Inter-organisational asset management: linking an operational and a strategic view

Antti Ylä-Kujala*, Salla Marttonen, Timo Kärri and Tiina Sinkkonen

School of Business and Management,
Lappeenranta University of Technology, Finland
Email: antti.yla-kujala@lut.fi
Email: salla.marttonen@lut.fi
Email: timo.karri@lut.fi
Email: tiina.sinkkonen@lut.fi
*Corresponding author

David Baglee

Department of Computing, Engineering and Technology,
University of Sunderland,
Sunderland, UK
Email: david.baglee@sunderland.ac.uk

Abstract: Interconnections and interdependencies are increasing globally. The formation of inter-organisational relationships is a result of the wide-ranging phenomenon of networking. When traditional organisational boundaries are blurred, many challenges arise in coordination and management. They can, however, be addressed by emphasising inter-organisational cost and asset management, a concept novel to the literature. We also claim that companies are able to realise concrete benefits from such joint actions, especially in the long-term. The main objective of the paper is to demonstrate the benefits of inter-organisational asset management on the operational and strategic level with our asset management models. Two focal conclusions emerge. Firstly, we exemplify, and prove, that companies can create economic value collaboratively on either, the operational or the strategic level. Secondly, the cause-and-effect relationship between operational decisions and strategic outcomes is highlighted by integrating the two levels of inter-organisational asset management. Managerial implications can be drawn from both.

Keywords: inter-organisational asset management; IOAM; operational asset management; strategic asset management; industrial maintenance; networks; value creation; economic value; modelling; inter-organisational cost management; IOCM; open-book accounting.

Reference to this paper should be made as follows: Ylä-Kujala, A., Marttonen, S., Kärri, T., Sinkkonen, T. and Baglee, D. (2016) 'Inter-organisational asset management: linking an operational and a strategic view', *Int. J. Process Management and Benchmarking*, Vol. 6, No. 3, pp.366–385.

Biographical notes: Antti Ylä-Kujala is a doctoral student in the School of Business and Management at Lappeenranta University of Technology, Finland. He received his MSc (Tech.) in 2014, and currently, he is working in the research team of capital, capacity and cost management (C3M). His various research interests include accounting in networks, joint asset management, open-book accounting as well as the implementation of inter-organisational methods, models and tools.

Salla Marttonen is a Postdoctoral Researcher and a Project Manager at the School of Business and Management, Lappeenranta University of Technology, Finland. She received her DSc (Tech.) in 2013. Her dissertation addressed flexible asset management in industrial maintenance. She works in the research team of capital, capacity and cost management (C3M). Her research interests include value, costs and profitability of maintenance and asset management in companies and company networks.

Timo Kärri is a Professor at the School of Business and Management, Lappeenranta University of Technology, Finland. He received his DSc (Tech.) in Industrial Management in 2007. His dissertation considered timing of capacity changes in capital intensive industries and his current research interests include capital, capacity and cost management.

Tiina Sinkkonen is a University Lecturer at the School of Business and Management of Lappeenranta University of Technology, Finland. She has been teaching cost management and currently, she is doing her doctoral dissertation. Her research interests are focused on maintenance cost models and life-cycle costing.

David Baglee gained his PhD from the University of Sunderland in 2005. He is a Senior Lecturer and Project Manager at the University of Sunderland, UK and Visiting Professor in Operations and Maintenance at the University of Luleå, Sweden. His research interests include the use of advanced maintenance techniques and technologies to support small businesses and maintenance within ultra-low carbon technologies including wind turbines, electric vehicles and hydrogen fuel cells.

1 Introduction

We live in a globalised society that is highly interconnected and interdependent both physically and virtually via the ever-growing internet, and industrial organisations are no exception to the rule. Fierce global competition in most traditional industries has forced companies to concentrate more on their core competencies and thus collaborate with other organisations, which has ultimately led to the formation of complex business networks (e.g., Shalij et al. 2009; Meira et al. 2010; Caglio and Ditillo 2012). There are several ways to establish an inter-organisational relationship between two legally independent companies, outsourcing of internal activities being a predominant one. In practice, most moderately sized organisations have nowadays outsourced at least one of their activities to an external service provider. Clearly, a burden of someone else is a core competence to others, and thus the literal basis of their existence. For instance, the entire maintenance service industry has originated from the willingness of industrial manufacturers to outsource (e.g., Campbell, 1995; Martin, 1997; Levery, 1998; Al-Turki,

2011) the maintenance of fixed assets, e.g., plants and machinery. Moreover, industrial maintenance is just a small part of a greater framework called asset management that incorporates a variety of asset-related tasks and decisions within an organisation, or alternatively in the inter-organisational interface (e.g., Ahonen et al., 2010). That being said, industrial maintenance is contextually the operating environment in this paper, and asset management is the factual subject.

The continuous increase in inter-organisational relationships and networking will eventually blur organisational boundaries (Håkansson and Lind, 2004), which naturally, but unfortunately, easily creates confusion and conflicts between the collaborating partners. Yet, the economic success of these companies may depend greatly on enhancing network coordination and joint management, and thus overcoming anything and everything that hinders collaboration is essential. The grown demand for inter-organisational transparency and openness of formerly internal, and sensitive data are arguably eminent topics in the area, and also potential sources for the above-mentioned disagreements. The method for disclosing multifaceted cost data and other information from one company to another is known as open-book accounting (e.g., Seal et al. 1999; Kajüter and Kulmala 2005; Kumra et al., 2012). Particularly small companies are wary of data misuse and abuse conducted by their larger and more powerful partners, who could opportunistically monopolise also the benefits offered by the openness (Windolph and Möller, 2012). However, a certain level of transparency is a prerequisite for inter-organisational cost management (IOCM), which has been emphasised as an important tool in improving coordination and management in networked environments (e.g., Axelsson et al., 2002; Coad and Cullen, 2006; Fayard et al., 2012). We argue that companies are able to create tangible value by implementing open-book accounting as a part of inter organisational cost management in their business networks. At the same time, it is also important that the benefits are shared equitably, not necessarily equally, between the companies. Even though organisations are rather interdependent these days, the sharing of data and information is not often reality.

All things considered, we claim that networked companies should acknowledge, for the sake of mutual competitiveness, the significant value creation potential that is currently 'hidden' in the inter-organisational interface. Especially in long-term relationships, companies could, and should, pay attention to joint asset management besides the more evident forms of cost collaboration in purchasing and value chain operations. *The main objective of the paper* is, therefore, demonstrating the benefits of joint, inter-organisational asset management (IOAM) to companies in the spirit of open-book accounting. *Objective-wise*, value creation is exemplified from the operational perspective (physical asset-level maintenance) and strategic perspective (balance sheet-level asset positioning) in the industrial maintenance context. Our research questions can be phrased as follows…

- What is meant by the concept 'IOAM'?
- How can value be created collaboratively with operational and strategic asset management?

