



RESEARCH REPORT 165

Esa Nopanen – Taina Piispa – Anita Lukka

VALUE ADDED LOGISTICS IN SUPPLY AND DEMAND CHAIN

COSTFIX

**NEW OPERATION MODEL FOR MAINTENANCE MATERIAL
LOGISTICS IN PAPER INDUSTRY**

**Department of Industrial Engineering and Management
Lappeenranta University of Technology
FIN-53851 Lappeenranta, Box 20, Finland**

**ISBN 952 – 214 – 089 - 9
ISBN 952 – 214 – 090 – 2 (pdf)
ISSN 1459 – 3173**

Lappeenranta 2005

ABSTRACT

Authors: Esa Nopanen, Taina Piispa, Anita Lukka

Title: New Operation Model for Maintenance Material Logistics in Paper Industry

Department: Department of Industrial Engineering and Management

Year: 2005

Place: Lappeenranta

Research report. Lappeenranta University of Technology.

49 pages, 16 figures, 10 tables.

Keywords: paper industry, material logistics, maintenance, outsourcing

This research report illustrates and examines new operation models for decreasing fixed costs and transforming them into variable costs in the field of paper industry. The report illustrates two cases – a new operation model for material logistics in maintenance and an examination of forklift truck fleet outsourcing solutions.

Conventional material logistics in maintenance operation is illustrated and some problems related to conventional operation are identified. A new operation model that solves some of these problems is presented including descriptions of procurement and service contracts and sources of added value.

Forklift truck fleet outsourcing solutions are examined by illustrating the responsibilities of a host company and a service provider both before and after outsourcing. The customer buys outsourcing services in order to improve its investment productivity. The mechanism of how these services affect the customer company's investment productivity is illustrated.

1 INTRODUCTION.....	4
1.1 BACKGROUND FOR THE RESEARCH.....	4
1.2 FOCUS OF THE COSTFIX PROJECT.....	4
2 SERVICES.....	6
2.1 DEFINITION OF SERVICE	6
2.2 SERVICES VS. GOODS.....	6
2.3 SERVICES RELATED TO FORKLIFT TRUCKS	9
2.4 LOGISTICS SERVICES	11
3 MAINTENANCE.....	13
3.1 DEFINITION OF MAINTENANCE	13
3.2 MAINTENANCE OUTSOURCING	14
3.3 OUTSOURCING OPTIONS FOR THE FORKLIFT TRUCK FLEET.....	16
4 MATERIAL LOGISTICS OF MAINTENANCE	18
4.1 MATERIAL LOGISTICS OF MAINTENANCE.....	18
4.2 METHOD FOR DESCRIBING THE CONTENTS OF A BUSINESS SERVICE ENTITY.....	19
5 CASE 1: MATERIAL LOGISTICS OPERATION MODEL	22
5.1 MATERIAL LOGISTICS OF THE MAINTENANCE OPERATION MODEL CURRENTLY IN USE.....	22
5.2 NEW OPERATIONAL MODEL FOR MATERIAL LOGISTICS OF MAINTENANCE.....	25
5.2.1 <i>Description of the new operational model</i>	25
5.2.2 <i>Information flows of the new operational model</i>	26
5.2.3 <i>Responsibilities in the new operational model</i>	28
5.3 MATERIAL DELIVERY VOLUMES OF THE CASE PAPER INDUSTRY COMPANY	30
5.4 SOURCES OF ADDED VALUE OF THE NEW OPERATIONAL MODEL	31
5.5 CONTENT OF THE SERVICE CONTRACT.....	32
5.6 CONTENT OF THE NEW PROCUREMENT CONTRACT	33
5.7 DIFFERENT SERVICE PRODUCTS OF MATERIAL LOGISTICS OF MAINTENANCE.....	34
6 CASE 2: FORKLIFT FLEET OUTSOURCING SOLUTIONS.....	35
6.1 INVESTMENT PRODUCTIVITY	35
6.2 MAINTENANCE OUTSOURCING	36

6.2.1 Maintenance outsourcing impacts on the material purchasing / sales process 41

6.2.2 Maintenance outsourcing impacts on the material transportation process 42

6.2.3 Maintenance outsourcing impacts on the information maintaining process 44

6.3 ASSETS MANAGEMENT OUTSOURCING..... 45

6.4 OUTSOURCING OF THE FORKLIFT TRUCK USE 48

7 CONCLUSIONS 51

REFERENCES

1 INTRODUCTION

1.1 Background for the research

The Costfix project is a part of the VALOSADE (Value Added Logistics of the Supply And Demand Chain) research program funded by TEKES (National Technology Agency of Finland). Operational research was carried out by the VALORE –research group at Lappeenranta University of Technology. Other research modules of the VALOSADE program are PIPELINE, EDYNET and SMILE.

