturing facilities, such as dies. As in translation interfaces, decision making with regard to the transfer and adaptation of manufacturing resources and product re-designs might also occasionally be supported. In addition, OBA facilitates decision making with regard to price revisions and the long-term alignment of investments into product development and manufacturing resources. At the same time, some important differences can be noted.

One difference is that decision making with regard to supplier selection becomes less relevant. Moreover, the price of the exchanged product is not decided upon by cost-plus pricing. The price is instead a consequence of the cost target that is set by the buyer independently of the supplier's cost information. Accordingly, profit margins for different kinds of sub-components are also not explicitly negotiated in interactive interfaces (Cooper and Slagmulder, 1999a, 1999b, 2004).

Other major differences can be noted with regard to decision making during product development. Functional and interface requirements are for example established together by the buyer and supplier (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2009). This contrasts to translation interfaces, where this decision is formed independently by the buyer before any suppliers are contacted. In addition, decision-making is frequent and not compressed to formal meetings where different technical solutions and their related costs are presented. In addition, larger investments that have no value outside of the relationship might be conducted to a larger degree. Cooper and Slagmulder (2004) observes for example that the supplier needs to invest more frequently into its manufacturing facilities to produce the unique product designs and invests into a specific software to model the cooling of the buyer's engines.

3.4.1 Synthesis: Open Book Accounting in interactive buyer-supplier interfaces

Table 5 (p. 74) summarises the observed design and use of OBA in interactive interfaces. These interfaces build on an open-ended dialogue in which buyers and suppliers combine their resources to each other (Araujo et al., 1999, 2016). This provides opportunities for larger adaptations of the buyer's *and* supplier's resources to each other, but puts also particular demands on the OBA design. As it is difficult to develop deep interfaces with many firms, a limitation of the participants in OBA to the buyer and supplier can for example be noted. In contrast to subcomponent-level cost targets, the buyer provides only component-level cost targets, based on which also the price is established. Moreover, the buyer shares information on the specification of its product and its interface with the purchased component and information on its testing procedures. Prototypes and testing equipment might also be shared by the buyer and some of the supplier's engineers work co-located with the buyer's engineers.

Table 5 Design and use of Open Book Accounting in interactive interfaces

Design	Use
Participants: Buyer, supplier (competing suppliers are almost never observed, relationships to competing buyers might be problematized) *Data items provided by suppliers:* cost breakdowns, including earned profit margin, necessary investments, product's sensitivity to volume and raw material price changes, assumed general efficiency improvement rates, customer preferences, preferences of buyer's end customers and new resource combinations/technologies that have become available, different resource combinations that might fulfil the function; ideas on how to improve the buyer's product and interface with the supplier's component, the price is set based on buyer's cost targets, not based on cost-plus pricing, information on cost of standardised components sourced from sub-suppliers *Data items provided by buyers:* cost target for component, feedback (incl. suggestions of cheaper suppliers for standardised products), long-term product portfolio plan, drawings on own end product and parts interfacing the externally purchased part, prototypes, test equipment, information on testing procedures	*Direction of attention:* • Different possible product specifications and related costs, with focus on larger resource adaptations of resource combinations, also including changes of the buyer's product • Cost and quantity changes over time • Efficiency improvements over time • Risks in product development and manufacturing, incl. risk of incompatible designs during parallel engineering • Coordination of investment into product development and manufacturing facilities • Synergies in purchasing of standardised components *Facilitated decisions:* • Product development: technical and interface requirements, different designs and related costs, investments into dies and other, larger investments into product development and manufacturing facilities • Price revisions, transfer of resources between business partners, changes in facilities, product re-designs • Decisions about long-term investments in product development and manufacturing facilities • Synergies in purchasing, in particular with regard to standardised products, such as bolts

3.5 Problematization of prior research and refined research questions

3.5.1 Problematization of prior research

As part of the literature review, large differences in the design and use of OBA could be observed *across* standardised (p. 42), specified (p. 53), translation (p. 65) and interactive (p. 74) buyer-supplier interfaces. At the same time, a rather coherent picture of the design and use of OBA could be found *within* the respective interfaces. As outlined throughout the chapter, differences in implementation do nevertheless also exist within each interface as buyers and suppliers implement their own modified versions of OBA in specific interfaces.

The literature review has also substantiated the observed gap of studies on OBA in interfaces where significant interdependencies arise during the use and maintenance of the exchanged products, such as in capital equipment sales. Capital equipment sales are associated with particular interdependencies that arise as the equipment is used over extended periods and requires maintenance with spare parts and other resources (see Chapter 2.3.4). While prior literature (see for example Fabrycky and Blanchard, 1991, Hofmann et al., 2012) provides normative arguments for suppliers and buyers of capital equipment to base decision making on Life Cycle Cost calculations and outline their calculation, no prior study has been found that explicitly studies how such LCC calculations are designed and used between business partners in practice. Moreover, such financial calculations might also only be one part of the overall OBA information exchange between buyers and suppliers. The latter might also encompass several other kinds of financial and nonfinancial information that business partners share to manage their specific product- and maintenance-related interdependencies with each other.

3.5.2 Refined research questions

In line with this substantiated gap and the derived analytical framework, the research questions for the empirical study of this thesis can be refined.

- First, how do the specific resource interdependencies in capital equipment sales impact the design of OBA in terms of the participants of the information exchange and the shared data items?

- Second, how is the OBA information used in capital equipment sales? In particular, to which areas does it direct attention and which decisions does it support?

While these questions are directed at extending theory on OBA to capital equipment sales, some additional general aspects of OBA might naturally also be discovered as part of the empirical study (Keating, 1995, Dubois and Gadde, 2014).

Chapter 4

Research methods

The aim of this chapter is to describe the research methods applied in the study on Open Book Accounting (OBA) in capital equipment sales. The chapter starts off with a discussion of the philosophical premises of the thesis. In the subsequent subchapters, the research design, the data collection and the data analysis methods are presented and their alignment with the outlined philosophical premises is discussed.

4.1 Philosophical premises of the thesis

Authors of methods texts in both accounting (see e.g. Hägg and Hedlund, 1979, Hopper and Powell, 1985, Otley and Berry, 1994) and industrial networks (see e.g. Easton, 1995, Järvensivu and Törnroos, 2010) have argued that the adequacy of the applied research methods depends on the philosophical premises that underlie the specific research project. A useful starting point for discussing the philosophical position of this study is provided by Burrell and Morgan's (1979) widely adopted framework. They argue that scholars implicitly or explicitly make assumptions along four interrelated dimensions: ontology, epistemology, human nature and methodology.[10] They present each dimension in the form of a continuum, the outer positions of

[10] Morgan and Burrell (1979) discuss also different assumptions about the nature of society and, thus, make a distinction between the sociology of regulation focused on social order and equilibrium and the sociology of radical change. These differences in assumption are not discussed here.

which they integrate into an objectivist and a subjectivist approach to social science (see also Morgan and Smircich, 1980, Easton, 1995). Across all four dimensions, the present study is located in the middle of the two extreme positions.[11]

4.1.1 Ontology

Ontology refers to the nature of the phenomenon under investigation (Burrell and Morgan, 1979). For objectivists, the social world is made up of hard, tangible structures and exists independent and prior to its appreciation by the observer. Subjectivists, in contrast, argue that reality is a product of our consciousness and accordingly does not exist independently of it.

Taking a position in between these two extremes, it is emphasised that certain structures exist independent from us as observers; these are, however, at the same time inherently difficult to capture, in particular as they are interwoven in the form of complex networks and subject to constant change. Some parts of these structures, such as products and facilities, take also "harder" forms and are easier to grasp than social objects, such as "business units" and "relationships". In our scholarly understanding of these complex structures, we are guided by prior theory, which, in consequence, introduces some subjectivity in our perception. The thesis draws on the resource layer of the industrial network approach, which is one particular theoretical lens. This research perspective highlights certain aspects of these complex structures and side-lines others. The same applies with the other concepts of the analytical framework, which distinguishes between the design (participants, data items) and (attention directing and decision facilitating) use of OBA. Our perception of existing structures is accordingly shaped by others' prior explanations of these structures and remains necessarily partial. Likewise, the thesis might also have a performative impact on its readers. As certain aspects

[11] Similar positions have been adopted by prior scholars drawing on the industrial network approach. Easton (1995, 1998, 2002, 2010) and Holmen (2001) have for example more specifically discussed how scholars might apply critical realism as methodology (Bhaskar, 1975, Sayer, 1992; see also Modell, 2017a, 2017b, on critical realism in accounting studies). Järvensivu and Törnroos (2010) consider also critical realism in industrial network studies compare it with moderate constructionism. The focus of this subchapter lies on my personal reflections and not on describing any specific methodology as such.

of the observed structures are described, these might become more prevalent and be enacted compared to other aspects.

4.1.2 Epistemology

Epistemology refers to whether and how knowledge can be acquired (Burrell and Morgan, 1979). Objectivists argue that it is possible to explain and predict what happens in the social world by studying regularities and causal relationships between its constituent elements. Knowledge creation is a cumulative process by which new insights are added and disconfirmed hypotheses eliminated. As knowledge is hard and real, it can easily be transmitted. Subjectivists, in contrast, reject the search for regularities and objective knowledge. They argue that the social world is relative and as such can only be understood from the point of view of those directly involved in the activities that are to be studied.

In terms of epistemology, the thesis adopts also a position in between these two extremes. In particular, it is believed that the inherent complexity and constant change of social structures make it difficult, if not impossible, to form predictions. Some individual resources might for example be combined and then lead to certain consequences; when combined with other resources, the outcome might be a different one (see for example Håkansson and Waluszewski, 2002). Similarly, as other alternative resource combinations might become available over time, certain resource combinations might cease their function and lose their central position in the network. What is seen as knowledge changes accordingly not only as we might understand additional aspects of these "objective" structures, but also as these structures themselves change over time. Knowledge can accordingly primarily be gained on the structures that are at work at certain points of time. Due to the inherent complexity, the gained knowledge might take the form of specific, "best" explanations while other, unobserved forces might equally be at work. This perspective on knowledge does at the same time not preclude the linking of the results of this study with observations made by other scholars in other settings. In contrast, by comparing deep probing studies, we might receive a better understanding of existing structures and how these might change over time.

4.1.3 Human nature

Human nature refers to the relation between human beings and their environment (Burrell and Morgan, 1979). While objectivists argue that the behaviour of individuals is conditioned by existing structures, subjectivists highlight the free will and autonomy of individuals.

Taking again a viewpoint between these extremes, it is acknowledged that existing structures change themselves over time and both limit and enable change. As resources for example share interfaces with certain other resources, they are more difficult to change in certain circumstances (see e.g. Gadde and Snehota, 2000). At the same time, as we become aware of these interfaces, it becomes possible to form new interfaces. In this process, existing structures might have an enabling function (Håkansson and Snehota, 1995).

4.1.4 Methodology

Methodology refers to the way in which one might understand and create knowledge of the social world (Burrell and Morgan, 1979, Ahrens and Chapman, 2006). Scholars believing in an objective, stable world attempt to derive universal concepts and relationships and aim to measure those. They draw thereby primarily on deduction (Järvensivu and Törnroos, 2010); they derive hypotheses and then collect data to test them (see e.g. Eisenhardt, 1989, Eisenhardt and Graebner, 2007, Yin, 2014). Subjectivists, in turn, are rather occupied with understanding how individuals subjectively experience and interpret the social world. They draw thereby primarily on induction (Järvensivu and Törnroos, 2010). Data collection takes place before data analysis and theorisation (Glaser and Strauss, 1967).

In line with its positioning in between these extremes, the thesis builds on an abductive, qualitative research approach (see also Ahrens and Chapman, 2006, Lukka and Modell, 2010, Easton, 2010). In abduction, theoretical framework, empirical fieldwork and case analysis evolve simultaneously rather than sequentially. Abductive research is accordingly characterised by a flexible use of theory across all phases of the research process and an emerging definition of the study object, the case (Ahrens and

Dent, 1998, Dubois and Gadde, 2002, 2014, Dubois and Araujo, 2004). Scholars drawing on abduction view a broad knowledge of different theories as beneficial as it sensitises them to different aspects of the empirical case and alternative explanations they might otherwise miss (Alvesson and Sandberg, 2011, Alvesson and Kärreman, 2007, 2011). The boundaries of the case emerge usually over the course of abductive research projects as new empirical insights are gained and different theoretical explanations are considered (Ahrens and Dent, 1998, Dubois and Gadde, 2002, Dubois and Araujo, 2004).

4.2 Case study design

4.2.1 Main case

In line with the study's ambition to contribute with a detailed understanding of OBA in capital equipment sales and its philosophical positioning, the research design of a single case study with embedded cases has been adopted (Easton, 1995, Dubois and Araujo, 2004, Halinen and Törnroos, 2005, Yin, 2014). The buyer-supplier interface between Heavy Machinery, a reputable manufacturer of specialty vehicles, and Contractor, one of its major customers in the Asia/Pacific region constitutes the main case. The specific interface has been chosen for several reasons.

To begin with, Heavy Machinery has been selected as it constitutes an ideal match with the study's research interest, its need for in-depth data and its abductive research approach. As a well-known manufacturer of specialty vehicles, Heavy Machinery matched the interest to study the influence of maintenance-related interdependencies on OBA. Maintenance-related products and services constitute about two thirds of overall revenue/cost over the life cycle of its specialty vehicles. As Heavy Machinery had participated in several research projects with other universities before, it understood that the project would require in-depth access to interview partners, meeting observations and documentation material. Moreover, it welcomed the abductive research design, which required flexible access over an extended time period so that data analysis and theorising could be interwoven with data collection (Ahrens and Dent, 1998, Dubois and Gadde, 2002). In return, it was agreed that the Stockholm School of Economics would carry all research-related costs and that Heavy Machinery and its business partners would remain anonymous in any research publications. Synonyms are accordingly also used throughout the study to refer to individual firms and business units and the technical resources are described in relatively general terms. In order to manage confidentiality concerns, Heavy Machinery was also provided with a presentation of the research results and full copies of the empirical chapters. No wishes for changes were presented during or subsequent to the meeting.

Heavy Machinery's interface with Contractor has been identified as particularly interesting to study. Contractor constitutes one of the first customers with which Heavy Machinery has introduced OBA. As a demanding large customer, the connected changes remained also not limited to Contractor and the sales organisation serving it, but transpired to Heavy Machinery's European development and production facilities and Heavy Machinery's suppliers. Focusing on the specific interface offered accordingly the unique opportunity to combine observations made throughout the internal and external supply network into a coherent study. Similar OBA exchanges have subsequently also been introduced with several other customers, underlining the significance of the made observations.

4.2.2 Embedded cases

The interface between Heavy Machinery and Contractor is embedded with many other directly and indirectly connected resources (Håkansson and Snehota, 1995) and these leave naturally also their imprints on the design and use of OBA in the interface (see e.g. Cooper and Yoshikawa, 1994, Alenius et al., 2015). As these connections have been identified over the course of the research project, the case has been expanded accordingly to include these directly and indirectly connected resources in the form of embedded cases (Dubois and Araujo, 2004, Yin, 2014). As the resource interface is described in detail in the following chapter (Chapter 5), the following description is kept short and limited to organisational resources.

Heavy Machinery is structured into several business units ("divisions") that have the highest operational responsibility for their respective businesses, but share Contractor as a customer. Final develops and produces the overall vehicle and sells it to Contractor. Core is an internal supplier to Final. It develops and manufactures an important core component and the vehicles' electrical steering systems. It entertains also specialist engineering resources that it sells to Final and several other divisions. Service had been created shortly before the field interaction began by a merger of the aftermarket businesses of several divisions, among those Final's and Core's. It is accordingly responsible for providing Contractor with all maintenance-related resources. Final, Core and Service entertain facilities in several parts of the world; the focus of this study has, however, been limited to the European operations that develop and produce the vehicles that Contractor uses. SalesOrg is the fully-owned sales organisation in the Asia/Pacific region that serves Contractor. The Final and Service divisions are represented at SalesOrg.

Final, Core and Service are responsible for their own supplier relationships. Interdependencies exist, however, naturally as Service purchases and sells maintenance-related products for Final's and Core's products. As part of the study, several component supplier relationships have been selected together with key informants and studied in more detail (Halinen and Törnroos, 2005). Following Araujo et al.'s (1999, 2016) typology, the corresponding interfaces could be characterised as archetypical standardised, specified and translational if the connected additional maintenance-related resource interdependencies were ignored.[12] Significant maintenance-related interdependencies exist, however, in all studied interfaces. These interdependencies were accordingly carefully studied and resulted for example in the description of three different kinds of (modified) translation interfaces (see Chapter 5.3.1). As part of its extended production system, Heavy Machinery draws also on several contract assemblers that pre-assemble modules based on Heavy Machinery's specifications.

[12] No interactive interfaces could be identified as part of the study.

The interface is also affected by competing equipment manufacturers, other customers to Heavy Machinery and four different kinds of Independent Aftermarket Service Providers (IASP). The latter group does not develop and manufacture any equipment itself, but provides maintenance-related products and services in competition to Heavy Machinery and its main competitors.

4.2.3 Focal actor perspective

The resources in the interface have been studied almost exclusively from the focal actor perspective of Heavy Machinery (Halinen and Törnroos, 2005). The only direct interaction with other actors has been in the form of two observed meetings between Heavy Machinery and Contractor (see Chapter 4.3.2). While a similar perspective has been adopted by many accounting scholars before, it has also been criticised as it might potentially lead to biased accounts (Caglio and Ditillo, 2008). The following explanations are accordingly offered for why such a perspective has been adopted nevertheless.

First, the adopted philosophical position highlights that any observation is partial and subjective and, accordingly, (un)consciously biased to some degree. In contrast to highly objectivist research, the objective is accordingly not to provide knowledge that is generalizable across situations and time (McKinnon, 1988, Atkinson and Shaffir, 1998), but to understand specific situations and perspectives in detail. As Easton (1995) observes, studying all actors, their connections and perspectives on each other is impossible in open, interconnected business networks as no researcher can be expected to possess the required resources (on similar observations, see also Otley et al., 1995, Halinen and Törnroos, 2005). Deliberate choices form accordingly part of any research project that acknowledges embeddedness. As networks do not have any natural boundaries, it remains also unclear whether and how an extension to a few further actors could possibly ever completely eliminate subjectivity. In contrast, the extension to several actors might make it even more difficult to discern whose perspective is actually taken in the resulting research text.[13] In line with these considerations, it has been decided to follow one focal firm and clearly discern its perspective on a specific interface. At the same time, it is acknowledged that Heavy Machinery's perspective itself is not unitary. As the empirical description will illustrate, its different business units contribute differently to the design and use of OBA, too.

Second, while opportunities to interview Contractor and different suppliers had been offered several times, it was felt that any interaction with other actors would also have exacerbated ethical dilemmas. The author had already to watch his tongue extremely closely when interviewing people from different internal units as the unconscious "transfer" of some sensitive information might have caused heated discussions (see also Scapens, 1990). Provided all the knowledge he had gained on how Heavy Machinery regulated the information flow towards Contractor and its own component suppliers, it appeared difficult to ask meaningful questions without conveying too much sensitive information. Releasing any information on recent adaptations of product documentation, product designs etc. might at the same time have seriously harmed these relationships.

Third, the focal actor perspective of Heavy Machinery was specifically chosen as Heavy Machinery can be regarded as a nodal firm in the wider network

> "Partners of the nodal firm may come and go, but there is, it seems, the development of stable networks in most industries. Hence, the nodal companies might develop the models needed and educate new partners accordingly." (Tomkins, 2001, p. 183).

Heavy Machinery's position as a nodal actor has been evidenced during the field study in several contexts. Heavy Machinery constitutes for example one of only a handful worldwide specialty vehicle manufacturers. In addition, it could be observed how Heavy Machinery transferred its ways of working to new suppliers and customers. Gaining an in-depth understanding of its point of view appeared accordingly of particular importance.

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[13] This problem has been encountered and discussed by Thrane and Hald (2006). They studied a buyer and several of its suppliers explicitly. Confronted with the need to take the perspective of one actor during the writing of their research report, they reported the results from the perspective of the buyer only.

4.3 Data collection

As characteristic for abductive research projects, data collection took place over an extended period of time, from March 2012 to November 2015. One reason for such lengthy fieldwork is found in the iterative nature of the abductive research process in which the researcher switches forth and back between data collection, data analysis and readings of the literature rather than conducting these activities sequentially (Scapens, 1990, Dubois and Gadde, 2002, 2014). Data collection has accordingly been paused at multiple times to transcribe and analyse already collected material and connect it to existing literature. Another reason can be found in the time-consuming (re-) negotiations of access that form a natural part of abductive research projects (Ahrens and Dent, 1998). In the present study, the extension to SalesOrg required for example the consent of local top management. Direct discussions with SalesOrg halted several times for different reasons. In SalesOrg's region, research co-operations between academia and industry were uncommon; SalesOrg had accordingly not participated in any research projects before. Furthermore, accountants and, in consequence, accounting researchers were seen as "chartered bean counters" without much understanding of the business and feared as they were connected to internal audits. Moreover, hierarchy was of high importance and the contact had accordingly to be backed up by managers with the "right" seniority level at the European operations. As the related concerns became only known over time and could only successively be addressed, the connected discussions took several months to complete, from September 2014 and April 2015.

As common for case study research, multiple sources of data have been combined in the case study (see for example Scapens, 1990, Ahrens and Chapman, 2006). The use of different data sources facilitated the discovery of new aspects and the parallel testing of contemplated explanations (Dubois and Gadde, 2002, Ahrens and Chapman, 2006, Lukka and Modell, 2010, Easton, 2010). Interviews constituted the primary source of data, but these were complemented with observations and documents (Table 6, page 87, see also Appendix 2).

Table 6 Collected data

	Number of inter-views	**Total interview length (hh:mm)**	**Average interview length (hh:mm)**
Core[1]	20	34:02	1:42
Final[1]	17	30:41	1:48
Service[1]	21	36:49	1:45
SalesOrg	19	31:02	1:38
Total	77	132:34	1:43
Observa-tions	• 2 shorter production tours at Final and Core • 1 day "internship" in Final's production • Shadowing of strategic purchaser, Core, during one work week • Guided tour at regional distribution centre, SalesOrg • 2 meetings with Contractor: vehicle audit, monthly "customer health meet-ing"		
Docu-ments	About 1,200 pages (information package for new employees, marketing mate-rial, product documentation, SalesOrg's "standard" Life Cycle Cost model, or-ganisation charts)		

[1] European organisation

4.3.1 Interviews

As part of the study, 77 interviews were carried out with 68 representatives from different hierarchical levels and functions of Core, Final, Service and SalesOrg. Five of these interviews were carried out over the phone due to the geographic distance to the interviewees; the remaining 72 interviews were carried out in person. On four interview occasions, two or three interviewees were present at the same time. Fifteen interviews constituted re-interviews with individuals that had been interviewed before in order to follow up on specific aspects and more recent developments. Interviews lasted between thirteen minutes for a short meeting as part of which a longer interview was scheduled and three hours and nine minutes. The average length was one hour and forty-three minutes. All but three interviews were recorded and transcribed in full by the author. The three unrecorded interviews took place with two interviewees who expressed their discomfort about being recorded. On these occasions, extensive handwritten notes were taken. Immediately after the interviews, the notes were transferred to the computer and complemented from memory.

Interviewees were either located by referrals or through direct contact subsequent to observed meetings. Interviewees were usually first contacted by e-mail with a description of the overall research project and its relation to the specific interview. Two to three days after this initial introduction, interviewees were called up and a meeting was booked. No potential interviewee denied an interview. Likewise, no interviewee asked for a referral denied her help.

The abductive approach to research impacted interviewing in three regards. First, it affected the scheduling of the interviews. Due to the geographical distance to Heavy Machinery's operations in Europe and Asia/Pacific, some trade-offs needed to be made between "efficient" data collection and allowing time for reflection. In the beginning, data collection was mainly carried out in the form of day-trips with one to three scheduled interviews. This allowed for sufficient time to transcribe and analyse the collected material and match it with prior theory. In later phases, when the research project had been further specified in terms of its theoretical and empirical focus, data collection was mostly carried out in the form of longer field trips. During these trips, the author had access to a desk in the open office landscape of Final's and Core's co-located purchasing departments and was issued a key tag so that he could move around freely between Heavy Machinery's different sites and offices. In order to allow for some analysis and reflection, interviews on similar technical or organisational issues were either divided up across several field trips or at least across several days of the same trip, allowing for some reflection in between. Moreover, the number of interviews scheduled per day was limited to a maximum of three. This facilitated reflection and preparation for the following interview. Having some idle time allowed the author also to follow up on spontaneous invitations for lunch and coffee.

Second, the abductive approach affected also the preparation of the semi-structured interviews. Whenever new questions arose in connection to interviews, the analysis of already collected material or readings of the literature, these were noted in an Evernote database. When planning interview trips, these questions were reviewed and re-arranged into interview guides. The connected work could take up to one and a half workdays per interview. This time-consuming preparation was deemed valuable for several reasons.

To begin with, it allowed the scholar to remember and refer to specific aspects he had noticed before. In the manner of a detective, he could accordingly confirm and extend his evolving understanding in relation to the case as a whole and its specific embedded cases. Moreover, it was observed that referring to particular aspects had also a reassuring, signalling effect on interviewees. As the author could ask detailed questions right away, interviewees generally understood during the first minutes of the interview that he had a good, detailed understanding of Heavy Machinery and its external relationships. Detailed questions acted accordingly as an implicit reassurance of him as a trustworthy, well established interviewer at Heavy Machinery with whom one could openly share specifics rather than stay in the vague and general. This was of particular high importance as the scholar usually had not met interviewees before the actual interview and touched upon technically and commercially sensitive issues. Furthermore, interview guides served as an overall structure for the rather conversational interviews and as a backdrop to which the scholar could refer towards the end of the interview and check whether all questions had been touched upon. They had accordingly a disciplining function during the otherwise rather conversational interviews.

Third, the abductive research approach affected also the execution of the interviews. Extensive notes were for example not only taken for documentative purposes in the case of the three unrecorded interviews. Extensive notes were also taken during recorded interviews. In these latter circumstances, the primary objective was not to document the interview, but to strengthen the scholar's focus as an interviewer and to reflexively identify and test potential explanations for what has been said before in the ensuing discussion (Alvesson, 2003, Kreiner and Mouritsen, 2005).

4.3.2 Observations

Several observations were also carried out as part of the research project (Scapens, 1990, Yin, 2014, see also Appendix A2.3 for a detailed list of the observed meetings). Observations were documented with the help of extensive in situ field notes. These were transferred into digital formats and complemented with additional information from memory during "quiet periods" in the field (Ahrens and Dent, 1998) and evenings of the same day. The different observations can be classified into three groups.

First, the researcher took part in several tours through the European production facilities and SalesOrg's regional distribution centre. The objective of these tours was to learn about these facilities and the products that are produced and stored at these as well as any changes and challenges subsequent to the introduction of OBA. The visits contributed largely to the technical understanding and eased subsequent interviewing. One of the production tours was for example in the form of a full-day "internship" in Final's production as part of which the author stayed with the employees of an assembly station, but was also offered extensive guided tours to other work stations, the prototype assembly, testing and logistics facilities. As the machines were in the process of being assembled, he could ask many clarifying questions about specific components and subcomponents, their technical interfaces to other parts and so on. In addition, he could ask questions about the lean production process.

Second, a strategic purchaser working at the Core division has been shadowed for a complete work week (Czarniawska, 2007). The objective of these nonparticipant observations was to better understand the ways of working at Heavy Machinery and to introduce the research project to prospective interviewees. The choice of the strategic purchaser felt natural as he was one of the main informants at that point in time, attended most meetings in production and engineering at Core and was co-located with Final's strategic purchasers. In order to maximise the number of observed meetings, a particular week at the beginning of the month was selected during which Core also had its divisional meetings. Over the course of the week, sixteen meetings were attended in total. These included also a departmental meeting of Final's purchasing unit and a full day "commodity council meeting" with purchasers from different divisions sourcing hydraulic components. Prior or subsequent to the meetings, the researcher usually received an explanation of their focus, frequency, participants and the design of any documents reviewed during the meeting. As Heavy Machinery applies lean principles, most information taken up during meetings is highly visible within the respective meeting rooms. As usual during longer trips, the scholar got issued a key tag and used a desk next to the shadowed purchaser for note taking in between interviews. He could accordingly also overhear any additional (phone) conversations the strategic purchaser had and was also offered explicit explanations of those. Several of the meeting participants were interviewed during subsequent field trips. During these interviews, references were made to particular observations in line with the abductive research approach.

Third, two meetings between SalesOrg and Contractor were observed. During one of these meetings, Contractor critically reviewed one of the vehicles it considered buying at SalesOrg's facilities. The other meeting took the form of a monthly "customer health meeting" and took place at Contractor's headquarters. The meetings were highly valuable as the scholar could learn more about Contractor and observe the use of OBA information within the relationship. The meetings were followed up by a re-interview of the responsible key account manager in order to better understand the background and the specifics of the discussed technical and commercial issues. The observed meetings served also as a valuable backdrop when interviewing other employees at SalesOrg.

4.3.3 Documents

Throughout the study, different kinds of documents were also collected (Scapens, 1990, Yin, 2014). These included a comprehensive information package that new employees receive on their first working day, organisation charts, different kinds of marketing material and product documentations and LCC calculations. These documents fulfilled different functions. The information package for new employees provided for example a good overview of Heavy Machinery, its different divisions and history. Organisation charts were referred to in the beginning of interviews when interviewees were asked to describe their current and past positions, the structure of their current unit and other units they regularly interact with. Different generations of marketing and product documentation material could be compared and changes in information provided to customers could be traced over time. SalesOrg's "standard" life cycle cost calculation and accompanying material provided to customers was also collected for one vehicle model.

4.4 Data analysis

4.4.1 Consideration of alternative theoretical explanations

Following an abductive research approach, data collection and data analysis have been highly integrated from the start of the research project (Scapens, 1990, Ahrens and Dent, 1998, Dubois and Gadde, 2002). From its start, the project had been focused on management accounting in business networks, drawing on the industrial network approach (Håkansson and Snehota, 1995, Håkansson et al., 2009) as meta-theoretical lens. As first empirical insights were gained, the focus became also relatively quickly more specifically directed to OBA as a particular inter-organisational management accounting technique (Caglio and Ditillo, 2008). Despite this relatively clear empirical and theoretical focus, other theories have also been considered flexibly over the course of the research project. As such flexible reference to different domain and method theories (Lukka, 2005, Lukka and Vinnari, 2014) is regarded as an implicit sign of the quality of abductive research projects (Ahrens and Dent, 1998, Lukka and Modell, 2010), some examples shall be provided in the following.

An interesting empirical finding has for example been that the Core, Final and Service divisions appeared to share external business partners, but at the same time remained independent in their decision making in relation to those. Before the inherent tension could be connected to and explained by Heavy Machinery's use of OBA in capital equipment sales (see in particular Chapters 5.3.1 and 7.3.1), alternative explanations were also considered. This involved a close reading of texts on the organisational structure of the purchasing function (e.g. Lysons and Farrington, 2006, van Weele, 2010, Bocconcelli and Håkansson, 2008), purchasing synergies (e.g. Faes et al., 2000, Rozemeijer, 2000, Smart and Dudas, 2007, Matthyssens and Faes, 1997) and the interrelationship of intra- and inter-organisational management controls (e.g. Håkansson and Lind, 2004, Cuganesan and Lee, 2006, Thrane and Hald, 2006, van Veen-Dirks and Verdaasdonk, 2009).

Similarly, following the discovery that the configuration of Enterprise Resource Planning (ERP) systems appears to play an important role in steering internal visibility in relation to OBA (see in particular Chapter 8.2.2), some papers on ERP systems and management accounting have been read (see e.g. Boland, 1999, Quattrone and Hopper, 2001, 2005, 2006, Dechow and Mouritsen, 2005, Hyvönen et al., 2008, Brivot and Gendron, 2011). A paper by Markus et al. (2000) was particularly helpful in gaining an overview of the different ways in which ERP systems might be configured. This knowledge was of high value when preparing and conducting interviews on the subject matter.

Broader readings of some method theories (Lukka, 2005, Lukka and Vinnari, 2014) besides the industrial network approach informed also the research project. Academic visitors recommended the author for example to read a few texts on Actor Network Theory (for example Callon, 1986, Latour, 1990, Latour, 1992). Latour's (1990) discussion of the different initiatives that hotel owners take to ensure that guests return their room key at the reception desk proved of particular significance. It sensitised the author to the many resource adaptations that Heavy Machinery continuously undertakes to reduce the likelihood and impact of parallel relationships between Contractor, Independent Aftermarket Service Providers (IASPs), major component suppliers and competing equipment manufacturers (see Chapters 6.2 and 6.3). Data collection and analysis was accordingly re-focused to make visible the detailed arrangements that shall eliminate these potential "anti-programmes" (Latour, 1990) and thereby stabilise the focal information exchange (Dambrin and Robson, 2011).

In a similar manner, some limited readings on boundary objects (Star and Griesemer, 1989, Carlile, 2002, Oswick and Robertson, 2009) sensitised the author to study more closely the level of detail provided in operations and maintenance manuals and accompanying spare part books and how they facilitated the work of different units. This led accordingly to the empirical insight that these pieces of information had become less detailed following the introduction of OBA (Chapter 6.1.1) and that Heavy Machinery increasingly sold maintenance-related products as part of larger kits (see Chapter 6.3.3). Moreover, it proved also useful as the information that Heavy Machinery received from its own suppliers were discussed with engineers and purchasers (see Chapter 7.3.1).

The parallel reading of different domain and method theories proved accordingly useful as it facilitated data collection and the consideration of alternative explanations (Alvesson and Kärreman, 2007, 2011). It thereby contributed to an overall deeper empirical and theoretical understanding (Scapens, 1990).

4.4.2 Formalised data analysis

The analysis of the collected data in terms of the domain theory of OBA and the method theory of the industrial network approach was relatively formalised. It included three major steps.

Empirical pattern making

In a first step, the focus lied on arranging the extensive empirical material into larger patterns. Ahrens and Dent (1998) describe pattern making as being

> "based on detail. But it abstracts from detail to concepts, grouping like with like and tracing interconnections. (…) The theoretical demand is the processing of detailed information into patterns that are replete, in that they account for all observations and are holistic, in the sense that they explain observed outcomes" (ibid, p. 28-33).

Initial pattern making was influenced by three considerations. First, it appeared useful to distinguish between the "definition" (later: design) and the "use" of OBA information. During data collection, it was observed that both aspects were highly complex in themselves. Heavy Machinery and Contractor exchanged for example several pieces of information and the design of these individual pieces appeared highly complicated, too. At the same time, the information was used to form decisions in different areas. By separating these highly interrelated aspects analytically, it was felt that the complexity could be reduced for the reader. In this context, it was also decided that design-related discussions should precede use-related discussions. In consequence, references could be established between the two parts and repetitions minimised. Second, given the empirical observations and the application of the industrial network approach, it appeared important to understand *who* designed or used the exchanged information. Accordingly, analytical subcategories were established for the relationship between Heavy Machinery and Contractor, Heavy Machinery's firm level, indirectly connected component suppliers and "other" actors (different kinds of IASPs, vehicle manufacturing competitors). Third, within these subcategories, some additional smaller patterns could be established. The different pieces of information that Heavy Machinery and Contractor exchanged could for example be distinguished and information on their respective characteristics clustered.

Relating empirics to prior literature

In a second step, a switch occurred to the theoretical side of the thesis project. Ahrens and Dent (1998, p. 30) describe the objectives of this stage as moving from an "'experience-near' understanding of the field to a reinterpretation through the 'experience-far' concepts of the reader". The domain literature of OBA was accordingly re-read and complemented with additional publications that had been missed out before. While re-reading the literature, it was felt that a more detailed analytical framework was required that facilitates a more fine-grained analysis of the literature and the positioning of the present study (Ahrens and Chapman, 2006). Araujo et al.'s (1999, 2016) typology on resource interfaces appeared useful to cluster prior research. In addition, inspiration was drawn from Gordon et al.'s (1978) and Simon et al.'s (1954) classic works to define sub-variables on the design and use of OBA (see Chapter 2.2). Following the refined framework, prior studies on OBA could be analysed in a more detailed manner and a first draft of the theoretical chapters could be written. Moreover, the empirical data were rearranged. Compared to the initial analysis, a chapter describing the interface as such was for example added in bullet-point form and the analysis of the use of OBA became more fine-grained, specifying different areas into which attention has been directed and particular decisions that are taken on the different organisational levels. This resulted in a detailed structure of the empirical chapters that was aligned with the analytical framework and as such could also be used as a coding scheme later on. Furthermore, a rough sketch of the discussion chapter was established.

Formal coding and writing of the empirical chapters

In a third and final step, all empirical material as well as the chapter-wise coding scheme was transferred into NVivo 10, a software for qualitative data analysis (Seale, 2010). Over the next 1.5 months, all collected material was re-read and formally coded. As part of this process, the coding scheme and structure of the empirical chapters were also refined. Subsequently, all codes were printed off. In the process of writing the specific empirical subchapters, the related codes were re-read, specific examples selected and specific quotes were translated to English if necessary and anonymised.[14] The empirical material was accordingly "thinned out" (Ahrens and Chapman, 2006, p. 832) extensively. Once the theoretical and empirical chapters had been written, the discussion and summary chapters were drafted.

[14] Accordingly, all empirical material has been revisited in full at several occasions. During data collection, depending on available time, I either directly transcribed and read through interview transcripts or listened to those before conducting additional interviews. During data analysis, I coded all material and then revisited these codes when writing the respective subchapters.

Chapter 5

The interface between Heavy Machinery and Contractor

The purpose of this chapter is to describe the interface between Heavy Machinery and Contractor and thus the technical (product, facilities) and organisational (business units, relationships) that are adapted between the two firms and indirectly connected business partners. In contrast to other buyer-supplier interfaces, where most resources are concerned with the development and production of the focal products (see Chapter 2.3.4), interfaces through which capital equipment is exchanged are characterised by a large number of additional resources that are required to maintain the focal products during their use (see Chapter 2.3.5). In order to highlight these differences in resources and their implications for the design and use of Open Book Accounting (OBA), the following discussion is structured into four parts.

First, resources that are primarily connected to the development and production of the specialty vehicles as such are discussed. These include the customer-adapted specialty vehicle and its core component as products and centralised production facilities and vehicle delivery centres as facilities. In addition, they comprise different business units at Heavy Machinery and Contractor, which primarily coordinate the exchange of new vehicles, as well as connected relationships to contract assemblers that form part of Heavy Machinery's production system.

Second, the resources that are required to maintain the vehicles are discussed. Products exchanged to this end include spare parts in the form of components and subcomponents, labour hours of service technicians and supplementary service products. In order to handle these maintenance-related products, Heavy Machinery and Contractor require access to facilities in the form of maintenance workshops, component repair centres, global and regional distribution centres and warehouses. In addition, they require specialised business units that can coordinate the maintenance-related product exchanges. The exchange of maintenance-related resources is also impacted by four different kinds of indirectly connected Independent Aftermarket Service Providers (IASP). These do not develop and produce vehicles themselves, but provide some maintenance-related resources.

In a third part of the chapter, the focus rests on the indirectly connected relationships that are affected by the parallel exchange of vehicle and maintenance-related resources. These include the relationships to Heavy Machinery's component suppliers, other customers and competing vehicle manufacturers. In turn, the fourth and final part of the chapter summarises the made observations.

5.1 Resources primarily connected to the specialty vehicle

5.1.1 Products: specialty vehicles and core components

The speciality vehicles

The study focuses on the specialty vehicles manufactured by one particular division of Heavy Machinery, Final. Its product portfolio consists of several vehicle types that customers might require to carry out different steps in their operations. As each type includes different models, Final's total product portfolio includes about 200 vehicle models. Contractor requires three types of these vehicles in its own operations. The first type of vehicles can be seen as Final's traditional "core" product. It carries an important core component that is developed and produced internally by the Core division. The second and third vehicle types do not carry the internally produced core component.

The vehicles can be characterised as multi-technology (Brusoni et al., 2001), customer-adapted products. A vehicle consists on average of 3,000 components, of which a few hundred components are usually exchanged in product development projects. Developing a new vehicle or core component takes about five years, of which about 1-2 years are dedicated to testing in laboratories and on test sites.

The vehicles are highly customer-adapted and, accordingly, produced on order and in low volumes. Customers can choose among hundreds of "standard" options for each individual vehicle that are directly available from factory. In addition, customers regularly require specific adaptations of their vehicles to satisfy legal or site-specific requirements, mostly related to work safety. [15] These adaptations might be small, such as the attachment of additional lightening to the vehicle. However, they can also be quite drastic, requiring several hundred hours of engineering work.[16]

The core component

The different models of one of the three vehicle types carry one or several core components developed and manufactured by the Core division. These core components might constitute only a low percentage of the vehicle's product cost, but they are the most important parts of the machine.

> "The (core component) is the heart of the business. (…) If you look at the (specific vehicle model), all it is, it's a fancy carrier that carries two (core components) to where they need to be working. The (core components) are, if you like, our pulse." Product manager, SalesOrg, Service

Given matching interface and functional requirements, the core component can be developed and produced independently from the rest of the vehicle. Due to the modular architecture of the component's inner design, customers can choose among a few hundred core component variants.

[15] Examples of such work safety related adaptations might be the fitting of fire-retardant hydraulic hoses, additional safety rails and operator cabins that can withstand "roll-overs" and thus require different material specifications compared to "standard" configurations.

[16] Those more drastic adaptations are limited to about 5 percent of the total volume. Examples of these include the exchange of a commonly fitted major component with that of another manufacturer.

5.1.2 Facilities: centralised product development and production facilities and vehicle delivery centres

Centralised product development and production facilities

Product development and manufacturing is carried out at centralised facilities. Both Final and Core entertain several R&D centres and factories across the world, focused on particular vehicle assortments. Concentrating these resources at a few locations enables the generation of economies of scale and scope, despite generally low production volumes of individual vehicle models. The vehicles Contractor buys are developed and manufactured at the European sites of Final and Core.

Final's facilities are focused on product development, the final assembly of pre-assembled modules and testing of the vehicle. Apart from the core component and the electronic steering systems supplied internally by the Core division, Final sources all components from external suppliers. Accordingly, externally purchased parts stand for the vast majority of product cost.

In contrast to Final, Core has more considerable in-house production. In particular, many of the parts of the core component are produced in a specialised workshop from raw material inputs, such as steel blocks. Most of the core component's product cost are accordingly attributable to in-house production. In-house production is motivated by the importance and particularity of the core component. Only direct competitors are reported to have similar resources at their disposal. In-house manufacturing provides also the flexibility required to offer many variants without the need to maintain excessive safety stocks.

Vehicle delivery centres

At its sales organisations, Heavy Machinery entertains vehicle delivery centres. These are larger workshops through which new vehicles entering the respective region from the global production facilities pass. Vehicle delivery centres employ engineers and service technicians who carry out the vehicle adaptations that are not directly available from factory. The size of such adaptations is significant. At the sales organisation serving Contractor, SalesOrg, their assembly usually takes several weeks per vehicle.

5.1.3 Business units with focus on vehicle sales

Business units involved at Heavy Machinery

At Heavy Machinery, the highest operational responsibility lies with the divisions. They accordingly contain all necessary functions of a stand-alone-business. Divisions are held responsible for their consolidated operational profit and net capital employed. According to Heavy Machinery's general principles, each division should focus on a particular assortment of products, targeting a particular customer group. In consequence, Heavy Machinery has also only a very small number of overhead functions, primarily located at the corporate headquarters.[17]

Product development and production of the vehicles are primarily coordinated by the Final and Core divisions. The Final division develops, assembles and markets its vehicle models globally to external customers. It thereby relies on the core components, electronic steering systems and some engineering services provided by the Core division.

As Heavy Machinery places great importance in interacting directly with its customers, it entertains about 90 sales organisations worldwide. SalesOrg is a sales organisation in the Asia/Pacific region that serves customers across four countries, among these Contractor. As common for multinational firms (see for example Mouritsen, 1995, Dent, 1996), SalesOrg's legal entity is shared by several divisions. Individual sales are, however, always conducted through the respective divisions. Accordingly, one business line manager has the overall responsibility for the sale of Final's vehicles at SalesOrg, including the core component. It is assisted by key account and product managers who focus on vehicle sales to particular customers. Contractor is accordingly served by one key account manager. In addition, two product managers regularly participate at monthly meetings at which overarching technical and commercial questions are discussed.

[17] Examples of centralised functions are a unit providing financing solutions for customers' equipment and service purchases, group accounting and treasury, corporate communications and investor relations. Responsibility for the financial structure and taxation is accordingly also left with the corporate headquarters.

Business units involved from Contractor

SalesOrg's market is dominated by contractors. Contractors can conduct limited or all work in the operations of site-owners. They are generally selected through tendering processes. By hiring a contractor, site-owners can increase and decrease their operations flexibly, while keeping internal complexity and risk at a minimum. They do neither need to buy equipment and spare parts nor hire own operators and maintenance staff. In addition, they can set detailed work plans for contractors and attach contractual fines to these.

The advantages connected to contractors come at a certain price. Accordingly, contractors are mostly drawn upon during boom phases. In contrast, during downturn phases, as witnessed at the time of the study, site-owners tend to take outsourced work back in-house to save cost and increase the utilisation of their own in-house operations. This can result in overcapacities among contractors and, accordingly, fierce competition and high cost consciousness.