Furthermore, as the methodology, a case study is used to find answers to our topical questions. The study is not, however, only retrospective as we also plan the future in an optimistic way via scenario creation, with simple mathematical modelling as the medium. Our case setting takes place in an industrial maintenance network that is comprised of a maintenance customer that has decided to outsource the maintenance of its physical assets, and of a maintenance service provider that delivers the maintenance service for the mentioned customer. Even though an ideal network would also include an equipment provider that could be both the manufacturer of the physical assets and a service provider, we have simplified the network configuration slightly for practical reasons. Moreover, data collection has been conducted in two predominant streams. Firstly, in order to demonstrate the operational asset management of a company and its network, we have gathered production-related data and actual maintenance costs from years 2010 to 2013 from an industrial partner. Secondly, in order to emphasise the strategic asset management of a company and its network, we have studied the financial statements and other relevant balance sheet information of our case companies from a three-year period (2010 to 2012). Unlike in the case above, 2013 was excluded from the analysis because the data from that specific financial year was still unavailable at the time of data collection. Moreover, each future scenario is based on existing data.

2 Towards IOAM

As a concept, Håkansson and Ford (2002) describe a network as a structure where a number of nodes are related to each other by specific threads. When the definition is linked to the organisational context, the nodes represent individual business units, whether manufacturing or service companies, and their reciprocal relationships are the threads. As Håkansson and Snehota (2006) have phrased it, 'no business is an island'. Based on their argument and the above definition of a network, it can be argued that the industries around the world form a massive meta-network of interconnected and somewhat interdependent units. However, there are certain relational archetypes, i.e., distinct inter-organisational settings, which can be used to categorise and manage the complex network phenomenon in practice. Lind and Thrane (2010) have identified four typical sub-settings that are generally used to outline vertical networks, i.e., ones that consist of companies operating at different steps of a value chain. The first archetype, and by far the most common setting in the network literature, is a single dyadic relationship taking place between two legally independent companies. According to Lind and Thrane (2010), the other three settings are serial relationships in a chain (i.e., a company, a customer and a supplier), several counterparts in one direction (i.e., a company and several suppliers or customers), and multiple counterparts in two directions (i.e., a company and multiple suppliers and customers). Each one of the archetypes can be labelled as an inter-organisational relationship, but can they also be referred to as networks? In this paper, any structure that exceeds intra-organisational boundaries belongs to the network phenomenon, and thus a dyadic relationship is called a network as well.

As the perspective is in general clearly shifting from the traditional intra-organisational level towards the more complex inter-organisational level, the focus in both management and decision-making should follow accordingly. The blurring of organisational boundaries has created a need for inter-organisational performance measurement (e.g., Sahu et al., 2013) and IOCM, the main purpose of which is to achieve joint cost reductions and create additional value (e.g., Cooper and Slagmulder, 2004; Kulmala, 2004; Coad and Cullen, 2006; Agndal and Nilsson, 2009). According to Agndal and Nilsson (2009), IOCM is very often described as a collection of methods and techniques which are neither designed nor targeted for mere inter-organisational purposes. They include for instance target costing, cost tables/disclosed cost data and activity-based costing (Axelsson et al., 2002), and they are typically employed in some way or another to improve dyadic inter-organisational coordination of purchasing and value chain operations in the present cost accounting and management literature. There are numerous empirical case studies where a company and its supplier(s) have implemented at least one IOCM technique in the above-mentioned context (e.g., Mouritsen et al., 2001; Kulmala et al., 2002; Agndal and Nilsson, 2008; Free, 2008; Suomala et al., 2010; Romano and Formentini, 2012; Kumra et al., 2012). The nature of such customer-supplier relationship, and the purchasing strategy of the customer in particular, can be either transactional or relational (Axelsson et al., 2002; Agndal and Nilsson, 2010). Particular features of transactional, classical purchasing are a low degree of commitment and focus on the company's own benefits, whereas a high degree of commitment and focus on joint benefits are emphasised in relational, modern purchasing. Therefore, the success of most IOCM methods and techniques rely more or less on companies' willingness to build and maintain long-term relationships patiently by incorporating relational aspects in their collaboration. As an addition to the current IOCM tools, we claim that networked companies should pay attention, especially in the long-term relationships, to IOAM. It can be seen to comprise operational and strategic levels, which both feature and require divergent management methods, models and tools for controlling the physical and non-physical, current and non-current assets of a network. IOAM is an integral part of the more extensive 'IOCM-umbrella'.

Coad and Cullen (2006) point out that information sharing is a central concept in IOCM. Openness and transparency in information is often called open-book accounting, otherwise OBA (e.g., Kulmala, 2002; Seal et al., 2004; Windolph and Möller, 2012). For instance, Kajüter and Kulmala (2005) describe open-book accounting both as a means for improving the cost efficiency of a supply chain and as a trust-building tool for networks. Mouritsen et al. (2001) even refer to OBA as a novel supply chain strategy that influences the flow of products and services. If the techniques of IOCM are mainly similar with the intra-organisational alternative, as argued above, the need for disclosing information from an organisation to another with 'open books' is representative solely for IOCM, and also its potential weakness. Kajüter and Kulmala (2005) highlight that cost data is usually one of the most sensitive pieces of information in companies, and revealing such data is problematic due to fear of misuse. Suppliers with a weaker negotiation status in relation to their larger customers might especially feel that OBA is implemented in order to apply pressure on profit margins, which further has a negative effect on supplier satisfaction (Windolph and Möller, 2012). Because information openness is often an initial requirement for any IOCM practice to take place between two collaborating companies, opportunistic behaviour should be avoided and the trust-building dimension of OBA underlined instead. Lack of information transparency is one of the biggest barriers that hinder efficient management of inter-organisational relationships and business networks. As IOAM is particularly suitable for relational, long-term collaboration and value creation through this coordination, the significance of openness and mutual trust should be highlighted.

3 Operational view to value creation in asset management

The international standard ISO 55000 (2014) outlines asset management as "coordinated activity of an organization to realize value from assets". Further, according to the same standard, an asset can be defined as "item, thing or entity that has potential or actual value to an organization", and thus the value of an asset can clearly be tangible or intangible, financial or non-financial. However, we concentrate here on asset management of tangible, physical assets and their tangible, economic value. Hastings (2010) has applied, based on the traditional balance sheet itemisation, a so-called accountant's view to delineate a definition for physical assets. According to Hastings, they are physical items such as land, plant, buildings, machinery and vehicles, which are also typically known as fixed or non-current assets. When the content of this section is verbalised in terms of the above ISO 55000 definition, our 'coordinated activity' is maintenance management, our 'organisation' is a Finnish manufacturing company, our way to 'realise value' is improving long-term maintenance planning and decision-making, and finally our 'asset' is a hand-picked production machine. In summary, we approach the subject matter, IOAM, in this section from an operational, 'grass roots' perspective.