In addition to TEKES, the companies that acted as project funders represented the following fields of industry:

- a paper industry company,
- a forklift truck manufacturer,
- two logistics service providers, and
- a maintenance service provider.

These companies were also the focus of the research activities and they also acted as information providers and partners in the research.

1.2 Focus of the COSTFIX project

The aim of the COSTFIX project was to research and find out new operation models for decreasing fixed costs and transferring them into variable costs in the field of paper industry. The research focus was on paper delivery logistics, a paper mill's internal transportation equipment (i.e. forklift trucks) and material logistics of maintenance. These focus areas are illustrated in figure 1.

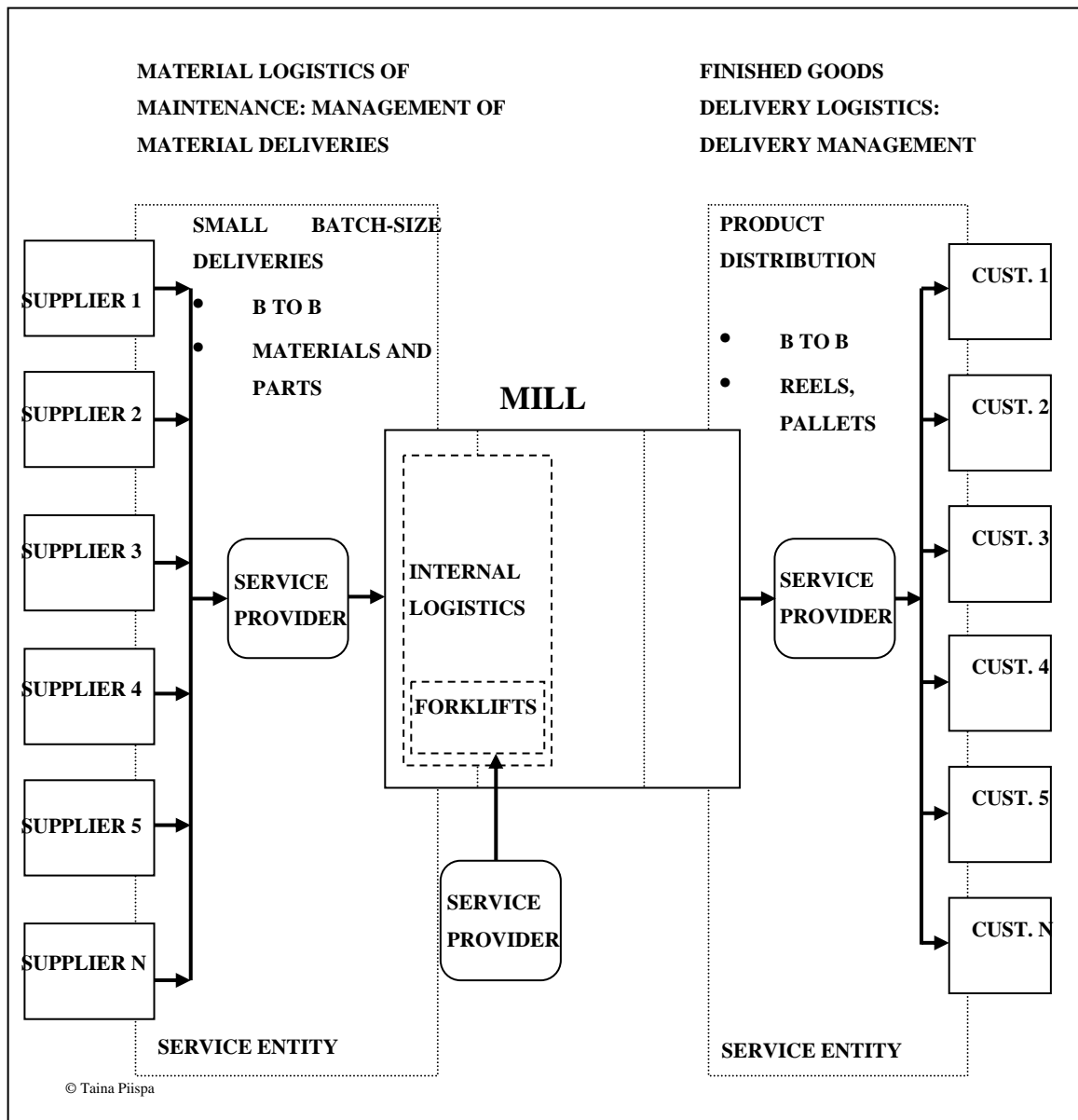


Figure 1. Focus areas of the COSTFIX research project.