Contractor is one of the largest contractor customers of SalesOrg and Heavy Machinery in general. It has existed for more than 30 years and resides over about a third of the local contractor market. Traditionally, Contractor has been a particularly loyal customer of two competitors to Heavy Machinery. This is also clearly visible when visiting Contractor's premises. Contractor's staff wears workwear with Contractor's own and the two competitors' brands stitched onto. In addition, the reception area is full of marketing material of these competitors. Contractor requires three main vehicle types for its operations, all of which Final can supply. Contractor has purchased a larger number of vehicles of one type from Final and uses vehicles of the other two types from competitors. At the moment, Contractor does for example not use any vehicle of the type featuring the core component from Heavy Machinery. By focusing vehicle purchases per type on a specific supplier, Contractor benefits from the compatibility of maintenance-related resources. At the same time, as most maintenance-related resource benefits arise on the site-level and Contractor has grown to operate on many sites, it could use alternative suppliers for each vehicle type in the future. Final works accordingly actively on reducing the perceived disadvantages of its vehicles compared to its competitors'. One of those disadvantages is connected to the service interval length of its core component, which Final and Core try to increase in product development.

Vehicle buying cycles are naturally long and individual purchase orders usually encompass several vehicles of a certain type at a time, as new sites are opened up or parts of existing vehicle fleets are replaced by new ones. While Contractor's purchasing department has an important role to play in particular sales negotiations, it often follows the recommendations of other units that evaluate the operational fit of the vehicle and the ability of Heavy Machinery to match Contractor's maintenance-related resource demands.

> "The information and the recommendation will come from the other sectors through the purchasing. So, how shall I say, you know, the purchaser really is only the most important person as the rest of the group is convinced. Because they put through the recommendation. And then, he will do the final negotiation. But, the concept and the persuasion has to come from the logistics and operation centres." National Business Development Manager, SalesOrg, Service

5.1.4 Connected relationships primarily related to the vehicle as a product: contract assemblers

Several indirectly connected relationships are involved in the development and production of vehicles. As Heavy Machinery's component suppliers, other customers and competing vehicle manufacturers affect and are affected by both the vehicle and maintenance-related product exchanges, they are discussed in an integrated manner in Chapter 5.3. Besides these relationships, contract assemblers play an important role that is limited to the production of the vehicles.[18]

Contract assemblers can be regarded as an extended arm of Final's assembly-oriented production system. Contract assemblers do not carry out any product development on their own, but assemble components into larger vehicle modules that are subsequently integrated into complete vehicles at

[18] Contract assemblers receive accordingly also only necessary information on the components as such and on how to assemble them into modules. They are subject to strict confidentiality clauses and do as such not affect the information exchange between Heavy Machinery and Contractor. In consequence, they are neglected in chapters 6 and 7.

Final's centralised production facilities. Final uses half a dozen major contract assemblers and several smaller ones that are all specialised on certain vehicle modules. Two particular arrangements with contract assemblers can be discerned. First, for some modules, Final purchases the components required for a particular module into its own warehouses and forwards them together as a package to contract assemblers. Second, for some modules, Final provides contract assemblers with forecasts. Based on these forecasts, contract assemblers plan their production and purchase components directly from Heavy Machinery's component suppliers, based on Final's centrally negotiated purchasing contracts. Occasionally, these latter assemblers might suggest smaller design or purchasing related changes, which are subject to Final's approval.

5.2 Maintenance related resources

Heavy Machinery commonly assumes a life cycle of about ten years for newly produced vehicles.[19] Several technical and organisational resources are required to ensure that the vehicles can be used over their extended life cycles. Insufficient support with these results in production stops and high opportunity costs for Contractor. The exact size of these opportunity costs is at the same time difficult to assess precisely. While Contractor might lose about 15,000 Euro in revenue per hour due to the breakdown of one of its vehicles sourced from Heavy Machinery, additional contractual fines from site-owners can result. In addition, individual machine breakdowns usually affect the efficient use of other types of equipment and extend to the wider business network it forms part of.

[19] This is also reflected in its guarantee to supply spare parts and accompanying services during this period. The ten year period applies from the time the last vehicle of a certain model has been produced. As a certain vehicle type might be produced over a time period of 5-10 years, the support period for individual vehicles is accordingly much longer. In addition, it is important to note that machine life can obviously vary and be, in rare cases, much longer. The vehicle registry of Heavy Machinery contains some machines from the 1960s that are still in use at customers and are, based on goodwill, supplied with spare parts.

5.2.1 Maintenance-related products: spare parts, labour and supplementary services

Spare parts in the form of components and subcomponents for the vehicle and its core component

Both the vehicle as such and the core component(s) require constant maintenance with spare parts when used.[20] Usual machine wear, exacerbated by the dirty environments in which the vehicles are used and good or bad operating and maintenance practices, drive the need for spare parts.

Maintenance is primarily carried out in either preventive or corrective forms. *Preventive maintenance* concerns the exchange of particular parts at specified service intervals. The aim of preventive maintenance is to avoid unexpected breakdowns and connected high, unforeseen opportunity cost.[21] Moreover, the aim is to avoid chain reactions in the technical system of the vehicle, where a certain failing component might lead to costly failures of other components.

> "If they are not doing the routine change-outs, you know, we specify that "You change your axels at x hours", but they decide "Ah, we will just push them a bit further." Then you have a catastrophic failure that takes out a whole lot of the stuff. (…) So, that will throw the running costs up. (…) You know, we will back it up to 8,000 hours, but after that it is a wing and a prayer. So if the transmissions goes and it screws out the up box, drop box and something else, bad luck."
> Product manager, SalesOrg, Service

Smaller preventive services might take a few hours to complete and include for example the exchange of filters, oils and some few components. Larger preventive service intervals are scheduled twice over a vehicle's life

[20] Instead of purchasing these products separately, customers can also enter into one of the different kinds of service agreements that Heavy Machinery offers. Based on the complexity of the contract, Heavy Machinery might take over maintenance planning on behalf of their customers and offer certain performance guarantees. In the most complex contracts, customers pay Heavy Machinery based on the hours they use their machines. At the time of the study, Contractor has not used any such service agreement.

[21] Unexpected breakdowns of the vehicle might nevertheless occur and require immediate consideration. About 80 percent of these unexpected breakdowns can be attributed to a single reason which are difficult to foresee and, accordingly, difficult to avoid with pre-emptive maintenance: hydraulic hose breaks. Customers are accordingly usually very skilled in dealing with those.

cycle. At these points, the vehicle is parked up for two to four weeks, taken completely apart and most of the major components are overhauled.

In contrast, *corrective maintenance* concerns components where the need of a repair can be seen as a given, but its exact timing is less certain. An example are hydraulic cylinders. During their component life cycle of about 12,000 hours, some smaller hydraulic leakage naturally occurs and requires the exchange of the seals included in the cylinder. When this hydraulic leakage exactly occurs is however highly uncertain, even though it naturally is easily noticeable.

> "When it leaks too much, you exchange the seals of the cylinder. So either it leaks externally so that oil drops or the piston's seal leaks, so that the cylinder sinks as it is load on it. Then, you know that you need to exchange the seals."
> R&D Manager, Hydraulics, Final

When the operator notices beginning hydraulic leakage, it will accordingly inform the maintenance workshop, which, in turn, will either perform the cylinder repair at the next scheduled service interval or plan for an additional service stop. Corrective maintenance is accordingly most appropriate for parts that have an easy technical interface supporting quick exchanges, and usually do not cause any connected failures in the larger technical system.

While most parts of the vehicle require regular maintenance with spare parts, the core component stands out as the part of the respective machines that requires the most frequent maintenance. Much of the perception of this type of Heavy Machinery's vehicles is accordingly not only dependent on the core component's performance, but also on the length and reliability of its service intervals and the quality of individual component repairs.

> "The (core component) is the one component that comes off the most consistent time. (…) The (core component) is the one thing that comes off every 400 (operating) hours. Every 600 hours. It comes off. And it goes somewhere to get repaired. So, those repairs have a big influence on the customer's perception of (Heavy Machinery). If he takes a component off, which will be called a (core component), and he sends it into the branch. The branch repairs the (core component), and it comes back, you have got a nice code of paint on it, all the stickers on it, and it lasts for 600 hours. The perception of the branch is beautiful. It's a good place, happy, no problems. Put it on and

it lasts 200 hours, everything falls over. So you can be as close as you like (to a customer), but you are only as good as your last repair." Product manager, SalesOrg, Service

The support with spare parts is connected to at least six further complexities that are important to understand (Table 7). First, Heavy Machinery does not only need to source and administrate the components it places on its vehicle in production, but also a multitude of subcomponents with the help of which these larger components are repaired. To give an indication, Heavy Machinery quoted prices for about 150,000 individual spare parts for current and past vehicle designs to customers at the time of the study.

Table 7 Complexities in the provision of spare parts

1	A large number of components and subcomponents are required as spare parts
2	The need for spare parts depends on the technical design of the vehicle and its components, its use and operations and maintenance practices
3	Differences in technical progress needs to be balanced
4	Different demand patterns exist for production and maintenance
5	Customers might require certain components on a regular basis that are not offered by or focused on by the capital equipment manufacturer
6	Vehicle repairs might be conducted in a number of different ways, depending on customer preferences and the availability of maintenance-related resources

Second, the technical need for individual spare parts might naturally differ widely depending on the technical design of the vehicle and its components as well as their use, site requirements and operations and maintenance practices. A specific part might for example be worn out much quicker on a certain vehicle model compared to another one. In addition, an axel placed at the back of a vehicle might for example have a longer service interval, and, accordingly, lower spare part demands than an axel at the front of the same vehicle. Furthermore, actual spare part consumption might vary by up to twenty percent depending on the characteristics of the site and the skill level of the customer's operators and service technicians. High humidity might for example speed up corrosion and high temperatures and sun might decrease the service interval of rubber parts, such as hydraulic hoses.

Third, additional complexity arises from the need to balance technical progress in the underlying components and their subcomponents. While suppliers might for example develop multiple new component generations over the life cycle of an individual vehicle, Heavy Machinery's customers might still require the "old", original component when repairing their machines as newer components do not fit the technical and interface requirements of their vehicles. This places particular demands on both Heavy Machinery and its component suppliers.

Fourth, an additional complexity arises from differing demand patterns for production and maintenance. For production, component demand is often rather stable and well plannable, allowing for the application of lean supply chain principles (see for example Fisher, 1997). In a company presentation, this situation is described as similar to a birthday party – "you know (the) number of guests and how many cakes you need"[22]. In contrast, maintenance-related spare part demands are more difficult to forecast and need to be satisfied immediately as vehicles otherwise cannot be used. Demand for spare parts usually only arises after several units of a certain vehicle have been sold and reach their first service intervals. Customer-specific vehicle designs and demands for items that are generally not considered spare parts[23] can exacerbate the situation. Aftermarket demand is accordingly described as a "surprise party" – "you never know (the) number of guests and how many cakes you need"[24]. The supply of spare parts builds accordingly on agile as opposed to lean supply chain principles (on the differences, see Fisher, 1997, Christopher, 2000).

Fifth, there are some components that Contractor regularly needs to buy, but that Heavy Machinery does either not offer or focus on for practical reasons. An example of a component that Heavy Machinery does not offer are tires.

> "We don't sell tires as a spare part. (…) There is only a certain number of tire suppliers in the world and there is only a certain production quantity. We don't

[22] Presentation provided by the Vice President Purchasing, Service, during an interview.
[23] Examples of components that are not usual maintenance items range from windowpanes and operator seats to welded parts that under normal operations should not require any replacement. These can, however, still be required when damaged.
[24] See Footnote 22.

get hold of tires to sell on the aftermarket. And if we would do so, we would be so expensive that we would not be competitive." Global Fleet Manager, Service

Examples of products that Heavy Machinery could supply, but does not focus on, are different kinds of hydraulic oils and greases that Contractor instead buys from large oil companies.

A sixth and final complexity arises from that vehicle repairs can be performed in different manners, involving complicated trade-offs and placing different demands on connected resources. One alternative for conducting maintenance is to stop the machine, take off the component, get it repaired at a component repair centre, put it back on and re-start the machine. This is, however, commonly associated with high opportunity cost, as the machine cannot be used whenever a component is missing. It is accordingly only feasible if the machine in question is not needed for a particular operational step while other kinds of machines carry out their work in the meantime, a replacement machine is available or the machine is currently anyways parked up.

Another alternative is to replace a failing component directly with a new component. Downtime is accordingly limited and no access to a component repair centre is needed as the used component is not repaired, but disposed of. In addition, new components might in some cases have longer service intervals compared to repaired ones as they are manufactured in clean factory environments, quality tested and well packaged so that they can be shipped across large distances and stocked in good conditions even in dirty environments. The "replace with new" strategy might accordingly be preferred in two cases. First, if the cost to repair a component outweighs the cost of a new one. Second, if new components have longer service intervals than repaired ones and individual exchanges are connected to long machine downtimes. In this case, the higher costs of new components are usually outweighed by lower opportunity costs.

Finally, a third alternative is a compromise involving immediate replacement and component repairs. It has two sub-variants. According to the first variant, customers stock several, new and repaired components in their own warehouses, circulate these among their machines and get them repaired at component repair centres operated by Heavy Machinery or Independent Aftermarket Service Providers (IASP). According to the second sub-variant, customers enter into component exchange agreements with Heavy Machinery. In this case, whenever a component is due for maintenance, they return the used component to Heavy Machinery and receive a repaired one in exchange. Heavy Machinery guarantees the quality of the repair and, accordingly, the service interval length of the component. For this sub-variant to work, Heavy Machinery needs to invest into stock and component repair centres or coordinate repairs with external component repair centres. From the customers' perspective, the choice between the two sub-variants depends on how frequently the individual components are turned around and whether IASPs exist or not. In some cases, Heavy Machinery might for example be able to circulate the components across different customers and organise repairs more efficiently than individual customers, such as Contractor, can do on their own or with the help of IASPs.

Labour of service technicians

In order to conduct preventive and corrective maintenance, correct any unexpected breakdowns and conduct component repairs, the labour of skilled service technicians is required. Contractor employs own service technicians, but also hires service technicians from Heavy Machinery as well as Independent Aftermarket Service Providers (IASP) for a certain amount of hours or particular repairs. Labour hours constitute accordingly another important maintenance-related product.

Additional maintenance-related service products

Heavy Machinery offers also a range of additional maintenance-related service products, such as training and vehicle inspections.[25] Heavy Machinery's technical training department offers for example training for customer's operators and maintenance staff. Trainings can range from short product introductions in connection to the commissioning of new vehicles to several days of training in simulators or on customer's sites.

[25] Heavy Machinery can also assist its customers in financing purchases of vehicles and maintenance related products. This is however not characteristic for the capital equipment interface and, accordingly, side-lined.

As part of formal vehicle inspections, error codes and other diagnostic information are retrieved from vehicles and combined with manual component inspections, following a structured protocol. The result is an explicit "health" status of the respective vehicle as well as a list and prioritisation of necessary repairs, including an indication of associated costs and downtime.

5.2.2 Maintenance-related facilities: Maintenance workshops, component repair centres, distribution centres and warehouses

The support with spare parts, labour and supplementary maintenance-related services builds on access to supporting facility resources. These include maintenance workshops, component repair centres and global and regional distribution centres and warehouses.

Maintenance workshops

Both Heavy Machinery and Contractor entertain maintenance workshops. Heavy Machinery entertains more than a dozen maintenance workshops across SalesOrg's region, which feature the necessary equipment and tooling to perform maintenance work. Service technicians working at these workshops are multi-skilled and accordingly expected to be able to conduct maintenance work on any of Heavy Machinery's vehicles. While some maintenance work, in particular that conducted at larger service intervals, might be carried out at Heavy Machinery's workshops, service technicians regularly travel over large distances to customers and assist those in repairing their vehicles on site.

In order to take care of their machines, most customers, including Contractor, entertain also own maintenance workshops on their respective sites. These maintenance workshops are staffed around the clock so that any unexpected breakdown can be corrected for immediately. Apart from fixing breakdowns, Contractor's service technicians repair vehicles sourced from both Heavy Machinery and competing vehicle manufacturers. In order to balance demand, Contractor occasionally calls in service technicians from Heavy Machinery and IASPs to conduct maintenance work at its workshops.

Component repair centres

As we have observed, many components are not replaced with new ones, but refurbished with subcomponents. These include the core component, but also many other major components, such as hydraulic cylinders, hydraulic pumps, axels, transmissions and engines. The quality of these repairs is important in order to ensure that the repaired components keep their subsequent service intervals and do not cause any unexpected breakdowns. Component repairs might require a particularly clean work environment, certain equipment and tooling, particularly skilled professionals and test benches, which are only available at specialised component repair centres.

At SalesOrg, Heavy Machinery entertains a number of own repair centres for core components and certain other vehicle components. Some other components are channelled to independently owned component repair centres. In addition, the vehicles contain one component, Component X, for which Heavy Machinery neither performs nor organises any maintenance services. Instead, it asks its customers to directly interact with Supplier X's local component repair centres.

Global and regional distribution centres and local warehouses

Heavy Machinery's global and regional distribution centres (DC) and local warehouses are specialised logistics facilities. They accordingly focus on inventory planning, ordering from suppliers, stock keeping, picking, packaging and local and international shipping.

Global DCs are responsible for purchasing and distributing spare parts related to the vehicles developed and produced in the same part of the world. The European DC accordingly supplies SalesOrg every working day with spare parts for the vehicles produced at Core and Final's European facilities. Upon customs clearance, packages with spare parts are either automatically forwarded to local warehouses, which serve customers and Heavy Machinery's maintenance workshops, or go into SalesOrg's two regional distribution centres located at major regional transport hubs. As the long transportation times (1-2 weeks) from distribution centres clash with the need to swiftly supply spare parts when needed, considerable stocks are held at local warehouses.

Contractor entertains also some local warehouses at each of its sites. These order and stock spare parts from Heavy Machinery, competing vehicle suppliers, Heavy Machinery's component suppliers and IASPs. Contractor's service technicians collect spare parts from these stocks when required for maintenance.

5.2.3 Business units with focus on maintenance-related product sales

Business units involved at Heavy Machinery

At Heavy Machinery, all aftermarket-related resources are coordinated by the Service division. Service has been established a few years ago by merging the service units of several "product divisions", among those Final and Core's, based on the insight that maintenance-related support requires the resources of a consolidated, independent division.

> "(As Service), we have got bigger muscles in order to be able to drive resource intensive projects. That was not so easy before for a small aftermarket unit to say "Now, I would like to have this tool." – "Yeah, but that costs a (million Euro)?!" We have the financial strength now, when we have the whole (aftermarket), and that is a very large gain that we can have a more resource intensive development unit when we go together and say "Yeah, but (one million Euro), that's not so much (…) considering a aftermarket business of (several billions)."
> Global Engineering Manager, Service

Moreover, the organisational split should also ensure that considerable focus is put on both the vehicle and maintenance-related parts of the business and that both parts are growing on their own.

> "Earlier, when (Final) as a division included parts and services, whether it grew or remained stable, it got measured at the total business level, not on a capital equipment or a parts and services level, which means that in a good year you can have all the growth from equipment sales and probably end up not growing your parts and services. It doesn't matter, because, as a division, you were still growing and nobody went too much into the details, as long as you see growth at a divisional level. But when you separate the parts and service business out, and then still say that you have to grow, which means that (Final) has to grow by itself,

selling equipment and (Service) has to grow by itself selling parts, so each one of us is then looking at the opportunities to grow the business. Not very difficult for capital equipment, because they still have the products and that is nothing we have changed for them when the divisionalisation happened, but for us, when it becomes parts and services businesses, we need to find new ways to grow our business without exposing ourselves to our suppliers." VP Marketing, Service

In addition, as a consolidated division, Service can also align the maintenance-related product portfolio, tools and processes across Heavy Machinery's different products. This eases their use by general-skilled service technicians and other staff at the sales organisations, providing service for different products in parallel.

A regional service sales manager and a technical reliability manager from the Service division at SalesOrg participate in monthly meetings with Contractor to discuss overarching maintenance-related questions. In addition, service technicians and warehouse staff, also belonging to the Service division, interact with Contractor on a daily level to coordinate maintenance-related product exchanges.

Business units involved at Contractor

Most units involved from Contractor in the relationship are also concerned with maintenance-related questions. The fleet asset manager, several maintenance area managers responsible for maintaining the equipment on particular sites, and a maintenance reliability controller, coordinating vehicle reliability issues across Contractor's different sites, participate in monthly meetings with Heavy Machinery. As noted above, these units have also a major impact on vehicle purchase decisions. On a daily level, operators, service technicians and warehouse staff working at Contractor's individual sites interact with SalesOrg's service technicians and warehouse staff.

5.2.4 Indirectly connected relationships primarily related to maintenance-related products: Independent Aftermarket Service Providers

Several connected relationships are important in providing both the vehicle and aftermarket-related products and are as such discussed in an integrated manner in the third part of the chapter. Independent Aftermarket Service Providers (IASPs), however, constitute a different group of competitors for Heavy Machinery that are purely focused on providing maintenance-related products. They shall therefore be discussed as part of this subchapter.

The relationship of Heavy Machinery with IASPs is regulated in competition law (see also Shapiro and Teece, 1994, Shapiro, 1995). According to these regulations, Heavy Machinery is not allowed to tie vehicle sales upfront to spare part sales and maintenance agreements. In addition, it is not allowed to limit the access of IASPs to components and subcomponents. This means that once Heavy Machinery has offered a specific spare part in a certain form to one of its vehicle-owning customers, IASPs have the right to purchase it in the same form from Heavy Machinery. Moreover, anticompetitive concerns might already be raised if Heavy Machinery should make spare parts available to its own maintenance workshops in different "packages" than it sells these externally. Finally, IASPs have the right to use Heavy Machinery's own article number when marketing spare parts and services. They might accordingly sell both genuine and non-genuine spare parts to Heavy Machinery's customers while retaining their original "resource identity".

Several IASPs are active in SalesOrg's region. For analytic reasons, these can be clustered into four groups based on the part of the product they focus on as well as the resources they have access to (Table 8, page 116).[26] In the following, a concrete example for each of the groups is provided.

VehicleRepairer

VehicleRepairer is specialised in providing maintenance services for vehicles sourced from Heavy Machinery and other competing manufacturers. It conducts smaller and larger maintenance services on those vehicles and hires out service technicians as temporary workers to Contractor, as well as other contractors and site owners in its area. Many of the service technicians have previously worked for Heavy Machinery, competing vehicle manufacturers, site owners or contractors before and are, accordingly, well trained. As part of its maintenance services, VehicleRepairer uses a mix of spare parts sourced from Heavy Machinery, directly from Heavy Machinery's suppliers and/or

[26] Similar IASPs are reported to exist in all of Heavy Machinery's major geographical markets.

Table 8 Four IASPs and their resources

		VehicleRepairer	**ComponentRepairer**	**CoreIASP**	**FinalIASP**
Resource in focus		Vehicle	Certain major components	Core component, in particular commonly exchanged mechanical components included in it	Vehicle, in particular commonly exchanged mechanical parts, and some major components
Available resources	Resources necessary to conduct maintenance (access to spare parts, workshops / component repair centres)	X	X	X	X
Available resources	Resources to identify and purchase components from other sources than Heavy Machinery	X	X	(X)	X
Available resources	Resources to analyse component specifications (material analysis and measurement techniques, 3D scanners), produce and distribute non-genuine copies (CNC machines, warehouses) and to experiment with design improvements	-	-	X	X
Available resources	Marketing and sales resources (internet product catalogues, EDI ordering, sales staff)	-	-	-	X

X = specialised resources available, (X) = available to limited degree, - = not available

larger IASPs, such as CoreIASP and FinalIASP. VehicleRepairer is well known to potential customers in the proximity of its hometown. It does therefore not require any superior marketing resources.

ComponentRepairer

ComponentRepairer is focused on particular component repairs, such as axels, transmissions, up boxes and dropboxes of a number of popular brands, among those the brands that Heavy Machinery uses in its vehicles. It operates nine authorised component repair centres across SalesOrg's region. As an authorised component repair centre, it sources the required subcomponents from the component manufacturer, which also provides it with overhaul instructions, training and required tooling.

CoreIASP

CoreIASP is focused on conducting overhauls of the core components of Final's and a competing manufacturer's vehicles. It is the only of its kind in SalesOrg's region. It was founded by former employees of Heavy Machinery and one of its competitors about fifteen years ago. CoreIASP entertains three centralised component repair shops in different parts of SalesOrg's territory to which customers can send their core components. In addition, it dispatches technicians to conduct overhauls on site at major vehicle-users.

Initially, CoreIASP bought most of the parts used in component overhauls from another IASP, operating the same business model in another part of the world. However, in recent years it has built up own engineering and production facilities in order to produce non-genuine copies of the mechanical parts included in the core component. In order to produce these parts, CoreIASP does not need to have access to all resources that are necessary to develop and produce complete core components and integrate them with the rest of the vehicle.[27] It is enough for CoreIASP to invest into 3D scanners, measurement and material analysis equipment and flexible CNC machines, supporting small batch production. These technologies have advanced drastically and become cheaper during the past years, easing the copying of Heavy Machinery's mechanical parts.

[27] In recent years, CoreIASP has also tried to enlarge its scope and launched some own core components that could be seen as copies of Core's older product designs. Even though it continues to sell these self-developed components, according to interviewees, this has not been a major success for CoreIASP. It is therefore sidelined from the discussion.

> ”Is it four, even four years ago, we could make a part and if it was complex to produce, no one could really copy it. But, in the last four years, the technology of CNC machines, in material analysis and everything has progressed. It’s very hard to have a machined part that someone cannot easily copy today. And that’s something we did not face four years ago. This has been a huge contributor in starting to see our market share (on spare parts for core components) decline.” Product manager, responsible for core component, Service

In order to convince customers of the advantages connected to purchasing its parts, CoreIASP has also experimented with design changes of some mechanical parts that have caused troubles at customers.

> “They started with taking a look at our (core component). Then, they saw that there are some weaknesses that they could improve and so they did a modification of the part of the (core component) and sold it as a kit to the customer and said “Test this!” And the customer tested it and it perhaps didn’t go so well the first time, but one was quickly there again and came up with a solution, because one was there. “Test this instead.” And, in the end, they found something that perhaps worked better than our components for some customers. And then they had a foot in the door and began to sell such parts to the (core component) and continued to exchange more and more parts and started to do overhauls for the customers.” Product portfolio manager, Core

CoreIASP can, however, neither produce all parts in-house nor identify and purchase them elsewhere. This concerns in particular hydraulic seals, which have a high impact on the performance of the core component and require careful designs and material specifications. Following competition law, CoreIASP buys these parts from SalesOrg.

As CoreIASP is meanwhile well known to SalesOrg’s customers, it does not require any particular marketing resources. Losing a customer’s core component to CoreIASP is extremely hurtful for SalesOrg, as it is almost impossible to revert. As part of the first maintenance service, CoreIASP systematically machines the housing of the core component in a way so that some of Core’s original spare parts do not match it anymore. The result is a “captured” core component that SalesOrg cannot serve if it does not completely exchange the housing, which is extremely costly and therefore avoided by customers.

FinalIASP

Like CoreIASP, FinalIASP focuses on the production and distribution of non-genuine mechanical parts for Final's and other manufacturer's vehicles. However, it focuses on other parts of the vehicle than the core component. In addition, it does perform some component overhauls. In order to be able to provide customers with repaired components, it also buys used components from prior users and recycling companies and refurbishes them. FinalIASP has own centralised production facilities and entertains warehouses and service workshops across SalesOrg's region, which sell parts and fit them on customer's vehicles. In addition, FinalIASP has representative offices in three additional countries outside SalesOrg's region, which are all also important markets for Final's vehicles. FinalIASP has built up particular internet marketing and sales resources, making it easy for customers to locate and order spare parts, e.g. via online catalogues and Electronic Data Interchange (EDI).

5.3 Indirectly connected relationships related to both vehicle- and maintenance-related resources

The parallel exchange of vehicle and maintenance-related resources in the interface between Heavy Machinery and Contractor places also particular demands on indirectly connected relationships with component suppliers, other customers and competing vehicle manufacturers. These relationships are discussed in the following.

5.3.1 Component suppliers

Apart from the core component, Final purchases all components of its vehicles from external suppliers. These components are either standardised (e.g. bolts and nuts), produced on Heavy Machinery's designs (e.g. vehicle frames, hydraulic oil tanks) or developed and produced by suppliers on Heavy Machinery's functional and interface requirements (e.g. hydraulic pumps, axels, engines).[28] The interfaces with the suppliers of these components show accordingly similarities with those described by Araujo et al. (1999, 2016) and studied by prior research on Open Book Accounting (see Chapter 3). However, as component suppliers are not only involved in the development and production of the vehicle, but also the provision of maintenance-related resources, important differences can be noted. These are most substantial for translation interfaces, but smaller differences can also be observed for standardised and specified interfaces.

Modified standardised buyer-supplier interfaces

Relationship interfaces with suppliers of standardised components are primarily affected by the organisational split into product (Final, Core) and maintenance-related (Service) business units at Heavy Machinery, the demand of standardised components as spare parts and the availability of global distribution centres (DC) in the interface. While standardised components are generally seen as predestined for global sourcing as they are standardised and do not require any joint product development resources (see for example Lysons and Farrington, 2006, van Weele, 2010), these resources have facilitated the further adoption of global sourcing of standardised components at Heavy Machinery.

The Service division requires higher volumes of some standardised components than any of Heavy Machinery's product divisions (e.g. Core, Final). This is so as a high amount of standardised components is usually required in the maintenance of individual vehicles. In addition, the Service unit is responsible for supporting vehicles and other equipment produced by different product divisions around the world. These different products often contain the same standardised components, further increasing Service's total demand of them.

The Service division disposes also over global DCs, containing important resources in the form of purchasing professionals, expertise in international shipping and warehousing capacities. DCs have purchasing departments, which entertain relationships with a large number of suppliers, both existing, pre-qualified suppliers delivering to any of Heavy Machinery's product units

[28] No interfaces with component suppliers that can be characterised as interactive could be identified as part of the study.

and alternative suppliers that do not deliver to any product unit. Purchasers at Service have accordingly access to price information from several suppliers for individual standardised components, facilitating comparisons. Global DCs are also specialised in international logistics. Accordingly, when required, they can distribute parts from local suppliers that are not able to conduct international exports themselves. Moreover, global DCs have also the capacity to store components and can therefore serve as buffers should disruptions in global supply chains occur.

The Service division's specialised resources contrast accordingly with those of production units (Core, Final). For those units, standardised components constitute only a minor purchasing value. In addition, due to lean production they do not dispose over larger warehouses and manage risks related to supply chain disruptions by primarily purchasing from local, flexible suppliers.

As an own division with specialised purchasing and logistics resources, Service accordingly aims for global sourcing of standardised products. Product divisions, such as Final and Core, however, often follow Service's decisions for standardised components in order to benefit from better deals, further increasing its effects on external relationships.

Modified specified buyer-supplier interfaces

Specified interfaces are mainly affected by the different demand patterns of specified products for production and maintenance (see Chapter 5.2.1). Production requires a stable, lean supply of components at higher quantities, which often can be forecast. In contrast, the demand for specified spare parts is more difficult to forecast. This concerns in particular parts that are required less regularly, are only placed on a few vehicles, not used in production anymore or not considered regular maintenance items. This puts Heavy Machinery in a naturally challenging position. It is on the one hand expensive to keep large stocks of these parts. On the other hand, if these are directly available when needed, this reduces customers' equipment downtime and Heavy Machinery can accordingly charge premiums on both its equipment and spare parts.

In order to cope with these challenges, product (Final, Core) and service divisions (Service) can use different suppliers for some specified parts. The product divisions (Core, Final) interact with suppliers focusing on relatively cheap volume production of specified components. In contrast, Service entertains parallel relationships with suppliers that can produce components flexibly and in low batch sizes. The higher prices charged by these latter suppliers are outweighed by higher margins on spare parts that are available on short notice, lower working capital needs and lower scrapping costs connected to excess stock. As a result, specified interfaces differ from archetypical ones as production of single designs is not necessarily delegated to single suppliers (see Chapters 2.3.3 and 3.2).

Modified buyer-supplier translation interfaces

Heavy Machinery sources many of its major vehicle components, such as hydraulic pumps, cylinders, axels, transmissions and engines, through translation interfaces. It relies accordingly on its suppliers to develop components that are adapted to the functional and interface requirements of its different vehicles and to provide these to its own production facilities and/or to those of its contract assemblers. At the same time, the need to maintain these components during the vehicles' use adds additional resource demands. Translation interfaces that are indirectly connected to capital equipment sales differ from archetypical ones in particular with regard to the exchanged products, the required facilities to support maintenance and the organisational units involved in their coordination (Table 9, page 123).

With regard to the *exchanged products*, four differences shall be highlighted in particular. To begin with, additional dependence arises from the need of Heavy Machinery to not only source components, but also different kinds of subcomponents from these suppliers. In contrast to archetypical translation interfaces, subcomponents are accordingly not only exchanged as parts of larger components, but also as products themselves. Relying on the same supplier for multiple components and component generations does accordingly not only provide cost advantages in the development and production of the components themselves. It also reduces the need for maintenance-related investments (e.g. investments into stocks, maintenance workshops, component repair centres) and maintenance-related costs. The number of spare parts that need to be administrated, purchased, stocked and distributed can for example be reduced while spare parts availability increases.

Table 9 Modified translation buyer-supplier interfaces connected to the interface between Heavy Machinery and Contractor

	Translation Interface 1: Internal component repairs	**Translation Interface 2: Component repairs channelled to external component repair centres (multiple exist)**	**Translation interface 3: Larger component repairs executed by component supplier**
Maintenance-related product resources	Components *and* subcomponents are exchanged as products • Alignment of subcomponents across components eases spare part support and reduces investment needs • Increase of interdependence in terms of time • Packaging for global distribution and agile as opposed to lean supply • Suppliers with own commercial interests in spare part sales		
	HM needs to purchase components and subcomponents	HM might still needs to purchase components and subcomponents in lower volumes (as number of internally conducted repairs might vary across sales organisations and customers might nevertheless require subcomponents)	HM does - under normal conditions – only need to purchase consumables, but not components and other subcomponents needed in larger repairs
Maintenance-related facility resources	• SalesOrg requires own component repair centre(s) and spare part stocks	• SalesOrg with no own component repair centre & lower spare part stocks • External component repair centres, multiple exist	• Consumables exchanged by SalesOrg or customer • Supplier's maintenance workshops and component repair centres
Business units	**HM:** Final/Core, Service **Supplier:** Product unit; sales org.	**HM:** Final, Service, SalesOrg (coordination with repair centres) **Supplier:** Product unit, sales org, local component repair centres	**HM:** Final, Service, SalesOrg **Supplier:** Product unit, Aftermarket unit, local unit **Contractor:** with local supplier unit

Second, spare part supply extends resource dependence also in terms of time. Heavy Machinery generally requires its suppliers to provide spare parts for at least ten years after the last vehicle with a certain component has been manufactured. This requirement holds also should the technology and/or subcomponents of subsequent component generations differ significantly. Even when suppliers decide to discontinue support after this period, they are required to inform Heavy Machinery. Heavy Machinery might then either stock a certain quantity of components and subcomponents or investigate, together with the supplier, the possibility to provide customers with upgrade kits that allow them to shift between component generations in their existing vehicle fleets. Even when Heavy Machinery occasionally changes component suppliers for new vehicle generations, it depends on its suppliers to continue the supply with spare parts for existing vehicles for several years.

Third, the parallel supply for production and maintenance leads also to different packaging and supply requirements. Lean supply to production is commonly based on minimalistic packaging facilitating safe transports between the supplier's and Heavy Machinery's production facilities. Any excessive packaging is resource consuming, as it requires packing and unpacking and leads to waste. In contrast, components and subcomponents sold for maintenance purposes are sent around the world and stocked at distribution centres and local warehouses for longer periods. Spare parts packaging needs accordingly to be more extensive. At the same time, it should not be too bulky, as this might lead to excessive transport and storage costs. Smart, different packaging solutions are accordingly required. In addition, the demand of spare parts is a "now" demand that is more difficult to foresee. Heavy Machinery depends accordingly on its suppliers' ability to provide spare parts swiftly for both new and old components. At the same time, demand in production can be forecast with higher accuracy and based on lean principles.

Fourth, suppliers might have their own interests with regard to spare parts sales. In particular, they might aim to benefit from team effects (Alchian and Demsetz, 1972) on two levels. First, they aim to benefit from team effects on the product level by applying price differentiation depending on the end product in which their components are integrated.[29] Second, they aim to benefit from team effects on the component level by charging high prices on the subcomponents required to maintain the focal components.

> "That is a small classic thing that a few suppliers can, or might, try to accomplish. If spare parts exist for a product, then, most often, one earns money on the spare parts in our industry. So then, they always want to continue selling in as many as possible main products so that they can sell their accompanying products, spare parts, afterwards with high margins and never have a development with price reductions on their spare parts. Instead, it is always and will always be the main components that are exposed to competition among suppliers. But if they have unique spare parts to these components, you' will always be in a much worse

[29] Interviewees observed suppliers using price discrimination between components integrated in Final's products and those integrated in the products of another division, producing products for a supposedly less profitable end customer market.

> negotiation position as purchaser." Project manager, Purchasing Department, Final

An additional group of differences with regard to translation interfaces arises from the need for *maintenance-related facilities*, such as specialised component repair centres. As part of the study, three different arrangements could be discerned, which are also connected to particular *coordination demands*.

The first kind of interface concerns components, which Heavy Machinery repairs at its own component repair centres. The kind and number of internally conducted repairs varies between sales organisations and over time. Besides several repair centres for core components, SalesOrg entertains two larger component repair centres at which different major components are repaired. SalesOrg sources subcomponents required for these repairs from suppliers via Service's global distribution centres. The relationships to suppliers providing these components are accordingly mainly coordinated on a global level. Product divisions (Final, Core) coordinate issues related to product development and vehicle production with product development and sales units of the suppliers. In addition, the Service division coordinates maintenance-related matters, mainly with the suppliers' sales units.

The second kind of interface concerns components that Heavy Machinery does not repair itself in-house, but channels to third parties. At SalesOrg, these third parties take mostly the form of local service organisations of the original component manufacturer.

> "At the moment, we have our (Supplier 1) valves, pumps and motors and our (Supplier 2) motors repaired by the OEM (Original Equipment Manufacturer). Ok? The main reason for that is that these are far more technically developed than a cylinder, ok? So and before they come back to us, they need to be tested. To have a hydraulic test bench, to do some of those big valves and pumps, that's quite expensive and (SalesOrg) hasn't had the volume that would warrant buying a test bench that big. So (Supplier 1) and (Supplier 2) both have sizable test facilities. They can do full flow and full pressure, so they can simulate a proper working environment, whereas you need to test both of those together. Sometimes, small hydraulic companies could probably do the pressure, but they couldn't do the flow. Or if they could do the flow, they wouldn't be able to get it up to the right pressure. So (Supplier 1) and (Supplier 2) have both put good

money into test benches, which we will need to do if we are gonna do that in-house. And training." Purchasing manager, SalesOrg, Service

These external component repair centres conduct accordingly their own facility investments and source usually also directly the required spare parts. As the number of repairs conducted internally or channelled to third parties differs between sales organisations, some purchasing of spare parts via global distribution centres, however, nevertheless occurs, too. Individual repairs are coordinated locally between SalesOrg and the component repair centre. In parallel, other issues related to product development, production and spare parts are dealt between the suppliers' product development and sales units and the product (Final, Core) and service (Service) divisions at Heavy Machinery, as under the first interface. As different companies are expected to be able to conduct such repairs in general, the availability of local repair centres does not affect supplier selection as such.

The third kind of modified translation interfaces concerns an important component of Final's vehicles, Component X, for which only the original component supplier resides over the necessary resources for exchanges and larger repairs. Heavy Machinery sells accordingly only some consumables, such as filters, for the respective component, but does neither own component repair centres nor channel components to third parties. For all larger maintenance-related matters, Heavy Machinery advices its customers, such as Contractor, instead to take direct contact with Supplier X's component repair centres. Heavy Machinery and Contractor are accordingly highly dependent on the availability of component repair centres close to its operations, the coordination and quality of individual repairs and the supplier's pricing.[30] In addition, it is dependent on a concurrent view on the benefits and (opportunity) costs attached to either a "replacement with new" or "replace with repaired component" strategy (see Chapter 5.2.1).

Maintenance-related resource requirements limit accordingly also the choice of supplier. Supplier X has been selected due to the supreme geographical fit of its service workshops with the location of Heavy Machinery's

[30] The item in question is of such commercial importance that adverse pricing strategies of replacement components might make it impossible for Heavy Machinery/SalesOrg to sell vehicles in the first place (see Chapter 7.3.3).

customers. A potential supplier change would accordingly not only require both considerable technical changes in the vehicle design, but also high investments into new service workshops on the side of the new supplier or similar in-house competence on the side of Heavy Machinery. The relationship is, however, not completely unbalanced, as Heavy Machinery stands for a large market share of vehicles requiring the specific component. Supplier X might therefore experience efficiency problems at its production facilities and service workshops following a supplier change.

Coordination for Component X occurs both centrally in order to manage product and maintenance-related questions upfront and locally with regard to individual repair issues that might arise. The supplier has a global product unit with engineers and sales managers that liaise with Final's engineers and purchasers and a central aftermarket unit coordinating maintenance-related issues with Heavy Machinery's Service division. In addition, its local unit coordinates particular repairs directly with Contractor. Occasionally, SalesOrg might be involved in these local discussions, too (see Chapter 7.3.3).

5.3.2 Other customers to Heavy Machinery

Heavy Machinery's other customers also affect and are affected by the parallel exchange of product and maintenance-related resources between Heavy Machinery and Contractor. To begin with, customers naturally use Heavy Machinery's vehicles in a slightly different manner and accordingly have different ideas about which new product features Heavy Machinery should integrate into those. An example of this is that Heavy Machinery has historically prioritised site owners as customer group and their preference for speed over long service intervals of core components. As these preferences stand in contradiction to contractors', Contractor has purchased vehicles carrying the core component from a competing manufacturer. However, as contractors have become a larger customer group, Heavy Machinery has in recent years adapted its product development strategy to focus more on the length of service intervals. Furthermore, customers might require different customer-specific adaptations of existing machines, which might be incompatible with those required by other customers. Contractor's ability to convince Heavy Machinery of new product features and adaptations depends accordingly on its own commercial importance and the compatibility of its own demands with those of other customers (on other accounting studies with similar observations, see for example Dent, 1987, Håkansson and Lind, 2004, Håkansson et al., 2010).

Moreover, other customers to Heavy Machinery affect also the availability of important maintenance-related resources to Contractor. If other customers use the same or similar vehicles at sites in its proximity, this can serve as a reassurance to Contractor that SalesOrg has spare parts available at local warehouses nearby, trained its own service technicians and either invested into component repair centres or liaised with third-parties which are prepared to conduct the necessary work when needed.

5.3.3 Competing vehicle manufacturers

Heavy Machinery competes in the upper medium and premium market segment. While several smaller regional competitors exist, Heavy Machinery and its two major global competitors hold significant shares in this market. As mentioned before, Contractor buys different vehicle types from these three major manufacturers. It thereby benefits from the compatibility of maintenance-related resources between the different vehicle models of a certain type, sourced from a single supplier. At the same time, after some years of growth, Contractor could use multiple suppliers per vehicle type.

The relationship between Heavy Machinery and its major competitors is a complicated one. On the one hand, the firms compete fiercely with each other with the combined performance of their vehicles and accompanying maintenance-related resources. They have about the same technical and organisational resources for developing and producing vehicles. In addition, each of them disposes of significant maintenance-related resources, focused on supporting their own vehicle fleets.

On the other hand, the vehicle manufacturers share some of their suppliers for different reasons and even sell some non-critical parts to each other. Reasons for this are found in the characteristics of their own and supplying industries. In particular, there are just a few global manufacturers of the major components Heavy Machinery and its competitors source through modified translation interfaces. Neither Heavy Machinery nor its major competitors would have the resources to develop and produce all of these components on their own. It would only make their vehicles utterly expensive and therefore impossible to sell. In addition, the number of available suppliers is in some cases further reduced by the need to select suppliers with component repair centres close to customers. Heavy Machinery and one of its competitors have accordingly also traditionally relied on the same supplier for Component X.

5.4 Chapter conclusions

As the discussion proceeded above, a complex interface between Heavy Machinery and Contractor emerged. Some resources in this interface appear primarily connected to the development and production of the customer-adapted vehicles and similar to those discussed as translation interfaces in prior literature (see Chapters 2.3.3 and 3.3.1). However, a large number of additional resources are required to maintain Heavy Machinery's vehicles over their extended life cycles. Heavy Machinery and Contractor exchange for example large amounts of spare parts and labour hours as maintenance-related products. In addition, specialised facilities, such as maintenance workshops, component repair centres and global and regional distribution centres and warehouses, are required to support these maintenance-related product exchanges. These exchanges and the supporting facilities have also particular coordination demands. Both Heavy Machinery and Contractor entertain several specialised units that coordinate maintenance-related issues across their firm boundaries. In addition, several indirectly connected relationships are affected to significant degrees by maintenance-related coordination demands. These concern in particular those to component suppliers, but also those to other customers of Heavy Machinery and competing vehicle manufacturers. Furthermore, several different kinds of Independent Aftermarket Service Providers (IASPs) emerge in the capital equipment interfaces. These actors do not develop and produce any vehicles themselves, but provide maintenance-related products in competition to Heavy Machinery and its major vehicle-producing competitors.

The need to maintain capital equipment over its extended life cycles gives accordingly rise to a large number of additional technical and organisational resource interdependencies. Given the focus of this thesis, these observations give rise to follow-up questions on how the design and use of Open Book Accounting (OBA) between Heavy Machinery and Contractor might have to look like in order to support the management of these interdependencies. These questions are focused upon in the following two empirical chapters.