3.1 How to improve maintenance planning and decision-making in a business network?

There is a great number of models and divergent techniques that can be used to improve planning and decision-making in the industrial maintenance context. The life-cycle model (LCM), which has been created particularly for long-term maintenance management, is our alternative option. It can even be utilised by multiple companies at the network level. The LCM was presented for the first time in a paper of Kivimäki et al. (2013), where its basic structure had already taken shape, its fundamental operating logic had been fixed, and the first model version also tested in a real-life case setting. Kivimäki et al. (2013) describe the model as being suitable for item-level (i.e., asset-level) decision-making, monitoring realised costs and profits from the past and forecasting the future. Instead of forecasting something uncertain and unseen, we will rather emphasise the phrasing 'planning the future', as the realisation of any plausible future scenario is dependent on realistic organisational goal-setting and follow-up.

Despite the many merits of the first version, we returned to 'the drawing board' and improved the model further based on the feedback from our industrial partners in cooperation. An enhanced version, called 'The LCM for maintenance service management', was introduced by Sinkkonen et al. (2014). In this paper, the completed structure of the model and also its updated operating logic are illustrated explicitly, formula by formula. Although the model is designed to be suitable for varied industrial environments and conditions, we do not try to present a universal, turnkey-type solution for maintenance planning and decision-making. The LCM is a maintenance management approach and a tool for establishing tangible, economic value out of a company's physical assets. However, incorporating the network perspective, which acknowledges a maintenance customer, a maintenance service provider and an equipment provider all together, makes it truly unique. Despite the organisational boundaries in question, world-class performance in operational asset management, such as industrial maintenance, can be achieved only through systematic planning and coordination (Mishra, 2014).

The LCM is based on the present value method, which denotes that all asset-related cash flows, whether cost or profit items, are discounted (i.e., appreciated) annually to their present day values. Therefore, the main results of our model are formed from discounted values, and due to the adopted life-cycle perspective, especially on cumulative basis. There are two distinct key figures; *cumulative net present value* (*CNPV*) and *benefit-cost ratio* (*B/C-ratio*). As stated in (1), *CNPV* is comprised of the sum of discounted cumulative cost savings (CPV_S) and discounted cumulative maintenance-related profits (CPV_{MRPL}) reduced with discounted cumulative costs (CPV_C). The profits, or alternatively losses, in the CPV_{MRPL} are basically annual changes in maintenance customer's (a network context) or asset owner's (a company context) loss of production. Unlike the *B/C-ratio*, which is somewhat parallel to typical performance measurement metrics, the *CNPV* expresses a monetary net value for maintenance.

$$CNPV = CPV_S + CPV_{MRPL} - CPV_C \tag{1}$$

where

CNPV cumulative net present value

CPV_S cumulative present value of cost savings

CPV_{MRPL} cumulative present value of maintenance-related profits (or losses)

CPV_C cumulative present value of costs.

Moreover, the three above-mentioned components of CNPV can be further reduced to smaller subcomponents. As shown in (2), the cumulative present value of costs (CPV_C), for example, is calculated in such a way that maintenance costs are first discounted year by year and then added up over the whole life-cycle. The other two, the CPV_S and CPV_{MRPL}, are naturally formulated in a similar way. At this point, it is not practical or reasonable to describe the logic of the LCM in closer detail. An extensive illustration about the structure of the model can be found in Appendix.

$$CPV_C = \sum_{n=1}^{k} \left(\frac{1}{(1+i)^n} \cdot C_{n,total} \right) \tag{2}$$

where

CPV_C cumulative present value of costs

$C_{n,total}$ annual maintenance costs.

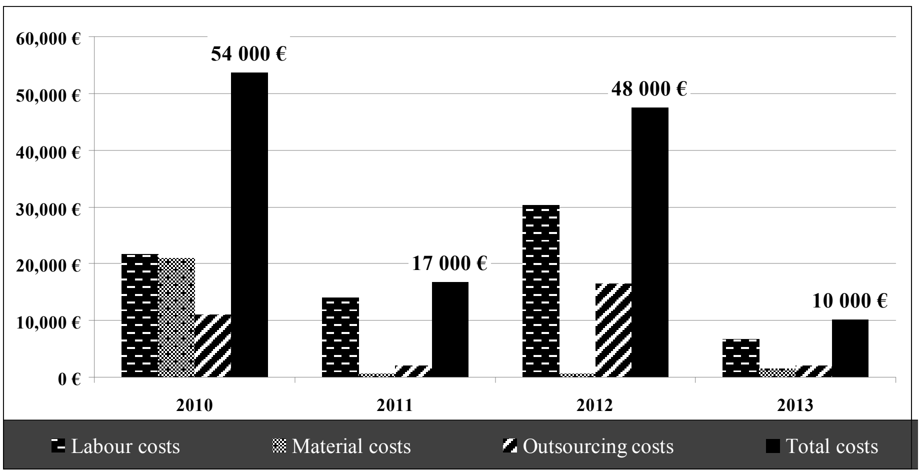
It is important to understand the characteristics of the *CNPV* because it is recognised as a synonym for created economic, life-cycle value in the model. As the *CNPV* is a net figure by nature, and is expressed in an unambiguous monetary unit (Euro), it symbolises the created economic value quite aptly. All things considered, and as an answer to the topic's question, we claim that maintenance planning and decision-making can be improved, in a network or a company, with our model by paying attention to the value of the *CNPV* over a given period of time.

3.2 Exemplifying the creation of economic value with long-term maintenance management

Our case company, Company A, is a Finnish manufacturing organisation of several distinct bulk products that have a variety of diverse industrial and other professional applications worldwide. We have chosen, in collaboration with Company A, to study both the past and planned maintenance of a certain piece of production machinery that is essential in the processing of their raw materials. Even though Company A has occasionally used external workforce in the past to maintain the above-mentioned machine, they have recently (approximately since 2010) outsourced its maintenance to one notably smaller local service provider, Company B. These two companies form a maintenance network, the asset-level maintenance costs and profits of which can be studied, allocated, planned and monitored with the LCM. In order to make things simpler, all references to Company A's production machine will be made as 'the asset' from now on.

A maintenance cost breakdown of a four-year time period (2010 to 2013) is presented in Figure 1, where the annual total costs are divided to internal labour, internal material, and external outsourcing, which comprise Company A's payments to Company B for provided maintenance services. As can be seen, there is substantial variation in annual cost levels, and besides that, the overall trend has been slightly downward as well. It seems that the years 2010 and 2012, as well as the years 2011 and 2013 have been maintenance-wise similar to each other. In 2010 and 2012, a number of larger and more expensive service operations have been conducted to the asset. Therefore, two conclusions that we can use as guidelines in planning future maintenance can be drawn. The level of maintenance total costs regarding the asset varies biennially, and it has a declining trend. In addition to the costs, we also require adjunct data and information related to the production and manufactured product to be able to determine a value for the CNPV. However, Company A was not willing to disclose any product-related data, i.e., *unit production costs* and *profit margin ratio*, so they had to be estimated. The former was evaluated to be around 50 € per ton, and the latter was set to 35%. Both are kept constant over our designated life-cycle.