This research report concentrates on the maintenance of the forklift truck fleet, assets management and operation outsourcing issues, and on material logistics of maintenance. Chapters 2-4 build a theoretical background for this research report by illustrating services and defining maintenance and the material logistics of maintenance. The empirical part consists of two cases. Case 1 illustrates a new operation model for material logistics of maintenance. Outsourcing issues of a forklift truck fleet are examined in case 2.

2 SERVICES

2.1 Definition of service

According to Grönroos (2001a) service is a process consisting of a series of more or less intangible activities that normally, but not necessarily always, take place in interaction between a customer and service employees and / or physical resources or goods and / or systems of a service provider, which are provided as solutions to the customer's problems.

Kotler (1997) defines service as “any act or performance that one party can offer to another that is essentially intangible and does not result in the ownership of anything. Its production may or may not be tied to a physical product.”

The most important characteristic of service is that it is an *interactive process*, not a physical thing. Other characteristics such as partly simultaneous production and consumption processes, and customer participation in the service production process can be derived from the process characteristic of a service. (Grönroos, 2001b)

As described in the above-mentioned definitions, consumption of a service is *process consumption* rather than physical product-related *outcome consumption* (Grönroos, 1998).

2.2 Services vs. goods

There are certain similarities between goods and services. According to Axelsson and Wynstra (2002), the most important similarities are:

- both services and goods should fulfill a need and have a function for the customer, and

- both services and goods should be competitive and provide value for the customer.

In addition to similarities, there are also fundamental differences between services and goods. Axelsson and Wynstra (2002) have adapted the following categorisation from Normann (1992):

Table 1. “Differences between goods and services” (Axelsson and Wynstra, 2002; adapted from Normann, 1992).

<u>Goods</u>	<u>Services</u>
- Tangible	- Intangible
- Can be demonstrated before the purchase	- More difficult to demonstrate (not available)
- Can be stored	- Cannot be stored
- Production occurs before consumption	- Production and consumption simultaneously
- Seller produces	- Buyer / customer takes part in production
- Production, sales and consumption on different locations	- Production, consumption and (often) sales on the same location
- Can be transported	- Cannot be transported (but the producer and the customer can move)

Basically if the source of the core benefit of a product can be considered more tangible than intangible, the product can be seen as a good. If the source of core benefit is more intangible than tangible, we are talking about a service (Berry & Parasuraman, 1991). Many products are mixtures of tangible and intangible elements, having both tangible and intangible features in certain proportions. Axelsson and Wynstra (2002) illustrate product offerings with a continuum where pure goods are at one end and pure services at the other:

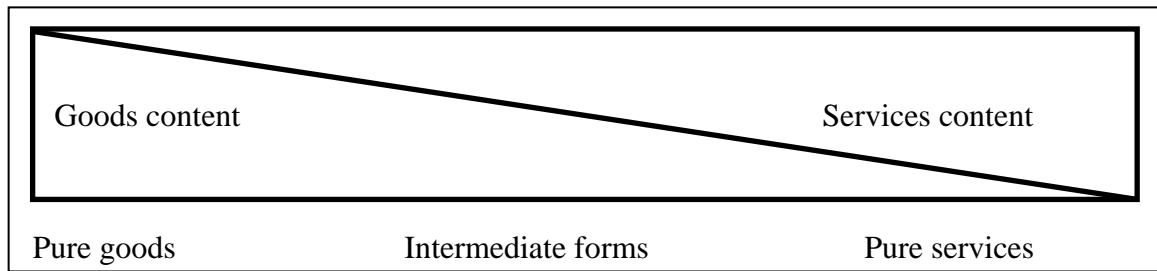


Figure 2. “Goods, services and intermediate forms” (Axelsson and Wynstra, 2002).