Chapter 6

The design of Open Book Accounting in the interface between Heavy Machinery and Contractor

The focus of this chapter lies on describing the Open Book Accounting (OBA) design applied in the interface between Heavy Machinery and Contractor. The chapter sets accordingly out by describing the data items Heavy Machinery and Contractor exchange with each other in order to manage their resource interdependencies. As their relationship is embedded with other firms, the second part of the chapter considers the influence of parallel information exchanges with additional participants, in particular between Contractor and Heavy Machinery's component suppliers, Independent Aftermarket Service Providers (IASP) and competing vehicle manufacturers. The data exchanged between Contractor and these indirectly connected firms poses a significant challenge to Heavy Machinery as it might cause doubt on and destabilise its information exchange with Contractor and reduce its ability to sell maintenance-related products. Heavy Machinery has accordingly implemented different means by which it indirectly reduces the likelihood and impact of these parallel information exchanges. Some of these build on co-operations with component suppliers and some are based on different kinds of internal adaptations in product development and logistics. These adaptations constitute an important part of the overall OBA design and are accordingly reviewed in the third part of the chapter. As usual, the fourth subchapter summarises the made observations.

6.1 The design of Open Book Accounting between Heavy Machinery and Contractor

6.1.1 Data items provided by Heavy Machinery to Contractor

Heavy Machinery provides Contractor with several data items. These include prices for vehicles and maintenance-related products and services, Life Cycle Cost (LCC) calculations, different indicators of opportunity and labour cost, operations and maintenance manuals and information on new product development projects.

Vehicle price

SalesOrg maintains general price lists for local "standard" versions of Final's different vehicle models. List prices include accordingly the local adaptations that are required for legal reasons, but not any customer-specific adaptations or discounts.

> "If they then want to go further, well, then we obviously talk about the options they want and how many machines they want to buy. And then, we make a structured discount based on volume or, you know, we may offer some spare parts or we may offer some technicians on site. Thus, it generally comes down to that you've got to qualify the customer. (…) So there is quite a bit that goes into it. We don't just straight price it out there and open the bid. We are trying to understand what they need to get the job done, and we try to tailor our offer the best we can." Business line manager, SalesOrg, Final

Much time is accordingly spent on identifying the quantity and types of vehicles that are required for a new site or as replacements, specific adaptations Contractor demands and any maintenance-related products it wants to have included in the initial offer price. SalesOrg can price some of the vehicle adaptations quite easily, as they are similar to those made on the same or similar vehicle models for Contractor and/or other customers before. Otherwise, costs for components, their engineering and fitting and connected warranties are investigated and added to the vehicle list price. The kind and number of included maintenance-related products varies greatly between vehicle types and Contractor's prior experiences with the respective vehicle type. If Contractor purchases a particular vehicle model for the first time, it usually asks for a number of replacement components and some training of its operators and maintenance staff to be included. As part of the discussion, Heavy Machinery tries also to understand which potential discounts might create most value for Contractor.

List prices of the individual elements of a particular offer might be taken up with Contractor in order to illustrate their value and the implicitly offered discount. Associated cost information of the included products are, however, never shared with Contractor. Interestingly, the key account manager presenting the offer to Contractor does also not have access to this information himself. The offers are prepared by Final's business line and product managers at SalesOrg in cooperation with global marketing units and presented to him in the same format as he forwards them to Contractor, without any margin information. As customers have historically formed their equipment purchasing decisions based on vehicle prices, vehicles have been priced highly competitively.

Prices for spare parts, labour of service technicians and supplementary maintenance-related products

Initial vehicle sales are naturally followed by a large number of transaction episodes over the vehicle's life cycle as part of which maintenance-related products are exchanged. Competition law generally precludes the upfront binding of vehicle sales to the sale of service contracts. At the time of the study, Contractor did also not use any such service contract itself.[31] Pricelists

[31] Law precludes the upfront binding of machine and service contract sales. The two elements can of course still be offered separately. Heavy Machinery provides accordingly also some service contracts for its vehicles. These focus either on particular components or the complete vehicle and either include only spare part related cost or even all necessary labour cost. These service contracts benefit also from the general OBA design as applied between Heavy Machinery and Contractor as it stabilises their pricing and provides Heavy Machinery with certain sales and performance related advantages compared to its competitors in the aftermarket.

for spare parts, labour and supplementary maintenance-related products are accordingly important to assign an economic value to individual, maintenance-related transaction episodes.

Heavy Machinery applies a global pricing strategy for the 150,000 components and subcomponents it sources and distributes as *spare parts* via its global distribution centres. Global standard prices follow an overarching structure that specifies value drivers for homogeneous groups of spare parts. The pricing of a particular filter might for example depend on whether it constitutes a main or secondary filter, its filter medium and size. Heavy Machinery's spare parts pricing is accordingly independent of the purchase cost of a part and its original supplier. Global standard prices are adapted to the geographical market in terms of currency and purchasing power and to the specific customer by applying a structured discount based on the customer's annual spare parts purchasing volume.

This formal approach to spare parts pricing is motivated by considerations of internal consistency and the competitive situation. Internal consistency helps to avoid incidences of customers questioning the pricing of a particular part based on the pricing of another, similar part and limits grey imports from other countries. In addition, the structured approach helps to extract the maximum price for a particular part, given its particular competitive situation.

The spare part prices offered to Contractor are revised once per year and communicated as customer net prices.[32] Specific reasons for price changes are usually not provided.[33] While SalesOrg resides over its volume-based discount schemes, it has itself also no insights into why prices of specific parts are changed by Service's global pricing unit. The raw material of individual parts is also not specified. Due to the large number of part numbers and prices, Contractor checks individual part prices in Heavy Machinery's online catalogue or by calling the local warehouse closest to its respective site.

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[32] With some of its customers, Heavy Machinery signs agreements as to which it does not adapt its net customer prices in local currency for certain spare parts over a certain amount of time, usually 1-3 years, if the customer signs up to a service agreement. Contractor has, however, not signed any such agreement.

[33] Exceptions might be drastically changing exchange rates between the currency in which Service's global distribution centres source parts from suppliers and the local currencies in which SalesOrg bills its customers. As exchange rates have been rather stable for the respective countries, such changes have, however, not been implemented during the studied period.

Service technician's *labour* is charged in two different ways by Heavy Machinery. The first variant applies when Contractor asks Heavy Machinery to support their maintenance workshops with service technicians for a given amount of time. Service technicians' labour is then charged based on the booked time, multiplied by the applicable hourly labour rate. Any potential travel costs and consumed spare parts are added to this sum, too. SalesOrg communicates the applicable labour rates per workshop and qualification level of its service technicians to Contractor once per year. No customer-specific discount is offered on labour charged this way. The exact calculation of applicable labour rates remains internal to SalesOrg.[34]

The second variant of pricing labour applies for components repaired at component repair centres and larger vehicle overhauls. In these cases, a fixed price might be offered for the respective repair. The fixed price is calculated based on the expected time for the repair, multiplied by the applicable labour rate for service technicians employed at the component repair centre, and expected spare part consumption. A particular discount might be applied on the sum of its parts, depending on the competitive offers by IASPs at the specific site of Contractor. On the initiative of the regional service sales manager, such discount offers are prepared by product managers for maintenance-related products and authorised by the business line manager for Service at SalesOrg.

Supplementary maintenance-related products might or might not include a tangible product as well as a labour part. They are accordingly charged in a similar manner as either spare parts, flexible or fixed price repairs.

Life Cycle Cost calculations

While Heavy Machinery has always provided customers with vehicle prices and prices of maintenance-related products and services, it got confronted with requests for an additional set of information about ten years ago: information on the Life Cycle Costs (LCC) of its vehicles. Falling together with

[34] The internal calculation is, at the same time, as common in the industry, based on a few elements: the salaries for service technicians (incl. social insurance costs and holiday allowances), overhead cost allocations, the number of productive hours for the year (excluding any internal training) and a relatively low profit margin.

the first signs of a downturn in the industry, the information demand marked a change in customers' buying behaviour that was there to stay.

> "I think the market was not particularly mature before. Instead, one bought machines from a known brand. (Heavy Machinery), one knew that we had good machines, one got the production speed and productivity one expected to get. And, I think, one still buys much like this today. However, today, one wants to support the choice and to be able to compare models and manufacturers much, much more and in a different way. The industry has matured a lot during the past years. Before, one did not care that much about prices in certain segments. It was not important." Global Fleet Manager, Service

This industry-wide change has also been reflected in the relationship between Heavy Machinery and Contractor. Before buying its first vehicles from Heavy Machinery, Contractor requested detailed LCC calculations from Heavy Machinery, adapted to the site on which it intended to use the machines. Since then, LCC calculations have been commonly exchanged in connection to vehicle purchases and Contractor's tenders for specific jobs.

Heavy Machinery's LCCs give an indication of "the running cost on certain componentry over the life of that machine"[35] in terms of spare part-related cost. LCC calculations generally follow a two-dimensional structure. Columns show the expected component-related costs accruing during a particular future year for a specific vehicle, depending on its age and its assumed use during the year. The forecasted costs are broken down by subsystem in the rows below, thereby following a maintenance-perspective.[36] All components and subcomponents related to the breaking system or core component are for example listed under their respective categories.

Customers can receive the calculations both in an overview or detailed format. The overview format (Figure 3, page 137) lists the subtotals of the respective categories, while the detailed format provides a complete

[35] Product manager, Service, SalesOrg

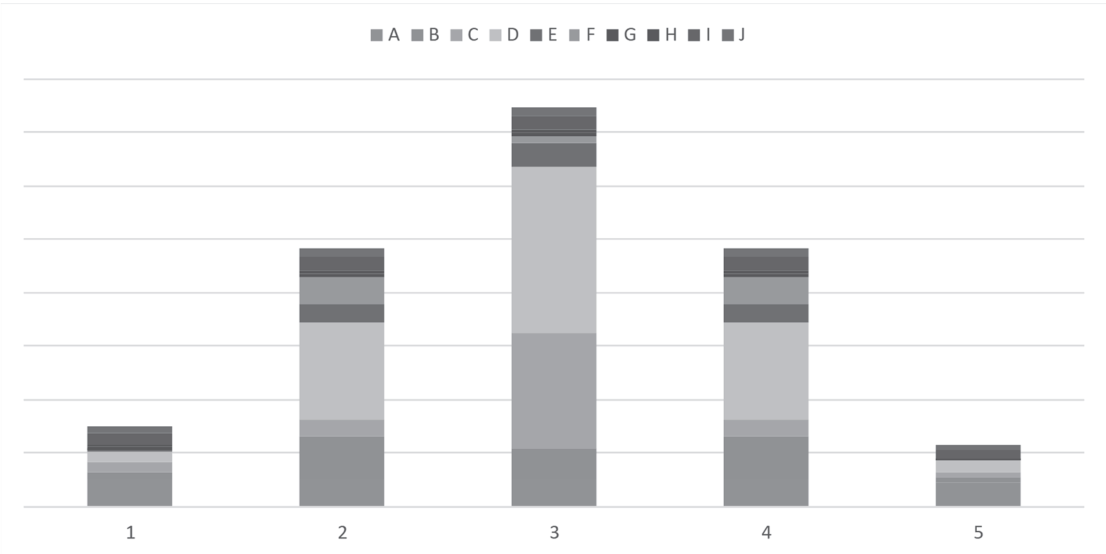
[36] This contrasts to a production perspective where cost breakdowns are structured according to the bill of material of a particular vehicle module, supplied by a contract assembler or produced internally. Modules naturally include parts of many different subsystems. The maintenance-focused structure shall facilitate the tracking of errors (e.g. breaking system shows potential problem) to their causes (e.g. a valve in the breaking system requires replacement) and the tracing of costs on the level of the respective sub-system (see also Chapter 7.1).

Figure 3 Illustration of a Life Cycle Cost calculation for a particular vehicle model in the overview format – 5-year model

ENGINE HOURS		
	From	**To**
Year 1	xxx	xxx
Year 2	xxx	xxx
Year 3	xxx	xxx
Year 4	xxx	xxx
Year 5	xxx	xxx

ESTIMATED CONSUMED MATERIALS OPERATING EXPENDITURE					
	1	**2**	**3**	**4**	**5**
A	xxx	xxx	xxx	xxx	xxx
B	xxx	xxx	xxx	xxx	xxx
C	xxx	xxx	xxx	xxx	xxx
D	xxx	xxx	xxx	xxx	xxx
E	xxx	xxx	xxx	xxx	xxx
F	xxx	xxx	xxx	xxx	xxx
G	xxx	xxx	xxx	xxx	xxx
H	xxx	xxx	xxx	xxx	xxx
I	xxx	xxx	xxx	xxx	xxx
J	xxx	xxx	xxx	xxx	xxx
Oils & Lubricants	0	0	0	0	0
Fuel	0	0	0	0	0
Tyres	0	0	0	0	0
Total	xxx	xxx	xxx	xxx	xxx

Figure 4 Graphical illustration of the Life Cycle Cost of a particular vehicle model – 5-year model



specification of the spare parts that are to be consumed and the related costs per article. The information is also illustrated in accompanying figures that show the development of spare part related cost over time (Figure 4, page 137).

Depending on the purpose, Heavy Machinery might provide *"theoretical"* or *"practical"*[37] LCC calculations. Theoretical LCCs are based on Heavy Machinery's assumptions, while practical ones are based on the actual running cost of the respective vehicle model at a certain customer. Practical LCCs are accordingly regarded as more credible by customers. Their exchange is, however, naturally complicated due to their competitive sensitivity. As contractors compete in tenders, they do neither want that their competitors nor their customers (site-owners) learn about their cost levels and choices in terms of vehicles and operations and maintenance practices that drive potential differences. Similarly, as site-owners require their operations departments to compete with external contractors for jobs at irregular time intervals, those are also opposed to the sharing of internal data with their (potentially future) external competitors. While Contractor and other customers accordingly regularly provide Heavy Machinery with some details on its LCC, it is understood that Heavy Machinery does not forward those to other customer without their explicit consent. The exchange of practical LCC calculations is accordingly limited to the relatively few vehicle models used on sites at which Heavy Machinery performs all maintenance-related activities itself in the form of full-service contracts. In these contexts, the exchange of the related information is regarded as less sensitive as maintenance-related choices are primarily formed by Heavy Machinery and not its customers.

Theoretical LCC calculations can be standardised or specifically adapted to the customer. *Standardised, theoretical LCCs* give customers an indication of the maintenance-related costs of brand new "standard" vehicles and based on assumed "standard" operations and maintenance practices in SalesOrg's region. As discussed before, "standard" vehicle configurations include adaptations that are required from a legal point of view in SalesOrg's region, but not any customer-specific adaptations. Standard operating practices assume a certain amount of hours in operations by well-trained operators on sites

[37] Words used by Contractor's general manager in an observed discussion with a key account manager and a product manager of Heavy Machinery.

with specific variables. Standard maintenance practices, in turn, foresee for example the exchange of used components with new components in contrast to the use of repaired or service exchange components. In order to avoid heated discussions with customers, these "standard" configurations and practices are defined with considerable prudence and stated explicitly in accompanying disclaimers. Any customer-specific discounts are also not considered in standardised, theoretical LCCs.

Heavy Machinery and Contractor mostly use *specifically adapted, theoretical LCC calculations* in their relationship. Calculations are accordingly adapted to the resources in their interface, in particular the specific vehicle design, Contractor's use of the vehicle, Contractor's operating and maintenance practices and the local pricing of SalesOrg (on the complexity of spare parts supply, see also Table 7 in Chapter 5, page 107). To begin with, the LCC calculation considers the particular vehicle design, including some of its major customer-specific adaptations. In order to arrive at a realistic LCC, service interval lengths and related spare part costs are estimated for most vehicle components that require preventive or corrective maintenance.[38] Component-level design differences across vehicles are thereby also considered.

Second, the calculation is also adapted to Contractor's use of its vehicles and operational settings. Contractor's use is for example specified in terms of how many hours it has used the vehicles before, how many hours it aims to use the vehicle during a subsequent year on average, the number of years it plans to use them and their exact application. Moreover, Contractor's operational setting is also considered, for example in terms of its climatic conditions and the skill level of its operators.

Third, the calculation is adapted to Contractor's maintenance practices, in particular how closely it follows Heavy Machinery's recommended practices, whether it exchanges components with new or repaired ones and

[38] The required spare part need and timing can be assumed with some certainty for preventive maintenance items. For corrective maintenance parts, the occurrence of the required repair is also given, while its exact timing can be more uncertain (see Chapter 5.2.1). Accordingly, the related spare part need can be forecast for these components with some certainty, too. The timing of the corrective maintenance is however usually based on best guesses. Resealing of hydraulic cylinders might accordingly for example be assumed to occur once in the middle of the component's life cycle of 12,000 operating hours. It can, however, naturally occur at 4,000 or 7,000 operating hours. The connected potential inadequacies with regard to the timing are known and accepted by customers.

whether it uses any service exchange agreements. This latter choice takes accordingly care of both Contractor's own preferences as well as the maintenance-related resources available at SalesOrg and indirectly connected component repair centres.

Finally, the calculation is also adapted to SalesOrg's pricing. At SalesOrg, this concerns in particular the local pricing and customer-specific discount offered to Contractor.

Theoretical, specifically adapted LCC calculations consider accordingly many of the complexities involved in the interface (see Table 7 in Chapter 5, page 107) and allow a very specific and detailed overview of some of the related costs. At the same time, they remain an *incomplete representation of all vehicle- and maintenance-related costs*, as they exclude costs related to some important resources. As Contractor knows about these limitations, it can however collect the information from its own accounting systems, Heavy Machinery and third parties (Table 10).

Table 10 Cost elements not included in Life Cycle Cost calculations

1	Machine price, potential salvage value and tax refunds
2	Spare parts not sold by or prioritised by Heavy Machinery and/or not considered regular maintenance items
3	Operator costs
4	Fuel and energy costs
5	Investments into maintenance workshops and warehouses
6	Labour costs
7	Opportunity costs arising during scheduled maintenance or unexpected breakdowns

First, the price of the vehicle, its salvage value and any tax refunds based on its depreciation are not included in the calculation. Contractor receives the sales price, including the costs of specific vehicle adaptations, separately from Heavy Machinery. Heavy Machinery does, however, not provides any guarantees for salvage values or any information on depreciation amounts as depreciation schedules differ largely among its customers, depending on their life cycle expectations and tax schemes.

Second, some components are excluded from the LCC calculation. These concern parts that Heavy Machinery does not offer (e.g. tires, overhauls or exchanges of Component X), Contractor generally buys from other sources (e.g. oils and greases) and components that are not considered regular maintenance items.

> "We do for example not include seats, armrests, rear mirrors, window panes or windscreen wipers (in the life cycle cost calculation) because they are no regular maintenance items. But, I do not say that they do not get broken. They do under guarantee get broken. But it has nothing to do with maintenance. It is as if you buy a car today and get a life cycle cost calculation with it. I promise you, there are no windowpanes, rear mirrors or mats included, as these should not get broken in "normal operations", when you drive your car or operate your machine."
> Global Fleet Manager, Service

Third, any costs related to operators are excluded from the calculation. This is so as Heavy Machinery does not get involved in its customers' operations and staffing decisions.

Fourth, no fuel and energy costs are included in the calculation. Heavy Machinery provides only some general, separate values for fuel and energy consumption. This is so as fuel and energy consumption can differ largely depending on operator skills and, as in the case of Contractor, site-owners often pay separately for fuel and energy. The related cost is accordingly irrelevant for Contractor when evaluating vehicles.

Fifth, any investments into maintenance workshops and warehouses are excluded due to the involved complexities. Some site owners might for example provide contractors with workshop space and some equipment, while others do not. As part of its product design process, Heavy Machinery aims to avoid the need for particular workshop equipment and therefore usually expects its customers to have generally equipped workshops in place. The size of stocks depends mainly on the distance from the site to Heavy Machinery's distribution centres and warehouses and the stock available from there. Heavy Machinery aims to match its stocks with customers' vehicle fleet and to deliver the required spare parts as quickly as possible, minimising the need for customers to keep excessive stocks themselves. The related investments are accordingly seen as comparable across vehicle manufacturers and vehicles and thus negligible in comparisons.

Sixth, any labour costs required for conducting maintenance work is excluded from Heavy Machinery's cost models. This is explained by the complexity involved in calculating required labour, travel times of service technicians and complexities on the maintenance workshop level. The calculation of required labour is for example complicated by that it does usually not only take time to exchange an individual component, but also to access and disconnect it from interfacing components. Any assessments of labour would accordingly need to be based on specific time and motion studies for each individual vehicle and each conceivable maintenance operation. Neither Heavy Machinery nor any of its vehicle producing competitors do at the moment have the resources to conduct such studies. In addition, time spent travelling by service technicians and associated travel costs can be substantial and differ largely, depending on the location of the closest maintenance workshop. Moreover, customers usually consider a range of additional factors than those related to particular vehicles when planning the staffing of their own internal maintenance workshops. These include the need to correct any unexpected breakdowns, requiring permanent staffing, different staff categories besides service technicians (e.g. maintenance planners, logistics staff) and the sharing of maintenance resources across different kinds of equipment, sourced from different suppliers. Heavy Machinery can generally provide checklists that help calculating labour cost. Contractor, however, prefers to use its own models to calculate these costs.

Finally, opportunity costs that arise when customers cannot use their vehicles due to maintenance or unexpected breakdowns are ignored. This negligence is motivated by the complicated nature of calculating opportunity costs related to machines that form part of a larger production system.

Indicators of opportunity and labour cost

In order to make it possible for Contractor to assess the size of opportunity and labour costs, Heavy Machinery provides several other data items. Those include indicators of expected machine availability, the service interval lengths of major components, the ease of serviceability of vehicles and the availability of maintenance-related resources.

When asked, Heavy Machinery can for example provide some indicators on *machine availability* through expected values for meantime between failure (MTBF) and meantime to repair (MTTR) over the life cycle of machines. At the beginning of the life cycle, meantime between failure is relatively high and meantime to repair low, translating into a high overall machine availability. During later years, for which larger overhauls are scheduled, meantime between failure is naturally lower and meantime to repair higher, followed by a change to similar values as at the beginning of the vehicle's life cycle.

A second set of data that customers demand and critically review are the *service interval lengths* that Heavy Machinery advises for the replacement of major vehicle components, such as core components, engines or transmissions, as these correspond to relatively long machine downtime and connected opportunity cost.

When considering the purchase of new vehicles for a particular project, Contractor demands also information about the *ease of serviceability of the specific vehicle in question* from Heavy Machinery. Information to these ends is in particular collected through informal "vehicle audits", as part of which Contractor visits SalesOrg's vehicle delivery centre and inspects vehicles of the type it considers buying.

> **General manager, Contractor:** "Ok, so how do I need to service the (specific vehicle model)?"
> **Product manager, Final:** "Well, it is a weekly small service in the workshop and then with X hours."
> **General manager, Contractor:** "Ok." (Looking at colleague)
> **Maintenance manager, Contractor:** "Yeah, that's what we usually do."
> **General manager, Contractor:** "Ok, so where and how do we service the machine?"
> **Product manager, Final:** "Yes, we positioned all the parts you need to service on this side of the vehicle over here." (Switching sides of the vehicle)
> **General manager, Contractor:** "Oh, that's nice." (Looking at the parts that are accessible on that side of the vehicle by opening and closing the respective hoods) – "Ok, maybe, we should also get up onto the vehicle." (Climbing onto the vehicle with product manager to inspect the placement and ease of serviceability of further components.) (Observation of customer meeting, 2015-04-21)

Besides inspecting the physical placement of components, Contractor asks a range of additional questions during these audits on *the availability of maintenance-related resources*. These include questions on the geographical location of other vehicle users, what this means in terms of the location of spare part stocks required to maintain the vehicle and whether Heavy Machinery is prepared to invest into additional stock at its closest local warehouse if Contractor bought the vehicle. Moreover, it asks Heavy Machinery to specify the supplier Component X in order to assess the available support from the supplier's local service organisation.

Operations and maintenance manuals and spare part books

With every vehicle Contractor buys, it also receives specifically adapted operations and maintenance manuals and spare part books from Heavy Machinery in both printed and soft copy formats[39]. Operations manuals describe the functions of the vehicle and their operating requirements, while maintenance instructions provide information on for example recommended service intervals. Spare part books, in turn, include exploded views of the vehicle, its modules, components and subcomponents. Based on the drawings and accompanying part lists, Contractor's service technicians can accordingly identify individual parts and understand how they are connected with each other. They find also information on whether individual parts are sold as spare parts and in which form: individually, as part of a larger assembled component or as part of a kit including several parts. Spare part books state also Heavy Machinery's article numbers under which the respective parts can be ordered. As the main objective is to ease operations and maintenance, the technical information is kept on an overarching level with no details on the design of specific components being provided.

Information on new products: systematic interviews, prototype reviews and testing

Heavy Machinery is highly restrictive about information on new products and base development projects it carries out. Both key account managers and their customers usually only learn about new vehicles and core components

[39] Machines are delivered with a printed copy and several USB sticks which entail an identical soft copy.

when these are released onto the market, often at larger trade fairs. In the case of Contractor, some other forms of systematic interaction exists, however, with regard to new products.

First, Heavy Machinery regularly interviews important customers in a systematic manner in order to learn about their perception of its products and, in particular, how they compare to major competitor's products. These interviews are directly carried out by Final's and Core's global marketing teams. An example are "card games" in which customers, such as Contractor, are asked to rank the importance of certain features and to then assess how Heavy Machinery's machines compare to those of one of its major competitors the respective customer is most knowledgeable about.

Second, when Heavy Machinery has developed a new vehicle or core component, it verifies its design with selected customers by means of prototype reviews and tests. As part of prototype reviews, customers are invited to Final's product development facilities in order to critically review the serviceability and functional design of a new vehicle model. The objective is to correct for potential problems that otherwise might come up as challenges in "vehicle audits" when customers make purchase decisions. A certain number of vehicles and core components are also directly tested at customers for about a year during prototype tests before serial production starts. The aim of these tests is to detect any design related problems and to record maintenance-related costs in practice.

Heavy Machinery applies utmost care when selecting customers for prototype reviews and tests. Global marketing units contact business line managers of regions in which customers are known to use similar equipment. These contacts are accordingly selective and take only place once the design has been finalised and reviews and tests are planned in detail. As part of these consultations, potential customer candidates are critically reviewed. Customers should be considered "close" to Heavy Machinery, fulfil certain operations and maintenance-specific criteria, be known in the industry and agree on being named in marketing material. Moreover, the particular test site should be located close to one of Heavy Machinery's maintenance workshops and competitive activity, both from competing vehicle manufacturers and IASPs, should be very low or non-existent to minimise the spread of rumours and technical information before the vehicle's official launch. Customers that match these criteria are accordingly short listed. Only when their choice becomes confirmed by global marketing units, responsible key account managers and their customers are contacted. Customers that participate in specific prototype tests need to sign stringent confidentiality agreements and other contractual documents specifying how the tests are to be conducted, which data is to be recorded and transferred to Heavy Machinery and guaranteeing site access to Heavy Machinery's staff. Customers are at the same guaranteed spare part supply and a certain machine availability in connection with these tests. At the time of the study, Contractor has been involved in several prototype reviews and tests. Some of these have involved the product types it has not bought from Heavy Machinery before.

6.1.2 Data items provided by Contractor to Heavy Machinery

In exchange for this information, Contractor provides Heavy Machinery with different data items. These include information on current tenders and future vehicle demands, the current status of their vehicles and different kinds of feedback.

Information on current tenders and future vehicle demand

Future vehicle demand is either driven by new tenders in which Contractor participates and as part of which it will require new vehicles or replacement purchases. Tenders have usually short timelines included. The winner of a tender scheduled to begin in September might for example only be announced at the end of June. Given the long lead-times for vehicles, Contractor accordingly usually prepares its tenders with utmost care, discussing individual vehicle configurations, delivery schedules, prices and LCCs with Heavy Machinery. In a similar manner, Heavy Machinery regularly reviews with Contractor the age of its fleet and potential replacement purchases. This provides Heavy Machinery with a clear indication of its future sales potential for new equipment.

This information is highly sensitive. If Heavy Machinery for example informed other contractors on Contractor's choices in terms of vehicles and operations and maintenance practices, this might reduce its possibility to win the tender. Heavy Machinery tries to minimise the spread of information and rumours among its customers by assigning different key account managers to them. The key account manager responsible for Contractor does for example not cater any other larger contracting customers.

Current vehicle status

Heavy Machinery puts great emphasis on collecting information on the current status of Contractor‘s vehicles. This concerns in particular information on the number of operating hours of all vehicles and certain major components, their current geographical locations and whether they are currently in use, parked up or undergoing a larger overhaul at a workshop. The information is collected via service sheets in which service technicians document their work, via mobile phone applications that service technicians and key account managers draw upon when visiting customers and phone and e-mail contact between maintenance staff. The collected information is stored centrally in Heavy Machinery's fleet management tool, FleetData, which also contains additional information on the vehicles, e.g. their date of production and commissioning and the article and serial numbers of their major components. In recent years, Heavy Machinery has extended its tools so that it can also collect information on vehicles Contractor has sourced from competitors.

Feedback on spare parts pricing and labour rates

As spare parts and connected labour constitute the vast majority of the overall costs of a vehicle, customers frequently comment on their pricing. As Heavy Machinery applies a value-based, premium pricing strategy, it is important to distinguish between unjustified, general critique on its pricing and legitimate claims.

> "A lot of our sales people are closely aligned with our customers and the customers will tell them the price is too high. I tell the sales people. "If I hear a customer telling me that our prices are OK or that they are cheap, then I know that you aren't doing your job properly." So the more noise that I get from them that the prices are too high, means that we are not underselling our parts." Business Line Manager, Service, SalesOrg

In contrast to unjustified, general critique, legitimate claims are characterised by the information customers provide. Heavy Machinery expects Contractor accordingly to provide the article number of the concerned part, the name of the competitor selling this part cheaper, its price, preferably in the form of a concrete quote and information on the required quantity. In addition, Heavy Machinery expects Contractor to provide an indication of the price it would be prepared to pay to receive it directly supplied by Heavy Machinery. Legitimate claims might accordingly primarily include information from competing vehicle manufacturers selling similar parts as spare parts for their own vehicles and sub-suppliers to Heavy Machinery competing in the aftermarket. They might also involve IASPs. In order to underline the credibility of its claims, Contractor has then, however, to prove that the involved parts are either genuine or, in the case of non-genuine copies, of comparable quality in terms of design and service interval length.

Receiving legitimate feedback on parts pricing is seen as important and a sign of a good relationship with Contractor as it gives Heavy Machinery the possibility to act and show its sincerity in the relationship. Spare parts pricing is accordingly also a recurrent matter that is never taken off the agenda of the monthly coordination meetings between Heavy Machinery and Contractor. In addition, Heavy Machinery tracks Contractor's individual, phone-based spare part price enquiries and analyses their conversion into actual orders. Based on the assumption that Contractor only inquires about the price of a part when it needs it, unconverted quotes are seen as indications of a potential pricing issue. In particular if the connected commercial value is high, they might accordingly be taken up with Contractor.

Feedback on Life Cycle Cost calculations

In its internal Enterprise Resource Planning (ERP) system, Contractor tracks the performance of individual machines, their consumption of spare parts and maintenance-related labour costs. It has therefore a wealth of information based on which it can provide feedback on Heavy Machinery's LCC calculations. This feedback comes in different kinds of formats and can relate to complete machines as well as specific components. As noted before, Heavy Machinery is free to analyse this data along similar information obtained in parallel from other customers. It is, however, not allowed to pass the information on to other customers without Contractor's explicit consent.

The first format concerns *general comparisons* of Heavy Machinery's LCC calculations with the costs internally recorded at Contractor. The following dialogue, observed right at the beginning of a customer meeting, is representative of this.

> **Key account manager, SalesOrg:** "So how is the LLC tracking going? Are we doing OK?"
> **Maintenance reliability manager, Contractor:** "Yes, and we are following the suggested costs so far pretty closely."
> **Key account manager, SalesOrg: "**That is great to hear. Would you be able to share that data with us at some time? We are really interested in getting better estimations of the costs related to our machines and to decrease them."
> **Maintenance reliability manager, Contractor:** "Yes, we match the costs, so no problem so far."
> (Observation of customer meeting, 2015-04-25)

The second format concerns *feedback on specific spare parts* that require more maintenance compared to the model. An example are gear selectors, which held only several hundred hours in Contractor's vehicles instead of the vehicle's whole lifetime as suggested in the LCC model and had a list price of several thousand Euros. As part of the investigation, further data from Heavy Machinery's sales system and the diagnostic tool was collected to verify the issue.

The third format concerns the regular *provision of extracts from Contractor's ERP system* on encountered failures and performed repairs on its different vehicles.

The fourth and final format concerns the discussion of *LCC targets for individual major components* that Contractor wishes to achieve. One of the reviewed targets has for example concerned Component X.

Feedback on machine availability and logistics performance

As all customers, Contractor tracks closely and occasionally takes up indicators on machine availability (meantime to repair, meantime between failure) and Heavy Machinery's logistics performance with regard to spare parts. In the latter context, the measure of Delivered In Full On Time (DIFOT) is actively monitored and discussed. It describes the percentage of spare part orders that have been fulfilled on time and with all ordered parts included. It is accordingly indicative of Heavy Machinery's stock levels and effectiveness in order fulfilment. A low number indicates supply chain disruptions, which might result in higher opportunity costs experienced by Contractor as it cannot repair its machines when needed.

6.1.3 Synthesis

Heavy Machinery provides Contractor accordingly with a range of data items that can be seen as directly connected to the resource interdependencies in their interface. Price information concerns for example not only vehicles, but also spare parts, labour of service technicians and supplementary, maintenance-related products. As the need for these maintenance-related products varies between vehicle types, vehicle generations and suppliers, Heavy Machinery provides also additional information in the form of LCC calculations that are specifically adapted to the vehicle design, Contractor's use of the vehicle, available maintenance-related resources and their local pricing. Moreover, Heavy Machinery provides indicators that enable Contractor to assess labour and opportunity costs. In addition, Heavy Machinery provides operations and maintenance manuals and spare part books and involves Contractor in selected product development projects.

In return, Contractor provides Heavy Machinery also with data items that might be regarded as fitting well with the involved interdependencies. It provides for example information on future vehicle demands and the current status of its vehicles and provides feedback on spare part pricing, life cycle costs and machine availability and logistics performance.

Two interesting observations follow from this. First, particular precautions appear to be taken to limit the spread of information to other buyers and suppliers of capital equipment. Second, all commercial information appears to be based on customer-specific prices and technical information appears to be adapted so that it facilitates the operation and maintenance of vehicles, but not a detailed understanding of their technical design. This might be explained by Heavy Machinery's interest to extract the maximum of the "team effects" (Alchian and Demsetz, 1972) it creates on the level of the "overall package" by means of its premium pricing strategy. Nevertheless, Heavy Machinery is regularly challenged in its pricing by Contractor. In order to substantiate its claims, Contractor provides information from component suppliers, IASPs and competing vehicle suppliers. Accordingly, much of Heavy Machinery's ability to stabilise its pricing strategy and corresponding life cycle cost calculations with Contractor appears to depend on how well it manages its relationships with these indirectly connected firms. The next two subchapters will accordingly focus on this aspect.

6.2 The design of parallel information exchanges between Contractor and "uninvited" participants

At the time of the study, the interface between Heavy Machinery and Contractor has been characterised by increased cost pressures, improvements in material analysis and flexible manufacturing techniques and the internet as a communication medium (see also Chapter 5.2.4). These developments have facilitated, among other things, the establishment of parallel information exchanges between Contractor and Heavy Machinery's own component suppliers, Independent Aftermarket Service Providers (IASP) and competing vehicle manufacturers. While Heavy Machinery does not take part in these exchanges, they affect indirectly the information exchange it entertains with Contractor. This subchapter describes accordingly the basic data items Contractor exchanges with these – from the perspective of Heavy Machinery – "uninvited" participants.[40] The next subchapter reviews then the different means that Heavy Machinery has implemented with the intention to reduce the likelihood and impact of these parallel information exchanges.

[40] A reminder on the methodological choices described in Chapter 4 appears due here. It is important to note that the description in this subchapter is based on the description of Heavy Machinery on the information exchange between its customers, in particular Contractor, and these third parties. As Heavy Machinery is not part of the information exchange itself and neither Contractor nor these other parties have been interviewed, only the basic characteristics of their OBA exchanges can accordingly also be recorded here. See also the future research section in Chapter 9.3.

6.2.1 Data items shared between Contractor and Heavy Machinery's major component suppliers

Most suppliers of major components which interact with Heavy Machinery through modified translation interfaces (see Chapter 5.3.1) entertain either own component repair centres or cooperate with independently owned repair centres, such as those of ComponentRepairer.

The information exchanges between Contractor and these firms are based on two basic data items: "identifiers" revealing the identity of components and subcomponents and price information. By default, component suppliers might "smuggle" different kinds of identifiers on their components and subcomponents and packaging past Heavy Machinery to its end customers. These include in particular their brand names and article numbers.

> "Some of the issues that we have and we haven't been able to get on top of is that we will get some parts from a supplier and it will be branded in the supplier name. We will get it and we will then generate a part number in our store. Our customers buy it on that part number, it will go out still with their (i.e. the supplier's) brand on it. So once they have bought it once, they know what it is. It's got the company, it's got their part number, not our part number, our part number might be a sticker on the side, and then, after that they have seen the price variance from a local vendor, we have lost that business." National Business Development Manager, SalesOrg, Service

Other identifiers include the serial number on the component itself and the name of the component family group to which a certain component belongs. Own or certified repair centres can interpret serial numbers with the help of warranty databases and thereby receive access to the exact specification of the part. While the component family name is insufficient to source a specific component that might be further adapted to Heavy Machinery's functional and interface requirements, it can be sufficient to identify commonly exchanged subcomponents, which are shared across components within the family. An example are filters and other consumables that can be identified easily based on, for example, the engine family.

> "So just because your filters are with (Heavy Machinery) written on them doesn't mean the fitter doesn't know what the filter is. (…) It's because they know what the engines are, because you can't change an engine. You get a fitter that had more than two minutes experience, he is gonna say (component supplier's family name) just from looking at one end of it. He is gonna know what it is. (…) Electronically we do program them, but that's just a matter of a PC connection. The physical part of the engine is not changed. It is a generic engine that you can buy anyway. But that also comes down to the parts." Strategic Purchasing Manager, SalesOrg, Service

Based on the provided information on the part or its packaging, customers can accordingly identify the part and ask for competitive price information from the supplier or independent component repair centres, such as ComponentRepairer. Likewise, in Heavy Machinery's relatively concentrated industry, the owners of such vehicles are also easily identified and can be contacted proactively with price information by suppliers and IASPs.

6.2.2 Data items shared between Contractor and Independent Aftermarket Service Providers

Heavy Machinery is also challenged by the OBA information exchanges Contractor entertains in parallel with different kinds of Independent Aftermarket Service Providers (IASP, see Chapter 5.2.4), in particular CoreIASP and FinalIASP. These produce non-genuine copies of mechanical parts that Heavy Machinery designs internally and either produces internally or sources through specified interfaces. They thereby focus in particular on parts that are installed on a large number of vehicles and require regular exchange, are not critical for work safety[41] and do not lead to any larger systemtic failures when exchanged. CoreIASP and FinalIASP use these parts in their own core component and vehicle repairs, but sell them also directly to Contractor and other IASPs, such as VehicleRepairer. In addition, they try to source parts that they cannot produce themselves directly from Heavy Machinery's component suppliers and forward these to their customers.

[41] This excludes for example parts of the steering and breaking systems.

The information exchange between Contractor and IASPs builds in particular on four data items: Heavy Machinery's original article number as an identifier, Heavy Machinery's price list and CoreIASP and FinalIASP's own part prices, labour rates and claims on the service interval lengths of their parts. According to competition law, IASPs have the right to market genuine as well as non-genuine parts under the vehicle manufacturer's original article number. Their catalogues and websites list accordingly parts by Heavy Machinery's original article number. In addition, they can access price information by either asking Heavy Machinery for direct quotes or by collecting price information through their customers.[42] In SalesOrg's region, CoreIASP and FinalIASP accordingly systematically place their own spare parts pricing substantially below Heavy Machinery's. In addition, CoreIASP and FinalIASP quote cheaper labour costs for component repairs and regularly make claims about improved service interval lengths of their parts.

6.2.3 Data items shared between Contractor and competing vehicle manufacturers

Competing vehicle manufacturers naturally support only their own vehicles with spare parts and maintenance-related services and follow a value-based, premium pricing strategy similar to Heavy Machinery's. Nevertheless, Contractor's parallel OBA information exchange with them might affect Heavy Machinery.

The parallel exchange builds not on particular part numbers, but on the type of component or subcomponent and its price. Competing vehicle manufacturers might share some component suppliers with Heavy Machinery (see Chapter 5.3.1), but they usually refer to their components and subcomponents with the help of own internal article numbers as identifiers. The only way in which customers can accordingly identify extraordinary price differ-

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[42] While Heavy Machinery is legally required to sell its maintenance-related products to IASPs, it is not required to provide them at the same (discounted) price (see Chapter 6.1.1). Moreover, it can limit the access to its online catalogue and price list to machine owners. Accordingly, it becomes more difficult for IASPs to access and compare prices as they need to call Heavy Machinery for specific quotes. In addition, Heavy Machinery becomes also aware of the interest of these actors in the specific parts. IASPs accordingly try to access price information indirectly, via shared customers.

ences is by considering the components and subcomponents that fulfil similar functions in different vehicles and their pricing. These might trigger further investigations and discussions.

At the time of the study, Contractor for example wondered why it could buy a certain sensor for another vehicle, purchased from another vehicle manufacturer, for a relatively low percentage of the price of Heavy Machinery's. It accordingly started to investigate the matter and found out that it could purchase an identical sensor to the one supplied by Heavy Machinery for about the same, much lower price directly from the component supplier. It accordingly confronted Heavy Machinery with this information.

6.2.4 The effect of parallel information exchanges on the Open Book Accounting exchange between Heavy Machinery and Contractor

Heavy Machinery is not directly involved in the information and commercial exchanges Contractor entertains with component suppliers, IASPs and competing vehicle manufacturers. They have, however, an ambivalent impact on its relationship with Contractor.

On the one hand, the parallel information exchanges can be seen as positive as they reduce the pressure on Heavy Machinery's maintenance-related resources. Heavy Machinery does for example not necessarily need to offer and stock all possible spare parts. Whenever it cannot deliver a certain part, Contractor might be able to obtain it itself from another source. In addition, Heavy Machinery does not need to invest into component repair centres for all possible vehicle components or channel these to third parties. Component suppliers and IASPs might accordingly limit the impact of costly downtimes and reduce maintenance-related costs. This can provide Heavy Machinery with advantages in vehicle sales. These positive aspects are particularly pronounced with regard to Component X (see Chapter 5.3.1). In order to service this component, Heavy Machinery would need to invest itself substantially in maintenance workshops, component repair centres and logistics facilities. Limited to this component, it accordingly endorses and even facilitates parallel direct contact between Contractor and Supplier X. It provides for example Contractor with information on Supplier X's closest branch in connection with purchases (see Chapter 6.1.1). Moreover, it provides Supplier X with extracts from its FleetData database, specifying the name and location of customers with Component X integrated into their vehicles and the related serial number and configuration of the components.

On the other hand, the parallel information exchanges pose a serious and ever increasing threat to Heavy Machinery's OBA exchange and its commercial exchange with Contractor. First, they undermine Contractor's trust in the adequacy of Heavy Machinery's spare parts pricing. As we have observed, Contractor checks Heavy Machinery's pricing and confronts it regularly with requests for price reductions on particular parts. In addition, Heavy Machinery has observed Contractor "shopping around" for component repairs and other expensive parts.[43] This can be seen as the potential beginning of a vicious circle as part of which Contractor might doubt the pricing of an increasing number of spare parts and require less support directly from Heavy Machinery, leading to a less efficient use of maintenance-related resources at Heavy Machinery and even higher prices.

> "Bigger volumes mean more people, the more people we have, the more experience we have, the more experience we have, the more we can offer people support. It is like a daisy chain really. So if we don't get the pricing right, we cannot offer people a better service in the end and build our business. Try and stop people like (CoreIASP)!" Key account manager, SalesOrg, Final

Second, they undermine also the trust in and use of LCC calculations, as they might merely become an indication of "worst case" costs or as a product manager expressed his concern:

> "Customers only take the cost models and then, they bastardise them. They know what it costs from us and then they try to get everything cheaper." Product manager, SalesOrg, Final

This might in turn make it more difficult to use these calculations and connected information to manage interdependencies in the relationship.

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[43] Key account manager, SalesOrg, Final

The awareness of the potentially negative impact of these parallel information exchanges have increased during the past few years at Heavy Machinery for several reasons. One is the creation of the Service division, charged to increase maintenance-related product sales (see Chapter 5.2.3). Another one internal analyses, underlining the proliferation of parts customers source directly from component suppliers and IASPs.

As Heavy Machinery investigated its possibilities to reduce the likelihood and impact of these parallel information exchanges, two major ways of working crystallised. The first way concerns an even more active use of OBA information with customers, thereby underlining its added value to customers (see Chapter 7). The second way concerns adaptations with the aim to intervene indirectly in the parallel information exchanges. It is discussed next.

6.3 Adapting Open Book Accounting information exchanges with customers, component suppliers and Independent Aftermarket Service Providers

As Heavy Machinery is not part of Contractor's parallel information exchanges, it cannot affect those directly. However, at least ten different manners could be identified which Heavy Machinery regularly and pro-actively draws upon to affect the parallel information exchanges with component suppliers and different kinds of IASPs indirectly. These can be clustered into three larger groups (Table 11, page 158): adaptations with supplier involvement, internal adaptations in product development and internal adaptations in logistics.