Figure 1 Total and itemised maintenance costs of the asset from 2010 to 2013



Contrary to product-related data, the required production-related data was received, and some of the most crucial numbers are shown in Table 1. We use 6,240 hours per year as the value for theoretical *maximum operating time*, which means that Company A is capable of manufacturing the product five days a week and three shifts a day under ideal conditions. Therefore, the annual production quantity of 200,000 ton results in *average production speed* around 32 ton per a theoretical operating hour. These two figures are fixed over the life-cycle as well. Furthermore, *asset utilisation rate* and *total maintenance rate* are figures that portion Company A's annual operating time, e.g., the asset manufactured the product 73.5% of the time in 2010, and 9.6% of the time it was maintained. On the other hand, the *run-time maintenance rate* is not a portion of the maximum operating time, but rather a part of the *total maintenance rate*. In 2010, for instance, only 2.5% of all maintenance work to the asset was conducted during ongoing manufacturing. The *run-time maintenance rate* has a significant impact on the results, the *CNPV* in particular, as it does not increase loss of production.

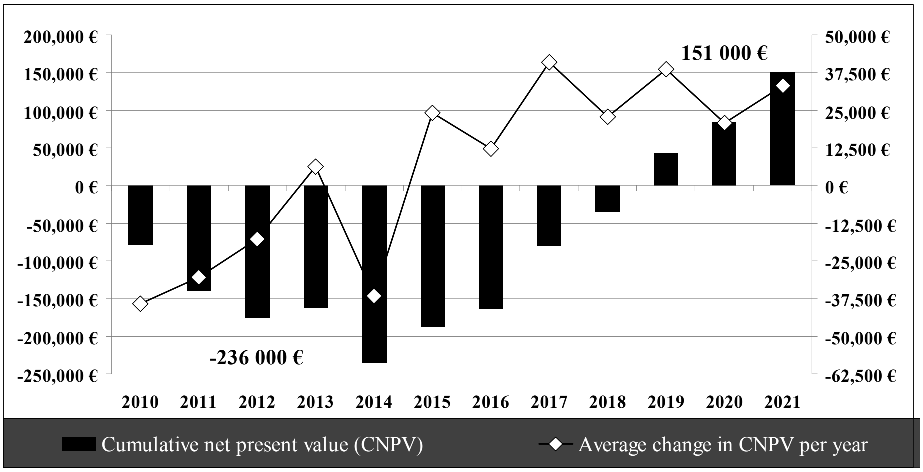
Table 1 Production-related data regarding the asset from 2010 to 2013

Production-related information	*2010*	*2011*	*2012*	*2013*
Theoretical maximum operating time	6,240 h/a	6,240 h/a	6,240 h/a	6,240 h/a
Average production speed	32 ton/h	32 ton/h	32 ton/h	32 ton/h
Asset utilisation rate (of max. op. time)	73.5%	75.9%	76.3%	77.8%
Total maintenance rate (of max. op. time)	9.6%	12.4%	10.7%	10.9%
Run-time maintenance rate (of total maint.)	2.5%	2.6%	10.3%	5.1%

So far, we have discussed past data that was received from Company A. In order to be able to quantify the economic value of the asset over its whole life-cycle, we need to plan the future by generating a realistic scenario, and for that, a worthy logic is required about the changes in the operations and maintenance of the asset. We present a 12-year life cycle (2010 to 2021), which includes five history years and seven planning years. Because the year 2014, which is considered here as a history year, was still under way when the data was acquisitioned, its values are based on average annual changes in the known data. From that point onwards, we have created a plan about how individual factors, such as *outsourcing costs*, *asset utilisation rate* or *total maintenance rate*, will vary in the future. For example, the last one is designed to drop 15% annually during the first two scenario years, and then this drop will decrease gradually first to 10% per year, and further to 5%, as there will be less and less room for additional intensifications. Moreover, our cost estimates have been established in such a way that the biennial cost variations and the declining overall trend are both properly considered. It should also be noted that Company B's increasing contribution in joint maintenance management is taken strongly into account.

Once the data had been collected and completed with our scenario approach, we were able to calculate the *CNPV* for the asset. As the *CNPV* is a cumulative figure, the model does not only define an end value for the life cycle, but a value for each year separately. The development of *CNPV* is illustrated in Figure 2, where 10% has been used as the interest rate for the discounting. In order to highlight the changes better, annual average is presented on the right axis as well. As can be seen, the *CNPV* is heavily negative throughout the beginning of the life cycle, where relatively high levels of costs dominate over the smaller profit items, i.e., cost savings and gains in loss of production. Cumulatively observed, the lowest point is the year 2014, the value of which is approximately –236,000 €. This is a result of two factors. On one hand, the production losses in that specific year are slightly elevated due to a higher *total maintenance rate* in comparison to the life-cycle average, and on the other hand, there is also notable build-up in maintenance costs from the preceding year, affecting the cost savings category.

Figure 2 The development of the CNPV



After the trough in the *CNPV* is realised in the end of 2014, the figure starts to improve year by year gradually, reaching ultimately a positive life-cycle end value around 151,000 €. The result is expected, as we planned a maintenance scenario for the asset that emphasised both operational improvements and cost intensifications. It has to be stated, however, that the magnitude of the figure is surprising. Just over seven years, Company A could benefit more than 385,000 € through small, gradual changes in the maintenance of the asset. The scenario is admittedly a little optimistic, because it is based on the presumption that the entire production can be sold annually. This has an eminent, negative or positive, impact on the calculated production losses, depending on the situation at hand.

As both the *unit production costs* and the *profit margin ratio* were estimated, we did a two-variable sensitivity analysis to reduce any uncertainty that might be related to these two factors in the *CNPV*. Minor changes were simulated separately and simultaneously, and the influences on the life-cycle end value of the *CNPV* are illustrated in Figure 3. As can be noticed, our estimates seem to have sensitivity to some extent, as the difference between the worst and the best alternative is over 500,000 €. However, concurrent 30%, positive or negative, change in both factors is a lot of sensitivity, and thus the reality lies probably somewhere in between. The changes on the negative side are not very dramatic, which indicates that the scenario is rather conservative than overly optimistic.