According to Axelsson and Wynstra (2002), a product is often defined as having different layers. These layers are *a core product*, *a basic product* and *an augmented product*. The nucleus – the core product - is the feature that a customer primarily buys. The middle layer – the basic product – defines the conditions under which the product is made accessible to a customer, such as the delivery method, guarantees and after-sales activities. The outer layer – the augmented product - consists of meta value that is associated with a brand or company name, but has no specific connections to the tangible product itself. These layers are depicted in figure 3.

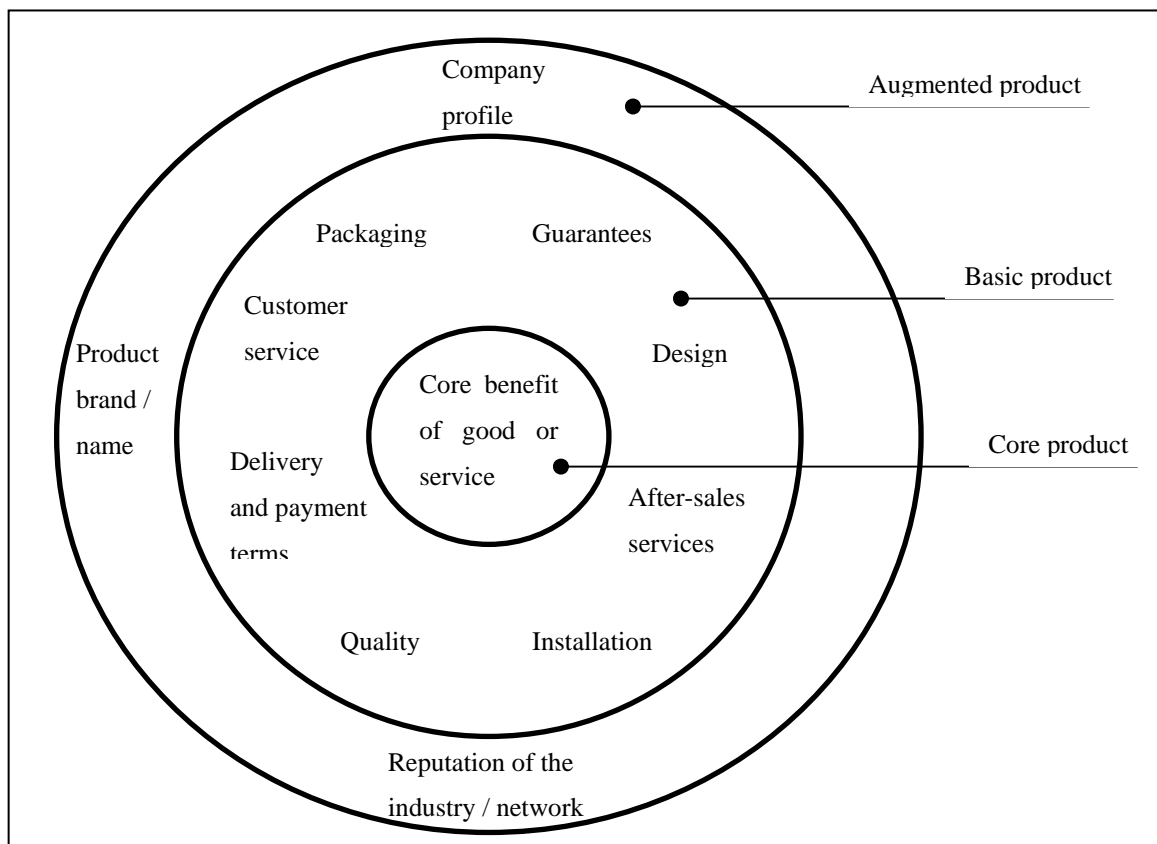


Figure 3. “The elements of an offering: core product, basic product, augmented product” (Axelsson and Wynstra, 2002; adapted from Kotler, 2000).

Nowadays, manufacturers in every field of industry have a strong emphasis on services that take place after an actual selling / purchasing transaction. Via these services, manufacturers try to be closely and vitally involved with customers through the whole lifecycle of their products. Manufacturers might find e.g. leasing contracts even more desirable than an outright purchase.

2.3 Services related to forklift trucks

The service offerings of forklift truck manufacturers appear to be similar. These service offerings – gathered from the Internet pages of various forklift truck manufacturers – can be depicted as in figure 4 below.