Before the individual measures are reviewed in detail, some of their general characteristics shall be highlighted. In particular, the measures can be seen as remaining mostly indiscernible by Contractor, inherently dynamic, connected to additional resource and coordination requirements and incomplete. The means remain mostly indiscernible by Contractor as they are implemented with the help of resource adaptations on Heavy Machinery's firm level and with suppliers and as such do not require any conscious, active involvement of Contractor. They are also not specifically targeted to Contractor, but to Heavy Machinery's customers and competitors in the

Table 11 Internal adaptations and supplier co-operations to influence parallel information exchanges

		Major component suppliers[44]	Repairer-IASP	Component-IASP	CoreIASP	Final-IASP
Adaptations with supplier involvement						
1	Implementation of unique as opposed to standardised designs of frequently exchanged components and subcomponents	X	(X)	(X)	(X)	(X)
2	Locking article number on component level	X	(X)	X	(X)	(X)
3	Sourcing subcomponents from alternative suppliers	(X)	(X)	(X)	(X)	(X)
Internal adaptations with focus on product design						
4	Patenting	-	(X)	-	X	X
5	Limited use of standardisation	(X)	(X)	-	X	X
6	Increasing number of new product releases	(X)	(X)	-	X	X
Internal adaptations of logistics resources						
7	One Stop Shop to decrease indirect purchasing cost	X	X	X	X	X
8	Internal distribution and limiting local purchases	X	-	(X)	-	-
9	Kitting of spare parts	X	X	X	X	X
10	Re-packing of unbranded parts	X	-	(X)	-	-

X = main impact, (X) = some, reduced impact, - = no expected impact

aftermarket in general. In addition, as all competing vehicle manufacturers apply similar means, they can be seen as a basic way of conducting and securing business in the industry that remains largely unproblematised. Moreover, individual means might often include some additional value for Contractor. While Heavy Machinery might for example implement a certain

[44] Interacting through translation interfaces (see Chapter 5.3.1).

hydraulic filter design that is not available from other sources to secure its sales, the filtration capacity might be increased in parallel and highlighted for Contractor.

The means are dynamic as Heavy Machinery has increased their application to a larger number of vehicles and components over time, based on internal analyses[45] and the focused work of the rather newly founded Service division to safeguard and recall its business. In addition, they are dynamic, because they need to be constantly re-implemented as new products are launched, requiring different kinds of components and subcomponents as spare parts. An example is the integration of new engines, fulfilling new emission norms and requiring different kinds of filters.

Their implementation is connected to additional resource and coordination requirements. The implementation of new product designs that are less susceptible to imitation by IASPs requires for example particular resources to quantify their costs and benefits and flexible development, production and logistics resources (see Chapter 6.3.2). Due to these resource requirements and their combined use, the effect of individual measures is also difficult to assess both before and after the measures have been implemented.

Finally and in consequence of the discussion above, the means can be expected to remain always incomplete, leaving room for some parallel information exchanges, as they cannot be implemented with regard to every vehicle, component and subcomponent due to their resource demands and the inherent dynamics. This would also not be efficient, as Heavy Machinery wants to sometimes benefit from the availability of alternative sources in some cases. Heavy Machinery is accordingly also constantly required to prioritise between the different ways and the components and subcomponents they should concern. In addition, they are also incomplete as most changes affect only parallel information exchanges with regard to vehicles produced in the future. The design, product documentation or spare parts offering of already delivered vehicles can for example hardly be changed by Heavy Machinery once it has left its premises. Such behaviour would also raise anticompetitive concerns.

[45] In other words, the design changes can also be seen as an outcome of the analysis and thus use of OBA data on the firm-level at Heavy Machinery. See also the piles in the framework in Chapter 2 and Chapter 7.2 on the firm level analyses conducted by Heavy Machinery.

6.3.1 Adaptations with the involvement of component suppliers

Three kinds of adaptations with component suppliers could be discerned at Heavy Machinery. Each of them concerns different kinds of components and, accordingly, different kinds of supplier interfaces.

Implementation of unique as opposed to standardised component designs

One way in which Heavy Machinery can affect the parallel information flows between Contractor and component suppliers is to adopt unique as opposed to standardised designs of frequently exchanged components and subcomponents. As a result, it becomes more difficult for Contractor to establish parallel information exchanges with component suppliers and IASPs for these parts.

An example that can serve as an illustration of such an adaptation and the involved complexities are hydraulic filters placed on Final's vehicles. Hydraulic filters are frequently exchanged in order to keep the hydraulic system free from dirt and avoid failures in connected parts. Final has traditionally used filter housings in three different sizes on its vehicles. One to three standardised filter elements were stuffed onto each other in these housings to achieve the required filter capacity. As the filter element was standardised, customers needed to only stock one kind and, besides from Heavy Machinery, could purchase it also easily directly from the component supplier as well as from several IASPs. The probability of insufficient filter exchanges and connected standstills could accordingly be seen as extremely low. A problem, however, was that customers bought a large part of these filters not from Heavy Machinery, but its component supplier and IASPs providing non-genuine copies of it.

In order to secure spare parts sales on future vehicles, Heavy Machinery therefore decided to change from one standardised filter element to three kinds of particularly designed filter housings and accompanying filter elements on its vehicles. The new filter elements are developed particularly for Heavy Machinery's vehicles by a filter supplier and as such have a particular geometric form and several seals attached to them. They are accordingly difficult to imitate. The filter and connected packaging is only marked with

Heavy Machinery's brand and article number, making it easier recognisable by service technicians and impossible to order directly from the component supplier. In parallel, filtration capacity is increased, leading to a higher overall product quality.

While the new filter design might reduce the likelihood and impact of parallel information exchanges between Contractor and component suppliers, its introduction has also been connected to new coordination and resource requirements. First, in order to keep investments into stock and the likelihood of supply chain breakdowns low, the unique filter designs had to be adopted by several of Heavy Machinery's product divisions apart from Final. The connected alignment of commercial and technical requirements took several years. Second, the technical drawings and connected bill of materials of all of Final's and the other product divisions' products had to be adapted, consuming several hundred hours of engineering resources. Third, Heavy Machinery's interface with the filter supplier also changed from a standardised to a modified translation one. Not only Heavy Machinery's customers, but also Heavy Machinery itself can no longer buy filter elements from alternative suppliers. In addition, investments into dies had to be made and any changes in quantity during the life cycle of the filters and efficiency improvements in the supplier's production facilities have to be coordinated more tightly with the supplier.

Locking article number of major components at suppliers

As we have noted, Heavy Machinery's Final division buys most of its major components through modified translation interfaces and repairs these either at own component repair centres or channels repairs to supplier's component repair centres (see Chapter 5.3.1). The components' design is accordingly adapted to the functional and interface requirements of Final's vehicles. An example are hydraulic pumps whose pressure and speed configurations, fixtures and oil connections are adapted to individual vehicle designs.

Heavy Machinery does generally not have the resources to remove the suppliers' brands from these components. Such brand removals might also be dysfunctional, as customers anyways know that Heavy Machinery does not produce these components in-house and regard the brand as a reassurance of component quality. In order to still limit the likelihood and impact of parallel information exchanges, Final has contractually agreed with almost all of its major component suppliers that they lock the article numbers that is displayed on the respective components in their internal sales systems. Customers can accordingly only buy it directly from Heavy Machinery.

> "So I mean if the sales organisation or the customer in (SalesOrg's region), which you will visit, comes and asks "I have a pump, it is a (Supplier A) pump, I want to buy it directly from you, it has the article number 900XXX", so goes (Supplier A) in and looks and says "No, sorry, that part is unfortunately locked against (Heavy Machinery)." Strategic purchaser, Final

Interestingly, the mechanism works even against Heavy Machinery's own sales organisations which cannot buy the components directly from suppliers, but only through Service's global distribution centres. This limits their ability to deviate from the global pricing concept and to avoid the unintended spread of conflicting product cost information to customers.

As only the component itself is locked, customers can, however, still buy subcomponents that are required for preventive or corrective maintenance directly from component suppliers or get those repaired at IASPs, such as ComponentRepairer. The likelihood and impact of these parallel information exchanges are at the same time also reduced. To begin with, even though components might be repaired several times during their component life cycle, they are usually completely worn out and require complete replacement several times during a vehicle's life cycle. Replacement components with matching configurations can, however, only be bought from Heavy Machinery. Moreover, if customers want to repair their components with minimum vehicle downtime, they either need to keep stocks of several components and circulate among those or they need to enter into component exchange agreements with Heavy Machinery or IASPs. In the latter case, the IASP has, in turn, to either purchase completely new components from Heavy Machinery at undiscounted prices or purchase used components or vehicles off the market and repair them so that it can offer immediate replacements. The locking of components increases accordingly the resource requirements of IASPs.

In contrast to most other adaptations, locking major components at suppliers is connected to limited additional coordination and resource requirements. The measure is well established in the industry, which means that Heavy Machinery has to pay no or only a small additional fee to lock the respective article numbers. Adaptations relate accordingly primarily to contracting with suppliers and the investment in and planning of stock as customers cannot buy the components from other sources.

Sourcing subcomponents from alternative suppliers

While locking article numbers can be seen as an effective mean for disabling associated parallel information exchanges on the level of major components, its impact on the subcomponent level is more limited. This is in particular a challenge for subcomponents that are frequently exchanged and shared across larger component family groups, such as filters or expensive subcomponent kits that are required during component repairs. Even if component suppliers agree to lock the article numbers of their component, they usually mark commonly exchanged subcomponents quite clearly with their brand and article number and sell these also directly or via IASPs to Heavy Machinery's customers. In addition, IASPs often provide well-established, non-genuine copies of these subcomponents at accordingly much lower prices whenever these are not patent-protected.

Heavy Machinery has traditionally lacked the resources to react to these challenges. While it has a general understanding of the basic functioning of major components and their interfaces with other components in its vehicles (see also Brusoni et al., 2001, Araujo et al., 2003), it naturally lacks insights into the exact technical specification of the subcomponents combined in major components and their related costs. In addition, it is usually dependent on the original supplier to supply spare parts as otherwise the component warranty might be void. Moreover, it has to fear negative impacts on the assignment of development and production resources of the component supplier if it was to sell non-genuine copies to its own customers. While customers, such as Contractors, might accordingly use non-genuine copies, Heavy Machinery has usually been "stuck" with the original component supplier, which, in turn, might charge high subcomponent prices and sell in parallel directly to Heavy Machinery's customers and IASPs.

In order to react to these challenges, Heavy Machinery has built up internal resources and entered into co-operations with alternative suppliers that develop and produce such subcomponents. These changes will be described at greater length in Chapter 7.3.1. For the moment, it is sufficient to note here that Heavy Machinery actively works on eliminating conflicting price information for subcomponents by providing those itself at competitive price levels. In addition, these items are marked with Heavy Machinery's brand and article number, easing the recognition by service technicians and connected ordering.

6.3.2 Internal adaptations with focus on the design of internally specified components

One particular reason for the proliferation of parallel information exchanges between Contractor and CoreIASP and FinalIASP can be found in the historically long product life cycles in Heavy Machinery's industry. Long product life cycles facilitate the business of IASPs in different ways. To begin with, long product life cycles lead to an increased number of vehicles and core components that use the same specified components. The market volume for mechanical parts produced on Heavy Machinery's specification increases accordingly and becomes interesting to consider for IASPs. Second, longer life cycles provide IASPs with the necessary time to examine and produce spare parts.

> "Yeah, it generally takes a certain time, perhaps a year or so, until pirates have started to produce spare parts. To begin with, they need to get hold of (core components), measure them and copy the parts and that takes some time. But then, they need to also get it working. Because if you just measure this part, you don't know which tolerances you can allow for and so on to make it still working. (…) So it becomes a bit of trial and error even for pirate manufacturers." Product portfolio manager, Core

Third, after some years, even initially patent-protected parts can be copied without the fear of any penalty and therefore do not need to be bought by IASPs from Heavy Machinery.

Heavy Machinery accordingly tries to affect the parallel information exchanges between Contractor and IASPs by regularly updating the design of mechanical parts, limiting their standardisation and protecting them with patents.

> "I think (Heavy Machinery) was quite lax in the fact that a lot of the product was quite old and the patents had been released because of the age of the product. And the new (core component series) has a lot of the internals on that, and I am seeing that there's patents on them. So, they are actually protecting the product now. Because they never really had the competition before." Product manager, SalesOrg, Service

The implementation of these strategies is at the same time highly complex as it is connected to additional resource and coordination requirements. First, due to limited R&D resources, Heavy Machinery needs to naturally prioritise between different possible R&D projects. In addition, within each project it needs to prioritise among the individual adaptations that shall be accomplished as each of them consumes resources and involves considerable technical risks. Such prioritisations are supported by business plans at Heavy Machinery that are relatively easily elaborated with regard to overall vehicle or core component features and connected sales opportunities. In contrast, they are much more difficult to make with regard to maintenance-related products and sales.

> "To begin with, it is difficult because I don't know the market share we have on the respective parts. Today, I do not know how much time it takes until we have lost which part of the market. If we say we launch a new (core component). On the first (core component) that we have out in the market, we should have 100 percent of all spare parts and then it (i.e. the share) sinks over time as time goes. And the slope depends also on which price policy we have on that core component. How much of a gap have we left to a pirate manufacturer to earn money? (…) As I don't know the slope and I don't know the price policy, I have difficulties calculating any differences because of these parts." Product Portfolio Manager, Core

Including considerations on maintenance-related product sales requires accordingly additional information systems that support detailed analyses on the market for particular components and subcomponents. Potentially influencing variables include Heavy Machinery's market share and pricing, the time it takes for IASPs to catch up and the threshold volume to make it an attractive market for IASPs. The collection of such information is further complicated by the complexities inherent in the interface (see Chapter 5), in particular the use of customer-specific designs and differences in operations and maintenance settings. These all might have an impact on the demand of a particular part and thus the feasibility of changing its design. Without access to such data, Heavy Machinery can only include clump sums in its business plans from maintenance-related product sales. In addition, it cannot identify particular components that R&D projects should focus on as they are most susceptible to competition.

Second, new product designs often build on known technical principles and resource combinations, which limit the ability to patent them.

> "We try to get as many own patents as possible. We have had that as KPI (Key Performance Indicator). (…) But the problem is that the more detailed one writes a patent, the more easy it is to get around it. That's how it works. One should basically write them as general as possible. (…) But it's difficult, isn't it? It's known principles, so it is not possible to always come up with something totally new. If that was the case, one could put out a very fat carpet, which would make it very difficult (for IASPs)." Project manager, Core

Finally, the adaptation of product designs has also an impact on connected resources. In particular, it requires flexible production facilities that can deal with different product designs, such as Core entertains. In addition, it might require the investment into additional stock and create more obsolescence. This creates some limits to the adaptation of product designs. Heavy Machinery has historically balanced these demands by primarily differentiating the design of specified components between its different vehicle types and core component families. Differences on these levels are also easier to motivate and maintain as size, functions and interfaces naturally differ on these levels. The high volumes connected to particular families might however sometimes necessitate even further adaptations as they become interesting to capture for IASPs.

6.3.3 Internal adaptations with focus on logistics

As the first two groups of adaptations require many resources, they can only be implemented on a low scale and with regard to few components and sub-components at a time. Accordingly, Heavy Machinery works with a range of additional internal adaptations in the area of logistics that reduce the likelihood and impact of parallel information flows between its customers and component suppliers and IASPs alike in a more general manner.

One Stop Shop

Heavy Machinery has for example integrated a One Stop Shop (OSS) solution, which means that it offers all spare parts required to maintain its vehicles immediately or with only short lead-times from its logistics facilities. While an OSS might also be interpreted as a general prerequisite to buying machines (see Chapter 6.1.1), a well-functioning OSS reduces also the likelihood and impact of parallel information exchanges.

An OSS removes for example one of the primary motivators for Heavy Machinery's customers to initially contact component suppliers and IASPs: Heavy Machinery's inability to deliver a certain part within a reasonable timeframe.

> "If we don't have it (the spare part) available, customers search for other ways to get it, and if they haven't done it before, they might get their eyes opened up for that there naturally exist different established competitors, but also pirate manufacturers and smaller dealers which can deliver the part as well. And then, it suddenly becomes a question of price, too, as they might find that they can also get it cheaper from that company. (…) So this can lead to quite some consequences." Global supply chain development manager, Service

Moreover, stocking parts close to customers and delivering them quickly provides Heavy Machinery with a natural advantage over component suppliers and IASPs as customers continue to plan their preventive and corrective maintenance activities with rather short time intervals in mind and experience additional unexpected breakdowns. With the help of efficient stock planning and logistics based on OBA information, Heavy Machinery can offer spare parts when customers need them and outperform aftermarket competitors which might only be able to offer the parts with extensive lead-times.

In addition, an OSS provides customers also with advantages in the form of reductions in indirect purchasing costs, an advantage that Heavy Machinery markets consciously. By purchasing from Heavy Machinery, customers need to only process one purchase order while they might need to order from several suppliers in parallel for a particular maintenance service otherwise. At the time of the study, Contractor reported indirect costs of about 110 Euros per purchase order, which accordingly need first to be set off by lower purchase prices.

> "Customers still want a one stop shop. So they are happy and they communicate this openly with us and they say, they are happy to pay the OEM a little bit more." National business development manager, SalesOrg, Service

Moreover, Heavy Machinery's customers are highly interested in further cutting their purchasing costs by electronic ordering and internal alignment of purchases. This concerns in particular large customers, such as Contractor, which has introduced electronic ordering with Heavy Machinery a few years ago. Electronic purchasing allows it to generate purchase orders directly from its maintenance planning system and thereby to avoid potential mistakes and related costs. In addition, due to Heavy Machinery's volume-based customer rebate scheme, Contractor has some incentives to reduce maverick spending of its different sites. In SalesOrg's region, all major vehicle manufacturers support electronic purchasing, but only a few component suppliers and large IASPs, such as FinalIASP, have the resources to support it. As electronic ordering systems build on the connection of a specific part with a preferred vendor, the number of instances in which Heavy Machinery is exposed to competition is reduced.[46]

Implementing and maintaining an OSS does not come free of charge. It puts also particular demands on Heavy Machinery's logistics resources. In particular, it requires Heavy Machinery to invest into considerable amounts of stock at local warehouses next to Contractor's operations and regional and

[46] See Cuganesan and Lee (2006) for an accounting study with similar observations and results.

global distribution centres and expensive air transport for quick stock replenishment. In addition, Heavy Machinery needs to transfer stock between its local warehouses when Contractor moves its vehicles to new sites or discontinues their use. Moreover, it needs to carry the costs connected to increased obsolescence.

Internal distribution and limited local sourcing

In order to secure its advantage in stock keeping, Heavy Machinery is also highly conscious about the information it provides to its component suppliers. One element of this is the strategy to source almost all spare parts through global distribution centres (DC) and to distribute them from there *internally* to regional DCs and warehouses. While this might be interpreted as a simple way of leveraging purchasing volume, it is mainly motivated by the reduced provision of information to suppliers.[47]

> "What that does is that in a market like this we are selling a machine and we haven't bought all those components in (SalesOrg's region), so the manufacturer and the distributors of these components don't know how many there is or how big that market opportunity is. If we don't tell them by not buying locally, then they won't be looking for that work. So to buy stuff through the DC at the right price keeps us safe. It stops the local market knowing the opportunity. So the more and more we put back to (the European DC), the local market thinks that the opportunity is decreasing and they won't be looking for the work. Because as soon as times get tough, like they are now, they are all scratching for a sale. They would do whatever they wanna do for a sale. They are gonna say "Aah, we usually sell all those to (Heavy Machinery). I wonder where (Heavy Machinery) uses them. I might give those guys a call." Strategic purchasing manager, SalesOrg, Service

Internal distribution is connected to particular resource and coordination requirements. It for example requires Heavy Machinery to entertain own DCs and warehouses and to coordinate transports internally. Drop shipments from component suppliers directly to regional DCs and local warehouses are avoided, even though they might reduce total logistics costs. In

[47] Purchasing volume can also be leveraged by mandating the sourcing of components from certain sources, but asking suppliers to distribute them directly by means of drop shipment to regional Distribution Centres, local warehouses and customers.

addition, particular restrictions on access to information are put in place to ensure that local sales organisations, such as SalesOrg, cannot start purchasing components and subcomponents locally. One of these restrictions concerns the elimination of all data that purchasers might need to conduct local purchasing, such as supplier name, article number and purchase price. While the ERP systems at the development, production and distribution facilities includes all this information, it is replaced by Heavy Machinery's internal article number, a generic description, the transfer price and sales price in the sales organisations' ERP system.

> "When they enter data into our stock system, it is very, very generic. So a valve might be a valve and that's it. You don't get to know what size, pressure, brand, part number. It's a valve. And it is on a drawing and it has a stock code. That's it. (…) When we ask for information about a part number, whether that would be the supplier, the manufacturer, manufacturer's codes, specifications, we don't get anything. All we get is the (Heavy Machinery) part number back. It's a protection mechanism so that we don't buy locally." Strategic purchasing manager, SalesOrg, Service

In addition, sales organisations are discouraged to investigate local sourcing alternatives as they are informed about and evaluated on their consolidated profit and thus the combined global and local profit of their local sales.[48] Consolidated profit information is at the same time only available to SalesOrg's business line and product managers and per vehicle type to limit any adverse use of the information (e.g. price reductions to customers or local sourcing). In case sales organisations should be confronted with credible pricing related threats or observe lower prices in their local markets, they accordingly need to contact Service's global marketing unit. Based on the input, the unit might discuss the issue with the strategic purchasing unit and/or reduce transfer and sales prices in order to avoid any local sourcing (see Chapters 7.2 and 7.3).

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[48] SalesOrg can accordingly only see the consolidated profit per vehicle type (which accordingly includes many different models and their spare parts). On article level, it can only see its local profit, which is about the same across item groups

Kitting of spare parts

In order to secure its market and recall lost sales, Heavy Machinery has also increased its efforts to sell spare parts in the form of kits. Selling spare parts as kits provides Heavy Machinery with a few advantages. One of those is that its customers cannot see the individual article numbers and prices of the parts included in a kit. They are accordingly provided with less information and possibilities to reflect upon whether they really need all the parts or whether they could save some money on some of the included parts by buying them from other sources.

Another important advantage for Heavy Machinery is that it is much more difficult for component suppliers and IASPs to supply kits compared to individual components and subcomponents.

> "When we say kits, we sell kits for (Heavy Machinery) machine maintenance. (…) So today, if a customer comes to us, we give him one kit which takes care of probably the engine, compressor, the cooler, the hydraulic system. He gets one box with all ingredients for doing the maintenance. If he decides to do it himself, he needs to probably shop from ten different people and they may have right things, they may have wrong things. So instead he just says ok, one part number "scheduled maintenance kit for 250 hours" and the problem is solved. If he chose to do it (i.e. buy from individual sources), then he probably is looking at twenty part numbers and different vendors. So we are trying to make it easier for them to do business with us, even though the box contains lot of other suppliers' parts in it, but it is one (Heavy Machinery) box and he has one number for ordering." Vice President Marketing, Service

Component suppliers and IASPs need to accordingly also invest more resources into matching Heavy Machinery's part numbers if they want to use those to market their own products. At the same time, it becomes more difficult for them to buy the parts that they cannot produce themselves from Heavy Machinery. Instead of buying them separately, they need to buy them in the form of the offered kits themselves.

Moreover, kits provide customers with two kinds of advantages. To begin with, they are sold at a discount compared to the price of individual parts. Furthermore, they provide efficiency advantages that are difficult to match by individual component suppliers and IASPs, even though they might be able to offer lower parts pricing. First, customers do not need to consult the manual at multiple times and ask questions to understand which parts they should purchase for a particular service. They also do not need to place multiple orders. They can order kits, which include all the parts they need for a certain service interval. Second, the occurrence of stock outs and costly interventions by Heavy Machinery are reduced as customers are less inclined to pick and choose individual parts based on the exploded views included in spare part books. Third, the individual components for a kit are only picked and packed once at a global distribution centre. As they are transported and stocked as "one" package throughout the remaining supply chain, any further unpacking, individual stocking, picking and packing is avoided. This reduces also workshop time, as the kit is collected from stock and dropped next to the vehicle in the maintenance workshop as it turns up for the respective service interval. The service technician accordingly does not need to spend any time identifying and collecting individual parts and can drop any used parts for recycling into the kit's packaging. Fourth, service quality is also standardised and improved as any remaining parts in the packaging serve as a reminder at the end of the service that something has been forgotten.

The implementation of kits poses particular resource and coordination requirements, some of which Heavy Machinery was struggling with severely at the time of the study. To begin with, Heavy Machinery needs to establish policies on which resources are to be combined in which kind of kits for new vehicles. A larger assortment of kits needs also to be offered as a consequence of customers' different operating settings. Due to differences in climatic conditions, customers require for example different filters for their air conditioning system and different oils and greases. Customer adaptation needs at the same time to be limited to these general differences in operating environment. Otherwise, working capital requirements might explode. In addition, the actual demand for some costly spare parts might differ depending on the operating setting, necessitating compromises within individual kits and the establishment of several kits for particular vehicles and components. One kit might then include the most necessary parts, while some other, more expensive kits include additional parts.

Moreover, changing associated product documentation is complicated in itself. Information on parts that could be purchased independently before needs to be eliminated from IT systems and new product documentation. In addition, based on old product documentation, provided with earlier vehicle models, customers might be able to identify components and subcomponents that are only sold as a kit for new vehicles. They might accordingly order these parts on the old article numbers or require them to be set up again. Particular processes have accordingly to be put in place to deal with these, from a competition law perspective, sensitive issues.

Furthermore, Heavy Machinery for example needs to entertain particular areas in distribution centres where frequently ordered kits can be packed in an efficient manner. It also needs to purchase packaging material from external suppliers and establish processes to ensure that kits are packed safely and in the same manner independent of the individual employee conducting the packaging.

Repackaging of unbranded components

Some spare parts bought from component suppliers do not carry any article numbers and brand information on the components itself, but only on their packaging. Accordingly, Heavy Machinery can remove the information contained on the packaging by either repacking it itself at one of its global distribution centres or by having it repacked by an external packaging provider. Heavy Machinery does this in particular for parts that are seen as important for the functioning of the machine and/or parts that are seen as important to brand by individual sales organisations.

Repacking is also connected to particular resource and coordination requirements as is evidenced by the discussions at Heavy Machinery during the study. As Heavy Machinery considered an extension of the line of the internally repackaged parts, it formally analysed the connected investment needs. It also observed that if the repackaging was to be performed to a larger degree in-house, it might need to change the skills and attitudes of its global distribution centres. Some of the units regarded their main resources as lying in the *distribution* as opposed to the *repackaging* of parts. In addition, Heavy Machinery reconsidered its global marketing policies in order to see which parts that should be re-packaged by default and how the packaging should exactly look like.

6.4 Chapter conclusions

As the discussion proceeded above, a complex OBA design emerged. Heavy Machinery and Contractor are the main *participants* in this design. With the exception of the parallel information exchange between Contractor and Supplier X, all other parallel information exchanges are problematized. In order to minimise the spread of information on new product development projects, Contractor is for example required to sign confidentiality agreements when participating in prototype reviews and tests. Similarly, Heavy Machinery pledges to not forward sensitive information to other customers, such as that relating to Contractor's current tenders and feedback on LCC. In order to underline its concern with confidentiality, Heavy Machinery has also deliberately assigned a key account manager to this account that does not interact with any of Contractor's larger competitors. Parallel information exchanges with component suppliers and IASPs are more difficult to control as competition law for example forbids the upfront binding of equipment and maintenance-related sales. Heavy Machinery has accordingly implemented different means by which it tries to indirectly impact parallel information exchanges Contractor might entertain with these actors. These include different kinds of co-operations with suppliers as well as internal adaptations in product development and logistics, which accordingly form important element of the overall OBA design in capital equipment sales.

Besides the limited number of participants, the OBA design appears to be also characterised by the particular *data items* that Heavy Machinery and Contractor exchange with each other. Besides price information, Heavy Machinery provides Contractor in particular with detailed, theoretical and specifically adapted Life Cycle Cost (LCC) calculations. These illustrate the spare part-related costs over time and are specifically adapted to Contractor's chosen vehicle designs, use of vehicles, operational settings, available maintenance-related resources and practices and local pricing. At the same time, LCCs provide limited insights into some related costs, for example labour and opportunity costs. Accordingly, Heavy Machinery provides some additional data items that support the assessment of the related resource interdependencies. These include indicators on machine availability, the service interval length of important components, the ease of serviceability of individual vehicles and the availability of maintenance-related resources. Moreover, Heavy Machinery provides Contractor with operations and maintenance instructions, spare part books and limited information in connection to new product development projects.

Contractor appears to mirror the information provided by Heavy Machinery. Exchanged data items include feedback on Heavy Machinery's pricing, LCCs and machine availability. In addition, it provides Heavy Machinery with feedback on the status of its vehicles and its future vehicle demand.

As noted, Heavy Machinery provides Supplier X with information on the geographic location and name of its customers with Component X integrated in their machines. It also provides Contractor with the contact details of Supplier X's maintenance workshops and component repair centres. Most interaction concerning the maintenance of Component X takes accordingly directly place between Contractor and Supplier X. This concerns the exchange of information on the use of Component X, lead time and commercial price information for spare parts, replacement components and labour.

Taken together, the exchanged data items appear accordingly to focus on making maintenance-related interdependencies more visible. Some commercial and technical data is at the same time actively hidden away. We will revisit these observations in more detail as part of the discussion in Chapter 8. Before that, we will review the use of OBA in the interface in the next Chapter.

Chapter 7

The use of Open Book Accounting in the interface between Heavy Machinery and Contractor

The purpose of this chapter is to describe the attention directing and decision facilitating uses of Open Book Accounting (OBA) in the interface between Heavy Machinery and Contractor. The chapter follows a fourfold structure. The first part outlines the use of OBA on the relationship level between Heavy Machinery and Contractor. The second and third parts look at its use by Heavy Machinery and in indirectly connected relationships between Heavy Machinery and its component suppliers respectively. The fourth part summarises the observations.

7.1 Use of Open Book Accounting between Heavy Machinery and Contractor

7.1.1 Attention directing use

As part of the study, three areas could be identified to which the OBA information exchange directs particular attention on the level of the relationship between Heavy Machinery and Contractor (Table 12, page 178).

Table 12 Areas to which Open Book Accounting directs attention on the level of the relationship between Heavy Machinery and Contractor

1	Long-term cost consequences of vehicle purchase decisions
2	Attainment of theoretical, specifically adapted Life Cycle Cost (LCC) in practice and the importance of each other's resources in general: identification and management of cost deviations
3	Improvement of LCC calculations over time and identification of further possibilities to reduce cost beyond those specified in LCC calculations

Attention to long-term cost consequences of vehicle purchase decisions

With regard to individual purchase decisions, attention is shifted from the price of individual vehicles to the total cost of the resource combination, consisting of the vehicle, maintenance-related products and opportunity costs that arise whenever vehicles cannot be used due to scheduled maintenance or unexpected breakdowns. As total costs depend on the design of individual vehicles, the intensity of their use, the setting in which they are used and operations and maintenance practices, particular attention is accordingly placed on the interaction of these cost drivers at particular sites and with regard to specific jobs.

> **Maintenance reliability manager, Contractor:** "I would just like to ask whether you could help us with alternative cost models as well. We have just the standard model at the moment (…), but we might need to work on projects in other conditions. So it would be good to know the costs connected to changed parameters."
> **Key account manager, SalesOrg:** "Yeah, well, in our model we can accommodate for that. It is just important that you give us the parameters you are looking for and then we can put it in. It is difficult for us to just give you some general model. It is some specialist software in (Europe) which calculates that for us. But just give us the values you are looking for, also with regard to new jobs, and we help you with our theoretical model estimates."
> **Maintenance reliability manager, Contractor:** "Yeah, that would be really good. Because otherwise we can just work out how costs develop compared to the standard model and not discuss it with regard to specific jobs, for example when (variable X) changes and that would be good to work out together."
> (Observation of customer meeting, 2015-04-25)

With the help of OBA, Contractor's and Heavy Machinery's attention is accordingly shifted to learning about the impact of different cost drivers on total costs. Directing its attention to these aspects helps Contractor to submit tenders for jobs that differ from those it has done before. Heavy Machinery can also benefit from this attention as it can sell more vehicles and charge premium prices if it finds ways to reduce maintenance-related and opportunity costs for Contractor.

> ”So they would say to us “Your machine is (X Euros) more expensive. It's probably gonna cost us the same to run. But we are going to go with you because you supported us in the last two years. When we have called you, you have answered the phone. When we have asked for service or had parts problems, you have sent them up or you have got them delivered to us as quick as possible. Your competitor down the road hasn't done that, but he is offering us the machine for (X Euros) cheaper. So, that's why we gonna go with you because of your parts and services support.” So, the parts and service, in the end, will either kill you, or people are willing to pay more money for a machine, if they receive that service.” Key account manager, SalesOrg, Service

Attention to attaining theoretical, specifically adapted Life Cycle Cost in practice and each other's resources in the interface

Heavy Machinery's *theoretical, specifically adapted* LCC calculations provide a benchmark for vehicles in use that may or may not be achieved in practice. Attention is accordingly directed to monitoring the development of costs over time and to identifying and managing potential deviations from these models. Realising expected, theoretical LCCs in practice creates a predictability that is of high value for both firms. As Contractor uses LCC calculations in the preparation of its own tenders, predictable, low LCCs increase its chances of winning tenders and allow it to reduce associated risks. Unpredictable cost developments over the life cycle of vehicles might in contrast quickly turn jobs that looked profitable at the outset into highly unprofitable ones. Delivering on the expected LCCs is also important to Heavy Machinery, as Contractor usually sticks with its current supplier for a certain vehicle type as long as it feels the vehicles deliver the lowest total cost, and that these are “under control”. Finally, meeting predicted costs means also that fewer reasons exist for Contractor to engage with IASPs.

> "As long our (core component) performs as it should do, they will never go to a supplier like (CoreIASP), because they have bought it. It should last for this service interval and then you replace these parts and then you know the costs will be this, but if you reduce the life time or we can't deliver spare parts, then they start to look into different directions and then the copy-makers come in or they change it to (Major Vehicle Producing Competitor A) or something." Vice President R&D, Core

The use of OBA to identify and manage deviations compared to theoretical, specified LCC can in particular be discerned in the relationship between Heavy Machinery and Contractor.

> "You know a year or so later, after their first purchase, they came to us and said "Can you work with us in regard to our LCCs? Because the (vehicles) are costing more than what we have seen in your calculations." And then, they were good and bad. They were not saying we were doing anything wrong or we had done anything wrong. They were saying "Are we not looking after them properly? Why do they cost 20 or so dollars (an hour) above what we were told?" So, we had to work pretty closely with them. And we were having a few problems. There were some operational practices that weren't right. And they have acknowledged that. But, by working together, to resolve that issue, I think, today, you'll find that our LCCs are running very close to what they have asked for." Key account manager, SalesOrg, Final

As many resources are directly and indirectly connected to the interface and can cause deviations, the LCC calculations direct also attention to the need to learn more about each other's resources in general. Deviations might for example be the result of poor vehicle or component designs, different use patterns or bad operations and maintenance practices. Equally, their management might require the adaptation of a number of resources and their interfaces. A deep understanding of each other's resources can accordingly be seen as a precondition for joint investigations of deviations.

> "They might say "The coupling costs us a grand and we are changing it every 200, 300 hours." We could say "Well, you guys drive the trucks wrong." We could just make accusations. We don't know that. We have got to work with them and they need to be truthful with us and we need to be truthful with them. And they say "Look, we do everything we can do to stop this. We don't want to

see it. It's obviously costing us a lot of money and a lot of downtime. We don't wanna see it either." So we have to take them on their merits and say "Alright, is it a product issue or is it the way you are operating?" And they might say "Come and have a look, if the problem is us, tell us." Step on it and then you have to have that working relationship and that's where we can reduce costs." Key account manager, SalesOrg, Service

Attention is, however, not only directed to current resources of the business partners that might have caused deviations. Additional attention is also put on resources that Heavy Machinery and Contractor might need to develop to reduce the likelihood of such deviations in the future. For example, it directs Heavy Machinery's attention to the need to develop resources that help it to proactively re-design components and subcomponents that do not keep their suggested service intervals and, accordingly, cause higher costs.

"And we also need to become a little bit more professional here and kind of start looking at the feedback data from the field and transfer it the whole way back to the drawing board of our engineers and say "This article here, that you have designed four years ago and which we thought would hold 2,500 hours, holds only 125 hours and that isn't OK, we can't work this way." And, then get up the learning curve so that one re-designs when a part didn't work well in the field. We do that today, but mostly based on product warranty or product safety issues. Not proactively from a service perspective." Global Fleet Manager, Service

Attention to the improvement of Life Cycle Cost calculations and further cost reductions

A third area to which in particular Contractor's feedback on LCC information directs attention is the need to improve those estimations over time and to find ways in which LCCs can be further reduced, beyond those specified in current cost models.

With regard to the former aspect, it is important to note that the LCC models Heavy Machinery provides upon the release of a new vehicle model are estimations that are naturally not without mistakes. Initial estimations are based on prior experience from *similar* vehicle models, carrying *similar* components, and information from component suppliers for the individual component as such as well as a low number of prototype tests carried out over relatively short periods compared to a vehicle's total life cycle. The LCC models accordingly naturally require further refinement for the *specific* resource combination a new vehicle model represents. These refinements can be realised over time as larger vehicle fleets are used in different applications and operating and maintenance settings. Based on the feedback provided by Contractor and other customers, Heavy Machinery can improve its calculations and communicate these improvements to Contractor for use in future tenders.

In addition, the feedback directs attention also to improving operations and maintenance practices and therefore reducing costs hopefully even further, below the costs described in initial LCC models.

> "Recently we rolled out a reliability engineering process, so that, now rather than just replacing parts on machines, we are actually gathering all the failure data on a machine, analysing it and then identifying the root cause. So often the failures, rather than replacing parts, it is actually a symptom of another underlying issue. So we need to go back and correct those root causes. (…) It could be a blown sensor, but if you see a whole lot of blown sensors, it may turn out that there was a harness, a defective electrical harness, that was failing prematurely and that was blowing up the sensor on an infrequent level. So, it is only when you start looking at this data over long periods of time and over a number of machine that you can actually identify particular fault notes, root causes, and then put in place maintenance and service strategies to address that. Overall, you will improve the availability of the (vehicle) and the meantime between failure of the (vehicle)." Business line manager, SalesOrg, Service

Such a focus requires accordingly also the investment into specialised staff and tools on the side of Heavy Machinery. Occasionally, the attention of component suppliers, such as the supplier of Component X, is also required to understand a pertaining problem and identify improved component designs and maintenance arrangements.

7.1.2 Decision facilitating use

OBA directs not only attention to these three areas; it also supports the making of specific decisions within them (Table 13, p. 183). Some of these decisions are discussed in the following.

Table 13 Decisions made by Heavy Machinery and Contractor that are facilitated by the OBA information exchange

1	**Decisions related to long-term cost of vehicle purchases**

	o Decisions with regard to new tenders
	    o Selection of vehicle design
	    o Decisions on how to manage delivery schedules/bridge lead time
	o Decisions with regard to replacement investments
	    o Supplier selection decision for vehicle types
	    o Decision to interact and work on changing perception
	    o Decision of Heavy Machinery to offer and implement incentive schemes with Contractor related to the service intervals of major components

2	**Decisions related to ensuring the achievement of expected Life Cycle Costs (LCC) in practice**

	o Decisions with regard to operator abuse: additional training and disciplining talks, deactivation of options on machines to reduce possibilities for abuse
	o Decisions with regard to product design-related problems
	    o Decisions on whether and how to investigate component issues and on whom to involve
	    o Decisions on how to correct for and avoid future problems
	    o Decisions on the distribution of associated costs
	o Decisions on pricing issues
	    o Spare parts pricing: decision making with global pricing unit
	    o Labour pricing: decision making on reductions and internal follow-up discussions

3	**Decisions with regard to improvements of LCC calculations & reducing LCC further**
	o Decision of Heavy Machinery to invest into necessary facilities o Joint decisions with regard to particular vehicle components: vehicle inspections with particular component focus, disassembly of specific components with particularly long service intervals, workshops with suppliers and customers

Decisions related to long-term cost of vehicle purchases

Contractor makes vehicle purchasing decisions mainly in connection with tenders for new sites or larger fleet replacements. As Contractor is bound to its *tenders* and often does not have much time to start its operations once it is informed about their outcome, it usually takes most decisions related to required vehicle purchases already in the process of preparing the tender. This includes in particular the selection of the specific vehicle model with Heavy Machinery. In this context, Contractor usually discusses two to three vehicle models of a specific type with Heavy Machinery in terms of their performance and associated long-term costs. Vehicle selection is accordingly in particular facilitated by theoretical, specifically adapted LCCs and assessments of the vehicle's ease of serviceability. In addition, experience from past machine purchases and Heavy Machinery's subsequent support are also weighted into the decision as a further appreciation of opportunity cost.

> ”They will say "What's it gonna cost us to run the machine? What's the actual cost? If we have had one before, do we get support from them? Do they give us help when we need it? Are they flexible in regards to seeing account management?" And then they may make a decision based on that." Key account manager, SalesOrg, Final

Interestingly, while Contractor might consider different vehicle models, it usually sticks to its suppliers for a particular vehicle type in its tenders due to its experience and efficiencies with regards to maintenance-related resources. This means that Heavy Machinery is usually contributing with information on one vehicle type, while its competitors deliver information on the other two vehicle types Contractor regularly requires in its operations. Being involved in the preparation of tenders for the specific vehicle type is accordingly also an important signal of the ongoing health of the relationship.

> "If they'd stopped coming to us that means they are buying them from somewhere else, maybe just not from us. So we need to obviously feel our way around. So when they are tendering on jobs and they are still asking us "What's the price of equipment? How quickly could I get a (specific vehicle)?" Then, that's good for us. That means that they are still working with this, they are still willing to use our equipment." Key account manager, SalesOrg, Final

As the timelines of specific tenders might be very tight, Heavy Machinery and Contractor need to also form decisions on how they might bridge the time between the start of operations and the delivery of new equipment. Heavy Machinery might accordingly offer to temporarily lease a vehicle at a discounted price while Contractor waits for the delivery of the new vehicle, decide to reserve and/or move production slots or even release firm orders in production on the "speculation" that Contractor wins the tender and ultimately can confirm the order. The provision of information on Contractor's participation in particular tenders can accordingly lead to concrete orders being placed by SalesOrg at central production facilities. In these cases, the design of the vehicle is carefully selected with Contractor. By choosing a basic configuration that might also fit other contractors in its region, SalesOrg can reduce its risks in case Contractor should not win the tender in the end.

As Contractor currently only sources one vehicle type from Heavy Machinery, the ability to sell vehicles of the other two vehicle types is reduced to larger *fleet replacement* decisions. As part of those, Contractor decides to slowly phase out parts of its existing fleet of a certain vehicle type and replace it with new vehicles. Heavy Machinery puts accordingly great emphasis on formally and informally analysing the age and use of Contractor's vehicles purchased from competitors. In line with these analyses, it can proactively interact with Contractor over longer periods prior to when such decisions are made and try to change Contractor's perception of its vehicles. Heavy Machinery might accordingly decide to strategically put even more focus on supporting the vehicles Contractor already uses, invite it to participate in prototype reviews and tests and invite it to look at suitable vehicle models when these undergo adaptations for other customers at its regional vehicle delivery centre.

In addition, Heavy Machinery has recently decided to remove some of the fears connected to the long-term cost developments of its vehicles by guaranteeing the service interval lengths of some major components.

> "If you got a customer that had a competitor's (vehicles) and all of a sudden they look at (Heavy Machinery), they have got fear in their eyes, because they are going "Well, do we *really* trust these guys? Do we *really* gonna get these hours? Are they going to put the costs of the components up?" and that type of things. So that's why the cost model becomes a really important tool for us to be able to take away a lot of that fear, so we can say "No, we'll go and guarantee that this component will last 8,000 hours and if it only lasts 6,000 hours and you have to replace it, well, then you only pay to the percentage of use you've got. So, you know, if it only lasts 80 % of the 8,000 hours, well, then you get it for 80 % of the replacement costs of a new component." And there's triggers in there that we can try and work with the customer and I am sure that there is certain value in switching from one competitor to the other, because the biggest thing is "I don't want to buy the (vehicle)." (…) So, yeah, the industry has changed so much

> so that you need to be prepared to back your components and back the product, because otherwise you just give business away, because competitors are doing it." Business Line Manager, SalesOrg, Final, emphasis in original

The OBA information provides accordingly the basis for decision making on partially quite advanced incentive schemes. According to these, Heavy Machinery bears some of the cost if components underperform and benefits in case they outperform the suggested service interval lengths.

Decisions related to ensuring the achievement of expected Life Cycle Costs in practice

Several decisions can also be identified that are taken during the use of vehicles, in particular to ensure that these keep to their theoretical, specified LCCs. Deviations are on the one hand identified by Contractor as part of its constant analysis of vehicle-related costs and their comparison with promised LCC. On the other hand, deviations might also be identified by Heavy Machinery's staff while conducting service work or formal vehicle inspections on Contractor's vehicles as part of which information is collected by observation and with the help of diagnostic tools. Depending on the root cause of the deviations, different kinds of decisions might be motivated.