Figure 3 Two-variable sensitivity analysis on the CNPV

Unit production costs (€/ton)	Profit margin ratio (%)						
Change-%	- 30%, (24,5%)	- 20%, (28,0%)	- 10%, (31,5%)	**0%, (35,0%)**	+ 10%, (38,5%)	+ 20%, (42,0%)	+ 30%, (45,5%)
- 30%, (35€/ton)	-64 000 €	-34 000 €	-5 000 €	**24 000 €**	54 000 €	83 000 €	113 000 €
- 20%, (40€/ton)	-34 000 €	-1 000 €	33 000 €	**66 000 €**	100 000 €	134 000 €	167 000 €
- 10%, (45€/ton)	-5 000 €	33 000 €	71 000 €	**108 000 €**	146 000 €	184 000 €	222 000 €
0%, (50€/ton)	**24 000 €**	**66 000 €**	**108 000 €**	**151 000 €**	**193 000 €**	**235 000 €**	**277 000 €**
+ 10%, (55€/ton)	54 000 €	100 000 €	146 000 €	**193 000 €**	239 000 €	285 000 €	331 000 €
+ 20%, (60€/ton)	83 000 €	134 000 €	184 000 €	**235 000 €**	285 000 €	335 000 €	386 000 €
+ 30%, (65€/ton)	113 000 €	167 000 €	222 000 €	**277 000 €**	331 000 €	386 000 €	440 000 €

As a conclusion, it can be stated that companies are clearly able, when certain limitations are acknowledged, to realise considerable value from their physical production assets by improving maintenance planning and decision-making gradually in the long-term. Despite the fact that our example is presented solely from the perspective of a maintenance customer (Company A), service providers, such as Company B in this case, benefit from the collaboration as well. When joint actions are underlined in improving maintenance management, for instance the predictability of machine breakdowns and repairs evolves, which will reduce the service provider's costs and increase its profit margin. In order to 'balance the scales', the customer company could also distribute a certain portion of its economic value, e.g., through performance-related bonuses, as a sign of goodwill. As can be noticed, there is an immense number of different possibilities, the realism of which seem, however, to depend partly on the contractual circumstances between the companies as well. We are convinced that companies should focus increasingly on two things in operational, IOAM. Firstly, the emphasis in asset's maintenance management should be on longer time periods than previously, i.e., on life cycles. Secondly, all planning and decision-making regarding an important asset should be made together with network partners, which requires extensive inter-organisational openness and trust.

4 Strategic view to value creation in asset management

By concentrating on the strategic side, in this section, we move from the 'grass roots' to an 'eagle-eye' perspective to be able to study the subject matter, IOAM, on the top management level. Contrary to limiting the point of view to physical assets only, the scope of top management falls typically upon the entire organisation instead of a single asset, and thus a wide range of divergent industrial assets should be included. As remembered, the accountant's view by Hastings (2010) categorises different assets based on their balance sheet positioning. Physical assets, such as buildings and machinery, are referred to in the financial statement context as non-current assets. There are also faster moving items, i.e., current assets, on the balance sheet, which include cash, inventories (materials, work in progress, finished goods, etc.) and accounts receivables. Therefore, strategic asset management comprises both the non-current and the current assets. Yet again, in terms of the ISO 55000 definition for asset management, our 'coordinated activity' is strategic management, our 'organisation' is a network of Company A, our way to 'realise value' is increasing profitability with flexible asset management, and finally our 'asset' incorporates a variety of different assets.

4.1 How to increase inter-organisational profitability with flexible asset management?

There are two generally accepted ways to delineate the profitability of an organisation. A company's annual earnings can be proportioned either directly to its total sales or relatively to the capital invested. *Return on investment* (*ROI*) is a common option for determining a company's relative profitability. It is typically defined in the area of financial statement analysis as the ratio between *earnings before interest and tax* (*EBIT*) and the capital employed, which includes both equity and liabilities with an interest. However, we have taken another approach to defining *ROI*, true with the asset management perspective, where the assets are highlighted instead of equity and liabilities, as shown in (3). This new type of formula, called the flexible asset management model (FAM), has been previously presented by Marttonen et al. (2013a, 2013b). So far, it has been used mainly in illustrating flexible working capital management under different conditions, but the FAM can be employed to manage 'an asset portfolio' of a network as Marttonen et al. (forthcoming) also demonstrate. While working capital is undeniably an important part of a company's 'asset portfolio', the number of physical, fixed assets on the balance sheet can be controlled for strategic purposes, respectively. They have often a bigger impact on profitability as well.

$$ROI = \frac{EBITDA\% - \left(FA\% \cdot \frac{1}{B-1} \right)}{\frac{CCC}{365} + \frac{r}{365} + FA\%} \tag{3}$$

where

ROI return on investment

EBITDA% earnings before interest, tax, depreciation and amortisation/total sales

FA% fixed assets/total sales

B average depreciation period

CCC cash conversion cycle

r residual.

Similarly with the conventional *ROI* alternative, the company's earnings in the FAM are located in the numerator, and its assets, equivalent to equity and liabilities, are located in the denominator. As a consequence of using the *cash conversion cycle* (*CCC*) in the equation to measure the employment of working capital, the earnings (*EBITDA*%) and the fixed assets (*FA*%) have to be divided by the total sales. The *CCC* is comprised of the cycle times of inventories, accounts receivables and accounts payables. For example, the cycle time of inventories, i.e., the days that inventories are outstanding on average, is calculated in such a way that the amount of inventories is proportioned to total sales. The same analogy is suitable also for *residual* (*r*), which includes, by definition, the remainder of the company's working capital. Its components are the cycle times of other current assets and other current liabilities. All things considered, and as an answer to the topic's question, we claim that an organisation can improve the *ROI*, and thus its profitability, by managing its total assets, i.e., *FA*%, *CCC* and *r*, effectively and flexibly.

4.2 Exemplifying the creation of economic value by reorganising the assets on the network level

Our case network comprises Company A, which is a Finnish manufacturing organisation, and Company B, which provides the former with comprehensive maintenance services. In addition to their rather close operational collaboration in the field of industrial maintenance, Company A and Company B could, and should, pursue strategic joint benefits as well. We use the FAM to demonstrate how companies can create economic value with flexible, strategic asset management and act as a 'well-oiled unit' by adjusting the amount of their fixed assets and the *CCC*. Naturally, before making any further adjustments, we needed some data to be able to even determine the current values of *ROI*. Year-end financial statement information of Company A and Company B from the accounting periods 2010, 2011 and 2012 was used for the purpose. The information of year 2013 was not available yet at the time of data acquisition, and thus it has been excluded from the analysis.

Table 2 Current values of the components of the FAM model in the network

Component:	*Company A:*	*Company B:*	*Network:*
EBITDA%	10.0%	2.1%	9.8%
FA%	134.1%	4.1%	131.7%
B	24.5 d	4.0 d	24.4 d
CCC	59.9 d	70.3 d	130.2 d
r	–84.0 d	–12.5 d	–96.5 d
ROI	*3.4%*	*3.6%*	*3.0%*

The values for the different components of the FAM for the whole network and separately for each company are presented in Table 2. All figures of Company A and Company B have been calculated from the above-mentioned financial statement information as a three-year average in order to eliminate potential inconsistencies in the results, i.e., the effect of an exceptional year. Network-level numbers have been weighted proportionally, e.g., the *EBITDA*% of the network is the ratio between the total annual earnings of the two companies and their combined total sales. On the other hand, figures that illustrate cycle times on the network level, i.e., the *CCC* and *r*, are delineated simply by adding up the equivalent values of Company A and Company B. What should be said about the values then? Company A's *FA*% is one and a third times its annual total sales, which is an outstandingly high value. Moreover, the *CCC* can be reckoned fairly long in the case of both companies, which is also reflected in the unsatisfactory network-level figure. Their collective working capital does not cycle even three times a year, and thus there is lots of 'dead money' tied in organisational structures.