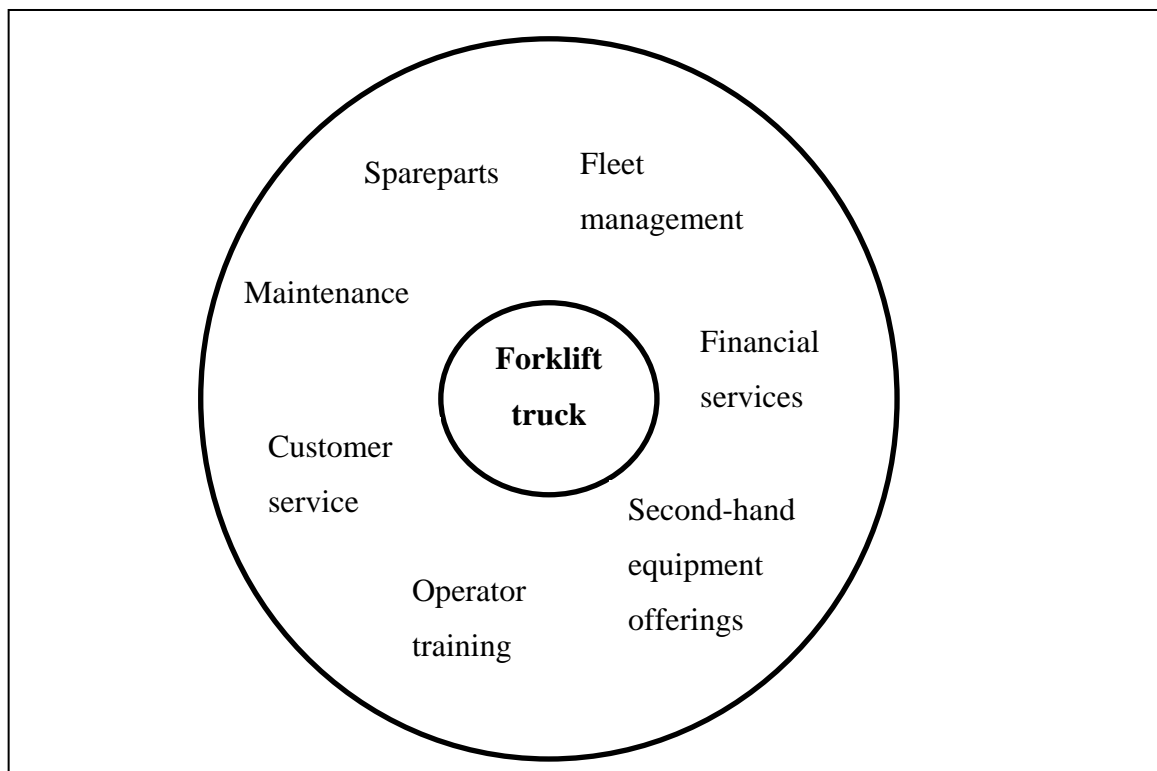


Figure 4. Service offering of a forklift manufacturer (www.linde-forklifts.com, www.toyotaforklift.com, www.kalmarind.com; 2005).

Depending on the manufacturer's way of thinking, fleet management services can be defined to comprise almost every element depicted in figure 4. Basically fleet management services can be considered to include elements such as *fleet planning* and *rental services*. These services are aimed at optimizing the customer's forklift

truck fleet in order to have a right number of forklift trucks designed and tailored for each activity performed in the customer's facilities. Rental services make it easy for customers to adapt their fleet capacity under temporary peak periods.

Financial services enable customers to free capitals for more profitable targets. These services typically include various leasing arrangements, such as operating, finance and maintenance leasing. The terms of leasing options vary. *Operating lease* is similar to a conventional rent arrangement. The customer acquires a forklift truck for a rental period and pays fixed monthly payments. The maintenance costs of the forklift truck are not included in the payments. Under this arrangement there is usually no obligation or option to buy the forklift truck at the end of the rental period. *Finance leasing* minimum payments cover finance costs plus interests. Maintenance costs are not included in the monthly payments and the customer is responsible for the residual value of the forklift truck at the end of the leasing period. Monthly payments of the *maintenance lease* include the maintenance and financial costs of the forklift truck. The lessee has no responsibilities related to the residual value of the forklift truck.

Operator training services partly ensure that the drivers achieve higher productivity with less damages and injuries. The drivers are taught how to drive more efficiently and safely, and how to avoid unnecessary wear of the forklift trucks. Driving courses are held best on site with the customer and as close as possible to the drivers' natural working environment (www.kalmarind.com, 2005).