Some costs increases might be traced back to *an inappropriate use of the vehicles by Contractor's operators ("operator abuse").* An example that came up at the time of the study are overspeeds. These arise when operators drive the vehicles too fast and lead to increased fuel burn and pressure on the vehicle's components, thereby increasing maintenance-related costs. As part of a vehicle inspection, Heavy Machinery's service technicians could identify a large number of such overspeeds across a number of Contractor's vehicles. Heavy Machinery and Contractor accordingly decided to hold disciplining talks with Contractor's operators and provided some additional training to them. In addition, Heavy Machinery decided to investigate the possibility to technically deactivate a gear on the vehicles, which would remove the possibility for operators to overspeed. The further investigation showed that such a technical adaptation would touch upon work safety relevant aspects of the vehicle. Accordingly, it was decided to not make this adaption locally, but to pass it on to Final's global R&D department for approval and implementation.

Another group of issues are mostly *product design related* and as such require smaller or larger changes in the design of a specific component and/or component interfaces. Reacting to such problems is critical for Heavy Machinery as customers otherwise engage with IASPs to find "quick fixes" or, if the problems sustain, change completely to other vehicle suppliers. Such design problems are accordingly connected to a large number of joint decisions that might be further facilitated by the OBA information. Decisions concern for example whether and with which priority the business partners should consider the issue, how the issue should be investigated and by whom. Depending on the size and potential cause of the problem, global product development units and component suppliers might be involved. Global product development units might, in turn, prioritise the problem and either immediately initiate a product care project, decide to consider it only when designing the next vehicle generation or fully decline the request. The advantage of involving global product development units is that technical changes are properly engineered and documented and can relatively easily reapplied across all machine users with similar problems. Alternatively, the problem might be managed by SalesOrg's engineers together with alternative local suppliers. In addition, decisions need to be made as to how costs are to be split. Heavy Machinery might for example consider the issue free of charge, but Contractor might purchase the improved item at full price, install it on its vehicles at its own costs and review and report upon the new component's performance at regular intervals.

A problem Contractor experienced with its gear selectors can serve as an illustration. According to its accounting records, Contractor had purchased approximately one gear selector for each of its vehicles during the past year. It accordingly assumed that it might require one additional gear selector per year and vehicle over the vehicle's life cycle. At the same time, Heavy Machinery's LCC calculations claimed that gear selectors should usually hold over a vehicle's whole life cycle. As the related cost corresponded to a notable increase in the vehicle's LCC, it constituted a significant problem that was seen worth further joint investigations. SalesOrg decided accordingly to contact Final's global R&D department and the supplier of the gear selectors.

The global R&D department decided to not prioritise the issue. The supplier, however, argued that the problem might be related to the placement and design of the gear selector in the operator cabin. The current gear selector was placed close to where operators might keep their beverages, which means that spills of coffee or coke might naturally occur and reduce considerably the service lengths of the component. As operators could not be forbidden to take beverages into the cabin and the problem caused significant costs, it was accordingly decided by SalesOrg's local engineering unit to identify alternative gear selector designs that might better sustain such spills and placed elsewhere in the cabin. Accordingly, SalesOrg presented an alternative component to Contractor that matched the existing technical interface. Contractor decided to buy the component and to test it on one of its vehicles. In addition, it promised to report on whether the problem sustained or to subsequently exchange the gear selectors across all of its vehicles.

Finally, some issues might be characterised as concerning the *pricing of spare parts or certain repairs*. Due to the value-based, premium pricing strategy, reacting to pricing issues is always a delicate matter.

> "The worst you can do is to send a customer an invoice for (15,000 Euros) for a repair. He gets on the phone, sends an e-mail and he gets cranky, he gets upset. And you, as a manager for the service department, go and say "OK, we will do a deal. OK that was (15,000), but now we give you that for (9,000)." What's he gonna say? "You have ripped me off! How can you charge (9,000), when you charged me (15,000)?" That makes it worse, because you haven't justified anything. You haven't got the relationship to explain why it costs (15,000) and (15,000) was probably even the right price." Product manager, SalesOrg, Service

Accordingly, units interacting directly with the customer are not authorised to provide customers with any concessions. They also do not have any insights into product cost and related profit margins, which would be required to make such decisions. Customer-interfacing units are accordingly only allowed to record the problem and unset a decision process internally to Heavy Machinery, the result of which they, in turn, have to communicate to Contractor.

> "All they need to know is that if they give me specific market information about the competitive price of materials, I will then find a way to support them to be able to compete. But they don't need to know what the cost is. Because then they start making their own judgment on what's fair and what's not fair. And that's not their area of responsibility." Business Line Manager, SalesOrg, Service

The internal decisions differ based on whether the issue concerns only spare parts pricing or includes a labour component. If it only considers spare parts pricing, the issue is prioritised by SalesOrg's product and business line managers based on the provided information and forwarded for consideration to Service's global pricing department. Depending on the input, the global pricing department might, in turn, prioritise the request and investigate potential problems that might have led to the pricing issue. In some cases, the price might be wrong, as the item has initially been categorised wrongly due to a poor technical description.[49] In some cases, the problem might uncover an unusually high purchasing price from component suppliers that requires follow-up actions by Service's purchasing department (see Chapter 7.3). In rare cases, a direct price change might be justified. Special prices for SalesOrg might accordingly be implemented or a global price change might be considered, as part of which a global benchmarking study might be conducted.[50] Price changes might also be limited to particular customers. If a price change is declined on the global level, SalesOrg might, in turn, either consider local price reductions or local sourcing as alternatives or simply inform Contractor of the declined request.

In contrast, if the pricing issue concerns labour cost, decisions are taken on the local level. Depending on the amount of included spare parts, some concessions on labour costs might be approved by SalesOrg's top management. If the issue has arisen out of a service quality problem, it might also be discussed with the involved service administrators and technicians in order to secure learning and avoid any repetitions. An incidence with a service technician conducting work on one of Contractor's sites can serve as an illustration. As the work had not been planned properly and the technician had no

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[49] Depending on whether a part is for example described as a "guide" or "pipe", its value drivers and price might differ significantly.

[50] As volume increases might not always offset price decreases across Heavy Machinery's global markets, such studies are necessitated to assess the consequences of changes of the general pricing model.

overnight bag with him, he had to return home and come back on the next day, causing delays of the repair and considerable travel costs. SalesOrg apologised by offering some concessions to Contractor and discussed the issue with the involved staff.

Different decisions are accordingly taken depending on whether the problem has its root cause in operator abuse, vehicle or component design or pricing. As the analysis and resolution of problems usually takes time and involves different units, Heavy Machinery and Contractor carefully note reached decisions and responsible units in meeting protocols and distribute those within their respective organisations. The notes from the prior meeting serve also as input to the next meeting, making those "living" documents and establishing a paper trail. When a particular issue is solved, it is also moved to a separate section of the document, which serves as a "memory" of the issues that have been resolved as part of the relationship.

Decisions with regard to improvements of Life Cycle Cost calculations and further Life Cycle Cost reductions

At the time of the study, Heavy Machinery and Contractor have also started to make decisions on how to improve the initially theoretical LCC estimations for specific vehicle designs and on how to reduce them jointly even further. Concrete decisions can be classified into two larger groups, First, Heavy Machinery's decision to invest into *particular facilities* that provide a solid technical basis for such interactions. It acquired for example specialised software that facilitates the continuous analysis of data received from Contractor and other customers.

> "To collect information is quite easy. We have today systems that give us all data. The problem is to analyse it in an efficient, cost- and time-efficient, manner. (…) We have looked at systems into which one can feed this kind of data and which then can learn itself and tell us "In X hours, this valve will break, that we see from experience." (…) And then one can order and plan after that as well."
> Global Technical Service Manager, responsible for Final's products, Service

In addition, the decision was formed to rename SalesOrg's technical department into "Reliability and Tech Services Department" and to recruit several engineers purely dedicated to analysing customer data, identifying root causes and proposing improved maintenance strategies.

Second, some decisions are taken on a continuous basis as *particular component costs and associated resources* are considered. As Contractor focused in particular on the LCCs of Component X and communicated component-level cost targets to Heavy Machinery, it became the first component subject to joint decision-making. Based on the identified gap between desired and experienced LCC, Heavy Machinery decided to conduct specialised inspections of the component across all of Contractor's vehicles and to disassemble a component which had sustained particularly long service intervals in order to learn about potential differences. The firms decided also to conduct workshops with Contractor, the supplier of Component X and Final's global product development unit to consider the application engineering of Component X, the alignment of maintenance resources and commercial aspects, including its pricing.

7.2 Use of Open Book Accounting by Heavy Machinery

The disclosed OBA information directs not only attention to specific aspects on the relationship level and facilitates decision making with regard to those. It is also used unilaterally by Heavy Machinery. In this context, the information is mostly analysed in relation to larger customer groups and vehicle populations rather than individual customers, such as Contractor.

7.2.1 Attention directing use

On Heavy Machinery's firm-level, the OBA exchange has directed attention in particular to two larger areas: the need to consider long-term cost consequences during product design and the need to invest into and efficiently coordinate maintenance-related resources (Table 14).[51]

Table 14 Areas to which Open Book Accounting directs attention on Heavy Machinery's firm level

1	• Long-term cost consequences of vehicle and core component design choices o Service interval lengths of major components o LCCs/spare part cost of major components o Ease of serviceability
2	• Need to invest into and efficiently coordinate maintenance-related resources o Specialised maintenance-related sales and marketing resources to identify and "hunt" maintenance-related sales opportunities o Supplementary maintenance-related products, such as upgrade kits for core components and plug and play modules for other vehicle parts o Component repair centres o Logistics facilities (global and local distribution centres, local warehouses)

Long-term cost consequences of vehicle and core component design choices: service interval lengths, Life Cycle Cost and ease of serviceability

As we have observed, Contractor places considerable attention to the long-term cost consequences of its vehicle design choices. Parallel to the implementation of OBA, these demands have also transpired to Heavy Machinery's firm level, in particular Core's and Final's product development units, where more attention has been directed to the long-term cost consequences

[51] An additional area to which attention *remains directed* is vehicle manufacturing-related cost, which still contributes an important, even though much smaller, part to total vehicle cost (compared to other products than capital equipment). No explicit link between the introduction of OBA and a change in production cost focus could, however, be established as part of the study at Heavy Machinery. It is accordingly neglected in the following discussion.

of vehicle and major component design choices. In particular, more focus has been placed on service interval lengths and LCCs of major components and the ease of serviceability of vehicles.

The increased attention to *service interval lengths and LCCs* of major components can in particular be observed with regards to the core component. As noted, the core component is particular in that it requires frequent, extensive[52] repairs. Heavy Machinery's increasingly cost conscious customers place accordingly high attention to the costs related to those frequent repairs, including opportunity costs that arise as machines have to be stopped when core components are exchanged. High, reliable service intervals and relatively low maintenance cost at these intervals are accordingly seen as desirable by customers.

Heavy Machinery had historically not put a major focus on the length and cost related to the service intervals of its core components. Instead, it had paid more attention to the product's functionality, in particular its speed, in development projects. The introduction of service interval length and cost targets in product development marked accordingly an important historic break.

> "Some time back in time, we have often focused on making a faster, and a faster, and a faster (core component) which has resulted in that we have the world's fastest (core components), but we maybe do not have the world's most reliable (core components). So the past few years, the focus has been on that aspect instead, to improve (the core components) in terms of reliability and life length, more than making them faster." Product portfolio manager, Core

By focusing more on the service interval length and LCC in product development, it was accordingly hoped to close the gap to a major vehicle manufacturing competitor. As the competitor's vehicles featured core components with longer service intervals, most contractors, including Contractor, and many site owners in Sales Org's region exclusively used that competitor's equipment at the time of the study. The service interval lengths and spare part related costs of core components could accordingly be seen as a

[52] A core component repair can take about 2-3 workdays to complete at a component repair centre. Time for transport and fitting components on the vehicle need to be added to this.

bottleneck that precluded Heavy Machinery from selling vehicles of the particular type to Contractor and other customers at present, a situation Heavy Machinery aimed to change.

More attention has accordingly been directed to the length of service intervals, expressed in terms of operating hours between overhaul, and LCC, articulated as spare part related cost per operating hour. Interestingly, LCC targets for product development units have, however, not been formulated in terms of actual prices charged to customers, but the respective spare parts' production or external purchasing cost. The intention of this is to clarify the specific focus of the involved business units. While engineering units should focus on increasing service interval lengths and lowering the cost of individual parts, global marketing units are responsible for their pricing independently of their cost.

An increased attention to the *ease of serviceability* of new vehicles and core components can also be observed at Core's and Final's product development units. The Service division became for example more involved in formulating maintenance-related requirements at the concept stage of new product development projects at Final.

> "So what I do with representatives in my project team is breaking down our aftermarket requirements. We might for example have a requirement that the filter should not sit on the roof of the cabin, as we then cannot serve it easily. It should maybe sit at maximum an arm length inside the vehicle and not higher up than a meter from the floor. (…) So, this are our requirements from the aftermarket for the engineers and then they need to follow these. Because the problem that we historically have had is that production is quite strong and they want to have it in one way. For example, they want to *mount* the engine in an easy manner. But that's perhaps not what *we* want. *We* want that one can *lift out* the engine very quickly. And, that does not always go hand in hand, that's why we have started with these requirements. It is nothing we have worked with before so much, but we have started to work very much with it since May this year." Project Manager New Product Development, Service, emphasis in original

Attention to the investment into and coordination of maintenance-related resources

The OBA exchange puts also attention to the need to further invest into and coordinate efficiently maintenance-related resources on the firm level in order to support already sold vehicles. As we noted, customers constantly monitor Heavy Machinery's maintenance-related support and make their decisions on future vehicle purchases dependent on the support they receive on their current vehicle fleets. The OBA data exchange further supports this focus on the firm level through two specific kinds of analyses. These are described in general terms in the following before their use is described with regard to four areas to which they direct Heavy Machinery's attention in particular.

The *first set of analyses* is based on Heavy Machinery's LCC models, vehicle status information received from customers and additional vehicle related data saved in Heavy Machinery's central database FleetData. By linking this information together, Heavy Machinery can establish a relatively precise assessment of the current life cycle stage of individual vehicles and their major components, their income generating potential and their future maintenance-related resource demands.

> "Basically, it is all run on the hour meter of a machine. The hour meter, believe it or not, that's the most important thing to a sales company on a machine. (…) The hour meter on a (vehicle) doesn't turn off and that's what generates your income." Regional Sales Manager, SalesOrg, Final

Establishing a link between the two sets of data in an analysis is at the same time not without challenges. As we have noted before (see in particular Table 7, Chapter 5.2.1, page 107 and Chapter 6.1.1, page 135 ff.), LCCs differ depending on the design of the vehicle, its use and operating and maintenance requirements. In addition, challenges arise from the need to collect vehicle status information not only from Contractor, but a larger number of customers, and to make them available at central locations to support firm level analyses. Finally, customers might source certain parts not from Heavy Machinery, but other suppliers, further complicating the interpretation of the results of the analysis. These challenges are managed by Heavy Machinery in different manners.[53]

First, Heavy Machinery simplifies its firm level analyses by basing them on *standardised, theoretical LCC* calculations in contrast to *specifically adapted, theoretical LCC* calculations that are used in particular relationships (see Chapter 7.1, page 177 ff.). As noted before (see Chapter 6.1.1, page 135 ff.), standardised, theoretical LCC calculations account for vehicle adaptations that are required from a legal perspective in order to be allowed to sell them in SalesOrg's region, but not for any customer-specific vehicle design adaptations. In addition, they are adapted to what SalesOrg considers "standard" operations and maintenance practices in its region. These differ from those observed in other regions of the world. At the same time, significant customer-specific differences naturally occur even within SalesOrg's region, but are neglected in this type of LCC calculations. Some customers might for example use their vehicles "much harder", employ less well-trained service technicians or use repaired components or service exchange agreements instead of new components during overhauls.

Second, the analyses are adapted to the current operating hours of individual vehicles and their forecasted use, as far as such information is available. As noted before, Heavy Machinery saves reported operating hours and the current vehicle status (e.g. in use/parked up/scrapped) in its central database, FleetData, together with some information on the vehicle type, its commissioning date, its current location and the serial numbers of its major components. If current as well as prior reported operating hours are available, Heavy Machinery can accordingly discern the life cycle stage a particular machine is in and estimate the average number of hours it might be used

[53] Despite these adaptations, some general limitations connected to Heavy Machinery's business model nevertheless still remain. One of these limitations is connected to the cyclicality of Heavy Machinery's business. The analyses are accordingly only correct as long as machines are used in practice as forecasted. Actual machine use can, however, change dramatically, which has been criticised by several interviewees as Heavy Machinery does not adapt its forecasts and targets during running years. A second limitation is connected to the need for local market knowledge in making these analyses. Accordingly, Heavy Machinery does make such calculations mainly on the level of the sales organisation (SalesOrg) and not centrally for the whole of Heavy Machinery. An exception are analyses on the sales potential of upgrade products for which more rough estimates are considered sufficient by Service's and Core's global product management units. In order to ensure some accuracy, this more general data is discussed and verified with some of the largest sales organisations.

during the following years, given persisting business conditions. In contrast, if recent and prior operating hours are not available, Heavy Machinery can estimate the life cycle stage and expected machine hours only based on the vehicle's commissioning date and assumptions on the average number of hours a specific vehicle type might be used during a calendar year.

> "If it hasn't got a current hourage, we have to take it back from when it was commissioned and say, well, it is commissioned such and such, the dates. So, it should be at 5,000, 10,000, 15,000, whatever hours. (…) So you look at, in the lifespan of five years, to get to your 25,000 hours, you work out, "OK, well, year 3, that's where it should be." And then you can take a dollar figure based on that, as to where it should be." Product manager, SalesOrg, Service

Third, as estimations based on commissioning date naturally introduce potential errors, Heavy Machinery has invested into several resources that facilitate and encourage the collection and updating of actual vehicle hours. It has for example configured its IT systems so that it can extract information on machines whose operating hours have not been updated recently. Service administrators, regional service sales managers and key account managers can accordingly focus their efforts on contacting customers and updating hours of machines Heavy Machinery's staff otherwise might not have touched otherwise. In addition, Heavy Machinery has introduced new devices to facilitate data gathering and reduce potential mistakes in data entry. One of these are mobile phone applications that allow service technicians to directly enter and upload vehicle status information when visiting customers. Another one is the introduction of remote monitoring devices on its vehicles. If ordered by Heavy Machinery's customers, these send continuously vehicle status information directly to both the customer's and Heavy Machinery's servers. Moreover, the need to regularly update hour meter information is underlined by its use on the firm level, creating additional pressure on its service administrators and sales managers.

Finally, customers might source certain parts not from Heavy Machinery, but other suppliers. These represent an untapped potential, which Heavy Machinery might be able to recall. At the same time, these might require some effort as customers might have signed up to long-term supply contracts or enjoy cheaper conditions that Heavy Machinery might need to match first.

For attention directing and decision facilitating uses, Heavy Machinery distinguishes accordingly between four different revenue levels: the total revenue potential, revenues that are achievable without extra efforts, revenues that are achievable with extra effort from regional service sales managers with a certain probability of success and revenues that might be achieved, but only with a lower probability of success and with extensive support from different local and global units within Heavy Machinery. While the total potential can be calculated through linking LCC and vehicle status information, the other revenue levels require the involvement of regional sales managers knowing more about their customers. Based on their knowledge, they for example set the revenue level they perceive as achievable without much extra efforts.

> "Well, this year, so 2015, was the first year where the marketing team would send out a spreadsheet to all the service managers and supervisors. It was pre-populated with our machine data from (FleetData), serial numbers, customers, and the last updated hours, and also linked into the LCCs for each machine. (…) The service managers would go through and indicate how much of that share of wallet we believe we would actually get. So from a hundred percent, are we gonna get 70 % of spare parts because the customer buys these X amount of parts from our competitors or different peoples than (Heavy Machinery)? So we go based on history, what we know we get. We might get 70 % and we would populate all that information and then send that back." Regional sales manager, SalesOrg, Final

In addition, sales managers provide Powerpoint presentations and Excel files with additional information on the additional revenue that might be realised with a given probability of success or only with the help of local and global management. The files list also the actions that service sales managers consider necessary to this end.

While the first type of analyses accordingly concerns the complete vehicle, including its major components, and is based on linking standardised LCC calculations to vehicle status information and information saved in the FleetData database, *the second type of analysis* is limited to core component repairs. It builds on internal data on important parts used during component repairs and sold by Heavy Machinery to CoreIASP and systematically collected feedback from customers.

As noted before, CoreIASP is the only major competitor for core component repairs in SalesOrg's region. At the same time, it is also a customer to Heavy Machinery, buying particular parts it can neither imitate itself nor get hold of from other sources. By comparing the number of particular spare parts sold to CoreIASP with the number of its own executed core component repairs, SalesOrg can accordingly estimate relatively precisely its own market share of core component repairs.

> "So, since 2010, on a yearly basis pretty much, I have gone into (the IT system) and I can tell every spare part that (CoreIASP) buys, every nut, bolt, everything. So what I do, I take a specific set of seals that they buy from us, that they can't buy anywhere else. There's nothing better than these two specific seals, but they are deep inside the (core component). The only reason to buy that seal is to repair a (core component). (…) So I look at the two main (core component designs) we have in (our region) and two sets of internal seals. (…) If they buy 300 of those seal sets, they are repairing 300 (core components) of that type. That's it. That's very simple. If they buy 200 of that other seal set, they are repairing 200 (core components) of that type. And they (Service's global product managers) say, "How can you prove that?" I say, "Well, there is no reason to buy that part of the (core component) unless you have it completely open and stripped. There is no other reason to go there except you are gonna rebuilt them." To me, it makes sense." Product manager, SalesOrg, Service

In addition to analysing sales data to CoreIASP, Heavy Machinery collects and analyses the customer feedback its local maintenance workshops and component repair centres receive in order to locate the customers that send their core components to CoreIASP.

> "So I'll talk to a branch and I say "Well, do we fix (Customer A's) (core components)?" "No, we don't repair (Customer A's) (core components), they go to (CoreIASP)." Or like with (Customer B), where we know they have these many (core components) and we know that they were sending 12 of their 28 (core components) to (CoreIASP)." Product manager, SalesOrg, Service

In contrast to the first type of analysis, the second type of analysis provides accordingly the advantage that it does not require any assumptions on the core components' actually experienced service interval lengths, use and operating and maintenance practices. In addition, subcomponent level sales cannot be interpreted incorrectly.

> "I mean when they (Service's global product managers) did a market analysis on components, they used a part number that (CoreIASP) buys and said (Heavy Machinery) has got, you know 95 %, of the market. We do! *But* we sell 50 % of it to (CoreIASP). *Haha!* So does that really mean anything? It doesn't, because they can't get a better product than if they buy it from ourselves." Product manager, SalesOrg, Service

As these two sets of analyses are regularly conducted, they direct the attention to at least four major areas that could be identified as part of the study.[54] Firstly, as the two sets of analyses have allowed the identification of maintenance-related sales opportunities and large gaps between current and potential revenues in particular, more attention has been placed on proactively identifying maintenance-related sales opportunities with regard to particular vehicles, customers and vehicle types and on proactively "hunting"[55] these. In particular, more focus has been placed on the need to invest into and coordinate efficiently *specialised maintenance-related product sales and marketing resources* to support such work.

This new attention on maintenance-related sales contrasts with the prior focus on selling vehicles and satisfying maintenance-related demands primarily reactively, based on communicated demands by a few, relatively loyal and large customers.

> "The sales organisations were not particular professional in their business. The business was based on the customers' demands. One knew which customers one had and then one did business with the customers. What we want to do is to see which machines are in operation and that's our customer base. We don't care whether they are called (Customer A), (Customer B) or Joe's Garage, if he owns a machine. It's the machine that drives our revenue. Can we increase and say

[54] As part of the study, no explicit use of OBA information with regard to investments into and improved coordination of maintenance workshops could be observed. An explanation might be that customers' use of these workshops differs largely, depending on their own workshop resources, making any use of the two analyses with regard to maintenance workshops less useful. Instead, Heavy Machinery tracks closely maintenance workshop cost and service variance, a measure of capacity utilisation.

[55] Word used by Business Line Manager, SaleOrg, Service

"OK, these large (site owners) you work with very well, they buy from us, but what about the others?" 30, 40 percent of our fleet hasn't been touched before. Why? If they can just buy two, three, four, five things each year from us, that's already high revenues! And, that's what one has not been doing. Instead, one has been quite comfortable and worked with the large customers." Global Fleet Manager, Service

More focus has accordingly been put on identifying the earning potential of individual machines and customers in order to direct sales and product managers in their work.

"There is now a bigger machine database in (the region), (FleetData), and it has a national working team supporting the (branches) to ensure that they are getting every cent they can get out of their clients. *They are running that side of the business like an accountancy.* Each machine should have the earning potential of X. Why we are getting return Y? And that's the question that service teams and regional teams are now responding to." Regional sales manager, SalesOrg, Final, emphasis added

Secondly, the analyses have also directed more attention to the possibility to develop and sell *maintenance-related products* for already sold vehicles, such as upgrade kits for core components and plug and play modules for larger vehicle overhauls. Upgrade kits allow customers to convert their existing core components to newer generations. They can thereby benefit from increased service interval lengths and lower LCCs of newer versions and less complexity in their own operations, as all their core components are of the same design. Plug and play modules are complete assemblies made up of several spare parts. As the module is exchanged as a complete, maintenance-related downtime and, thus, opportunity cost is reduced. Heavy Machinery has always *reactively* offered such products when demanded by *particular customers*. Based on the analyses, a general urgency has however been created to offer such update products more *proactively* and *to all customers*, also to avoid further sales losses to IASPs, such as CoreIASP and FinalIASP.

"Customers expect us to be proactive in terms of the design. So there is no good buying something from (Heavy Machinery) if we don't come up with a modification or improvement, but someone else. (CoreIASP) has been a *good* thing in a way to us, in that they have taken us out of a sense of comfort, thinking that we release a product now and then in six years' time we release another one. And everybody is gonna be happy, because there is no alternative. But now, there is more alternatives in the market than just us and (Vehicle Manufacturing Competitor A). So that has kept us very honest in terms of how we see the product, the (core component) product. So they have been good to us, *not* good *to* us, but good *for* us." Product manager, SalesOrg, Service, emphasis in original

Apart from creating a general urgency for providing maintenance-related products, the analyses help also to direct attention to particular vehicles and core components for which the development of such upgrades is particularly useful. Not only can the total number of vehicles with particular major components be identified with help of the analyses, but also their life cycle stage. As upgrade products are only economically advantageous for vehicles and major components at a certain life cycle stage, this latter information is of particularly high importance.

"I do not say that all customers should do this (upgrade). If you have an old (core component), which maybe has a remaining life length of around thousand hours left and then you mount such an (upgrade) kit on it, you do not get a new (core component), but an old, worn out (core component) with some new parts. So then you maybe will not benefit from this cost as you need to change the rest of the component before as well." Product portfolio manager, Core

Furthermore, the analyses help also in directing the sale of such maintenance-related products as customers with suitable vehicles and components can be identified. Upgrade kits and plug and play modules can accordingly also be used as a reason to contact specific customers and offer further maintenance-related services.

Thirdly, the analyses help Heavy Machinery to direct its attention to the need to adapt its offering of component repairs, conduct the associated investments into *component repair centres* and to monitor and improve its repair efficiency. In their quest to reduce the LCCs of their vehicles, customers have become increasingly interested in reducing the use of new components during overhauls. Instead, they have become interested in drawing on repaired components and service exchange agreements. While SalesOrg has conducted some component repairs and service exchange agreements before, the market for repairs and service exchange agreements was accordingly assumed to increase dramatically, also as a large number of machines that had been sold some years ago were about to reach their first major service intervals.

The first set of analyses directed accordingly attention to the questions of which component repairs and service exchange agreements Heavy Machinery should offer in the future and whether the volumes for specific components might warrant the investment into own repair centres or whether repairs should be channelled through to external business partners.

> "We need to make sure that we are ready to be able to 1) support our product and 2) grow our revenue and our market share. So, through the data coming out of (FleetData), it is very clear: We know exactly when pretty much every single machine in the pool is going to be due for ex-components or major rebuild. So now we are pulling all that data together so that we can then go to the customers and say "We can support. We can do this. We can do that." to grow our revenue." National Service Manager, SalesOrg, Service

In addition, the analyses outline also the number and geographic location of upcoming repairs, directing attention to the need to plan the future location of component repair centres.

> "(The component repair centre in City A) does certain (component repairs). Is that the best locations currently for the potential growth in the (component repair) area? Yes, it is at the moment. In twelve months' time, it won't be. So that's why we are going out to see: "Do we have one centre of excellence where we do all of our (repairs) and then just supply the key branches or the key areas to support our customers?" So that's the second part of the work we are doing." National Service Manager, SalesOrg, Service

Moreover, as part of the two analyses, major competition from ComponentRepairer, CoreIASP and FinalIASP could also be perceived for the component repairs Heavy Machinery already offered. Attention has accordingly been directed to how the efficiency of currently and newly offered component repairs might be increased to match those competitors. Particular attention has accordingly been directed to the pricing of spare parts used in component repairs, labour cost and means to increase workshop efficiency and turnover speed.

> "I mean the other thing that we do not do very well is that a customer that brings a (core component) in, doesn't care whether there is another ten (core components) out there and he is the eleventh and it's gonna take us three weeks to get to it. That's not his problem. That's our problem, but we have made it his problem. (…) So that's the issue that we have got internally, that we need a quicker guaranteed turnaround time." Product manager, SalesOrg, Service

Fourthly and finally, the OBA exchange and accompanying analyses have also directed more attention to *spare parts stocking and logistics*. As observed in Chapter 6 on the design of OBA, customers regularly review Heavy Machinery's logistics performance and provide information on the status and location of their vehicles. In addition, Heavy Machinery has put much emphasis on establishing a One Stop Shop that allows it to deliver spare parts on short notice and reduces the urge of customers to investigate other possible sources. Information gained from the OBA exchange and connected analyses directs attention to two aspects with regard to logistics in particular. One of these is the need to ensure the adequate initial stocking of spare parts for new vehicle and core component models.

> "If you are (the national sales manager) and you have got a *brand new* machine that you are putting into a market, which is a new opportunity, but we have no market history or intelligence on the performance or the reliability, you have got to make sure that you protect your interest in sales, to ensure that you have material to support the machine in the event you have any downtime. And that's where it gets tricky on determining who deems what is critical. Really, anything that's gonna shut a machine down is considered critical." National Logistics Manager, SalesOrg, Service

A second aspect with regards to logistics is the need to constantly (re-) balance the amount of stock kept at distribution centres and local warehouses with machine fleets. Based on the OBA information and accompanying analyses, Heavy Machinery can identify when customers move their machines to different locations, when a larger number of repairs with a connected increase in spare part demand can be expected and when the use of certain machines is discontinued.

7.2.2 Decision facilitating use

The OBA information and connected analyses do not only direct attention into these areas on Heavy Machinery's firm level, they do also facilitate decision making within them (Table 15, page 206).

Decisions in product development to foster long-term cost focus: service interval lengths, Life Cycle Cost and ease of serviceability

The increased attention to service interval lengths, LCC and the ease of serviceability has been followed by the decision to introduce specific targets with regard to these three areas and to follow up those consciously during product development.

Heavy Machinery has for example decided to introduce specific targets for both *service interval lengths* and *LCC* for new development projects concerning core components. These targets are derived from information gained through the aforementioned structured customer interviews (Chapter 6.1.1, page 144). The commercial value attached by customers to increasing service interval lengths and lowering spare part related LCC is also formally assessed and included in the commercial business plans of new product development projects.

> "Okay, the customer wants to have this star (drawing on white board). But what can the star give him at the end? What is the money back for this star? How much can we invest to have the star and after that, what price can we set on the star? It is depending on the money value for the customer, because if we make a star that is more expensive for the customer than he actually can pay for it, then there is no product. (…) So from the interviews with the customers, one question I sort of ask is, if the customers say, "Ah, it is very costly for us if the machine breaks down, if the machine breaks down in between overhauls, then I have an unplanned stop and the whole (operation) stands still." - "Aha, how long does it stand still?" I might ask and he says "Ah, it can take a day or two."

"Okay, a day or two, it must be very expensive for you to stop the whole (operation) for a day or two." – "Yeah, it costs like (writing a financial number on white board)". Then I have something, then I know, (tapping on board), how to build a money bag, because I know if we can decrease this one to, let's say zero or a lower number, then I can sort of translate it to what he believes what the cost is to have a standstill. So then I know vaguely, how much it is worth for the customer." Product portfolio manager, Core

Table 15 Decisions made on Heavy Machinery's firm level that are facilitated by the OBA information exchange

1	**Long-term cost consequences of vehicle and core component designs**
	• Service interval lengths and LCCs:
	  o Specific targets for new core component development projects, connected to commercial business plans
	• Ease of Serviceability
	  o Proactive specification of maintenance-related criteria in the concept stage of new product development projects
	  o Formal service audits before release to serial production

2	**Investment and coordination needs of maintenance-related resources**
	• Maintenance-related sales and marketing resources to identify and hunt maintenance-related sales opportunities
	  o Division into "hunting" and "farming" units, employment of regional service sales managers and product managers with knowledge in marketing, introduction of supporting IT tools
	  o Operational sales plans to coordinate sales and marketing resources
	  o (Revenue) targets and incentives
	  o Focus and timing of monthly maintenance-related sales campaigns
	• Maintenance-related products
	  o Upgrade kits
	  o Plug & play modules
	• Component repair facilities:
	  o Product portfolio, investment and location decisions
	  o Initiatives to increase repair efficiency, reduce pricing of spare parts used in repairs and improve planning
	• Logistics facilities:
	  o Initial stocking
	  o Redistributions between logistics facilities
	  o Prolongation, fire sales and scrapping of excess stock

The decided service interval length and LCC targets (based on production or external purchasing cost) serve as guidelines for the responsible product development units. As product development involves creativity and multiple changes, detailed estimations with regard to these targets can, however, usually only be made towards the end of product development projects, when the general technical design has been finalised and individual subcomponents, their service interval lengths and production or external purchasing costs can be broken down in Excel sheets. The relatively late estimations limit the ability to make further larger design changes. The main contribution of these targets is accordingly seen in guiding engineers during the project as such.

> "I mean, it is difficult and takes its time to follow it up, so that becomes (a challenge). Sometimes you need to wait five years before you have the answer and can terminate the project. So, it is also a bit dangerous with these targets. But it is still an important way to express it. Customers express low running cost. Yeah, but if it concerns this product, what is cheap? Sometimes (X Euros) are cheap, sometimes (X Euros) are expensive, it depends on which product it is. It gets a little bit soft, but we still have some figures to measure us against." Project Manager, Core

In order to further the *ease of serviceability* of vehicles and their major components, it has been decided to introduce mandatory maintenance-related requirement analyses and service audits in Heavy Machinery's product development processes. The concept stage at the beginning of new product development projects at the Final division can for example no longer be passed without having specified maintenance-related requirements. These maintenance-related design requirements can take many different forms. They can for example concern the physical placement of components on the machine, the necessity to reach certain subcomponents or screws, the need to mark certain parts in a specific manner or to alter their shape to avoid confusion and incorrect repairs by service technicians. They can also concern limitations on the need for special equipment and training when repairing vehicles and components. In the establishment of these criteria, the Service division acts as a spokesperson for customers based on feedback received through OBA on earlier generations. In addition, it invites sales organisations with a particular interest in the product to submit their views and interacts in systematic interviews with potentially important customers to inquire about their views on the ease of serviceability of current and future vehicle generations.

Furthermore, formal service audits have been implemented as a requirement before serial production can start. These serve as a check to see whether the initial maintenance-related design criteria have been fulfilled by product development units in practice or not. Representatives from the Service division visit accordingly Final's premises to learn about and check the design of different vehicle parts during prototype assembly and complete a final service audit to see whether the respective service intervals can be completed easily. While the design of the prototype itself might not be changed directly following the audits, due to time pressure, the observations are logged and changes are implemented before the final vehicle design is released for serial production. In addition, requirements and audits have led to the establishment of checklists, serving as a memory of earlier discussions and improving the ease of serviceability over time.

Decisions regarding investments into and the coordination of maintenance-related resources

As observed, the OBA information and connected analyses have also directed Heavy Machinery's attention towards four further maintenance-related matters: maintenance-related sales and marketing resources, maintenance-related products, component repair facilities and logistics facilities. Within these areas, the information and accompanying analyses are also regularly drawn upon by Heavy Machinery to facilitate different kinds of decisions (Table 15, page 206).

Based on the awareness of its sales potential and existing gaps, Heavy Machinery has for example worked on improving its *maintenance-related sales and marketing resources.*

> ”The company had put people who were good technicians in roles, but whether they were good salesmen (was unclear). There was no training, no qualification, so what we have done is we have put that team under (the product marketing manager), we put into place an integrated sales and marketing programme and we have identified how we farm the business, so the day-to-day selling and how

we look at what we are not selling and what we are, where the gaps are in our business, compared to the potential to what we should be achieving." Business line manager, SalesOrg, Service

Specific decisions in this area include the introduction of a structural split at SalesOrg into units being charged with "hunting" available maintenance-related sales potentials and those responding to customers' daily support requirements. As part of this split, the new role of regional service sales managers was introduced. Being trained in selling maintenance-related products, their role focuses on regularly visiting customers in their territory and dealing with the commercial aspects within the relationships, including the identification and recalling of maintenance-related sales. In addition, a number of product managers was employed at SalesOrg's regional headquarters, focusing on the coordination and support of regional service sales managers. They prepare accordingly also particular discounted offers, if required. In contrast, maintenance workshop supervisors, maintenance technicians and warehouse staff became responsible for "farming" the business and thus supporting customers in their day-to-day business. In addition, several IT tools were adapted to improve the identification, tracking and conversion of maintenance-related sales opportunities.

Moreover, several recurring sales and marketing related decisions are regularly supported by the two sets of analyses, including operational sales planning, target setting and the launch of maintenance-related sales campaigns. Operational sales plans are for example established in the form of customer specific "Heat Maps". Heat Maps state the specific opportunities regional service sales managers might achieve on their own and with the help of local product management and global marketing units, their commercial value to Heavy Machinery, their probability of success and actions that might be required.

"And then those are allocated to a (regional service sales manager) and I take some myself and then we go out and we get the traction. If at any point in time that we are not getting the traction, we will revisit it, and then we will talk to the marketing team and say "Well, you know we are not really getting the traction with our clients on this item, and we know that the potential is there. We need to market it a little bit more." So we will have a brainstorming session, we will have a look at our company already endorsed products as in such, and we might come up with something like a (plug and play) module or something where the client is giving us feedback "You are here and you need to be here." So, we will work out how we can get there, obviously increasing revenue on the way." National business development manager, SalesOrg, Service

Heat Maps accordingly enable joint decision making between SalesOrg's regional service sales managers and central product management units and provide guidance for their further work. Heat Maps are also shared with staff "farming the business" in order to solicit feedback and align their attention to the overall goals. When actions on the local level do not lead to the desired results, Service's global product management and pricing units are involved. The analyses and accompanying sales plans facilitate accordingly decision making between otherwise distant local and global units involved in the "hunting" of sales potentials and supported their joint decision-making.

"I guess it's a way of putting it on paper. Previously you would be relying on trying to get what's in my head into management's head. If you can put it on paper in a format that everybody understands, you can provide the clarity. (…) Now we have got an analysis by part numbers. It is all that local intel and understanding your position in the market that you are in." Regional Service Manager, SalesOrg, Service

In addition, based on the detailed information, formal revenue targets and incentives are set for different internal units. Potential revenues seen as achievable with extra effort of regional service managers become the stretch target for these managers and are reflected in their individual compensation plans. In addition, at different levels of aggregation, these become also the spare parts related revenue target for SalesOrg's different local warehouses, SalesOrg's central product management units and SalesOrg's maintenance-related revenue target within the Service division. The achievement of these targets is monitored closely by SalesOrg's top management and further decisions are taken whenever deviations become visible.

National business development manager, SalesOrg, Service: "So then, we do a quarterly review versus the plan, which gives us an indication of what happens, which then breaks down into the branches."

> **Interviewer:** "And what is that for kind of data that you are looking at here?"
> **National business development manager:** "This is an extract from the first quarter sales. Ok? So basically it tells me the percentage. Green is on target, like traffic lights. Amber is "we are sort of not quite there, but you know we are not in trouble sort of thing" and then red is "the area is not doing as well as expected" and this is where I need to pull the (regional service sales managers) together and then target to pick up the revenue in these branches."

In order to support regional service sales managers in their effort to close potential sales gaps, SalesOrg's product management has also decided to introduce monthly sales campaigns. Based on the now centrally available information on the life cycle stages of vehicles and major components and feedback from regional service managers, SalesOrg's product managers form decisions on the maintenance-related products that shall be offered as part of monthly sales campaigns and the timing of specific campaigns. In addition, it contacts global product management units to negotiate special prices for the included spare parts and global engineering units to initiate the specification of plug and play modules for specific campaigns. With the help of campaigns, regional service sales managers are provided with reasons to proactively contact customers with suitable vehicles and sign up them ahead of time, thereby reducing the window of opportunity for IASPs to offer competing products.

The OBA information and analyses are also used to support several decisions with regard to *maintenance-related products*, such as upgrade kits and plug and play modules. When Core develops a new core component generation, it for example decides together with Service's global product management unit whether it should subsequently design and produce upgrade kits for older product generations. The decision is mainly based on information noted in the FleetData database, in particular the number and life cycle stage of core components of the earlier generation. Based on this information, the potential profitability of providing such upgrade kits can be assessed. In addition, based on the information, the Service division might launch global campaigns subsequent to the launch of upgrade kits and SalesOrg might identify and contact potential customers in its region. Decisions with regard to plug and play modules are supported in a similar manner.

Several decisions have also been supported by the OBA information and accompanying analyses with regards to *component repair centres*. As SalesOrg forecasted an increased customer demand for repaired as opposed to new components, it conducted detailed business plans outlining the necessary investments. These concerned decisions as to which major component repairs should be conducted at internal repair centres or channelled to external business partners, where those component repair centres should be located, how repair processes should look like and which investments into spare parts and complete components this might require. The plans were in particular informed by an extrapolation of the life cycle stages of already sold vehicles and their major components over the next few years and the vehicle's current geographical locations.

In addition, with regard to already offered component repairs, the OBA information has facilitated decisions with the aim to recall lost component repairs from CoreIASP and ComponentRepairer. These include in particular decisions with the aim to increase internal repair efficiency, lower the cost of consumed spare parts and coordinate repairs more efficiently. In order to increase repair efficiency, SalesOrg conducted for example benchmarking studies across its own component repair centres and those of other sales organisations in order to identify the number of hours certain repairs should take and identified component repair centres that required further support to increase their efficiency. In addition, SalesOrg invested into specialised workshop containers including all the necessary tooling and instructions to facilitate the efficient repair of core components. Furthermore, SalesOrg reengineered what spare parts used in internal repairs might need to cost, based on market prices and existing local labour cost, and negotiated special transfer and sales prices with Service's global marketing unit.

Finally, several decisions with regard to the initial stocking and re-balancing of stock among *global and regional distribution centres and local warehouses* are facilitated by the OBA information and accompanying analyses. Initial stocking becomes necessary when a new machine model is launched or is sold for the first time within a certain geographical region. It is particularly challenged by that new machines have no history. Spare part demands can accordingly not be based on prior demands. In addition, any failure to deliver spare parts to early adopters of a particular machine model might severely harm both future sales of the specific machine and Heavy Machinery's reputation in general.

In this context, standardised LCC calculations provide product managers with a first indication of the spare parts that might be required for preventive and corrective maintenance during the first year of machine use. In addition, the software used to calculate LCCs indicates some parts that might not be required from a maintenance perspective over the life cycle of the machine, but, when failing, might lead to immediate machine breakdowns. Product and supply chain managers can accordingly use standardised LCC models as a basis for their initial stocking decision.

At the same time, the initial suggestion requires manual adaptation to cope for limitations of the standardised LCC calculations, potential performance guarantees extended to customers, logistics requirements and currently stocked parts. Standardised LCC calculations assume for example that components are exchanged with new ones rather than repaired ones. In order to match its general offering of repaired components and service exchange agreements, SalesOrg might accordingly add additional repair kits, components and subcomponents to its stocking list. In addition, the timing of corrective maintenance activities based on standardised LCCs might not necessarily be correct.[56] The respective parts might accordingly be stocked much earlier. Some major components that usually should not be required before major overhauls might also be added manually due to performance guarantees extended to early adopters and the geographical location of SalesOrg, prohibiting quick deliveries from global distribution centres. The selection of additional stock on top of that suggested by standardised LCC models is facilitated by spare part books, which product managers carefully analyse. Moreover, the final total list is checked against spare parts stocks to identify already stocked parts that are compatible to the new vehicles and similar parts that have not been sold before. The respective parts are eliminated from the list, which, in turn, is subsequently implemented.

Following initial stocking, continuous follow-ups are also supported by the OBA information. Based on forecasted component repairs, SalesOrg

[56] See also footnote 38, page 139.

adapts for example its stock of repair kits over time. In addition, OBA information is used to make decisions about stock redistributions. Redistributions might in particular become necessary when contractors move their machines to new sites.

> "So (site owners) don't tend to move vehicles around sites very much. But contractors', and we are pretty contractor heavy in (the region), contractors' machines will move. So the ability for us to know our customers and know where they are moving to and when they are moving there (is important). So if a customer is now moving to (Region A), I'll be in touch with the (Region A) side of (Heavy Machinery), the branch down there, and say "We have got four (vehicles) coming your way in September of this year. You might wanna have a look at what we need to do to support those four (vehicles)." We probably already have (vehicles) in the areas, but is the numbers right now? And that's where (Peter) from the planning side of things would really have a look at it and maybe make some recommendations to us." Key account manager, SalesOrg, Final

In addition, stock might also be redistributed when a new machine model begins to be used at multiple locations. Major components might then for example be moved from local warehouses close to a specific early adopter to more centrally located, regional distribution centres. The stock can then accordingly be used across a larger number of customers.