In the following strategic asset management scenario, we do not emphasise the maximisation of the benefits of an individual company, such as Company A, which has prospectively power-wise a 'dominating position' in the collaboration, but instead our true goal is to create dividend, network-level value. The sharing of joint benefits could be based on the organisations' informal agreements or even on written maintenance contracts. There are, however, some limitations. Firstly, we have assumed that the total sales and profit margins of Company A and Company B will remain constant, which denotes that their *EBITDA*%s stay unchanged as well. Secondly, the *residual* will be revised neither, because the accounting items included in the factor are most likely directly uncontrollable by the companies' mutual decisions. That being said, all our flexible asset management techniques are directed on either fixed assets, total inventories, accounts receivables (of the maintenance service provider, otherwise Company B) or accounts payables (of the customer, otherwise Company A).

Encouraged by positive past experiences of maintenance cooperation, Company A has agreed, together with Company B, to start concentrating on strategic asset management, which they believe would increase the competitiveness of the network. As the profitability of the relatively small Company B has been unbearably low for years, Company A has decided to take the ownership of all Company B's fixed assets and inventories. After all, those assets on its balance sheet have served the needs of Company A, which has for a long time been Company B's biggest customer by far. Additionally, the new-found strategic joint focus will also lead to major intensifications in the assets. By getting rid of evident 'asset overlap', the required total amounts of fixed assets and inventories are reduced, which means that Company A will have now less assets than before despite the reorganisation. Even further, in order to optimise the utilisation of assets, the two companies have decided to alter the terms of payment in their mutual transactions in such a way that the length of Company B's *CCC* will be shortened substantially.

Table 3 Adjusted values of the components of the FAM model in the network

Component:	*Company A:*	*Company B:*	*Network:*
EBITDA%	10.0%	2.1%	9.8%
FA%	127.5%	0.0%	125.1%
B	23.4 d	1.0 d	23.3 d
CCC	58.3 d	19.0 d	77.3 d
r	–84.0 d	–12.5 d	–96.5 d
ROI	*3.5%*	*39.6%*	*3.5%*

The impacts that our scenario has on the FAM and its components in the network of Company A and Company B are presented in Table 3. Company B's *FA*% goes naturally to zero after its fixed assets are reorganised completely to the balance sheet of Company A, the *FA*% of which is respectively dropped by almost seven percentage points due to the intensifications. As Company B is extremely small compared to Company A, the transferred fixed assets have little to no effect on the network-level *FA*%, which mainly follows Company A's figure. Furthermore, it can be immediately noticed that our flexible asset management manoeuvres also reduces the cycle times of working capital. The *CCC* of the entire network drops by nearly 53 days, a difference that is largely caused by Company B's diminished number. This is a result of two separate arrangements. In its *CCC*, Company B gains approximately 31 days by giving up all the inventories, and another 20 days come from altering the terms of payment between the two companies. The new terms induce an approximately 40% decrease in the year-end figure of accounts receivables, which is realistic, given Company A's predominant position in Company B's clientele. The *CCC* of Company A is also slightly reduced due to the intensification of its overall inventories. However, the new terms of payment expedite Company A's cycle time of accounts payables, which unfortunately revokes partly the benefits that are received from fewer inventories.

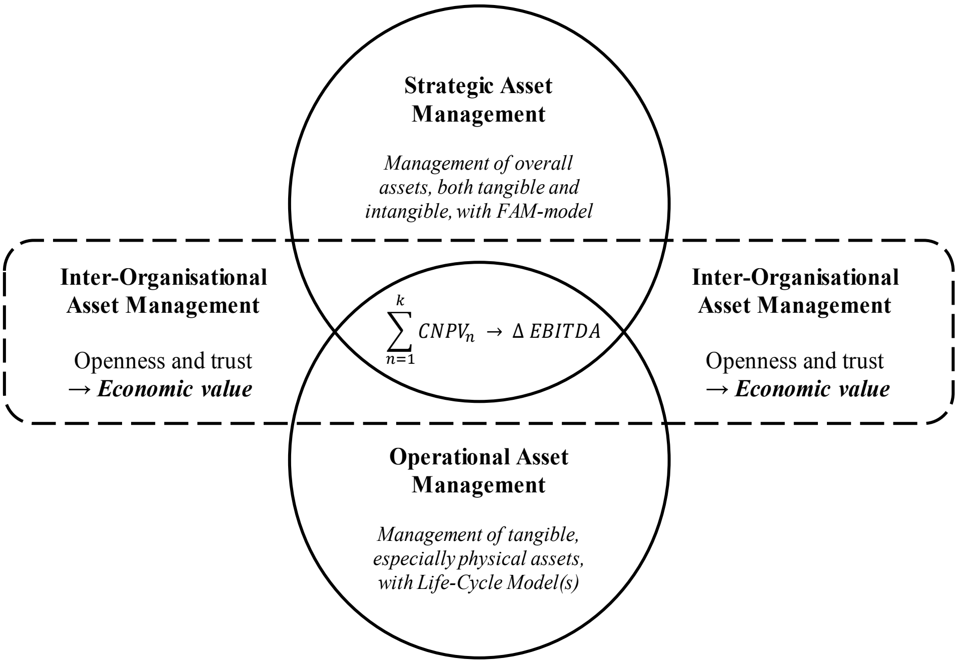
At first, it seems profitability-wise that Company B is the ultimate winner in our flexible asset management scenario, as its *ROI* has impressively jumped by 36 percentage points. These results should not be, however, surprising after we have alleviated Company B's balance sheet by removing its fixed assets and inventories. Naturally, the new terms of payment between the two companies help as well. The overall gain, on the contrary, is more moderate, as there is a half percentage point raise in the network-level *ROI*, which equals effectively the created economic value. That being said, the value that is now mainly realised for Company B should be shared in reality more equitably in order to Company A to become interested in such an arrangement at all. For instance, Company B could return the favour by offering cheaper maintenance services to its loyal customer. Company A's profit margin, and thus its *EBITDA*% and *ROI*, would increase due to the lower cost level as a result.

As a conclusion, it can be said that flexible asset management creates evidently strategic-level benefits for networked companies as a lighter asset structure equals higher profitability, i.e., economic value. Because we did not simulate any kind of growth in the companies' total sales or their profit margins by changing the numerator, the created value originates explicitly from a smaller amount of tied-up capital, which is released from both the fixed assets and the working capital. Therefore, the economic value that was established in our scenario should be perceived rather as proportional than absolute, as our actions did not have any impact on the financial performance of either Company A or Company B. Nevertheless, the elevated relative profitability of an organisation looks always better in the eyes of different stakeholders, such as investors, and the capital that was previously tied in the assets can also be invested somewhere else with higher rate of return expectations. However, an extensive reorganisation of assets between two legally independent companies may sometimes be problematic when there is a risk of a formation of a dominant market position, such as a monopoly. We claim that inter-organisational, strategic asset management is something that companies should be taking very seriously, especially if they are already collaborating on a long-term basis. 'Asset overlap' can be reduced by reorganising assets in a flexible way, which will improve the profitability of the network and the individual companies as well.