In addition, stock that has not been sold to customers within a certain time period is identified by SalesOrg's logistics unit. Based on current machine fleets and their suggested spare part needs, the stocking of non-moving parts might either be prolonged, stock returns to global distribution centres conducted or fire sales initiated.

> **Logistics Manager, SalesOrg, Service:** "So maybe this material is three years old and the DC (distribution centre) won't take it back, they don't need it. (…) They have certain inventory targets as well, and they may already have a number of that product. So, we work closely with our (product management unit) here to do fire sales campaigns. (…) So what we do is, we look at what the cost is of the material, which customers have those machines that this material is likely to suit and make them an attractive offer to purchase it at a substantial discount."
> **Interviewer:** "So here you would have then someone in (the product marketing) team going to the (FleetData) database, looking "Ok, where do we have these (machines)?"

Logistics Manager, SalesOrg, Service: "Yes, and there is a "where used" function in it that can tell us exactly which machines that product fits to and who those customers are that purchase it globally. So not only can they target (machines in our region). They can go "Ah, there's a machine in Indonesia. Let's get onto the marketing manager or the regional manager in Indonesia and let's let them know what we have got.""

If stock redistributions and fire sales are not successful, parts might be scrapped as a last resort. In order to avoid the revival of scrapped parts by recycling firms and IASPs, Heavy Machinery requires recycling companies to issue certificates of destruction.

7.3 Use of Open Book Accounting in indirectly connected component supplier relationships

The focus of this subchapter lies on the use of OBA information gained from Contractor and other customers in Heavy Machinery's indirectly connected supplier relationships. As observed before, the interface affects and is affected in particular by the indirectly connected relationships with major component suppliers interacting through modified translation interfaces (see Chapter 5.3.1, page 122 ff. and Chapter 6.3.1, page 160 ff.). Three different kinds of modified translation interfaces have been observed in particular, depending on whether Heavy Machinery conducts component repairs in-house, channels these to external component repair centres or asks its customers and suppliers to directly coordinate maintenance-related matters with each other. In line with these prior observations, the OBA exchange between Heavy Machinery and Contractor directs particular attention to these three kinds of modified translation interfaces and particular aspects within those (Table 16, page 216).

7.3.1 Modified translation interface 1: Internal component repairs

Heavy Machinery interacts with most of its major component suppliers through the first kind of modified translation interfaces. As part of the interface, two kinds of products are exchanged: components that Heavy

Table 16 Areas to which the Open Book Accounting exchange between Heavy Machinery and Contractor directs attention in indirectly connected supplier relationships

1	Modified translation interface 1: Internal component repairs • Purchase cost of frequently exchanged subcomponents
2	Modified translation interface 2: Channelled component repairs • Efficient coordination of component repairs
3	Modified translation interface 3: Component X • Local pricing of replacement components • Relative opportunity cost advantages of "replace with new component" strategies compared to "replace with repaired component" • Efficient coordination of repairs and replacements

Machinery technically integrates into its vehicles and offers to its customers as complete replacements parts and subcomponents which Heavy Machinery and its customers use during minor and larger component repairs.

Background: Open Book Accounting designs with regard to modified translation interfaces (Type 1)

In order to understand the use of OBA information gained from Contractor in this interface, it is useful to revisit the OBA design between Heavy Machinery and Contractor with regard to these major components. In addition, we need to understand the OBA design implemented in these indirectly connected relationships between Heavy Machinery and its major component suppliers.

As part of its *OBA design with Contractor*, Heavy Machinery locks the article numbers of most major components at suppliers (see Chapter 6.3.1, page 161 ff.). Accordingly, customers, such as Contractor, can only buy genuine *components* fitting the technical interface and functional specification of their vehicles from Heavy Machinery. In contrast, *subcomponents* included in these components are usually not locked, but clearly marked with the original component supplier's brand and article numbers and sold by those directly or via Independent Aftermarket Service Providers (IASPs) to Heavy Machinery's customers. ComponentRepairer for example buys subcomponents directly from Heavy Machinery's axel supplier and uses these in its competitively priced axel repairs. In addition, as the market for those subcomponents can be large due to their spread across many components with slightly differing configurations, non-genuine copies do often exist at even lower prices. An example are filters, for which non-genuine copies are available from a large number of sources. While Heavy Machinery aims to reduce competitive pressures in its OBA design with internal adaptations (Chapter 6.3.3), it cannot eliminate these pressures completely for all subcomponents.

> "There are some really commercial products where you can't tie them with such (exclusivity) agreements, because those are not only used at (Heavy Machinery), which means they are used everywhere. (…) Thus, you need to be prepared to take the market openly in the field, because nobody is going to give you that advantage, stops selling directly and all that. You will fight the market directly."
> Vice President Marketing, Service

The *OBA design applied between Heavy Machinery and its major component suppliers* is in this context also important to understand. It differs largely from the design reported by prior scholars for (traditional) translation interfaces (see Chapter 3.3). At the same time, it shares striking similarities with the OBA design implemented between Heavy Machinery and its own customers (see Chapter 6). According to the OBA design, Heavy Machinery receives a good understanding of the competitive pricing of *components*, but not of the technical design and costs of their *subcomponents*.

> "With regards to components, it is exactly as we say, it is market values that rule. And what competitors charge. We have thus no open books on their components so to say. But we expose them to competition all the time, more or less."
> Purchasing Manager, Final

Heavy Machinery gains insights into *component* level pricing through its purchasing strategy built on multiple sourcing with single sourcing of major components for a specific vehicle type. Heavy Machinery can hence constantly check the component pricing and technical solutions of existing suppliers against each other. In addition, at larger time intervals, alternative suppliers are invited to larger tenders. Its current suppliers of hydraulic cylinders have for example been selected based on a large tendering process as part of which Heavy Machinery mapped all major European cylinder manufacturers, visited a number of them and tested the durability of product samples. The same component price applies irrespective of whether Heavy Machinery buys components for its production or in order to sell them to customers as replacement parts.

In contrast, Heavy Machinery's major component suppliers do not provide any information on the exact technical specification of their components' *subcomponents* and related product cost in order to protect their own maintenance-related sales.

> ”I mean they are not stupid. They wanna make money. One of our biggest suppliers is (Supplier D). (…) Most of the spare parts we are buying from them is from a central warehouse in the US, like our distribution centre. So you know how they mark up the prices on those parts.” Purchasing Manager, Final

The only financial information provided for subcomponents are accordingly their list prices. Moreover, discussions during product development are mostly facilitated by Heavy Machinery's functional and interface requirements and exploded views provided by the suppliers. Exploded views, in turn, share similarities with Heavy Machinery's spare part books. They provide an overview of the outer measures of the components and some of their subcomponents. Subcomponents that can be purchased as spare parts are also marked in these. In addition, exploded views provide some general technical data. However, no information on the exact specification of integrated subcomponents is provided, which would be necessary to understand the design of subcomponents and to reengineer their cost.

> “(Supplier A) owns the construction. We don't own the construction of the cylinder. If we want to take apart a cylinder and try to see if it says something on the seals, but there is nothing mentioned, one can't know what material it is. One can only measure its dimensions, but one can't know if it is a special material for low friction or high pressure or high temperatures for example. We don't know that. That's why I want that we use the same seals as (Supplier A) has used because there is a thought behind their construction, based on the requirements we have had. Because we have demands on the work cycles, pressure, temperature, which oils it should work with. And then (Supplier A) weights all these

> demands together and sees to that the seals meet our demands. But I still don't know what kind of seal it is." R&D Manager, Final

As part of the OBA design between Heavy Machinery and major component suppliers, suppliers also mark spare parts clearly with their brands, sell these primarily in the form of kits and distribute them via global distribution centres. The information shared by Heavy Machinery's suppliers reminds accordingly much of the one Heavy Machinery shares with Contractor (see Chapter 6). Heavy Machinery has accordingly a good insight into the competitive pricing of major components. At the same time, it has no visibility with regard to the product cost of major components and their subcomponents.

This becomes even clearer if one regards Heavy Machinery's general challenges connected to checking the pricing of subcomponents in its wider network. As all of its major component suppliers apply similar OBA designs and mark up their subcomponents, comparing the subcomponent level pricing of competing suppliers with each other is relatively fruitless. Another possibility would be to compare the costs with similar parts Heavy Machinery buys directly from subcomponent manufacturers for other purposes or to ask suppliers of such components for competitive price quotes. This is, however, also challenged by the large amount of subcomponents, their varying technical complexity and Heavy Machinery's partially quite low demands for those. In addition, it would require extensive internal coordination as product engineers and strategic purchasers working with hydraulic cylinders are for example not knowledgeable about seals that are most frequently exchanged in cylinder repairs and that are managed by a separate "standard parts" commodity team.

Attention directing use

In this context, the OBA exchange between Heavy Machinery and Contractor helps to direct attention to *specific subcomponents* and their cost. This focus is to be understood as a joint consequence of the OBA exchange between Heavy Machinery and Contractor and the OBA design between Heavy Machinery and its major component suppliers falling under the interface.

As we have learned before, Contractor provides Heavy Machinery regularly with feedback on the pricing of *specific* spare parts (see Chapter 6.1.2, page 147 ff.), which Contractor can identify and source apart from Heavy Machinery from other sources. Credible feedback includes the competitive price of the part and its source. Based on the information, Heavy Machinery and Contractor form decisions, of which further investigations of the price and concessions on the side of Heavy Machinery are some of the possible actions (see Chapter 7.1.2). In addition, Contractor along other customers provides Heavy Machinery with information on the status of its vehicles. This information is analysed on Heavy Machinery's firm level in order to identify current sales gaps and make decisions on the offering of component repairs (Chapter 7.2.2). The pricing of spare parts plays therein a major role, as it is the most common motivator for customers to engage directly with component suppliers and IASPs.

The importance of Heavy Machinery reacting to these challenges is further underlined by prior observations on the design of OBA (see Chapter 6.3.1). If Heavy Machinery does not react to the connected challenges, customers might identify and purchase additional spare parts from other sources. In addition, sales organisations might try to react to the challenges by buying certain spare parts locally from other sources and thereby convey precious information to suppliers, thereby further intensifying competition (see Chapter 6.3.3).

Service's global pricing unit is primarily responsible for the pricing of maintenance-related products and accordingly also for acting upon such information. It thereby acts as an internal filter of whether such requests are to be dealt with internally or whether suppliers need to be involved. The pricing unit considers in its analyses the input from sales organisations, including competitive price information, along other information, such as the kind of the part and its purchase price from Heavy Machinery's current suppliers.

As major *components* are locked and not available from other sources, only a low number of pricing requests concerns those. Heavy Machinery enjoys also generally favourable *component* prices from its major component suppliers. Most component-level price discussions are accordingly primarily a sign of Heavy Machinery's value-based, premium pricing strategy rather than an indication of too high prices being charged by its suppliers.

"Sometimes, when I am travelling, I get to hear from sales organisations "WTF, we can buy a competitor's pump for a third of the price." And then, I can say "Yes, but we buy it for a third of the price the competitor buys it. It is the market analysts that have set that price level. It is not our mistake." Strategic purchaser, Final

Occasional requests relating to the pricing of components are accordingly mostly dealt with internally by Service's pricing unit. Heavy Machinery's purchasing units and major component suppliers are not involved.

In contrast, pricing requests concerning *subcomponents* are more frequent as Heavy Machinery is exposed to direct competition from its own component suppliers, their subcomponent suppliers and IASPs. Already high purchasing prices from suppliers, taking benefit of the invisibility of subcomponent level cost, leave generally also less room for further reductions of sales prices. Accordingly, these *specific* cases are often not dealt with internally at Service's pricing unit, but forwarded to Service's strategic purchasing unit for consideration with suppliers.

"We get a lot of input on wrong prices and such things from our price group, which sits here (pointing to another part of the open office landscape). (…) So it comes back from the (sales organisations), which say "We cannot sell this here, because it is too expensive." They send this input to the price group, which goes (into the system) and looks "Oh, something has happened here. So they come to me and say "Listen, (Alex), you need to take a look at this, something has happened, we cannot sell this article as your supplier has increased the price and we cannot sell it. What shall we do?" Then, it is my job to call the supplier and see what has happened. (…) As long as there are no complaints from the market, that it is a wrong product or price, we just continue buying." Strategic purchaser, Service

OBA helps accordingly Heavy Machinery to direct its attention to *specific subcomponents* into whose purchasing it might need to inquire more closely, including the consideration of supplier changes. Considering the outlined general challenges connected to such investigations, the emphasising of specific subcomponents is an important contribution of OBA. As a consequence, the specific subcomponents that are considered based on customer input change naturally also over time as customer feedback does. At the time of the study, the pricing of different kinds of filters and subcomponent kits required for the repair of several major components, including axels, transmissions and hydraulic cylinders, were focused on particularly by Service's purchasing unit.

As the attention in modified interfaces depends mainly on the input from customers and sales organisations, it might appear primarily reactive. This might however give a false impression. Rather, particular subcomponents for which changes could be implemented in the past are put under constant, proactive surveillance. When new engine designs for example require different kinds of filters to meet improved emission standards, investigations on their pricing and replacement are undertaken proactively.

> "Parts breakdown looks always if there is a supplier (for the major component). If there is a supplier, they have historically only asked them if they offer these (subcomponents). But we have identified a difference in the process when we reviewed it lately. When we start to change from (Supplier A) to (Supplier B, a supplier of non-genuine filters,) the process we have today, where we always follow the (component) supplier, doesn't work anymore. So there, we have said that we need to involve purchasing into development projects. "Here is a new machine, OK, purchasing, what do you have for input on these new components, which suppliers do you see in contrast to the suppliers the product unit has chosen?" (…) So purchasing must be there and see "Ok, that is these filters that sit in the engine, that is these belts that sit on this compressor, yes, but shall we have them (from the component supplier), or not?" Global Engineering Manager, Service

In addition, Service's purchasing unit proactively monitors the volume development of particular groups of subcomponents. When subcomponent volumes increase as a larger number of components reach their service intervals, it might proactively contact suppliers, ask for price updates and initiate a supplier change for those.

> "If demand increases, I contact first the supplier and see what the prices are and ask for a new offer for the new demand. If I am not satisfied with the price, I look for other alternatives." Strategic purchaser, Service

Moreover, Service's purchasing and engineering units occasionally run projects together with the global distribution centres as part of which they try to identify the original (sub-) supplier of a particular subcomponent.

> "One pulls out lists that purchasing does and then we can go and try to look at the components and see whether they perhaps come in packages with the supplier's sub-supplier's name on or whether the original (sub-) supplier's name is engraved on the article. Because then we maybe can check prices directly with them." Global Engineering Manager, Service

The OBA exchange between Heavy Machinery and its customers helps accordingly to direct attention in indirectly connected modified translation interfaces of the first kind to specific subcomponents, whose product cost is generally invisible to Heavy Machinery. Initially, the attention to subcomponent level cost might appear as reactive to customer demands. Over the long term, a more pro-active approach is, however, adopted on the commercially most important subcomponents.

Decision facilitating use

Several decisions are also facilitated by the OBA exchange between Heavy Machinery and its customers in these indirectly connected modified translation interfaces. These can be divided into two larger groups: decisions on the general organisational setup at Heavy Machinery and decisions with regard to particular subcomponents (Table 17).

Table 17 Decisions facilitated in indirectly connected modified translation interfaces (Type 1) by Open Book Accounting

1	Decisions concerning the organisational setup • Separation of purchasing and engineering units for product (Final, Core) and aftermarket (Service) divisions • Definition of subcomponents that may be considered for changes • Establishment of a coordination forum between purchasing and engineering units
2	Decisions with regard to particular subcomponents • Decision to establish a business case including technical and commercial risks • Confrontation of original supplier or supplier change • Price reductions to Heavy Machinery's customers

Decisions relating to the organisational setup include the decision to create separate purchasing and engineering units at product (Final, Core) and maintenance-focussed divisions (Service) and to recruit additional employees to these units. The aim of this organisational split is to facilitate the technical and commercial investigation of subcomponent level cost issues. In contrast, when purchasing and engineering for production and maintenance had been integrated before, concrete business cases, prepared by purchasing managers aiming for cost savings, were often turned into toothless paper tigers by integrated engineering units.

> "If I wanted to do something like that when I was here at (Final) and said, "I have these bolts that I am buying from the original supplier. We pay, I mean this is an aftermarket item for them, so we pay a lot of money for this. Well, I can go to my local bolt supplier and buy the same item, exactly the same thing, but for a third of the price. Can I do that?" I cannot approve technically that change, so I need to go to the engineers so I say "You know what? I have this bolt and I have this bolt. It's a one third of the cost, can I change it?" And they say "No, we need to, we need to prove that first." – "Ok, fine, can you do that please." – "Well how much money are you gonna save on that?" – "Well, I don't know, (40,000 Euros) maybe per year" – "And they say, well you need to put a business case together and send it up." And when you do that and they sit and talk about engines and transmissions, and complete machines, these (40,000 Euros) are not worth that much really, so you never got their attention either. (...) So it was close to impossible to make that change. So we kept buying all the items for a very high costs. With (Service), we have our own engineering department, so we go to them and say "Hey, I got this bolt" So you build a business case and leave it over to them and they can sometimes make the decision "OK, go!"" Purchasing manager, Service

Due to the split, production and service units are flexible in developing their own strategies towards major component suppliers. They can accordingly also chose different suppliers for components and their subcomponents.

Another important organisational question concerned the question whether all subcomponents should be allowed to become the focus of further investigations or not. As the core component constitutes a carefully designed resource combination, it was decided that all connected subcomponents should be excluded from future investigations. Service's purchasers were accordingly informed of the article number series of these parts. In addition, important technical and commercial information connected to these parts were actively hidden in the IT systems from Service's purchaser to make any accidental investigations impossible.

In addition, the purchasing and engineering unit of the Service division discussed the introduction of a regular coordination forum in which subcomponent level cost issues are presented and decisions as to their further prioritisation are jointly made.

Other decisions are taken on a continuous basis as the prices of specific subcomponents are considered based on the feedback from customers and/or internal analyses. An important first decision of the responsible purchaser at the Service division relates to whether it should establish a business case or not. Business cases constitute the basis for posing credible threats to major component suppliers to reduce the pricing of their subcomponents and to brand them with Heavy Machinery's brand in parallel.

> **Engineer, Service:** "Yes, (John) has that commodity of (a specific group of major components) and he is of the opinion that (Supplier A) has bad prices, so he has started to look around for other (subcomponents). (…) It is not a project, yet. It is more like a case."
> **Global Engineering Manager, Service:** "It only becomes a project or how one shall call it, if one has established the potential."
> **Engineer, Service:** "Yes, and he wants to show to our supplier that we can order somewhere else if they do not shape up their pricing. So he does not want to change supplier initially, but he wants to"
> **Global Engineering Manager, Service:** "Find arguments for"
> **Engineer, Service:** "Yes, it is just to show that "we can do it ourselves, but we would like to keep doing business with you.""
> **Global Engineering Manager, Service:** "So that's how it was with (specific subcomponents) to (a major component). It was a gigantic savings potential, but when one showed that for the supplier, one got the same prices and stayed with them. So there, it was not even a question (to change suppliers)."
> **Engineer, Service:** "Yeah, they reduced their prices by (almost two thirds) and branded it. They removed their own brand."

Business cases are initially built on specific subcomponents. At the same time, the findings are usually applied across a larger category of subcomponents provided by the supplier. While the seal kit required for a particular cylinder repair might for example be investigated initially, all seal kits required for the repair of cylinders from the same supplier might subsequently be identified by Heavy Machinery and negotiations performed with regard to all of them.

In order to be counted as credible threats, business cases need to detail out the commercial potential of specific subcomponents as well as a strategy on how commercial and technical risks might be dealt with. The savings potential is established by taking out a physical sample from stocks at the distribution centre, investigating it together with other purchasers responsible for the respective commodity into which the subcomponent falls and sending out samples to alternative suppliers with a request to tender for a specific volume. Alternative suppliers can accordingly examine the subcomponents in their specialised R&D labs and establish an offering price. Heavy Machinery, in contrast, does not need to build up any specialised in-house resources.

> **Interviewer:** "But they said "We don't know which filter they design into their machines"."
> **Purchasing manager, Service:** "No, but for that you can draw on others' help. That is what filter suppliers help you to understand, if you have a good filter supplier. Because I don't think that we are super experts on filters. I mean we don't have the competence, at least not at (Service). A filter producer which demonstrably works much more with filters knows how the filter industry is built up, which media you can use and which medium you can replace with which other medium and so on."

Due to the concentrated nature of industrial markets, the original subsupplier of the component supplier might also be revealed as it recognises the subcomponent and informs Heavy Machinery about its parallel relationship. As Heavy Machinery is a large buyer of different kinds of subcomponents itself, suppliers might accordingly also offer to produce the subcomponents directly for Heavy Machinery, in branded form and at much cheaper prices.

In addition, technical and commercial risks are identified and further investigated. Technical risks are for example connected to that the quality of the replaced subcomponent might be inferior. Depending on the kind of part, the quality of alternative subcomponents might accordingly need to be verified in lab or field tests, which is connected to a certain cost. At the same time, standardised subcomponents, such as screws, might pose low risks as they are produced according to international engineering norms and might accordingly be replaced without any further technical investigations. Commercial risks include the denial of component warranty issues by the major component supplier. The relevance of these risks is investigated with the help of maintenance plans, contracts and Heavy Machinery's internal warranty databases. Maintenance plans might for example state that the subcomponent is most commonly replaced after the original component warranty has expired. Heavy Machinery might accordingly anyways not be able to recoup any warranty claims or claims from extended service interval performance guarantees from suppliers. In addition, alternative suppliers, specialised in the respective subcomponents, might contractually agree to take over component guarantees and to drive claims in court on behalf of Heavy Machinery against the major component supplier if necessary.

> "The supplier of the filters, they guarantee us that they will cover it if it is caused by the filter, so the guarantee moves from (Supplier C) over to the filter supplier. (…) So they said also to convince, those were actually the tipping points, "We are willing to drive the case in court if it goes to court, because we have a much better knowledge of this than (Heavy Machinery)." (…) So they would take our part, drive it against (Supplier C) to get the money from them, and that's because they said, we have lots of cases like this, we have better knowledge and experience than you have, so we will win more cases than you do." Purchasing manager, Service

If suppliers should not concede based on the presented credible threat, business cases are taken as decision memos and blueprints for actual supplier changes and implemented by Heavy Machinery. As part of such supplier changes, depending on the technical interfaces in components, suppliers might be asked to deliver the component without all subcomponents installed onto them. Alternatively, the decision might be formed to remove easily accessible subcomponents from vehicles in Heavy Machinery's assembly operations and to replace them with its own branded subcomponents. Finally, cheaper prices for these most competitive subcomponents usually lead to the subsequent decision to also reduce prices to end customers.

7.3.2 Modified translation interface 2: Channelled component repairs

The kind of component repairs Heavy Machinery performs in-house at its own component repair centres differ across its sales organisations and over time (see Chapters 5.3.1 and 7.2). At the time of the study, SalesOrg for example conducted only a few repairs of hydraulic cylinders and hydraulic pumps in-house. Instead, it channelled those to external repair centres, which possess specialised facilities enabling cost-efficient, high quality repairs. SalesOrg can generally select among a larger number of repair centres for these components. Besides repair centres owned by the major component supplier several independent, authorised and non-authorised repair centres exist that can conduct such repairs. Nevertheless, SalesOrg channels, for the time being, those repairs to the local organisations of its major component suppliers. In parallel, Heavy Machinery buys and sells spare parts for those components to customers. Compared to other sales organisations, the demand for those is, however, lower at SalesOrg.

Accordingly, the overall interface of Heavy Machinery with these suppliers can be split into two for analytic reasons (see Chapter 5.3.1, on compound buyer-supplier interfaces see also Ross and Robertson, 2007). Heavy Machinery and the major component supplier interact via the already described first kind of modified translation interface to coordinate component and subcomponent exchanges. In addition, SalesOrg entertains a modified translation interface of the second kind with the local outlet of the major component supplier to coordinate component repairs it does not perform itself in-house. Having discussed the first kind of interface before, we focus on the use of OBA information in this second interface in the following.

Attention directing use

Within these supplier interfaces, the OBA information exchanged between Heavy Machinery and its customers directs particular attention to the *efficient coordination of component repairs*. As observed before, based on the vehicle status information from customers and its LCC calculations, Heavy Machinery can forecast the timing of specific component repairs. In addition, by combining this data with information on its current stock of repaired components, it can assess the time span within which component repairs should be turned around in order to be accessible to other customers at the right point in time.

> "As long as that data is coming through, we can plan when we need to have more staff, when we need to have our suppliers hold equipment for us and how quickly we need to turn it around. Because, I don't know what you know about the (regional) fleet, but we have gone from having this many (illustrating with small distance between his hands) to this many (illustrating with large distance between his hands) and we are carrying spare parts for this many (illustrating with even smaller distance between hands than at the beginning). (…) It is not that we are running out (of replacement components) now, because the machines are relatively new. But, in six months' time, a lot of those first wave of machines that came to (our region) are due for component change-outs. So it is unprecedented for us. There is no history, because the machines weren't there. So they are using life expectancies and projected hours to give a future plan." Strategic purchasing manager, Service, SalesOrg

The information obtained from a lower number of loyal customers is in this context seen as particularly valuable as these use their machines relatively steadily and have asked Heavy Machinery to plan overhauls on their behalf. The business volume connected to these customers can accordingly be taken as relatively certain while it is more uncertain for other customers.

Decision facilitating use

As external component repair centres source subcomponents directly from the component supplier, insufficient stock presents a particular bottleneck that might slow down the efficient turnaround of component repairs. With the help of the OBA information received via Heavy Machinery, external component repair centres can take informed purchasing and operational decisions and thereby reduce the likelihood of stock-outs (Table 18, page 230).

> "I am talking to our local vendors that are mostly doing repairs. Because they need to have parts themselves. In pumps and motors, there is quite a few parts that are machined, that they hold on the shelf. So, in a pump for instance they take out some of the plates and they take new ones in. Then they take the old ones and machine them and this keeps them flowing. So they need to have enough of them, because the machining process can take some time." Strategic purchasing manager, Service, SalesOrg

Table 18 Decisions facilitated in indirectly connected modified translation interfaces (Type 2) by Open Book Accounting

1	Operational and purchasing decisions of external component repair centres

7.3.3 Modified translation interface 3: Component X

The exchange of Component X gives rise to a third kind of modified translation interface (see Chapter 5.3.1). Component X is particular in that Heavy Machinery provides only a very small number of frequently exchanged subcomponents, such as filters and different kinds of oils, for it. All repairs that require tools, including complete component exchanges, are coordinated directly between Supplier X and Heavy Machinery's customers, such as Contractor. The concerned component needs to be exchanged completely once or twice during the respective vehicles' life cycle.

Background: Open Book Accounting designs with regard to modified translation interfaces (Type 3)

In order to understand the impact of the OBA information obtained from Heavy Machinery's customers in the interface, it is important to first understand the OBA design between Heavy Machinery and Supplier X. The price for Component X for production and a few frequently exchanged subcomponents that are distributed by Heavy Machinery is set by means of negotiation. Heavy Machinery receives generally no insights into component and subcomponent level product cost. Product development is carried out based on Heavy Machinery's technical and functional requirements and some additional technical information that Supplier X shares. During larger parts of the development process, Supplier X has also staff co-located at Heavy Machinery's product development facilities to facilitate application engineering and verification.

The prices of replacement components and maintenance-related services is set locally by Supplier X's local organisations. In order to avoid any competition from Heavy Machinery on the sale of replacement components, considerable contractual penalties apply should Heavy Machinery sell components with serial numbers destined for its production as replacement components. As Supplier X needs to be involved in the commissioning of replacement components and can track serial numbers with the help of its sales and warranty systems, it can monitor the adherence to this rule relatively easily.

Attention directing use

In this interface, the OBA exchange between Heavy Machinery and its customers directs particular attention to the price of replacement components charged by Supplier X's local service organisations and issues related to avoiding unnecessary opportunity cost. This focus became particularly visible as part of an observed major controversy between SalesOrg and Supplier X's local sales organisation in which Contractor was actively involved.

As Component X needs to be replaced completely once or twice over the life cycle of a vehicle, the *purchase price of replacement components* constitutes a large part of the vehicle's total LCC. Accordingly, it is monitored closely by Contractor and Heavy Machinery's customers in general (see also Chapter 6.1.1). Over a period of less than two years, Supplier X's local sales organisation had doubled its sales price for replacement components. As one of Heavy Machinery's competitors used an in-house manufactured component in its vehicles and left its prices unchanged and another competitor had changed to another component supplier for its new vehicle generation, this price increase reduced SalesOrg's chances of completing future sales of this vehicle type and irritated with Contractor a large current user of those.

> "We have got issues with (Supplier X) at the moment, with the prices that they are charging us. So that's something that me and (Final's business line manager) are working on, too, because you know when we go up against you know (Competitor A) for example. Their Component Xs are, let's say, (X Euros). Ours is (twice that) cost. So then, by the time we had a mark-up on that, and then you will get your life cycle cost model, it blows out of the water. Because they (the customers) don't look at just the purchase price of the particular machine, they look at, well, how much is that machine gonna cost us to run? And then inclusive of, you know, the capital cost as well. So yeah, that's a, that's something myself and (Final's business line manager) are really driving home with (Service's business line manager) at the moment and even (Christian), our MD." National marketing manager, SalesOrg, Service

Two other challenges are connected to *opportunity cost*. One of those concerns opportunity cost that arise whenever Component X needs to be exchanged. As part of the price increases for new replacement components, Supplier X's local service organisation tried to motivate SalesOrg's customers to buy cheaper repaired components instead of new ones. Supplier X's intent behind this move was to steer used components back to itself, strengthen its own component repair business and reduce the business opportunities for IASPs. Repaired Component Xs achieve, however, less than half the service interval of new components. As individual component exchanges are connected to vehicle downtimes of up to four weeks, opportunity cost would accordingly explode drastically for Heavy Machinery's customers if they used repaired instead of new components.

A second challenge with regard to opportunity cost was that Supplier X quoted lead times of several months for new components. Accordingly, customers needed to plan their maintenance even more carefully and unforeseen breakdowns were connected to high opportunity costs. In order to avoid this and facilitate investments into maintenance-related resources by Supplier X, Heavy Machinery had generally informed Supplier X about the name of its end customers and the designated location of new vehicles.

> "We provide lists to (Supplier X) on where (Components X), or, yeah, our vehicles, are delivered to. (…) And, the reason for this is to secure that they know what arrives (in their local markets). Spare parts, trained staff, tools etc. needs to be in place. If we have a totally new (Component X) type somewhere in the world where they have never seen such a (Component X) before, it is otherwise difficult to expect them to have spare parts available." Purchasing manager, Final

The new strategy of Supplier X's local sales organisation, while coherent in itself, was highly problematic for Heavy Machinery and its customers as it increased the LCC and opportunity cost of Heavy Machinery's vehicles. It provided therefore a strong motivation for customers, including Contractor as a current major user of these vehicles, to choose competitors' vehicles over Heavy Machinery's.

Decision facilitating use

Based on the conflict, Heavy Machinery implemented several decisions (Table 19). One of these decisions was to start re-negotiations on the pricing of replacement components and applicable service levels with Supplier X; first, on a local level and, as these turned out unsuccessful, on a global level. Towards the end of the empirical study, top management from Final, Service and Supplier X have been involved in these negotiations. In addition, Contractor was flown in to meetings by Heavy Machinery to provide a customer's perspective and convince Supplier X of its importance. In addition, Heavy Machinery hoped to show to Contractor as a large user of these vehicles, that it took the concerns seriously and that a solution was on its way. These negotiations were, however, taking long time and still ongoing by the end of the field study.

Table 19 Decisions facilitated in indirectly connected modified translation interfaces (Type 3) by Open Book Accounting

1	Re-negotiations of the pricing of replacement components and service levels with Supplier X on local and global levels
2	Purchasing of replacement components via Heavy Machinery's production and stocking by SalesOrg
3	Investigation of the ability to replace the current supplier for replacement purchases

As a consequence, SalesOrg took also several other short-term decisions in parallel. These included the decision to buy Component X via its production and to stock it locally in order to cut lead-time on behalf of its customers. These purchases were connected to a substantial contractual fine. However, they were still cheaper than buying components locally at even higher prices. In addition, SalesOrg started to investigate other possibilities, including the involvement of alternative suppliers.

> "So now we are exploring other options at the moment. Because, effectually, we are getting no traction or support, whatever solution of the problem through (our Headquarters). So, we are talking to people who are going to assemble (Component X) here in Australia. We are looking at maybe we should assemble (Component X) here ourselves also. (…) We are also talking to (Competitor of

Supplier X) in regard to maybe using (their Component X) instead of (Supplier X's) (Component X)." Business Line Manager, SalesOrg, Service

7.4 Chapter conclusions

This chapter has described the attention directing and decision facilitating uses of OBA on three organisational levels: in the relationship between Heavy Machinery and Contractor, at Heavy Machinery's firm level and in indirectly connected relationships between Heavy Machinery and its major component suppliers.

In the relationship between Heavy Machinery and Contractor, OBA is primarily used to (re-)direct attention from the purchase price of individual vehicles to their long-term cost consequences, the attainment of theoretical, specifically adapted LCC calculations in practice and the joint improvement and reduction of LCC over time. Moreover, OBA facilitates also decision making within these areas. Individual vehicle purchases are for example made with both functional requirements, long-term cost and lead-times in mind. In addition, replacement purchase decisions for existing fleets are supported by LCC models and three proxies for opportunity cost (machine availability, service interval lengths, ease of serviceability). Moreover, by comparing realised cost levels with those mentioned in theoretical, specifically adapted LCC calculations, deviations can be jointly identified and managed. Disciplining talks with operators or different kinds of technical and commercial investigations might accordingly be carried out jointly or certain pricing issues debated. In addition, LCC calculations are improved based on Contractor's feedback over time and decisions are made on how cost can be reduced jointly even further beyond those stipulated in the theoretical, specifically adapted LCC calculations.

The use of OBA on the relationship level leads also to consequences on Heavy Machinery's firm level. Here, OBA directs attention to two larger areas in particular: product design from a long-term cost perspective and maintenance-related resources. In order to improve the design of its products from a long-term cost perspective, Heavy Machinery has for example implemented new targets on service interval lengths and LCC for its core components. In addition, it proactively identifies and monitors maintenance-related design requirements with the aim to increase the ease of serviceability of its vehicles. Two sets of analyses based on OBA information support the identification of investment and coordination needs with regard to maintenance-related resources. Based on these analyses, decisions on the investment and coordination of four kinds of maintenance-related resources are facilitated. Heavy Machinery has for example created particular business units focused on the "hunting" of identified maintenance-related sales opportunities. This "hunting" is further supported by customer-specific operational sales plans, revenue targets and sales campaigns that are derived based on OBA information. Moreover, upgrade kits and plug and play modules are proactively designed and offered to customers with suitable machines as maintenance-related products. These can therefore benefit from product design and maintenance-related productivity improvements. Furthermore, the investment into component repair centres is planned and decisions on efficiency improvements are facilitated. Finally, OBA information supports decision making with regard to initial stocking, redistributions between logistics facilities and the management of excess stock.

The OBA exchange with Contractor directs also particular attention to Heavy Machinery's relationships with component suppliers, in particular those entertained through three kinds of modified translation interfaces. With regard to one group of suppliers, OBA directs focus to and supports decision making with regard to the cost of subcomponents required in component repairs. With regard to another group of suppliers to which SalesOrg channels certain component repairs, attention is directed to the efficient coordination of those repairs. As subcomponent stocks provide a potential bottleneck in conducting repairs, suppliers base their purchasing on the plans provided by SalesOrg. In the relationship with the supplier of Component X, in turn, attention is primarily directed to the local pricing of replacement components and opportunity cost. Opportunity costs arise due to differing perceptions of the value of new versus repaired components and the lead-time connected to new components. As these weak points have become visible, Heavy Machinery has decided to renegotiate the relationship, to stock replacement components locally at SalesOrg and to investigate alternative suppliers of replacement components.

The use of OBA information appears accordingly well adapted to the resources combined in the interface (see Chapter 5). Correspondingly, its use differs also with regard to those of other OBA designs observed by other scholars before (Chapter 3). The next chapter will discuss these differences and similarities in more depth.

Chapter 8

Discussion

The aim of this chapter is to compare and contrast the findings of the empirical study on OBA in capital equipment sales with prior literature. The discussion is organised into three parts. As part of the first subchapter, the findings are analysed with the help of the analytical framework established in Chapter 2. Similarities and differences between the observed form of OBA in capital equipment sales and other, prior studied forms are accordingly highlighted with regard to the framework's individual elements and its overall character. The subsequent subchapters expand this discussion by highlighting some additional insights that could be gained as part of the study. More specifically, the second subchapter looks at the ways through which OBA information is exchanged, while the third subchapter takes a closer look at the observation that OBA seems to not only encompass the provision of information, but also its active hiding.

8.1 Open Book Accounting in capital equipment sales: similarities and differences

With the help of the analytical framework, the results of the empirical study on OBA in capital equipment sales can be compared with the findings on

OBA in other, prior studied buyer-supplier interfaces (Chapter 3). The analytical framework (see Chapter 2, in particular Figure 2, page 9) constitutes a few elements: interdependence and OBA, which, in turn, is made up of a design and use part. These individual elements are connected to each other by means of bidirectional links. In the following, the study's findings are first analysed separately for each of the framework's elements before the links between those are reviewed in the form of a synthesis.

8.1.1 Interdependencies in capital equipment sales

The interface between Heavy Machinery and Contractor has been the main concern of this study. The interface is characterised by resource interdependencies that arise as a consequence of the customer-adapted design of the exchanged capital equipment and its use and maintenance over extended time periods (Table 20, page 239). Heavy Machinery adapts the design of its vehicle models to Contractor's specific requirements. These adaptations take several weeks to complete and are facilitated by different facilities and organisational units. Some adaptations are implemented directly at Final's centralised product development and manufacturing units, while others are performed locally at SalesOrg's regional vehicle delivery centre.

In order to be able to use and maintain its customer-adapted specialty vehicles, Contractor requires spare parts in the form of components and subcomponents, the labour of service technicians and supplementary products and services. These maintenance-related product exchanges are facilitated by maintenance workshops, component repair centres and global and regional distribution centres and local warehouses. Moreover, they are coordinated by specialised business units, such as Heavy Machinery's Service division and Contractor's asset management, maintenance, operations and logistics units. Maintenance-related interdependencies affect also indirectly connected relationships with component suppliers, competing vehicle manufacturers and competing vehicle users. In addition, we can note the presence of Independent Aftermarket Service Providers (IASPs), which do not develop and produce any vehicles themselves, but provide maintenance-related products and services for different manufacturer brands. As the interdependencies induced by product development and production, the observed maintenance-

Table 20 The resource interface between Heavy Machinery and Contractor

Products	- Capital equipment: specialty vehicle - Maintenance-related products: spare parts, labour of service technicians, supplementary products and services (e.g. training, vehicle inspections)
Facilities	- Production-related facilities: Centralised product development and production facilities, vehicle delivery centres - Maintenance-related facilities: maintenance workshops, component repair centres, global and regional distribution centres and warehouses
Business units	- Supplier: Heavy Machinery o Product units: Final, Core divisions o Maintenance-related units: Service division - Buyer: Contractor o Product units: Purchasing as negotiator, but technical design decided upon by units involved in the use and maintenance of vehicles o Maintenance-related business units: Asset management, maintenance, operations and logistics units
Relationships	- Production-related relationships: Contract assemblers - Maintenance-related relationships: different kinds of Independent Aftermarket Service Providers (VehicleRepairer, ComponentRepairer, CoreIASP, FinalIASP) - Relationships impacted by production- *and* maintenance-related demands: o Component suppliers o Other customers to Heavy Machinery o Competing vehicle manufacturers

related interdependencies are highly specific. They depend for example on the chosen vehicle design, Contractor's use of the vehicle and its operating and maintenance practices. They also change over time as individual vehicles move through their life cycles and require support with different resources.

If we compare these interdependencies with Araujo et al.'s (1999, 2016) typology, we can draw several conclusions. To begin with, we can observe that the interdependencies related to the development and production of the vehicles are similar to those described for translation interfaces. In line with observations in prior literature (Burt et al., 2010, Benton, 2010, Hofmann et al., 2012), we can, however, also observe that the vehicles give rise to additional, maintenance-related resource interdependencies. These have not been described in Araujo et al.'s (1999, 2016) original typology (see Chapter 2.3.4) nor explicitly studied by prior scholars of OBA (see Chapter 3). Their interaction with product development and production related interdependencies and their joint influence on the design and use of OBA forms, accordingly, the main contribution of this thesis.

These observations have also consequences for our further discussion. Burt et al. (2010) argued for example that capital equipment might take different forms. It might take the form of standardised products, be developed by the supplier based on the buyer's requirements or developed jointly by the buyer and supplier. Accordingly, the findings of this study might be primarily applicable for capital equipment that is designed by the supplier based on the buyer's requirements. Caution might accordingly be in order with regard to drawing conclusions based on the study for other types of capital equipment as these might be connected to different kinds of resource interdependencies. The observations on the design and use of OBA are accordingly also primarily compared with prior studies focusing on the exchange of tangible products via translation interfaces (see Chapter 3.3.1; Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2008, 2009, 2010).

8.1.2 Design of Open Book Accounting in capital equipment sales

As part of the study, several observations have also been made with regard to the design of OBA and, thus, the participants of the information exchange and the exchanged data items (Table 21, page 241).

Participants of the information exchange

Heavy Machinery as supplier and Contractor as buyer of the capital equipment are for example the only directly involved *participants of the information exchange*. Neither competing buyers and suppliers nor sub-suppliers to Heavy Machinery or IASPs are invited to take part in the exchange. The only noticeable exception is Supplier X, which might coordinate repairs of Component X directly with Contractor. The potential presence of all other business

Table 21 Design of OBA in the studied interface

Participants of the information exchange	- Participants: supplier (Heavy Machinery) and buyer (Contractor), Supplier X (limited to Component X) - (Problematized participants: competing buyers and suppliers, sub-suppliers, Independent Aftermarket Service Providers)
Data items exchanged	- Supplier (Heavy Machinery) to buyer (Contractor): value-based, premium prices for vehicle and maintenance-related products and services, standardised and specifically adapted LCC calculations, indicators of labour and opportunity cost (expected machine availability, service interval lengths of major vehicle components, ease of serviceability of vehicles), operations and maintenance manuals, selective information on new product development projects - Buyer (Contractor) to supplier (Heavy Machinery): information on tenders it participates in and connected future vehicle demands, information on the status of its vehicles, feedback (on spare parts pricing, LCC, machine availability and logistics performance) - Supplier (Heavy Machinery) to supplier of Supplier X: geographic location of customers with Component X installed on their machines, particular maintenance-related problems - Buyer (Contractor) to supplier of Supplier X: maintenance-related matters connected to Component X - Supplier X to buyer (Contractor): commercial price information for spare parts, replacement components and labour

actors is problematized and several kinds of controls are implemented to limit the spread of information to and by these actors.

Contractual agreements, trust and organisational differentiation are for example drawn upon to avoid the spread of information to competing suppliers and buyers. Heavy Machinery pledges for instance to not distribute any sensitive information obtained from Contractor to other, competing contracting customers. This includes information on tenders Contractor takes part in and connected considerations of vehicle choices and operating and maintenance practices. It also includes information on Contractor's vehicle usage and different pieces of feedback information, such as "practical" LCC calculations. Heavy Machinery understands that any undue distribution of such sensitive information might not only destroy its relationship with Contractor, but might also lead to the spreading of certain information by Contractor that, in turn, might worsen its position towards other customers and competing vehicle manufacturers. In order to further reduce the likelihood of unintendedly spreading sensitive information across customers, Heavy

Machinery has also deliberately assigned different key account managers to its large contracting customers. Natural "firewalls" as to who has access to certain information from customers result from this organisational differentiation. In a similar manner, Contractor signs contractual agreements when participating in prototype reviews and tests, limiting the premature spread of connected information to competing equipment manufacturers and IASPs. It is also conscious about the impact on trust that a potential undue distribution of sensitive information might have.

Contractual agreements and trust are at the same time insufficient to limit potential parallel information exchanges between Contractor and Heavy Machinery's component suppliers and different kinds of IASPs. Competition law forbids the upfront binding of equipment sales to full-service contracts (see also Shapiro and Teece, 1994, Shapiro, 1995) and stipulates that Heavy Machinery has to sell its products to IASPs. Furthermore, Heavy Machinery cannot rely on the good intentions of its Contractor and other customers, which might decide to take advantage of available information and "shop around". These aftermarket competitors constitute at the same time a particular threat to Heavy Machinery's value-based, premium pricing strategy and, thus, its long-term profitability and ability to invest into its product development, production and maintenance-related resources.

Heavy Machinery implements accordingly a large range of alternative means with the intention to reduce the information available to these business actors and to exclude them from the exchange (Table 22, page 243). Some of these means build on co-operations with existing suppliers which help Heavy Machinery to implement unique designs of frequently exchanged spare parts and/or lock their article numbers. Others build on co-operations with alternative suppliers, recycling companies[57] and resource adaptations on Heavy Machinery's own firm level. The observed means have in common that they remain to a large degree indiscernible for Contractor, require dynamic, active work as new vehicles with new components and sub- components are launched, are connected to particular resource requirements and remain incomplete at any specific point in time. Their implementation is supported by the observed organisational differentiation into product (Final,

[57] The involvement of recycling companies was not discussed as part of Chapter 6.3, but emerged in the discussion of Chapter 7.2.