5 Discussion and conclusions

In today's world, no business is an island anymore, as companies are networking at an increasing pace and forming diverse inter-organisational relationships with each other. While a variety of formerly internal activities of a company, such as industrial maintenance and even asset management, have become something that should be emphasised in collaboration, the day-to-day practices of the industry still feature many difficulties. Despite the fact that even the most well-established business networks collaborate on a rather shallow basis, we claim that there are lots of hidden, unrealised benefits (i.e., value) in extensive network coordination and management. It can be even stated that the challenge is mainly educational due to intra-organisational resistance, a threshold that we would like to crack.

Figure 4 Linking of the operational and the strategic view in IOAM



In this paper, we have discussed IOAM, which can be recognised as an integral part of IOCM, an approach the two main purposes of which are finding joint cost reductions and creating network-level value. IOAM is comprised of two complementary perspectives, operational asset management and strategic asset management. So far, we have exemplified how companies are able to create economic value collaboratively on the operational level with our LCM and on the strategic level with our FAM. However, the linkage between the two models is still somewhat ambiguous. As illustrated in Figure 4, operational asset management (i.e., the LCM) and strategic asset management (i.e., the FAM) are connected through *CNPV* and *EBITDA*. When an organisation, such as Company A, utilises the LCM in the long-term maintenance management of an asset, it will create a certain amount of economic value in the pursuit of a maximal *CNPV* figure throughout the life cycle of the asset. Sooner or later, the created value that comprises cost savings and gains in loss of production is realised in the financial statement as well. There are basically three factors that have an effect on *EBITDA*; selling more products, getting a better profit margin or alleviating the cost structure. As can be noticed, actually two out of the three can be achieved, separately or simultaneously, with our LCM. If a company has implemented multiple LCMs in order to manage several critical production assets at the same time, then the sum of *CNPVs* leads to a change in *EBITDA*.

Two particularly important conclusions can be drawn from this paper. Firstly, we have demonstrated with two asset management models, the LCM and the FAM, that companies are able to create tangible, economic value together on the operational and the strategic level of asset management, especially when collaborating on a long-term basis. Our detailed introduction to the models and their hands-on utilisation provides lots of managerial insight and know-how. Secondly, the above-mentioned two dimensions, and thus also the two models, were integrated by introducing a novel concept called IOAM. By forming a linkage between our models as well as operational and strategic asset management in the wider context, IOAM can be seen as a comprehensive platform for both theoretical and practical purposes and further discussion. It also highlights the cause-and-effect relationship between operational decisions and strategic outcomes, which is a clear managerial implication as well. Even though the LCM and the FAM are just two examples of beneficial asset management tools, which can be seen as a limitation, they are still novel approaches in the field.

Lastly, future research directions are considered shortly. Evidently, our models still require additional testing in divergent industrial environments so that the results and the benefits of the models can be properly consolidated. Due to its nature as an operational model that incorporates a life-cycle perspective, the LCM should be implemented and tested in such a way that data is gathered for a longer period of time. This way the factors that influence the implementation process of an inter-organisational model could also be mapped in general. Additionally, we could study the linkage between operational and strategic asset management with our models by simulating their reciprocal behaviour in a real-life setting.

References

Agndal, H. and Nilsson, U. (2008) 'Supply chain decision-making supported by an open books policy', *International Journal of Production Economics*, Vol. 116, No. 1, pp.154–167.

Agndal, H. and Nilsson, U. (2009) 'Interorganizational cost management in the exchange process', *Management Accounting Research*, Vol. 20, No. 2, pp.85–101.

Agndal, H. and Nilsson, U. (2010) 'Different open book accounting practices for different purchasing strategies', *Management Accounting Research*, Vol. 21, No. 3, pp.147–166.

Ahonen, T., Reunanen, M., Pajari, O. and Ojanen, V. (2010) 'Maintenance communities – a new model for the networked delivery of maintenance services', *International Journal of Business Innovation and Research*, Vol. 4, No. 6, pp.560–583.

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

Axelsson, B., Laage-Hellman, J. and Nilsson, U. (2002) 'Modern management accounting for modern purchasing', *European Journal of Purchasing & Supply Management*, Vol. 8, No. 1, pp.53–62.

Caglio, A. and Ditillo, A. (2012) 'Opening the black box of management accounting information exchanges in buyer-supplier relationships', *Management Accounting Research*, Vol. 23, No. 2, pp.61–78.

Campbell, J. (1995) 'Outsourcing in maintenance management: a valid alternative to self-provision', *Journal of Quality in Maintenance Engineering*, Vol. 1, No. 3, pp.18–24.

Coad, A. and Cullen, J. (2006) 'Inter-organisational cost management: towards an evolutionary perspective', *Management Accounting Research*, Vol. 17, No. 4, pp.342–369.

Cooper, R. and Slagmulder, R. (2004) 'Interorganizational cost management and relational context', *Accounting, Organizations and Society*, Vol. 29, No. 1, pp.1–26.

Fayard, D., Lee, L., Leitch, R. and Kettinger, W. (2012) 'Effect of internal cost management, information systems integration, and absorptive capacity on inter-organizational cost management in supply chains', *Accounting, Organizations and Society*, Vol. 37, No. 3, pp.168–187.

Free, C. (2008) 'Walking the talk? Supply chain accounting and trust among UK supermarkets and suppliers', *Accounting, Organizations and Society*, Vol. 33, No. 6, pp.629–662.

Håkansson, H. and Ford, D. (2002) 'How should companies interact in business networks?', *Journal of Business Research*, Vol. 55, No. 2, pp.133–139.

Håkansson, H. and Lind, J. (2004) 'Accounting and network coordination', *Accounting, Organizations and Society*, Vol. 29, No. 1, pp.51–72.

Håkansson, H. and Snehota, I. (2006) 'No business is an island: the network concept of business strategy', *Scandinavian Journal of Management*, Vol. 22, No. 3, pp.256–270.

Hastings, N. (2010) *Physical Asset Management*, Springer, London, 370pp.

International Organization for Standardization (ISO) 55000 (2014) *Asset Management – Overview, Principles and Terminology*, 19pp.

Kajüter, P. and Kulmala, H. (2005) 'Open-book accounting in networks: potential achievements and reasons for failures', *Management Accounting Research*, Vol. 16, No. 2, pp.179–204.

Kivimäki, H., Sinkkonen, T., Marttonen, S. and Kärri, T. (2013) 'Creating a life-cycle model for industrial maintenance networks', *The 3rd International Conference on Maintenance Performance Measurement and Management*, Lappeenranta Finland, 12–13 September, pp.178–191.

Kulmala, H. (2002) 'Open-book accounting in networks', *The Finnish Journal of Business Economics*, Vol. 51, No. 2, pp.157–177.

Kulmala, H. (2004) 'Developing cost management in customer-supplier relationships: three case studies', *Journal of Purchasing and Supply Management*, Vol. 10, No. 2, pp.65–77.