Table 22 Means implemented by Heavy Machinery to reduce available information in the interface

Means implemented with existing component suppliers	- Unique as opposed to standardised designs of frequently exchanged components and subcomponents - Locking of article numbers on component level
Means implemented with alternative suppliers of subcomponents	- Sourcing subcomponents from alternative suppliers marked with Heavy Machinery's brand and article number
Means implemented with recycling companies	- Certificates of destruction to avoid the re-sale of discarded excess stock to IASPs
Means implemented on its firm level	- Product development o Patenting o Limited use of standardisation o Increased number of new product releases - Logistics o One Stop Shop o Internal distribution and limited local purchasing o Kitting of spare parts o Re-packing of otherwise unmarked products

Core) and maintenance (Service) units. For the maintenance unit, the implementation of the different means constitutes an important way of proactively securing its future sales potential. An important observation is also that it is difficult to implement some of these means retroactively. According to competition law, Heavy Machinery can for example not decide to offer certain parts, which it has sold separately before, only in the form of kits in the future.

If we compare these findings on the participants of the information exchange with prior studies on OBA in translation interfaces, several similarities and differences can be noted. First, we can observe that competing buyers and suppliers remain excluded from the OBA exchange (Cooper and Slagmulder, 1999a, 2004, Agndal and Nilsson, 2010). In addition to contractual agreements and trust, which have been observed in prior literature, we can, however also observe the use of organisational differentiation (Lawrence and Lorsch, 1967, Pfeffer and Salancik, 1978, Bocconcelli and Håkansson, 2008). While organisational differentiation towards external business partners has been noted in the wider inter-organisational accounting literature before (see for example Håkansson and Lind, 2004, Thrane and Hald, 2006), the study is the first to note its importance with regard to OBA.

Second, in contrast to prior studies, we can observe the exclusion of sub-suppliers and IASPs. In prior studies of OBA in translation interfaces, sub-suppliers participated in OBA and contributed for example with information on raw materials, the design of subcomponents and necessary investments into manufacturing facilities (Agndal and Nilsson, 2008, 2009). Information from and on sub-suppliers have also played an important role in prior studies of OBA in standardised, specified and interactive interfaces. In our discussion of standardised interfaces, we observed for example that the buyer might help its suppliers in negotiations with sub-suppliers (Romano and Formentini, 2012) or even centralise sourcing decisions with regard to a certain commodity on behalf of several suppliers (Kumra et al., 2012). Prior studies of OBA in specified interfaces noted the involvement of sub-suppliers in detailed technical and commercial information exchanges within the same (Kajüter and Kulmala, 2005, Romano and Formentini, 2012), parallel (Yoshikawa et al., 1994, Kulmala, 2004) and complimentary supply chains (Alenius et al., 2015). In interactive interfaces, in turn, prior research observed no regular direct involvement of sub-suppliers in the OBA exchange. However, buyers and suppliers still exchanged information on their names and cost levels (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2009). The conscious, general exclusion of sub-suppliers (with the exception of Supplier X) and information on sub-suppliers from the OBA exchange appears accordingly highly specific for the studied interface. Furthermore, different kinds of IASPs constitute a new group of excluded participants that have not been observed in translation interfaces nor in any other, prior studied buyer-supplier interface before (Chapter 3). In order to exclude component suppliers and IASPs from the information exchange, Heavy Machinery cannot draw on contractual agreements and trust. Instead, it draws upon different means that have not been observed by prior research. These create some incomplete invisibility for customers, component suppliers and IASPs, which at the same time remains constantly challenged. Parallel information and commercial exchanges are accordingly complicated and the focal information exchange is stabilised (Dambrin and Robson, 2011).

Data items exchanged among participants

Heavy Machinery as supplier and Contractor as buyer of capital equipment exchange a long list of *data items* with each other (Table 21, page 241). Heavy Machinery provides Contractor with data items that can be grouped into five larger groups: 1) transactional price information, 2) standardised and specifically adapted, theoretical LCC calculations, 3) indicators of labour and opportunity cost (service interval lengths, machine availability, ease of serviceability), 4) different kinds of operations and maintenance manuals and 5) highly selective information on new product development projects. In return, Contractor provides Heavy Machinery with four kinds of data items: 1) information on tenders it participates in and connected future vehicle demands, 2) information on the status of its vehicles, 3) feedback on Heavy Machinery's maintenance-related performance (spare parts pricing, LCC, machine availability, logistics performance) and 4) feedback on product designs through systematic customer interviews and the participation in prototype reviews and tests.

If we compare these data items with those exchanged between buyers and suppliers in prior studied translation interfaces, we can summarise our observations along three lines. First, in line with prior literature on OBA in translation interfaces, the selective sharing of information on upcoming product development projects and the provision of product demand forecasts appears to remain important (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2008, 2009, 2010).

Second, much of the commercial and technical information that has formed an integral part of OBA in prior studied translation interfaces appears to be exchanged in less detailed formats or not at all. Commercial information is for example entirely kept on the level of value-based, premium prices, based on which LCC calculations are also established. Heavy Machinery does accordingly neither share detailed cost breakdowns nor information on applied profit margins. Information on potential fluctuations in input costs, efficiency improvements or exchange rate movements of individual parts are also not disclosed in connection with price re-negotiations. This stands in stark contrast to the commercial information exchanges observed in translation interfaces by prior scholars (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2008, 2009, 2010). According to these prior studies, suppliers provide detailed disclosures on product costs and profit margins on the level of individual subcomponents. In addition, they proactively conduct and share analyses on the impact of volume and input cost changes and efficiency improvements that might arise over the long periods during which individual products are manufactured. Detailed product cost breakdowns have also been observed by prior research in specified (see e.g. Cooper and Yoshikawa, 1994, Kajüter and Kulmala, 2005) and interactive interfaces (see for example Cooper and Slagmulder, 2004, Agndal and Nilsson, 2009). In standardised interfaces, the exchange of at least some cost information limited to purchasing (Kumra et al., 2012, Romano and Formentini, 2012), logistics (Dekker and van Goor, 2000, Dekker, 2003, Agndal and Nilsson, 2010) or servicing (Kulmala, 2004) could be noted. The limitation of commercial information to information based on sales prices only appears accordingly very peculiar for relationships in which OBA is implemented. As the definition of OBA builds on confidentiality as a basic criterion (see Chapter 2.2.1, page 14, and for example Lamming, 1993, Hoffjan and Kruse, 2006, Caglio and Ditillo, 2012), the question might even be raised whether it can be considered as OBA at all. As vehicle prices and maintenance-related rebate schemes are, however, negotiated bilaterally, differ largely from standard list prices, are not disclosed to third parties and as such generally not available outside the relationship, an argument might be made for regarding those as part of OBA.[58]

[58] Contractor and Heavy Machinery are very careful to not spread the prices and configurations of vehicles under consideration for particular tenders to competing contractors. Contractor sees potential differences as part of its competitive advantage and Heavy Machinery aims to avoid the disclosure of specifically negotiated discounts to other customers. The same applies for SalesOrg's local standard prices and customer-specific rebate schemes on spare parts, labour and maintenance-related products. Heavy Machinery for example actively limits the spread of its "standard" price lists. According to the National Supply Chain Operations Manager, SalesOrg has recently changed its policy on who is allowed to access its online spare parts catalogue. Following legal revisions and in line with competition law, the catalogue is now only open to "machine owners". As competing component suppliers and IASPs usually do not own machines requiring high initial investment outlays, they do not have access to the online catalogue. Accordingly, they need to call Heavy Machinery manually and inquire about prices of specific parts. The limitation of access to the online sales catalogue limits in consequence their ability to understand Heavy Machinery's pricing structure and undercut the prices of large assortments of parts by applying a fixed percentage. Prices quoted to competitors in the aftermarket are usually also list prices; no volume-based discounts are offered to them. In contrast to online price quotes, "offline" quotes are also logged in SalesOrg's IT systems and accordingly traceable. Pending competitive threats can accordingly be analysed. The indirect spread of price information

Less detail is also provided with regard to technical resources. Heavy Machinery does for example not provide information on its product development and production processes. Neither does it provide the name and location of its suppliers, with exception of the supplier of Component X. Outside systematic customer interviews and prototype reviews and tests in which Contractor might participate, no information on product development projects is provided. The only indicator provided with regard to a vehicle's production is lead-time. Operating and maintenance instructions and spare part books lack also technical information that are necessary to identify the design, raw material and product cost of individual spare parts. This rather opaque (Lamming et al., 2001) technical information stands in contrast to more open information sharing in prior studied translation interfaces. In those, suppliers were found to provide detailed information on the technical design of their products, their product development and manufacturing facilities and their sub-suppliers (Cooper and Slagmulder, 1999a, 1999b, 2004, Agndal and Nilsson, 2008, 2009, 2010). The exchange of detailed information on the design of products and manufacturing processes has also been observed in specified (see e.g. Yoshikawa et al., 1994, Kajüter and Kulmala, 2005) and interactive interfaces (see e.g. Cooper and Slagmulder, 1999a, 1999b). The *active* hiding of technical information appears accordingly also rather particular for OBA.

Third, the majority of the data items exchanged in the interface is new to the literature of OBA and focused on maintenance-related interdependencies and connected costs. Heavy Machinery provides Contractor for example with LCC calculations that specify both the kind and volume of spare parts that are required to maintain the vehicles over their respective life cycles and that are specifically adapted to Contractor's forecasted use and operating and maintenance practices. With the help of service interval lengths, indicators on machine availability and assessments of their ease of serviceability, Contractor can also evaluate maintenance-related labour and opportunity cost. Moreover, Heavy Machinery provides Contractor with operating and

by Heavy Machinery's own customers, is at the same time difficult to regulate and might occasionally be driven by their interest to confront Heavy Machinery with competitive quotes. Still, price information cannot be regarded as "public" in the specific case.

maintenance manuals and spare part books in printed and electronic formats.[59] Contractor reciprocates the disclosure of these maintenance-related data items with information on the actual use of its vehicles and different pieces of feedback information on the data provided by Heavy Machinery.

As Heavy Machinery lacks the necessary resources to repair and exchange Component X, Supplier X is to some limited degree directly involved in the data exchange. *Heavy Machinery provides Supplier X with some data items*, such as the geographic location and name of customers with Component X integrated in their machines. SalesOrg might also discuss particular maintenance issues that Contractor or other customers bring up directly with Supplier X. *Contractor and Supplier X*, in turn, exchange information on the use of Component X, lead time and commercial price information for spare parts, replacement components and labour.

Synthesis

For the design of OBA, it can accordingly be concluded that additional maintenance-related resource interdependencies compared to prior studied translation interfaces do not lead to the exchange of simply *more* data items among *a higher number of participants*. In contrast, as most sub-suppliers and IASPs are excluded by different means, the OBA exchange is limited to Heavy Machinery, Contractor and Supplier X. In addition, much of the commercial and technical information that is exchanged in translation interfaces according to prior literature is only exchanged in more abstract formats or not at all. Some of the openness that has been observed in translation interfaces before is accordingly problematized and *actively* reduced. At the same time, a long list of new data items is exchanged that share a common focus on different elements of long-term, maintenance-related cost. The result is a particular OBA design that appears new to the literature of OBA.

The observed design is accordingly also much more complex than we might have guessed based on the descriptions provided in the engineering (see for example Fabrycky and Blanchard, 1991, Asiedu and Gu, 1998) and purchasing and supply management literatures (see for example Benton,

[59] As these data items are specifically adapted to the customer-adapted equipment design , they are at least initially confidential. Over time, they might, however, also be spread to IASPs as these receive access to the information via their customers.

2010, Burt et al., 2010, Hofmann et al., 2012), focusing almost exclusively on LCC calculations. Based on the study, one might for example conclude that all-encompassing LCC calculations seem very difficult to establish and exchange in practice due to the involved complexities in buyer-supplier interfaces (see in particular Table 7, page 107). Accordingly, Heavy Machinery and Contractor draw on LCC only as an estimation of spare part related cost and rely on a long list of additional data items as indicators of labour and opportunity cost and necessary facility investments (see Chapter 6.1.1). In addition, we can perceive that LCC calculations in themselves are highly unstable as their individual elements might be challenged. In order to become a trusted basis for interaction, Heavy Machinery accordingly needs to stabilise these calculations with the help of indirectly connected suppliers and arrangements on its firm level (Dambrin and Robson, 2011). Further, it must underline their credibility by using and living up to them proactively. This will be discussed next.

8.1.3 Use of Open Book Accounting in capital equipment sales

Table 23 (page 250) summarises the observed attention-directing use of OBA on three levels: the relationship between Heavy Machinery and Contractor, Heavy Machinery's firm level and the level of three indirectly connected relationships with suppliers of major components. Within each of the outlined areas, OBA supports also a long list of decisions.[60] Accordingly, the uses of OBA are discussed in an integrated manner with regard to each of these levels.

Between Heavy Machinery, as supplier, and Contractor, as buyer of capital equipment, the implemented OBA design draws attention to the long-term cost consequences of equipment purchase decisions, potential deviations from theoretical LCC calculations that might arise as the equipment is used in the complex interface and the need to improve LCC calculations further over time.

[60] In order to support readability, an overview table is only provided for the observed attention-direction use of OBA in the interface. For an overview of the connected decision facilitating use of OBA, please refer to Table 13 (page 179), Table 15 (page 202) Table 17(page 219), Table 18 (page 226) and Table 19 (page 229).

Table 23 Attention-directing uses of OBA in the studied interface

Relationship-level	- Long-term cost consequences of vehicle purchase decisions - Attainment of theoretical, specified Life Cycle Cost (LCC) in practice; identification and management of cost deviations - Improvement of LCC calculations over time and identification of further possibilities to reduce cost beyond those specified in LCC calculations
Supplier's firm-level	- Long-term cost consequences of vehicle and core component designs (service interval lengths of major components, LCCs/ spare part cost of major components, ease of serviceability) - Need to invest into and efficiently coordinate maintenance-related resources (specialised maintenance-related sales and marketing resources, supplementary maintenance-related products, component repair centres, logistics facilities)
Indirectly connected relationships with suppliers of major components	- Modified translation interface 1: purchase cost of frequently exchanged subcomponents - Modified translation interface 2: efficient local coordination of component repairs - Modified translation interface 3 (Supplier X): local pricing of replacement components; relative opportunity cost advantages of "replace with new component" strategies compared to "replace with repaired component" strategies, efficient coordination of repairs and replacements

On Heavy Machinery's firm level, OBA steers attention to the need to develop vehicles that are optimal from a long-term cost perspective and the need to invest into and coordinate efficiently different kinds of maintenance-related resources. These include proactive maintenance-related sales and marketing resources, supplementary maintenance-related products, component repair centres and logistics facilities.

In the indirectly connected relationships between Heavy Machinery and its own sub-suppliers of major components, OBA draws attention to different maintenance-related aspects. In some relationships, OBA draws Heavy Machinery's attention to the potentially excessive pricing of particular subcomponents and the need to investigate those by increasing its own visibility of related costs. In some other relationships, it draws attention to the efficient coordination of component repairs. Finally, in the relationship with

Supplier X, it mainly draws attention to the pricing of replacement components, potentially diverging perspectives on opportunity costs and the need to tightly coordinate maintenance-related work.

If we compare this use with that observed in prior studied translation interfaces (Chapter 3.3.1), several similarities and differences become visible. First, we can note that OBA is only to a very limited extent used to direct attention to and make decisions about product development and production related resources on the relationship level. In contrast, this use occurs almost exclusively on Heavy Machinery's firm level. Heavy Machinery develops "standardised" versions of new vehicle models based on information gained through systematic customer interviews and demand forecasts with larger groups of customers. It tests these products at several sites run by different potential buyers of the product. In addition, it develops maintenance-related products, such as upgrade kits and plug and play modules, based on analyses of the vehicle status of larger fleets of vehicles. Significant adaptations of these "basic" product models occur, but these are mainly performed by Heavy Machinery without much involvement of Contractor and not supported by the disclosure of other data than individually calculated, fixed prices without disclosed margins. This limited use contrasts significantly from prior studies on OBA in translation interfaces, where buyers and suppliers jointly conduct parallel engineering over extended periods of time based on detailed commercial and technical disclosures (Cooper and Slagmulder, 1999a, 2004, Agndal and Nilsson, 2008, 2009, 2010). It also differs from product design and production related discussions in specified (see for example Yoshikawa et al., 1994, Alenius et al., 2015) and interactive interfaces (see e.g. Agndal and Nilsson, 2009).

The limited joint use between buyers and suppliers of capital equipment with regard to product development and production does at the same time not mean that OBA is completely irrelevant in this area. It rather seems to play a different role, limited to Heavy Machinery's firm level. OBA allows Heavy Machinery for example to improve its internal analyses with some external customer data. It can accordingly better understand the demand for new products and adapt its production capacities. Moreover, it provides Heavy Machinery with a specific, customer-focused lens through which it can evaluate new development projects and even motivate the development of entirely maintenance-focused products. As customers analyse differences in long-term cost between vehicle models and manufacturers with the help of OBA information, internal development projects are now not only analysed in terms of their potential impact on performance improvements and product cost, but also in their ability to reduce spare part, labour and opportunity cost. This contrasts with a situation before the introduction of OBA, where the focus in product development mainly rested on increasing equipment performance and developing designs that are optimal from a production rather than a maintenance perspective. In addition, Heavy Machinery can assess whether and when it should launch maintenance-related products, such as upgrade kits and plug and play modules.

Second, in contrast to prior studied translation interfaces, OBA is also not used to draw attention to and facilitate decisions with regard to price changes as input cost, exchange rates and volumes might fluctuate and efficiency improvements might be realised over time (Agndal and Nilsson, 2008, 2009, 2010). Instead, vehicle prices are negotiated at the time of purchase without any cost and margin information being presented. Likewise, the prices of several thousands of spare parts, labour and supplementary products are adapted annually, usually without providing any specific reasons for those adjustments.

Third, OBA continues to be used to draw attention to and avoid potential disruptions in the supply chain. The focus shifts, however, from avoiding potential disruptions in product development and production along the extended supply chain (Agndal and Nilsson, 2008, 2010) to potential disruptions that might be caused by insufficient stocks of spare parts. The only data item discussed with regard to the development and production of vehicles is lead-time, while the stock of spare parts at the warehouse closest to the Contractor's site and the DIFOT indicator (percentage of spare part orders delivered in full on time) are closely monitored and discussed to avoid disruptions in the supply of spare parts.

Fourth, OBA appears to be most intensively used to direct attention to and make decisions about investments into maintenance-related resources and their efficient coordination. As maintenance-related costs constitute the majority of total vehicle cost, predictability of those is of particular value to Contractor. The provision of initial cost estimations evokes in this context a form of responsibility on the side of Heavy Machinery that extends a long time after formal product warranties have expired. If the equipment does not live up to its initial cost estimations, it becomes difficult for Heavy Machinery to sell additional vehicles in the future. In addition, Contractor might search the help of component suppliers and IASPs to achieve initially presented cost levels, which might undermine Heavy Machinery's maintenance-related business. Heavy Machinery and Contractor put accordingly a lot of their attention into identifying potential deviations from initial estimations, removing their root causes and finding ways to reduce costs further. The availability of OBA information provides also the opportunity for Heavy Machinery and its indirectly connected suppliers to plan investments into maintenance-related resources and to coordinate those more efficiently. With better planning based on OBA information received from customers, Heavy Machinery can create important efficiency advantages over competing vehicle manufacturers, component suppliers and IASPs. Moreover, it can proactively lock Contractor into maintenance-related sales deals before the latter even has noticed its demand for them and enquired with competing component suppliers and IASPs.

In conclusion, we can accordingly also observe large differences with regard to the use of OBA in the studied interface compared to translation interfaces studied by prior research. In particular, OBA appears to be less used with regard to product development and production related questions and price-renegotiations. Instead, its main focus on the three studied organisational levels seems to move to managing maintenance-related aspects, including the proactive management of potential disruptions caused by insufficient spare part stocks.

8.1.4 Synthesis and discussion of the implied links

In comparison to prior studied translation interfaces, the studied interface is accordingly characterised by additional maintenance-related interdependencies. This increase in interdependence appears at the same time not to be connected with a simply more comprehensive design and use of OBA compared to prior studied translation interfaces (Cooper and Slagmulder, 1999a, 2004, Agndal and Nilsson, 2008, 2009, 2010). Rather, we can observe how both the design and use of OBA change their characteristics. With the exception of Supplier X, most sub-suppliers are for example now consciously excluded from the information exchange. In addition, IASPs, a new group of business actors, are also problematized. Many data items that have been seen as important to coordinate product development and production are consciously and proactively removed from the interface or only presented in less detailed formats. This includes detailed product cost calculations as well as technical information on the design of products, product development and manufacturing facilities and the structure of the wider supply network. At the same time, information on different elements of long-term maintenance-related cost and performance is added to OBA.

The general focus of the use of OBA appears to also shift to maintenance-related considerations. Product development and production related questions are now merely dealt with internally at Heavy Machinery. In this context, the focus changes also from developing designs that are mostly optimal from a performance and production perspective to include maintenance-related considerations. On an overarching level, we can accordingly conceive a partial (dis)connection between the observed interdependencies in product development, production and maintenance and a design and use of OBA that is mostly centred on maintenance-related aspects on the relationship level.

Focus on particularly important (maintenance-related) problems

One explanation for this disconnection might be found in the argument that business firms need to tailor their OBA exchanges to certain, important problems as they are limited in their perception and information processing capacities (see Chapter 2.1.1 and for example Kulp, 2002, Lamming et al., 2004). As the investment into and coordination of maintenance-related resources is regarded as more important compared to product development and production related aspects, the information exchange would consequently shift to the former aspects while the latter aspects are side-lined.

Some empirical support for such a line of argumentation can be found in the study's observations. Investments into new vehicles are significant in financial value and impact Contractor's ability to provide certain services to its own customers in the medium- and long-term. At the same time, they are only made at distinct time intervals, usually connected to a tender or larger replacement purchase. As vehicle prices are fixed, they can be regarded as certain by Contractor from the moment an order is placed. They accordingly cause also no uncertainty in Contractor's connected tender calculations. Moreover, product design requirements can usually be adequately compressed in functional and interface requirements. Product development and production can accordingly be mostly carried out several thousand kilometres away from Contractor's operations. Only prototype reviews and tests and some very specific adaptations need to be performed locally.

In contrast, maintenance-related cost constitute the majority of total cost and involve high degrees of uncertainty. While they can be depicted in *theoretical* LCC estimations, their realisation *in practice* depends on how well a large number of technical and organisational resources are adapted to each other on a daily basis in the specific buyer-supplier interface. In addition, whenever things do not go as they should, significant opportunity costs can arise. A lot of the daily work in the interface centres accordingly on correcting any unexpected problems as quickly as possible and limiting their further impact within the extended business network. Pertaining problems might otherwise quickly turn a highly profitable project into a highly unprofitable one for Contractor and indirectly connected firms. By being better in managing maintenance-related aspects and reducing uncertainty, Contractor can create competitive advantages over its competitors, also as the majority of costs are connected to these. This becomes accordingly also a top priority for Heavy Machinery, whose ability to sell more equipment depends on Contractor's satisfaction not only with the functionality and performance of the vehicle as such, but, most importantly, with its maintenance-related support.

We can accordingly see how the business partners limit their OBA exchange to a few, easily interpretable data items that help them manage their maintenance-related interdependencies. Heavy Machinery and Contractor extend their OBA exchange for example to include information to indicators of spare part related cost (LCC, vehicle status) and labour and opportunity cost (service interval lengths, machine availability, ease of serviceability, logistics performance). At the same time, the exchange of other data items is reduced as it might only drown the business partners with unnecessary data and divert attention into less important areas (Kulp, 2002, Lamming et al., 2004). An example of such a piece of information is the product cost of the 150,000 individual spare parts which Heavy Machinery offers. As we could observe, the *internal* availability of such information *within its own organisation* is highly feared by Heavy Machinery's managers as it might divert the focus from creating additional value to primarily distributive fixed-pie discussions (Chang et al., 2013). Heavy Machinery works accordingly actively on hiding such information not only from its customers, but also from its own employees working directly with those.

Avoiding the disclosure of potentially misused information

Another explanation might be found in the observation that the detailed disclosure of commercial and technical information might be useful to coordinate product development and production related matters, but might "fire back" when maintenance-related aspects are discussed. The potential (mis)use of information in this latter area would accordingly preclude its disclosure in the first place (see Chapter 2.1.2 and for example Baiman and Rajan, 2002a, 2002b, Jarimo and Kulmala, 2008) and only more abstract forms of information would be provided (Miller and Drake, 2016). Some of the findings of our study underline the relevance of this argument.

We could for example observe that most of the team effects in the interface arise from combining the equipment with additional, maintenance-related resources and that the generated economic value is primarily distributed by means of the pricing of maintenance-related products between Heavy Machinery and its customers. The reason for this lies in how customers, including Contractor, have historically formed their buying decisions. Prior to the introduction of OBA, customers did not have access to information on the equipment's long-term cost and, accordingly, based their purchase decisions on the manufacturer's brand, the machine's functionality and its initial price tag. Vehicles have accordingly been priced highly competitively. At the same time, vehicle manufacturers could charge relatively high prices for their spare parts as customers lacked detailed insights into differences in maintenance-related costs and IASPs were still limited in their ability to produce non-genuine copies of frequently exchanged parts. Even though OBA has increased transparency for customers regarding total costs, initial vehicle prices have remained highly competitive. Most profitability for Heavy Machinery arises consequently still from the sale of maintenance-related products and services. If Heavy Machinery provided its customers accordingly with detailed cost breakdowns in connection to highly competitive vehicle sales prices, it would have large difficulties in justifying its high profit margins on spare parts and services both internally and externally later on.

Moreover, we could also observe how major component suppliers, IASPs and Contractor (mis)use the information available in the interface to their own advantage. Based on identifiers, component suppliers and IASPs for example provide Contractor with quotes for genuine and non-genuine spare parts in competition to Heavy Machinery. In order to preclude such (mis)uses of available information, Heavy Machinery actively works on reducing its availability. It for example cooperates with major component suppliers in order to provide parts with unique designs and lock article numbers on the component level. In addition, it engages with alternative suppliers of subcomponents and recycling companies and implements adaptations in product development and logistics on its firm level in order to steer information and commercial product flows to its own advantage. In this context, we could also see how sales gap analyses and, thus, the use of OBA information reinforces the connected conscious OBA design work.

The omission of detailed commercial and technical information from the OBA design and the reduced use of OBA in product development and production might accordingly be explained by the higher importance of maintenance-related aspects and the potential misuse of such information. Interestingly, the complementarity of the two lines of reasoning can be further underlined by observations on their combined use in practice. Heavy Machinery argues for example that the provision of spare parts in the form of kits reduces the informational complexity for Contractor. At the same time, it implements these changes consciously in order to reduce the amount of information available in the interface and to strengthen its own position vis à vis major component suppliers and IASPs.

8.2 Open Book Accounting and the intra-organisational level

In line with the analytical framework and the focus of prior literature on OBA, the discussion has so far been limited to understanding which data items firms exchange and how they use those to direct their attention and make decisions in capital equipment sales. Accordingly, we have focused less upon the ways in which they exchange this information. The form of transmission is, however, an important element of any accounting information system (see for example Gordon et al., 1978). As the thesis has provided some important insights in this regard, our discussion shall be widened in the following.

8.2.1 Automatic and manual information exchanges

In general, OBA information exchanges might be conducted in two ways: automatically through interlinked formal information systems and manually as individual business units request and provide information to their counterparts in other firms (Caglio and Ditillo, 2012, Cooper and Slagmulder, 1999a).

Heavy Machinery and Contractor appear to draw on *automatic information exchanges* with regard to relatively few data items. Contractor accesses for example the prices of spare parts, checks their stocking and places orders via Heavy Machinery's online catalogue and an EDI interface that connects its own maintenance-planning system with Heavy Machinery's Enterprise Resource Planning (ERP) system. In addition, Heavy Machinery has taken steps to automatize the exchange of vehicle status and performance information through the introduction of remote monitoring tools. Relegating these "routine" information exchanges to formal, interlinked information systems frees resources of the two firms, which these, in turn, can use to identify, analyse and manage specific problems. In addition, it provides opportunities for increasing the frequency of the respective exchanges at low cost, which improves their accuracy. Automatization contributes accordingly to the effectiveness and efficiency of the OBA exchange with regard to these frequently exchanged, invariant data items (Cooper and Slagmulder, 1999a, Kulp, 2002).

In parallel, Heavy Machinery and Contractor use *manual information exchanges* with regard to most data items. These include vehicle prices, LCC information and service interval lengths provided by Heavy Machinery, but also information on current tenders and different kinds of feedback information provided by Contractor. As the relevance of these pieces of information differs over time and usually requires explanation and discussion, their manual exchange contributes to the overall efficiency and effectiveness of the OBA exchange (Lamming et al., 2004, Caglio and Ditillo, 2012).

8.2.2 The intra-organisational dimension of manual information exchanges

Provided the high importance of manual OBA exchanges, Tomkins (2001) and Caglio and Ditillo (2012) argued that it might be important to study how these are supported on the intra-organisational level by the involved firms. Firms might for example need to ensure that their individual business units receive access to relevant, interface-specific information in order for them to be able to share this information with their counterparts in other firms.

Prior research on how firms support inter-firm OBA exchanges on their firm level in practice is at the same time rather limited and includes some controversies. Most prior literature has for example only commented in very general terms on that access to detailed, ABC cost information and experience with advanced costing techniques on the firm-level might be seen as a precondition to the implementation of OBA on the inter-firm level (Nicolini et al., 2000, Kajüter and Kulmala, 2005, Wouters et al., 2005, Coad and Cullen, 2006, Fayard et al., 2012). At the same time, some experimental studies have cast doubt on that the provision of detailed information to individual negotiators might lead to its actual use by these on the inter-firm level (Drake and Haka, 2008, Chang et al., 2013). Drake and Haka (2008) have for example conducted an experiment that showed that negotiators with access to detailed information share this information with their counterparts to a lower degree than negotiators with access to more coarse information. Despite their general ability to identify more cost reduction opportunities compared to negotiators with less detailed information, they accordingly achieve also on average fewer of them compared to negotiators with access to more coarse data. Drake and Haka (2008) explain this behaviour with inequity theory according to which negotiators have an aversion towards inequitable negotiation results in general and achieving lower results compared to their counterparts in particular. Due to the risk that their counterparts might receive a higher part of the available benefits in the following negotiations, negotiators accordingly avoid sharing such information from the outset.

In this context, the present thesis is the first to provide a detailed account on how firms support OBA exchanges by arrangements on the intra-organisational level in practice. The so far rather implicit observations made at Heavy Machinery are summarised in Table 24 (p. 261) and Table 25 (p. 263) in a more explicit format. In line with our discussions on the inter-firm level, the former table distinguishes the business units at Heavy Machinery that are directly or indirectly involved in manual information exchanges with Contractor. For analytic purposes, the many units are grouped into four larger groups, each of which includes units primarily concerned with vehicle- and maintenance-related sales. The table outlines also the kind of internal and external information these groups of units have access to. The second table summarises the areas into which this information appears to direct the units' own attention and in which it supports their decision making. The findings can be summarised as follows.

Directly customer-interfacing units

Directly customer-interfacing units form the first group of units. They include the key account manager responsible for vehicle sales to Contractor as well as several units responsible for the sale and provision of maintenance related products and services (regional service sales manager, service technicians, service administrators and warehouse staff). Directly customer-interfacing units appear to generally have access to the same kind of internal data items as they convey to or collect from Contractor. We could for example observe that the key account manager has access to the sales price of particular vehicle configurations. He can also access some indicators of LCC, opportunity and labour cost. At the same time, he appears to neither have

Table 24 Intra-organisational units of Heavy Machinery that are directly and indirectly involved in the OBA exchange with Contractor

Business Unit		**Internal information**	**External information**
Customer-interfacing units			
Final - SalesOrg	Key account manager	• Machine price, no insight into consolidated or local profit margins • Life Cycle Cost • Machine availability, service intervals, ease of serviceability and local maintenance support • No information on new product development projects unless own customers are involved in prototype reviews and tests	• Tenders and future vehicle demand • Vehicle status information • Feedback on pricing, LCC, machine availability, logistics performance • Internal analyses on vehicle's life cycle status
Service - SalesOrg	Regional service sales manager, service technicians, service administrators, warehouse staff	• Net customer prices for maintenance-related products, no insight into local or consolidated cost/ margin, • LCC • Machine availability, service intervals, ease of serviceability and local maintenance support • Maintenance and operations instructions, spare part books	• Vehicle status information • Feedback on pricing, LCC, machine availability, logistics performance • Regional service sales managers only: internal sales analyses per customer, quotes conducted over phone for maintenance-related products for customer
Business line and product managers			
Final - SalesOrg	Business line and product managers	• Machine price, local cost and profit margin • Business line managers only: consolidated profit per vehicle category • Machine availability, service intervals, ease of serviceability and local maintenance support • Information on upcoming prototype reviews and tests with customers in the region	• Same as KAM (through KAMs), however, from multiple customers who might stand in competition • Sales plans • Escalated problems

Service - SalesOrg	Business line and product managers	• Spare parts: net customer price, local landed cost, local profit • Labour: price, local cost, profit levels, utilisation • Business line managers only: consolidated profit on spare parts by vehicle type & price group • No information on individual spare parts apart from generic descriptions and Heavy Machinery's own article number	• Operational sales plans ("Heat Maps") and revenue targets per customer and region • Special purpose analyses for identifying product opportunities, sales campaigns, facility investments • Escalated problems by customer facing staff
Global marketing units			
Final (& Core) - Global	Marketing	• Machine price and production cost, consolidated and local profit levels • General information on LCC, machine availability, service intervals, ease of serviceability, however not adapted to local differences • Full insight into new product development projects	• Budgets of SalesOrg • FleetData via Service
Service - Global	Marketing, incl. pricing unit	• List prices for spare parts along cost and local and consolidated profit levels for specific sales organisation, local cost	• Budgets of SalesOrg • Access to FleetData, but global analyses limited to validation of upgrade kits and plug & play modules • Escalations from SalesOrg
Engineering and purchasing units			
Final - Global	Engineering	• Information on technical design and production/purchase cost • No insight on sales prices and margins	• Indirectly: Escalated problems with existing product designs, new product ideas • Directly: Systematic customer interviews and information from prototype reviews and tests
Service - Global	Purchasing & Engineering units	• Purchase price of spare parts • Limited insights into sales prices of spare parts • Limited technical information on Core's products	• Escalated price and branding-related problems

Table 25 Use of Open Book Accounting on the firm-level at Heavy Machinery

Business unit		**Areas to which attention is directed**	**Decisions taken**
Customer-interfacing units			
Final - SalesOrg	Key account manager	• Customers' vehicle purchases for new sites and as replacements • Problems that might cause deviations from LCC and other maintenance-related indicators and, accordingly, might hinder future sales • (To some degree: maintenance-related problems)	• Purchase decisions of customer • Revenue budget • Prioritisation and escalation of problems
Service - SalesOrg	Regional service sales manager, service technicians, service administrators, warehouse staff	• Maintenance-related sales, incl. identification and closure of potentially existing gaps • Identification and correction of deviations (in particular related to operator abuse, product design, pricing problems) and maintenance-related problems	• Proactive customer contact & sales • Customer-focused (revenue) budgets and sales plans • Prioritisation and escalation of problems
Business line and product managers			
Final - SalesOrg	Business line and product managers	• Overall sales and combined local and consolidated profitability in the region • Offering of vehicles and local adaptations	• Vehicle prices, prices of packages including labour and spare parts, bridging of lead-time, incentive schemes offered to customers based on expected service interval lengths • Prioritisation and escalation of design-related and pricing problems • Customers to contact for prototype reviews and tests • Local sales and cost budgets for SalesOrg
Service - SalesOrg	Business line and product managers	• Local vehicle and maintenance-related product offering	• Maintenance-related product offering (upgrade & plug & play kits, component repairs) and connected facility investments

		• Maintenance-related facility investments and local supplier structure • Reducing sales gaps and ensuring LCC are kept in practice and further reduced	• Maintenance-related local sales campaigns • Reallocation, fire sale and scrapping of spare part stocks • Choice of and coordination with external repair centres • Local sales and cost budgets for SalesOrg • Prioritisation, local resolution or escalation of technical and commercial problems
Global marketing units			
Final (& Core) -Global	Marketing	• Global sales and consolidated profitability • Vehicle offering (performance, total cost) • Design-related problems	• Decisions on product offering and its pricing • Prioritisation of escalated problems • Global budgets in alignment with local budgets
Service - Global	Marketing, incl. pricing unit	• Global sales and consolidated profitability • Global maintenance-related product offering, incl. facility designs and investments	• Decisions on product offering, pricing, branding of spare parts • Prioritisation of escalated problems • Global budgets in alignment with local budgets
Engineering and purchasing units			
Final - Global	Engineering	• Design of new vehicles from a long-term (product) cost perspective, incl. ease of serviceability • Correction of specific design-related problems • Aftermarket-related competition	• New product development projects • Product care projects
Service - Global	Purchasing & Engineering units	• Purchase price • Branding of spare parts and their packaging to reduce competition in the aftermarket	• Decisions on unique component and subcomponent design, locking of article numbers • Decisions of changes with and of suppliers for reasons connected to the pricing & branding of spare parts

access to product cost nor local or consolidated profit margins of vehicles as this information is kept private by Final's business line and product managers preparing these offers. Key account managers are also only informed about new product development projects for which the involvement of their customers in prototype reviews and testing is requested by global product development units. This means also that, if they get access to information on new product development projects, this happens only towards the end of the product development process. The spread of rumours to Contractor, competing vehicle manufacturers and Independent Aftermarket Service Providers (IASP) is accordingly consciously limited.

Similarly, we could observe that customer-interfacing maintenance-related units have access to maintenance-related price information, LCC and different indicators of opportunity and labour cost as well as to maintenance and operations instructions. Most other commercial and technical information are at the same time hidden from them. As we observed, technical information available in IT systems used by Heavy Machinery's global product (Core, Final) and service units (Service) are for example purposefully replaced by generic article descriptions (e.g. bolt, valve, hose) in SalesOrg's systems. In addition, all commercial information on the purchase/production cost of articles, their article number at suppliers and the name of suppliers is replaced by Heavy Machinery's own internal article number, information on the global distribution centre supplying the item, its landed cost and recommended sales price in SalesOrg's system. The screens containing information on local landed cost and local profit margins are, in turn, not accessible by customer-interfacing units. Only business line and product managers can access these.

These customer-interfacing units are also involved in the collection of different kinds of data items from Contractor. These include information on future vehicle demands, vehicle status information and different kinds of feedback, including competitors' pricing for vehicles and spare parts. In addition to access to this raw data, customer-interfacing units can also access some summary reports that are prepared by product managers based on this data. Key account managers for example receive analyses based on vehicle status information that specify the life cycle stage of vehicles sourced from

Heavy Machinery and competitors. In addition, regional service sales managers can access sales gap analyses and analyses on price enquiries made by customers over the phone.

As part of the study, we could note how this information directs the attention of these units to identifying and realising existing vehicle and maintenance-related sales opportunities and correcting potential deviations that might occur with regard to promised life cycle, labour and opportunity cost. Based on the obtained information, they might decide to proactively contact customers and support them in their vehicle and maintenance-related purchasing decisions. In addition, customer-interfacing units are involved in decision making on internal revenue budgets and sales plans and prioritise and escalate specific problems their customers encounter.

Business line and product managers

Business line and product managers form a second group of units. These units are primarily indirectly involved in the OBA exchange with Contractor as they set the commercial guidelines for customer-interfacing units and resolve design and price-related problems that are escalated to them. At the same time, they take occasionally also directly part in the monthly coordination meetings with Contractor and discuss particular escalated issues directly with their counterparts at Contractor. The reason for their occasional direct involvement lies in the importance of Contractor for Heavy Machinery in terms of business value and its position as lead-user in the local market. Compared to directly customer-interfacing units, business line and product managers have access to some additional internal information. They can for example access the screens with local cost and local profit margin information on machine and maintenance-related product sales. In addition, business line managers receive accounting reports on the consolidated profit of vehicle and maintenance-related sales *per vehicle type*.[61] As observed before, this higher abstraction level is itself purposefully chosen as managers accordingly cannot draw inferences from the profitability of the overall category on the profitability of individual products. Their ability to provide local price

[61] As described before, Final produces three different vehicle types. Each vehicle type includes many different vehicle models. Financial information per vehicle type is accordingly very crude and available for both Final and Service.

concessions that go beyond local profit margins or to conduct local sourcing is accordingly limited. Business line and product managers might be asked to indicate customers for prototype reviews and tests. They might accordingly have some more information on current product development projects compared to key account managers, which have this information only for their customers. They receive such information accordingly also a little bit earlier.

Through customer interfacing units and internal IT systems, business line and product managers can access approximately the same kind of information from customers. At the same time, in their daily work, they appear to commonly rely on higher level analyses across customers and vehicle types. Information on future vehicle demands of several customers are for example combined into the sales targets for key account managers. Similarly, sales gap analyses, operational sales plans and revenue targets exist for maintenance-related sales per customer and regional service sales manager. Their achievement is monitored with the help of accounting reports. Via the FleetData database, business line and product managers can also access some limited information on vehicle users in other countries. This information is in particular used in connection to fire sales of stock or if particular questions on a certain vehicle model arise in a sales process.

These units appear to use the information to direct their attention to particular areas and facilitate decision making therein. Attention is for example directed to sales revenue and local profits for SalesOrg's entire region rather than particular customers, the local product offering and connected facility investments. Within these areas, vehicle sales forecasts, sales gap analyses and escalated problems facilitate concrete decision making and follow-up with both customer-interfacing and global marketing units. We could for example observe how business line managers negotiate revenue targets with customer-interfacing units at SalesOrg and with global marketing units for SalesOrg as a whole. In addition, we could see how business line and product managers analyse the local product offering and connected facility investments as well as potentially necessary co-operations with external component repair centres. They also establish particular offers for Contractor and other customers, decide on the focus and start date of sales campaigns and prioritise among different commercial and technical problems escalated to them. We could observe how they either try to resolve these issues on the local level and/or escalates them to global marketing and engineering units, which might in turn prioritise and escalate those.

Global marketing units

Core's, Final's and Service's global marketing units can be identified as a third group of units involved in the OBA exchange with Contractor. They are mostly indirectly involved in specific customer relationships. The only exceptions arise in connection to systematic customer interviews that might be performed directly by Core's and Final's product marketing units or during Contractor's visits to Heavy Machinery's development and production facilities to give feedback on specific prototypes. Product managers from SalesOrg might follow along on such trips. In contrast to the first two groups of units, global marketing units have relatively unrestricted access to commercial and technical information for their respective products. Service's marketing unit has for example insight into purchase/production cost and the indirect cost allocated on the global and local level to specific spare parts. Services' marketing unit can also access information on current vehicle use via the FleetData database. In their daily work, the two units rely, however, mostly on more abstract information across customer groups and vehicle fleets from financial forecasts and reports as well as concrete problems escalated by sales organisations.

In line with this information, their attention appears to primarily lie with global sales and profitability and the global product offering and associated facility designs and investments. They accordingly form decisions on the global pricing of vehicles and maintenance-related products as well as problems escalated to them. They for example decide on specific price requests and escalate problems to purchasing and engineering units. In addition, they are involved in the establishment of local and global budgets and business cases for new vehicles and maintenance-related products.

Engineering and purchasing units

A fourth group of units appears to consist of Core and Final's engineering and Service's purchasing units. Based on the made observations, these units appear to have full insight into the technical design of products, their cost and suppliers. Two exceptions are, however, notable. First, engineering and purchasing units appear to not have access to the sales prices charged to specific customers. Accordingly, engineering units approximate LCCs based on purchase/production cost. Secondly, access to some technical information concerning Core's products is limited for Service's purchasing unit to avoid supplier changes.

Information from Contractor appears to be mostly filtered multiple times by units on the level at SalesOrg and global marketing units. Feedback on product design related problems are for example filtered first by business line and product managers on the level of SalesOrg while pricing related issues are filtered on the level of SalesOrg and by the pricing managers belonging to Service's marketing unit. An exception are prototype reviews and tests in which Heavy Machinery's engineering units directly interact with Contractor. As noted, engineering and purchasing units are indirectly involved in the information exchange with Contractor as they reside over the (standardised or unique) design of components and subcomponents and their locking and branding by suppliers. They also decide upon how often certain components are exchanged to make their copying by IASPs more difficult and which information operations and maintenance manuals, including spare part books, should contain.

Throughout the study, we could note how this directs the attention of Final's and Core's engineering units to designing products from a combined performance and total cost perspective. Potential aftermarket-related competition is also kept in mind. Life cycle cost are estimated with the help of production and purchase cost of individual parts. In addition, service interval lengths and the ease of serviceability are used for guidance in specific product development projects. The aim is to develop products with the lowest total cost, irrespective of their current profitability for Heavy Machinery. Furthermore, attention is directed to specific design related problems that are escalated to engineering units. OBA information affects also decisions on new product development projects and product care projects, as part of which specific, escalated problems are considered.

Based on the study, the attention of Service's purchasing unit seems to be directed to reactively finding solutions for escalated pricing and branding related problems. Over time, this has also resulted in a generally more proactive consideration of these products as products are still under their development. They might accordingly also initiate new agreements as part of which certain components receive a unique design and are locked at suppliers. In addition, they might decide to investigate pricing related matters with current and potential alternative suppliers. Such supplier changes are at the same time limited to Final's products.

Business- and interface-specific information design and use of Open Book Accounting

With these empirical findings, the present study contributes to the literature in several ways. To begin with, it confirms speculations by prior scholars that firms support inter-firm OBA exchanges with unit- and interface-specific designs of their intra-firm formal information systems (Tomkins, 2001, Caglio and Ditillo, 2012). In addition, this access to information appears also to be connected to particular uses of the information within the interface by these units.

Providing and hiding of information as part of intra-organisational design

The study contributes to the controversy as to how much information individual business units should receive access. As noted before, many prior studies have argued for providing units directly involved in information exchanges with very detailed firm-level cost information (Nicolini et al., 2000, Kajüter and Kulmala, 2005, Wouters et al., 2005, Coad and Cullen, 2006, Fayard et al., 2012). At the same time, Drake and Haka's (2008) experimental study has illustrated that the access to detailed information might actually be connected with a low use on the inter-firm level due to connected behavioural uncertainties. In this context, the study highlights that, similar to the inter-firm level (see Chapter 8.1.2), the firm-level design involves conscious choices as to both which information that should be provided to specific units and which other information that should *be actively hidden from them*. As it seems, customer-interfacing business units should be provided with the information, at the level of detail, that they are expected to share with their counterparts in other firms. At the same time, other information should be hidden from them completely or only available in more opaque forms.

The limitation of information appears also not only to reduce potential behavioural uncertainties (Drake and Haka, 2008). As part of the thesis, we could also observe that the limitation of information contributes to the units' understanding of their own internal and external roles. As customer-interfacing units for example received access to limited commercial and technical information, they understood that their role was to sell vehicles and maintenance-related products, serve vehicles and discuss the "added value" (in terms of higher service intervals and lower opportunity and indirect purchasing cost) Heavy Machinery provides to Contractor. In contrast, discussing the price of individual machines or parts and related profit margins was not part of their usual role. Only in a very limited number of cases and after additional information has been presented by Contractor, they might escalate pricing issues internally. In these rare cases, their internal role transformed to that of a representative of Contractor within Heavy Machinery, arguing for price concessions in front of other units with the authority to adjust prices. Similar observations were also made with regard to other units. Strategic purchases saw for example their focus on reducing the cost of externally purchased spare parts and engineers saw their attention directed to designing vehicles with low total costs. Despite the existence of occasional tensions[62], pricing questions are seen as an issue dealt with by marketing professionals who know which maximum price customers might be prepared to pay. In response to Dekker's (2016) call for more research on how firms manage the behaviour of units that are directly involved with external business partners, one might accordingly also argue that the definition of the access to internal and external information appears to play an important role.

In this context, the study emphasises also the inherent difficulty in limiting the access to information in formal information systems that generally follow an in-built integration logic (Davenport, 1998, Quattrone and Hopper, 2005, Hyvönen et al., 2008). In order to be able to distinguish the access to information, Heavy Machinery draws not on a single, integrated system, but a patchwork of formal information systems (Markus et al., 2000) and many specific rules of data entry and access (Gordon et al., 1978). One

[62] Such tensions could arise when the performance of products was increased with the intention to cut their LCC for the customer, but the marketing department then set a price that captured the additional value, resulting in stable LCCs. In these cases, discussions between marketing professionals and engineers could

ERP system, containing detailed commercial and technical information is for example used by Heavy Machinery's global units. Another system with more limited information is used by its sales organisations, such as SalesOrg. In addition, several other systems, such as FleetData, are used. Moreover, certain rules appear to exist with regard to data entry and access within these systems. In order to reduce the likelihood of supplier changes, certain technical and commercial information on Core's products is for example not saved in the global ERP system while the same is done for Final's products. Furthermore, certain screens with local cost and profit information are locked for customer-interfacing units in the system used at SalesOrg.

Which information that should be provided to and hidden from specific business units and the design of formal information systems is interface-specific. While the study accordingly provides insights on the information provided to business units of a capital equipment manufacturer selling through translation interfaces, future research might need to study the design and use by other units and in other interfaces. Such research might also provide opportunities for integrating inter-organisational accounting research with research on the implications of Enterprise Resource Planning (ERP) systems for management accounting. While this literature has grown substantially over the past few decades (see for example the reviews by Dechow et al., 2007a, Dechow et al., 2007b, Granlund, 2011), its inter-organisational dimension is still underdeveloped (Cuganesan and Lee, 2006).

Directly and indirectly involved units

The study emphasises also the need to consider intra-organisational units that are *both directly and indirectly involved in the OBA exchange*. Prior OBA research has focused exclusively on business units that are *directly* involved in manual OBA exchanges (Drake and Haka, 2008, Van den Abbeele et al., 2009, Masschelein et al., 2012, Caglio and Ditillo, 2012, Chang et al., 2013). Such a focus has also recently been reiterated by Dekker (2016) in his literature review and call for research on the interrelationship of intra- and inter-organisational management accounting. Provided the observations made in this studies, such a focus on directly involved units appears unnecessarily limiting.

As part of the study, we could observe the importance of indirectly connected units and their interaction with directly involved units in at least three contexts.

To begin with, it appears that the access to information can only be limited for directly connected units as long as they can escalate particular problems to indirectly connected units with access to more information. If customer-interfacing units for example were not able to escalate pricing-related questions via business line and product managers to global marketing units, they would require access to product cost and margin information themselves. This might, in turn, however, make it emotionally more difficult for these units to use commercial and technical information in interactions with Contractor and lead to role conflicts. In addition, it might be connected to a generally wider spread of this relatively sensitive information, as employees change employer over their extended careers and might establish contact with local suppliers. Sensitive information might accordingly be spread to customers, component suppliers, competing vehicle manufacturers and IASPs.

Furthermore, we could observe how the access to different pieces of information is connected to different uses and prioritisations by the involved units (on accounting for prioritisation, see also Håkansson et al., 2010, Håkansson and Lind, 2004, Dent, 1987). Customer interfacing units for example primarily prioritise among their different customers based on revenue potential, while SalesOrg's business line and product managers prioritise among the whole set of customers in their region and might take revenue as well as local profitability considerations into account. Global marketing units, in turn, prioritise among different regions and with consolidated profitability in focus. They might accordingly provide sales organisations with price concessions on reasonable grounds (e.g. pricing problems, sales campaign, offering of component repairs), but usually only if the impact on customers in other regions is limited. Otherwise, they might investigate the potential impact on these other regions first before reaching a decision. Finally, global engineering and purchasing units seem to prioritise in their decision making based on what has the largest impact on overall product and purchasing cost. These different prioritisations in decision making appear not coincidental, but systematically supported by differentiated access to information for directly and indirectly connected units and a system in which matters can be escalated.

Finally, indirectly connected units appear to play an active role in designing the information that directly connected units and external business partners receive. We could for example observe how purchasing and engineering units decide on the design of specific components, their update frequency, their branding and locking at suppliers. In addition, they design maintenance and operations manuals and spare part books. If these units and their work had not been studied in detail, important elements of the OBA design would potentially have been missed out, too. Accordingly, we might also have taken the invisibility of certain information as granted, which in fact is (pro)actively constructed by these units.

8.3 Providing and hiding information in business networks

Another element of the observed OBA exchange that might deserve more explicit consideration is the hiding of information on the intra- and interfirm level. Prior literature has observed hiding of information in two contexts. First, it has observed that firms might need to be selective in their information sharing with business partners, which implies the need to keep certain information private and, thus, hidden from their counterparts (see also Chapter 2.1). Selectivity reduces the risk of information overloads (see e.g. Lamming et al., 2004, Caglio and Ditillo, 2012) and the risk of that the information is misused by business partners (see e.g. Baiman and Rajan, 2002b, Jarimo and Kulmala, 2008). Second, the literature has observed that firms implement contractual controls and trust to limit the spread of sensitive information in the wider business network (Cooper and Slagmulder, 2004, Tomkins, 2001). While certain information might accordingly be shared among participants, the same information should remain hidden from nonparticipants. Across both earlier discussed contexts, hiding has accordingly been primarily framed as a decision to not share certain information and passively retain a certain invisibility for participants and/or nonparticipants that has existed from the outset, before OBA has been implemented. The decision as to which information that should (not) be exchanged are formed between the participants of the focal information exchange as part of the OBA design.

8.3.1 Three characteristics of active hiding

The active hiding observed in the present study appears to differ from these prior discussions in at least three ways. First, we can see how certain information that have been available to Contractor and other business actors before the introduction of OBA are problematized and turned invisible by Heavy Machinery later on. Examples include detailed descriptions in operations and maintenance manuals and accompanying spare part books, but also information depicted on spare parts and their packaging. Interestingly, this active hiding appears to even stretch to Heavy Machinery's firm level where the access to different pieces of information becomes more limited for different business units. Active hiding is accordingly not only about retaining a certain, pre-given invisibility for participants and nonparticipants; invisibility for these actors might also be proactively increased.

Second, active hiding appears to be a highly dynamic process; the kind of information that is hidden from Contractor and other business actors appears to change over time. Heavy Machinery combines for example vehicle status information collected from Contractor with LCC calculations to identify "gaps" in current sales that might be caused by a provision of too much information in the past and a previously unproblematized, active "smuggling" of information by its component suppliers. Similarly, unconverted quotations for spare parts are analysed in order to understand why Contractor did not buy them. Decisions on the further hiding of information are also made in the connection to the launch of new vehicle models and their connected components and subcomponents. Which information is to be hidden is accordingly not negotiated at the outset of the OBA exchange, but is continuously reconsidered as OBA enfolds.

Third, active hiding appears to involve other actors that might even not be considered as participants in our traditional understanding (see Chapter

2.2.2) as they do not provide or receive, but hide information. Heavy Machinery cooperates for example with component suppliers and alternative suppliers of subcomponents that might not be considered participants of its focal information exchange with Contractor. Similarly, we can note the involvement of a large number of internal business units at Heavy Machinery which appear to not provide any information to Contractor, but primarily be concerned with its hiding. An example are engineering and purchasing units at both the product (Core, Final) and maintenance-related units (Service) that (re-) consider the design and packaging of specific spare parts and initiate the locking of its article number in the supplier's systems. As the hiding of information is negotiated between actors that do not actively participate in the focal information exchange, it remains indiscernible by Contractor.

8.3.2 Invisibility as incomplete, actor-dependent and constantly (re-)negotiated

There might be different reasons for why prior literature has not considered active hiding as an important part of OBA before. One reason might be found in its implicit assumption that complete invisibility exists before OBA is implemented in a specific relationship. The origins of this assumption might be traced back to the beginning of the literature on OBA and inter-organisational control in general. Early works in these literatures have positioned themselves against neo-classical economics that foresees price as only information exchanged and "buy or make" as the only decisions made by firms (see e.g. Gietzmann, 1996, Van der Meer-Kooistra and Vosselman, 2000). Observing different degrees of interdependence between firms in business practice, the argument was formed that firms might need to exchange information in excess of "public" price information, which was seen as equivalent with complete invisibility. Access to price information only has subsequently become the implicit point of departure and comparison for most OBA research (see e.g. Kulmala, 2002). This might, in turn, have resulted in the depiction of OBA as a tool to *increase* rather than to *manage*, i.e. increase and decrease, visibility.

From a network perspective, such a view might be criticised as firms can be expected to have access to different pieces of public and private information from their many different directly and indirectly connected relationships and information exchanges at any given point of time (see also Tomkins, 2001).[63] Instead of assuming complete invisibility prior to the introduction of OBA, it might accordingly be more adequate to regard (in)visibility as a relative concept that depends on the network position of the specific actor and is constantly (re-)negotiated, i.e. increased and decreased, with the help of OBA. The study highlights in this context that even supposedly "public" prices might be subject to active hiding. "Public" prices for individual spare parts are problematized in the study as they stand in contrast to selling capital equipment based on minimum long-term cost as a new point of comparison. While being required to assign economic value to individual maintenance-related transactions, their comparative function is accordingly consciously challenged. The importance of the network position becomes also clearly visible in the empirical study. Based on its findings, we might speculate that IASPs have seen a lot of "public" information being provided on spare parts and documentation material that they could exploit. Before IASPs grew in size and extended their offers more aggressively, the same visibility might not have been experienced by Contractor. It remained also highly invisible to Heavy Machinery before it created its Service division and conducted quantitative market analyses based on vehicle status and LCC information. Furthermore, it might also be argued that the different means implemented by Heavy Machinery can be seen as targeted to changing different actor-dependent rather than "general" visibilities. We will return to this point below.

[63] Some studies have observed how increased visibility in one relationship leads to a better understanding of indirectly related relationships. Agndal and Nilsson (2010) and Alenius et al. (2015) observe for example how retailers use OBA information from manufacturers of white-label products. Based on the received information, they receive also better insights in the costs of branded products. These studies share, however, still initial invisibility / access to price information only as the point of departure in their focal relationships.

8.3.3 Embeddedness of information exchanges

Another highly related reason might be found in that prior research has empirically mostly focused on how network embeddedness leads to the expansion of individual focal information exchanges over time. Studies observed for example how additional participants are recruited from the same (Dekker and van Goor, 2000, Kajüter and Kulmala, 2005), competing (e.g. Cooper and Yoshikawa, 1994, Dekker, 2003) and complimentary supply chains (Alenius et al., 2015) and additional data items are exchanged accordingly. While integration might be one way of relating previously distinct information exchanges, it suggests a suppression of conflicts that form a natural part of business networks (see e.g. Håkansson and Snehota, 1995, Dubois et al., 2004). The observed active hiding might accordingly be seen as a symptom of prior research having paid inadequate attention to the question of how firms "embed" their information exchanges with other, already existing and conflicting information exchanges and thereby aim to improve their own network position.

Conflicting information exchanges in business networks

As part of the study, we could observe actors with differing agendas that provide conflicting information in the interface. While Heavy Machinery and Contractor focus on long-term equipment costs, including indirect purchasing cost, other actors promote a competing logic of direct purchasing costs of specific spare parts. Component suppliers attempt to secure their aftermarket sales and accordingly consciously "smuggle" certain identifiers past Heavy Machinery. In addition, IASPs proactively identify individual parts and discover and produce non-genuine copies that they market based on the component suppliers' and equipment manufacturers' article numbers. We could also observe competing equipment manufacturers, which compete based on long-term cost and apply similar spare part pricing logics. The price of specific parts might nevertheless differ occasionally and create conflicts. Moreover, we can observe that the focal information exchange between Heavy Machinery and Contractor also needs to be carefully related to already existing information exchanges Heavy Machinery entertains with competing contractors and site-owners.

Different ways of embedding information exchanges

Active hiding might be seen as one of four ways in which Heavy Machinery relates its "new" focal information exchange to these already existing information exchanges (Table 26, page 280). A deeper analyses reveals that Heavy Machinery *hides* specific pieces of information from Contractor and IASPs, its own suppliers and its internal units. Heavy Machinery co-operates for example with component suppliers and alternative suppliers of subcomponents to lock article numbers and provide unique, branded components. As the related information becomes private to the information exchange with its suppliers, it becomes unavailable to Contractor and IASPs. In a similar manner, Heavy Machinery repacks parts that are not marked physically to deceive Contractor and IASPs about their "real" identity. Interestingly, Heavy Machinery withdraws also information from its own suppliers by drawing on internal distribution and further limiting local purchasing. With the exception of Supplier X, suppliers receive accordingly no information on the location of Heavy Machinery's customers, their product requirements and business volumes.

In addition, we can observe the hiding of sensitive commercial and technical information from certain business units on the intra-firm level. Similarly, sensitive information collected from Contractor is made unavailable to key account managers supporting other customers.

Another way of relating can be found in Heavy Machinery's attempt to make information that it cannot hide alone or with business partners *irrelevant*. An example is the provision of spare parts as kits. Parts that Contractor and IASPs might be able to identify based on the information found on them or their packaging are combined with parts they cannot purchase elsewhere or copy that easily. Moreover, additional advantages in terms of logistics and service efficiency and effectiveness are promoted together with these kits that Contractor might forego if it purchased parts individually. Accordingly, the information provided on specific items becomes, at least from the perspective of Contractor, some other customers and IASPs, irrelevant. Comparisons with the maintenance-related products offered by other equipment manufacturers becomes also more difficult as the content of kits might differ.

Table 26 Four ways of relating information exchanges to each other

1. Hiding information - Co-operations with existing suppliers on locking article numbers and providing unique designs - Co-operations with alternative suppliers on providing branded subcomponents - Repacking of otherwise unmarked spare parts - Internal distribution and limited local purchasing - Hiding internal and external information from business units
2. Making "public" information irrelevant - Providing individual spare parts as kits
3. Adapting the incentives of others connected to the provision and use of conflicting information - Patenting - Limited standardisation of frequently exchanged parts - Increase in number of product releases - Manual destruction of discarded excess stock - One Stop Shop
4. Collection of additional information that provides information advantage - Vehicle status information and its combination with Life Cycle Cost calculations

A third way of relating can be found in Heavy Machinery's activities to reduce the *incentives* of specific actors connected to the copying of its internally designed parts. As Heavy Machinery for example increases patenting efforts, limits standardisation and increases the number of product releases, imitation of these parts becomes less interesting for IASPs. The manual destruction of discarded excess stock by recycling companies removes also possibilities for IASPs to buy certain parts cheaper. The incentives of Contractor and other customers to engage in sourcing from other sources is also reduced by these efforts. They benefit also from Heavy Machinery's One Stop Shop, which offers lower indirect purchasing costs and lower opportunity costs as parts are directly available.

A final way of relating can be found in Heavy Machinery's attempt to *create an information advantage* over maintenance-related competitors by exchanging additional information with Contractor, to which these other actors naturally have no access. As Heavy Machinery collects information on the status of Contractor's vehicles and combines them with internal LCC models, it can proactively contact Contractor and sell maintenance-related products before Contractor even realised a need for them and can ask competing actors for quotes. In addition, Heavy Machinery can become more efficient and effective by proactively planning spare part and facility resource needs. Moreover, based on the exchanged information, Heavy Machinery works together with Contractor on detecting and reducing deviations from cost models and reducing costs further. As these advantages cannot be provided by its maintenance-related competitors in the same manner and are of high value to Contractor, its dependence on Heavy Machinery increases.

Synthesis

The empirical observation that firms appear not only provide, but also actively hide information from each other can accordingly be connected to broader theoretical and empirical concerns. The study highlights (in)visibility not as a definite, but a situated concept that depends on the position of the specific actor in the business network and is constantly renegotiated. In addition, it highlights four specific ways in which actors might relate their focal information exchanges to other, already existing information exchanges in business networks and thereby impact other actors' visibility.

These findings have broader methodological implications. Future research might for example be advised to take the "invisibility" of certain information not as given, but to provide an account of how it comes about and is stabilised in business networks. As OBA concerns the provision of some information and the simultaneous hiding of other information, this might result in more symmetric descriptions of OBA. Moreover, we might need to expand our understanding of who constitutes a participant in OBA. As it seems, it is important to research all major directly and indirectly connected actors in an interface, not just those that actively provide and receive information. Furthermore, it appears important to pay more attention to how individual focal information exchanges are related to each other and how "new" forms of OBA become embedded in networks in which other kinds of information already fluctuate.

Chapter 9

Summary and Future Research

The aim of this chapter is to summarise the theoretical and practical contributions of the study and to provide recommendation for future research on Open Book Accounting (OBA). The chapter follows accordingly a threefold structure.

9.1 Theoretical contributions

9.1.1 Open Book Accounting in capital equipment sales

The main objective of this study has been to understand the design and use of OBA in capital equipment sales and how it differs from earlier studied forms. Capital equipment sales differs from earlier studied buyer-supplier interfaces in that resource interdependencies not only arise during the product development and manufacturing of the equipment, but also during its use and maintenance over extended periods (see e.g. Burt et al., 2010, Hofmann et al., 2012). Spare parts, labour and supplementary products (e.g. training, machine inspections) are for example required to conduct preventive and corrective maintenance. Their provision builds on maintenance workshops, component repair centres and global and regional distribution centres and warehouses. They require also tight coordination between different business units of the buyer and supplier to avoid high opportunity costs that result from scheduled repairs and unexpected breakdowns. In addition, substantial maintenance-related interdependence exists with indirectly connected business partners, such as other customers, competing equipment manufacturers and different kinds of component suppliers and Independent Aftermarket Service Providers (IASP).

A simultaneously more restrictive and more comprehensive design of Open Book Accounting

The study has shown how these particular resource interdependencies shape the design and use of OBA in the studied interface. The specific characteristics become particularly visible when the results of the study are compared with earlier studies of "traditional" translation interfaces in which no maintenance-related interdependencies have been observed and discussed (Cooper and Slagmulder, 1999a, 2004, Agndal and Nilsson, 2008, 2009, 2010). The observed design might for example be characterised as more restrictive with regard to some aspects and more comprehensive with regard to some other aspects. Despite the existence of a high number of actors in the interface, a more limited set of participants is for example involved in OBA. Only the equipment manufacturer, its customer and the supplier of one major component, Component X, for which the equipment manufacturer does not provide maintenance-related support itself, are involved in the exchange. While the exclusion of competing suppliers and buyers has also been noted in earlier studied translation interfaces (see in particular Cooper and Slagmulder, 1999a, 2004), the conscious, proactive exclusion of component suppliers and IASPs is particularly notable. Following their own distinct interests, these actors might destabilise the focal information exchange with conflicting information on the qualities and pricing of maintenance-related resources. Component suppliers and IASPs are accordingly not only disinvited from the focal OBA exchange; the equipment manufacturer implements even a long list of means that reduce their ability to develop potential parallel relationships with its customers.

Maintenance-related interdependencies necessitate also the exchange of different data items between the equipment manufacturer, its customer and the supplier of Component X. Compared to earlier studied translation interfaces (e.g. Agndal and Nilsson, 2008, 2009, 2010), the studied equipment manufacturer restricts for example access to commercial information beyond price information that is required to assign a monetary value to the many hundreds of maintenance-related exchange episodes that take place over the life cycle of individual machines. It also restricts the access to technical information beyond that required during the use and maintenance of the equipment (operations and maintenance manuals, spare part books). At the same time, it provides additional information on spare part-related Life Cycle Cost (LCC) and expected opportunity and labour cost (service interval lengths, machine availability, ease of serviceability). Besides the provision of information on upcoming projects and machine demands, the studied customer provides the equipment manufacturer also primarily with different maintenance-related data items. Examples are information on the current status of its vehicles and experienced LCC. The equipment manufacturer provides the supplier of Component X with the name and geographical location of customers which have the component implemented in their machines and, accordingly, likely require maintenance-related support. It might also escalate particular maintenance-related problems its customers experience and that have not been resolved in a satisfactory manner directly between its customer and component supplier. The buyer and component supplier, in turn, directly exchange information on the use of the component, lead time and commercial price information for spare parts, replacement components and labour.

Coordination of primarily maintenance-related interdependencies

The study highlighted also the different attention directing and decision facilitating uses of OBA information in the interface. Compared to earlier studied translation interfaces (Cooper and Slagmulder, 1999a, 2004, Agndal and Nilsson, 2008, 2009, 2010), less focus appears to be placed on *jointly* managing interdependencies related to product development and manufacturing. These matters are accordingly mostly dealt with *internally* by the equipment manufacturer. The OBA information provides here an important lens through which particular design related decisions might be analysed. They are for example not only analysed in terms of their implications for performance and production cost, but also increasingly in terms of their influence on long-term maintenance-related costs. In comparison to earlier studied translation interfaces, OBA is also not drawn upon to motivate price changes as a consequence of fluctuations in input costs, exchange rates, volumes and efficiency improvements or to proactively manage potential supply disruptions in product development and production (Cooper and Slagmulder, 1999a, 2004, Agndal and Nilsson, 2008, 2009, 2010).

Instead, the information directs primarily attention to and facilitates decision making with regard to maintenance-related resources in the interface. In the relationship between the manufacturer and buyer of capital equipment, the OBA information draws for example attention to the machines' long-term cost, potential deviations from theoretical, specifically adapted LCC calculations and the need to improve LCC calculations and reduce maintenance-related costs further over time. We could also observe how the equipment manufacturer directs more attention to investments into and the coordination of different maintenance-related resources. These include maintenance-related sales and marketing resources, component repair centres and logistics facilities. In addition, attention is directed to considering the launch of specific maintenance-related products, such as upgrade kits and plug and play kits. Moreover, the information exchange directs the attention of the studied equipment manufacturer to certain aspects of its relationships with its indirectly connected major component suppliers. With regard to a first group of major component suppliers, it for example directs attention to the potentially excessive pricing of subcomponents. With a second group, it directs attention to the coordination of component repairs. With a third group, it directs attention to the pricing of replacement components, different perceptions of opportunity costs and the need to tightly coordinate maintenance-related work.

The observed differences in the design and use of OBA might be explained by the high importance of maintenance-related costs and the self-interest of the involved actors. Maintenance-related costs outweigh for example initial machine costs by far and are connected to higher degrees of uncertainty. The active, joint management of these costs is accordingly emphasised in the interface. Moreover, the manufacturer's interest to charge value-based premium prices might be seen as limiting the possibility to disclose more detailed commercial and technical information and to discuss joint adaptations in product development and manufacturing.

9.1.2 Open Book Accounting and the intra-organisational level

The study has also contributed with new knowledge on the way through which information is exchanged in capital equipment sales. In line with prior findings in other interfaces (Cooper and Slagmulder, 1999a, Caglio and Ditillo, 2012), we could observe that most data items are not exchanged automatically through interlinked information systems, but manually between individual business units of the participating firms. Furthermore, four groups of business units of the equipment manufacturer could be distinguished that are directly and indirectly involved in these manual information exchanges, the specific pieces of information these have access to and their use of those in the interface.

These specific findings have relevance beyond the context of capital equipment sales. First, the study is the first one to describe the intra-firm information design of one of the parties involved in OBA and to link it explicitly to the inter-firm OBA exchange. As such, it can confirm earlier speculations by other authors that firms might support OBA exchanges with business unit- and interface-specific information designs on their firm level (Tomkins, 2001, Caglio and Ditillo, 2012).

Second, the study highlights the involved complexities in providing business units with the required information. In particular, the study highlights that this does not only concern the provision of certain information to business units, as suggested by prior research (see e.g. Kajüter and Kulmala, 2005, Wouters et al., 2005, Fayard et al., 2012), but also the conscious, proactive hiding of other information from them. Customer-interfacing units appear for example only be provided with information they are expected to share with their counterparts in customer organisations in a next step. All other financial and technical information is consciously hidden from these units. The active hiding might be seen as a way to reduce behavioural uncertainty for the involved business units (Drake and Haka, 2008) and to clarify their internal and external roles. The study shows that accomplishing the desired visibility is a complicated undertaking, in particular as Enterprise Resource Planning (ERP) systems follow their own, in-built integration logics (Davenport, 1998, Quattrone and Hopper, 2005). Firms appear accordingly to draw on a patchwork of information systems and establish clear rules of data entry and access to support the access to business unit- and interface-specific information.

Third, the findings highlight also that prior research's focus on business units that are *directly* involved in information exchanges might be too restrictive (see e.g. Drake and Haka, 2008, Chang et al., 2013, Caglio and Ditillo, 2012). Limitations of access to information for directly involved units build for example on the possibility to escalate particular problems to *indirectly* connected units that have access to additional information. Directly and indirectly connected units appear to also use the information to make different kinds of prioritisations (Dent, 1987, Håkansson and Lind, 2004, Håkansson et al., 2010). Moreover, indirectly units fulfil an important role in the definition of the information that directly involved units can access and share with external business partners. If indirectly connected units are accordingly not provided with more attention in future studies, important elements of the design and use of OBA might be missed out.

9.1.3 Providing and hiding information in business networks

The observation that firms seem to not only provide a selective number of data items, but also *actively* hide other information as part of OBA has led us to two further insights of more general character. First, we might need to reconsider our understanding of OBA as a tool to increase visibility in settings in which complete invisibility otherwise pertains (see e.g. Gietzmann, 1996, Kulmala, 2002). From a network perspective, (in)visibility is never definite; it is always relative (Tomkins, 2001). It depends on the network position of the specific actor and thus all its relationships and information exchanges it is involved in. It is also dynamic as actors constantly (re-)negotiate their information exchanges and thereby also increase and decrease visibility for others. As changes in visibility are connected to changes in network position, conflicts naturally occur.

Second, the study has highlighted different ways in which business firms might relate a certain focal OBA information exchange to other information exchanges in the wider business network. According to the study's results, firms might actively hide information, turn "public" information into irrelevant one, change the incentives of other actors and collect additional information that help them to create informational advantages over other firms in the wider network. The study illustrates accordingly different ways in which firms might (re-)act upon potentially conflicting information spread by other firms that naturally nurture their own interests. By embedding their own information exchanges with already existing, potentially conflicting information, firms can stabilise their information exchanges and improve their own network position. These observations contrast accordingly also with prior literature that has mostly focused on the expansion/integration of information exchanges (e.g. Cooper and Yoshikawa, 1994, Kajüter and Kulmala, 2005, Alenius et al., 2015), which suggests a suppression of inherent conflicts.

9.2 Practical contributions

9.2.1 Managerial guidance for capital equipment manufacturers

The study's results are particularly relevant for capital equipment manufacturers who want to sell their equipment based on its long-term cost and improve the coordination of connected resources. An important conclusion from the empirical study is that such initiatives should not be confused as the mere provision of *additional* pieces of information on spare part-related Life Cycle Cost, labour cost and opportunity cost. It is most likely also connected to a simultaneously increased, proactive hiding of other technical and commercial information on both the intra- and inter-organisational levels. Such hiding might be seen as controversial, given general calls for increased transparency in society (see for example Lamming et al., 2004). Equally, the implementation of certain means to hide information, such as the differentiation rather than standardisation of frequently exchanged components and subcomponents, might run counter to normative guidance in the business literature focusing on other types of products and buyer-supplier interfaces. Proactivity is also emphasised as it is difficult to retract information once it is made available due to competition law and the longevity of the equipment and corresponding documentation material. In their implementation efforts, managers might accordingly benefit from the thesis as it provides some guidance on how one might think about visibility in capital equipment sales.

Another important conclusion from the study is that capital equipment manufacturers should focus on collecting and analysing machine status information and different kinds of feedback information from their customers. The information provides not only opportunities for reducing long-term costs together with customers. It also facilitates the development of an information advantage over aftermarket-focused competitors and enables a more efficient coordination of maintenance-related resources. As the information can accordingly be seen as the "life blood" of capital equipment providers and its accuracy is of high importance, managers might also want to consider its automatized transmission and/or implement other tools that facilitate its continuous collection and analysis. Moreover, managers might want to ensure that each of their business units receives access to relevant data and necessary tools to draw the most benefit out of the information. The study provides here detailed insights into how different business units might use available information for attention directing and decision facilitating purposes.

9.2.2 Managerial guidance for other buyer-supplier interfaces

Managers from other industry sectors might also benefit from the study's results, in particular from those concerning the embeddedness of information exchanges. An important conclusion of the study has been that the introduction of any "new" focal OBA exchanges might rather constitute an adaptation of already existing information designs on both the firm- and inter-firm level. Managers might accordingly be recommended to begin any OBA initiative with a thorough analysis of the already existing information in the interface. This includes a consideration of the information that is currently exchanged with the specific business partner, but also any parallel information exchanges the firm itself and its counterparts are involved in. It also requires an analysis of the access to information by business units that are directly and indirectly involved in these exchanges.

As current and desired visibility are compared with each other, required changes can be identified. Further internal organisational differentiation and a (re-)definition of data entry and access rules might for example be necessary to proactively accommodate business partners' concerns about the potential spread of their sensitive information and minimise reputational risks. Similarly, some earlier exchanged data items might need to be removed completely from future exchanges or should only be provided in less detailed forms. At the same time, some new data items might need to be provided. These demands might also require changes on the firm-level where the access to information for individual business units might need to be redefined and new information systems might need to be introduced. Based on the results of the present study, it appears for example advisable to provide units directly involved in the OBA exchange only with the information these might be expected to discuss with external counterparts over time, given the characteristics of the buyer-supplier interfaces these are involved in. At the same time, it appears important to limit their access to other commercial and technical information as this might otherwise introduce behavioural uncertainty and create goal conflicts. The access to more detailed information might instead be limited to indirectly connected units to which related questions might be escalated. Moreover, managers might need to consider how they want to (re-)act to information provided by other actors in the business network and that might conflict with the desired visibility. According to the study's result, this might stimulate additional co-operations with existing and new business partners as well as firm-level adaptations.

9.3 Future research

While the thesis has refined and expanded prior research on OBA, several lines for future enquiry remain. Scholars might for example continue researching maintenance-related interdependencies and their influence on the design and use of OBA in several ways. Due to resource constraints, this study had for example to be limited to the perspective of the capital equipment manufacturer and to translation interfaces. Accordingly, it might be interesting to study more explicitly the perspective of other actors, such as customers, component suppliers and IASPs, and, in particular, their firm-level designs and uses of OBA. Furthermore, following the observation of Burt et al. (2010) that capital equipment might also be exchanged via other buyer-supplier interfaces than translation interfaces, research might be expanded to those. How does the presence of additional maintenance-related interdependencies transform the design and use of OBA in these interfaces? Given the observations made in this study, this appears an important empirical question.

More research might also be warranted on the intra-organisational support of OBA. While this thesis has outlined some elements of the intra-organisational design and use in capital equipment sales via translation interfaces, future research might study the intra-organisational support in other interfaces. Based on the observations made in this study, it appears advisable to not only focus on those business units that are directly involved in the OBA exchange, but also on those that form indirectly part of it. As this research might naturally touch upon formal information systems, one might also expect some research bridging the so far separate literatures of OBA and management accounting and Enterprise Resource Planning systems (see for example Dechow et al., 2007a, Dechow et al., 2007b, Granlund, 2011).

Finally, it appears useful to pay more explicit attention to how different distinct information exchanges are related to each other in business networks. The study has outlined four ways in which firms might relate their information exchange to conflicting parallel information exchanges of their counterparts. Other ways of relating might, however, naturally exist.

Appendix 1

List of studies included in the literature review

The literature review builds on 25 individual empirical studies reported in 17 publications. A list of the individual studies and the resource interface they fall under is provided below.

A1.1 Standardised interfaces

Publication	**Case(s)**
Dekker and van Goor (2000)	Dutch pharmaceutical network (manufacturer – wholesaler – retailer)
Dekker (2003)	Sainsbury
Kulmala (2004)	Case 3
Agndal and Nilsson (2010)	ReTailer
Kumra et al. (2012)	Nirmaan Construction Co.
Romano and Formentini (2012)	Cases B

A1.2 Specified interfaces

Publication	Case(s)
Munday (1992)	Plastic moulding industry (survey study)
Cooper and Yoshikawa (1994) Cooper and Slagmulder (1999a, 2004)	Tokyo-Yokohama-Kamakura supply chain and indirectly connected actors
Seal et al. (1999)	European supply chain between an assembler of subcomponents and one of its suppliers
Mouritsen et al. (2001)	LeanTech
Kulmala (2004)	Case 1
Kajüter and Kulmala (2005)	Eurocar network
Agndal and Nilsson (2009)	Relationship one
Caglio and Ditillo (2012)	Knitwear division of luxury fashion company and all directly connected suppliers
Kumra et al. (2012)	Yantra Tractor Co.
Romano and Formentini (2012)	Cases A
Alenius et al. (2015)	Food Store – Meat Pack – Meat Raw supply chain and indirectly connected actors

A1.3 Translation interfaces

Publication	Case(s)
Cooper and Slagmulder (1999a, 1999b, 2004)	Komatsu - Toyo Radiator (before the interface changed to an interactive one, see below)
Agndal and Nilsson (2008)	CarMaker – AutoParts relationship
Agndal and Nilsson (2009)	Relationship three
Agndal and Nilsson (2010)	VehicleMaker, TeleCom
Kumra et al. (2012)	Vigyaan IT Ltd

A1.4 Interactive interfaces

Publication	Case(s)
Cooper and Slagmulder (1999a, 1999b, 2004)	Komatsu - Toyo Radiator (after the interface changed to an interactive one)
Agndal and Nilsson (2009)	Relationship two

Appendix 2

List of interviews and observations

A2.1 Access negotiations with note-taking

#	Date	Function, title	Organisa-tional Unit[64]	Length hh:mm:ss	P/T [65]	Rec.66
1	2012-03-19	General Manager/Former strategic purchasing manager Purchasing Manager Indirect	Final	1:45:00	P	N
2	2012-04-12	General Manager/Former strategic purchasing manager	Final	2:00:00	P	N

A2.2 Semi-structured interviews

#	Date	Function, title	Organisa-tional Unit	Length hh:mm:ss	P/T	Rec.
1	2012-06-18	Production Manager	Core	1:23:02	P	Y
2	2012-06-18	Business Controller	Final, Core before	1:00	P	N

[64] If not stated otherwise, the interviewee belonged to a "global" unit. In contrast, interviewees that are part of the local country sales organisation in the Asia/Pacific region are marked as "SalesOrg".

[65] P=Personal interview in person, usual in a meeting room or the office of the interviewee; T=interview conducted over the phone, usual due to geographic distance

[66] Recording (and verbatim transcription), Y=Yes, N=No

3	2012-06-18	Strategic Purchaser, core product	Core	1:53:47	P	Y
4	2012-07-18	VP Strategic Purchasing	Service	1:22:13	P	Y
5	2012-08-15	Supply Chain Manager	Core	1:49:06	P	Y
6	2012-11-26	Strategic Purchaser, core product	Core	2:22:34	P	Y
7	2012-11-26	Product Portfolio Manager	Core	1:58:04	P	Y
8	2012-11-26	VP R&D, core product	Core	1:45:34	P	Y
9	2012-11-27	Strategic Purchasing Manager	Final	1:43:13	P	Y
10	2012-11-27	Purchasing Manager Indirect	Final	1:35:37	P	Y
11	2013-02-20	Tactical Purchaser	Core	1:43:00	P	Y
12	2013-02-28	Strategic Purchaser, core product	Core	1:30:53	P	Y
13	2013-02-28	Business Application Manager, Strategic Purchasing	Final	2:11:39	P	Y
14	2013-02-28	Tactical Purchaser	Core	0:22:33	P	Y
15	2013-03-13	General Manager	Final	1:51:33	P	Y
16	2013-06-12	Engineer	Core	1:57:50	P	Y
17	2014-02-25	Strategic Purchasing Manager	Service	2:18:05	P	Y
18	2014-03-27	VP Finance	Core	2:03:46	P	Y
19	2014-03-31	VP Human Resources	Core	1:56:06	P	Y
20	2014-03-31	Strategic Purchaser, core product	Core	2:23:42	P	Y
21	2014-04-11	Business Application Manager Strategic Purchasing	Final	1:34:13	P	Y
22	2014-05-07	Technical Service Manager	Core	1:17:26	P	Y
23	2014-05-07	Engineer	Core	0:19:10	P	Y
24	2014-05-14	Product Portfolio Manager	Core	2:16:01	P	Y
25	2014-05-19	Strategic Purchasing Manager, electronic control systems	Core	2:23:06	P	Y
26	2014-05-20	Strategic Purchaser, ERP roll-out responsible for purchasing	Service	2:00:52	P	Y
27	2014-05-21	Strategic Purchaser, Hydraulics	Final	2:30:26	P	Y
28	2014-05-21	Market Analyst	Service	2:39:59	P	Y
29	2014-06-04	Project Manager	Core	1:39:32	P	Y
30	2014-06-05	Project Manager, Purchasing Department	Final	1:37:03	P	Y
31	2014-06-05	Product Manager, responsible for core component	Service	0:59:31	P	Y
32	2014-06-16	Strategic Purchaser, core product	Core	2:02:16	P	Y
33	2014-06-16	Business Controller	Final, Core before	2:00:00	P	N
34	2014-06-17	Project Manager New Development Projects, Purchasing Department	Final	1:04:14	P	Y

35	2014-06-17	Strategic Purchaser, Hydraulics	Service	1:29:24	P	Y
36	2014-06-18	R&D Manager, Hydraulics	Final	2:42:37	P	Y
37	2014-08-04	Global Engineering Manager, plus 2 engineers for parts of the interview	Service	3:02:27	P	Y
38	2014-08-05	Service Agreement Manager	Service	2:30:09	P	Y
39	2014-08-05	Project Manager New Product Development	Service	1:54:41	P	Y
40	2014-08-15	VP Finance	Service	2:18:20	P	Y
41	2014-08-25	2 interviewees (present during whole interview): Global Product Portfolio Manager, Portfolio Manager Service Products	Service	1:40:19	P	Y
42	2014-08-25	3 Product Portfolio Managers (present during whole interview)	Service	1:36:10	P	Y
43	2014-08-25	Product Specialist, Fluids	Service	0:13:41	P	Y
44	2014-08-26	Strategic Purchaser, Standard Components	Service	1:36:13	P	Y
45	2014-08-27	Global Business Manager	Final	1:55:02	P	Y
46	2014-08-27	Product Specialist, Fluids	Service	1:29:55	P	Y
47	2014-09-02	VP R&D, core product	Core	0:54:52	T	Y
48	2014-09-24	Global Lead Buyer Fluid Management Solutions	Service	1:24:00	P	Y
49	2015-02-04	Global Supply Chain Development Manager	Service	2:23:27	P	Y
50	2015-02-04	Regional Business Manager, responsible for Asia/Pacific	Final	2:28:13	P	Y
51	2015-02-05	Global Technical Service Manager, responsible for Final's products	Service	1:36:08	P	Y
52	2015-02-05	National Marketing Manager	SalesOrg, Service	0:26:10	P	Y
53	2015-02-05	VP Marketing	Service	1:32:31	P	Y
54	2015-02-06	Product Line Manager	Final	1:26:32	P	Y
55	2015-02-10	Strategic Purchaser, Hydraulics	Final	2:24:24	P	Y
56	2015-02-12	Product Manager Service Products	Service	0:48:46	P	Y
57	2015-04-20	Commercial Manager	SalesOrg, Service	1:40:07	P	Y
58	2015-04-20	National Business Development Manager	SalesOrg, Service	2:13:12	P	Y
59	2015-04-21	Strategic Purchasing Manager	SalesOrg, Service	3:09:57	P	Y
60	2015-04-22	Key account manager, responsible for Contractor	SalesOrg	1:42:05	P	Y

61	2015-04-22	Pricing Manager Spare Parts & Services	SalesOrg, Service	0:56:23	P	Y
62	2015-04-23	Product Manager	SalesOrg, Final	1:30:00	P	N
63	2015-04-23	Product manager, responsible for core component	SalesOrg, Service	2:20:27	P	Y
64	2015-04-23	Product manager	SalesOrg, Service	1:40:41	P	Y
65	2015-04-24	National Marketing Manager	SalesOrg, Service	1:12:03	P	Y
66	2015-04-24	Key account manager, responsible for Contractor	SalesOrg	0:56:09	P	Y
67	2015-04-28	National Service Manager	SalesOrg, Service	1:51:41	P	Y
68	2015-04-28	Product Manager, responsible for Final's products	SalesOrg, Service	0:38:39	P	Y
69	2015-05-15	Business Line Manager	SalesOrg, Final	1:45:23	T	Y
70	2015-05-18	Logistics Manager	SalesOrg, Service	1:54:00	P	Y
71	2015-05-18	National Supply Operations Manager	SalesOrg, Service	2:13:00	P	Y
72	2015-05-18	Senior Management Accountant	SalesOrg, Service	1:14:15	P	Y
73	2015-10-28	Business Line Manager	SalesOrg, Service	1:46:46	T	Y
74	2015-11-02	2 interviewees: Regional sales manager/Key account manager, Regional service sales manager	SalesOrg, Final/ Service	1:51:27	T	Y
75	2015-11-04	Strategic Purchaser, Vehicle components	Final	2:10:16	P	Y
76	2015-11-04	Global Fleet Manager	Service	1:51:51	P	Y
77	2015-11-05	Strategic Purchaser, Hydraulics	Final	0:26:20	T	Y
Total interview length				**132:34:49**		
Average interview length				**1:43:19**		
Number of phone/personal interviews				**5/72**		

A2.3 Observations

#	Date	Length hh:mm	Business unit / division	Type of meeting
1	2012-03-19	0:30	Final, Core	Short production tour through Final's facilities
2	2012-06-18	0:30	Core	Production tour through Core's facilities
3	2014-05-05	0:30	Core	Daily production pulse meeting, core components
4	2014-05-05	0:15	Core	Weekly coordination meeting on product care projects in R&D
5	2014-05-05	0:15	Core	Bi-weekly R&D project meeting on progress of R&D project A
6	2014-05-05	0:15	Core	Daily pulse meeting of product portfolio managers
7	2014-05-05	0:45	Core	Monthly meeting for employees working with core components
8	2014-05-05	0:45	Core	Monthly division meeting
9	2014-05-05	1:00	Core	Management meeting, core component business
10	2014-05-06	0:15	Core	Daily production pulse meeting, core components
11	2014-05-06	0:15	Core	Bi-weekly pulse meeting on progress of R&D project B
12	2014-05-06	0:30	Core	Bi-weekly R&D project meeting on planned product tests of R&D project C
13	2014-05-06	1:30	Final	Weekly strategic purchasing department meeting
14	2014-05-07	0:30	Core	Coordination meeting between production and purchasing
15	2014-05-08	6:00	Final, Service, other product divisions	Meeting of strategic purchasing council for the commodity "hydraulics"
16	2014-05-09	0:30	Core	Product quality meeting; discussion of recent warranty claims and feedback from sales organisations around the world, prioritisation for future product care projects
17	2014-05-09	0:30	Core	Meeting on inventory reduction project
18	2014-05-09	0:15	Core	Coordination meeting on release of newly developed product to serial production
19	2014-04-22	8:00	Final	Internship day with fitters at assembly workstation, among others discussion of different vehicles, their modules and components, extended factory tour and small chats with fitters at different other work stations
20	2015-04-22	1:15	SalesOrg (Service and Final), Contractor	"Vehicle audit" and discussion of availability of maintenance-related resources

21	2015-04-22	1:30	SalesOrg	Guided tour at regional distribution centre
22	2015-04-24	2:00	SalesOrg (Service and Final), Contractor	Monthly "customer health meeting"
Total length		**25:15**		

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