Kulmala, H., Paranko, J. and Uusi-Rauva, E. (2002) 'The role of cost management in network relationships', *International Journal of Production Economics*, Vol. 79, No. 1, pp.33–43.

Kumra, R., Agndal, H. and Nilsson, U. (2012) 'Open book practices in buyer-supplier relationships in India', *Journal of Business and Industrial Marketing*, Vol. 27, No. 3, pp.196–210.

Levery, M. (1998) 'Outsourcing maintenance – a question of strategy', *Engineering Management Journal*, Vol. 8, No. 1, pp.34–40.

Lind, J. and Thrane, S. (2010) 'Towards accounting in network settings', in Håkansson, H., Kraus, K. and Lind, J. (Eds.): *Accounting in Networks*, p.368, Routledge, New York.

Martin, H. (1997) 'Contracting out maintenance and a plan for future research', *Journal of Quality in Maintenance Engineering*, Vol. 3, No. 2, pp.81–90.

Marttonen, S., Monto, S. and Kärri, T. (2013a) 'Profitable working capital management in industrial maintenance companies', *Journal of Quality in Maintenance Engineering*, Vol. 19, No. 4, pp.429–446.

Marttonen, S., Viskari, S. and Kärri, T. (2013b) 'Appeasing company owners through effective working capital management', *International Journal of Managerial and Financial Accounting*, Vol. 5, No. 1, pp.64–78.

Marttonen, S., Monto, S. and Kärri, T. (forthcoming) 'Enhancing collaboration in maintenance networks through flexible asset management', *International Journal of Strategic Engineering Asset Management*.

Meira, J., Kartalis, N., Tsamenyi, M. and Cullen, J. (2010) 'Management controls and inter-firm relationships: a review', *Journal of Accounting & Organizational Change*, Vol. 6, No. 1, pp.149–169.

Mishra, R. (2014) 'Structural modelling and analysis of world-class maintenance system: a graph theoretic approach', *International Journal of Process Management and Benchmarking*, Vol. 4, No. 1, pp.69–88.

Mouritsen, J., Hansen, A. and Hansen, C. (2001) 'Inter-organizational controls and organizational competencies: episodes around target cost management/functional analysis and open-book accounting', *Management Accounting Research*, Vol. 12, No. 2, pp.221–244.

Romano, P. and Formentini, M. (2012) 'Designing and implementing open book accounting in buyer-supplier dyads: a framework for supplier selection and motivation', *International Journal of Production Economics*, Vol. 137, No. 1, pp.68–83.

Sahu, S., Datta, S., Patel, S. and Mahapatra, S. (2013) 'Supply chain performance appraisement, benchmarking and decision-making: empirical study using grey theory and grey-MOORA', *International Journal of Process Management and Benchmarking*, Vol. 3, No. 3, pp.233–289.

Seal, W., Berry, A. and Cullen, J. (2004) 'Disembedding the supply chain: institutionalized reflexivity and inter-firm accounting', *Accounting, Organizations and Society*, Vol. 29, No. 1, pp.73–92.

Seal, W., Cullen, J., Dunlop, A., Berry, T. and Ahmed, M. (1999) 'Enacting a European supply chain: a case study on the role of management accounting', *Management Accounting Research*, Vol. 10, No. 3, pp.303–322.

Shalij, P., Devadasan, S. and Prabhushankar, G. (2009) 'Design of ISO 9001:2000 based supply chain quality management systems', *International Journal of Process Management and Benchmarking*, Vol. 3, No. 1, pp.1–23.

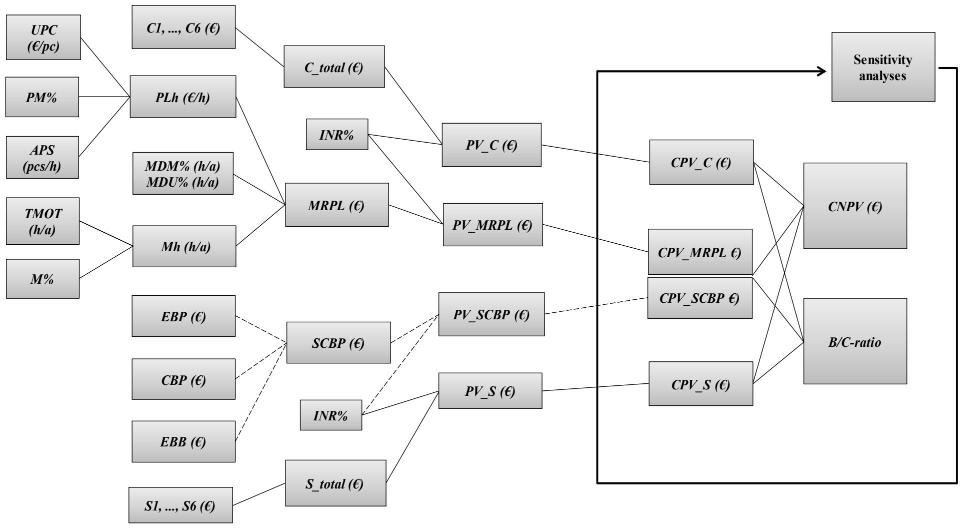
Sinkkonen, T., Ylä-Kujala, A., Marttonen, S. and Kärri, T. (2014) 'Better maintenance decision making in business networks with a LCC model', *The 4th International Conference on Maintenance Performance Measurement and Management*, Coimbra, Portugal, 4–5 September, pp.57–64.

Suomala, P., Lahikainen, T., Lyly-Yrjänäinen, J. and Paranko, J. (2010) 'Open book accounting in practice – exploring the faces of openness', *Qualitative Research in Accounting and Management*, Vol. 7, No. 1, pp.71–96.

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

Appendix

Figure A1 The structure and the logic of the LCM



Notes:

UPC unit production costs
PM% profit margin ratio
APS average production speed
PLh profit losses caused by one hour stoppage in production
TMOT theoretical maximum operating time
M% share of total maintenance (of max. operating time)
Mh annual maintenance hours in total
C1, …, C6 maintenance costs
MDM% share of maintenance performed during manufacturing (of total maint.)
MDU% share of maintenance performed during underutilisation (of total maint.)
EBP equipment sales-based profits
CBP contract-based profits
EBB equipment-based bonuses
S1, …, S6 maintenance cost savings
MRPL maintenance-related profit or loss (annual change in loss of production)
SCBP service or equipment provider’s annual total profits
INR% discount rate/interest rate
PV_C present value of maintenance total costs
PV_MRPL present value of maintenance-related profit or loss
PV_SCBP present value of service or equipment provider’s total profits
PV_S present value of maintenance total cost savings
CPV_C cumulative present value of maintenance total costs
CPV_MRPL cumulative present value of maintenance-related total profits or losses
CPV_SCBP cumulative present value of service or equipment provider’s total profits
CPV_S cumulative present value of maintenance total cost savings
CNPV cumulative net present value
B/C benefit-cost ratio.

Source: Adapted from Sinkkonen et al. (2014)