Basically the best way to assure the highest level of machine performance is to rely on high quality *spare parts*. When a problem with a forklift truck occurs, it is desirable that spare parts are delivered promptly. Even though forklift trucks are not fixedly involved in a paper mill's production process, it is imperative that repair times are kept as short as possible. In many cases, forklift trucks are operated in critical areas, such as stock or dispatching area. Problems in these areas will eventually result in paper mill shutdown, since the capacity of paper stock is limited.

The customer buys availability through a *maintenance contract*. The service providers may offer higher availability with lesser costs due to their extensive experience and deep understanding of their machines, and due to better and more efficient

maintenance processes. There are several options for maintenance service, such as *corrective, preventive and predictive maintenance*. Inspections and audits are carried out in order to both analyse the current state of a forklift truck fleet and to plan future maintenance, repair, upgrade and investment needs (www.kalmarind.com, 2005).

2.4 Logistics services

Lehtinen, Karvinen and Korhonen (2002) define logistics services as *services that external companies offer in order to fulfill buyers' / sellers' logistical needs*. According to Rosenbloom (1999) basic components of logistics are:

- transportation,
- materials handling,
- order processing,
- warehouse management,
- warehousing and
- packaging.

Logistics service providers may offer services that cover only one function of the customer's logistical activities (e.g. transportation service), or offer a complete solution that covers all of the above-mentioned components of logistics, providing the customers with *total management of the supply chain*.

While a service contract is made with one logistics service provider (lead logistics provider, LLP), there is typically a network that the lead logistics provider utilises in order to provide the customer with an adequate and comprehensive logistics service offering. Hence the LLP acts as an intermediary between a customer and subcontracted providers.

The framework illustrated by TNT Logistics (2005) suits well for both depicting the area of total supply chain management and for illustrating distinct services that form a total logistics service offering. The range of every major LLP's service offering seems to include services that fall into the following four categories (TNT Logistics, 2005):

- inbound logistics,
- manufacturing support,
- outbound logistics and
- aftermarket services.

The area of *inbound logistics* includes such services as transportation (by land, air and sea), freight management, procurement, warehousing, inventory planning, cross-docking and just-in-time deliveries. *Manufacturing support* entails such services as inventory planning and control, line replenishments, and management of product and part repairs. The area of *outbound logistics* includes such services as warehousing, distribution, call centre management and installations at the facilities of the customer's customers. *Aftermarket services* typically include such services as reverse logistics, spare part logistics and returns handling. (TNT Logistics, 2005)

Logistics service providers also offer comprehensive information system solutions. These solutions are used to integrate a service provider network consisting of multiple subcontractors and partners, each of them having a number of different information systems and processes. This is how outsourced logistics services can be integrated into the customer company's own business operations. (Finland Post Group, 2005)

3 MAINTENANCE

3.1 Definition of maintenance

Maintenance can be defined as follows (adapted from the SFS-EN 13306 standard, translated by the present author):

Maintenance is composed of all the technical, administrative and managerial actions throughout a machine's life cycle that are carried out in order to maintain or restore the machine's condition back to a state where the required task can be performed.

According to Järviö (2004), maintenance policies fall into the following five classes:

- service,
- preventive maintenance,
- corrective maintenance,
- modifications, upgrading and modernisations, and
- analytical maintenance.

The goal of a *service* is to maintain the machine's operating environment and the operating preconditions on as good a level as possible. *Preventive maintenance* comprises of techniques that aim to prevent and control machine malfunctioning. The tasks of a service and preventive maintenance are somewhat overlapping. Another common denominator for these two maintenance policies is that the maintenance tasks are carried out at regular intervals.

Corrective maintenance measures are carried out in a planned manner when a machine malfunction occurs. The aim of *modifying, upgrading and modernising* machines (i.e. continuous improvement) is to improve the machine's usability, reliability and maintainability. *Analytical maintenance* comprises measures used to define factors that have a negative influence on the processes in the sense of maintenance. (Järviö, 2004). Overall the emphasis should be on preventive rather than corrective maintenance measures.

Maintenance can be seen as a transformation process encapsulated in an enterprise system. The resources allocated to maintenance include labour, materials, spares, tools, information and money. Maintenance has its influence on the availability of production facilities, output volumes, maintainability, safety - and ultimately on profits. This process can be illustrated as the input-output model in figure 5. (Tsang, 2002; adapted from Visser, 1998)

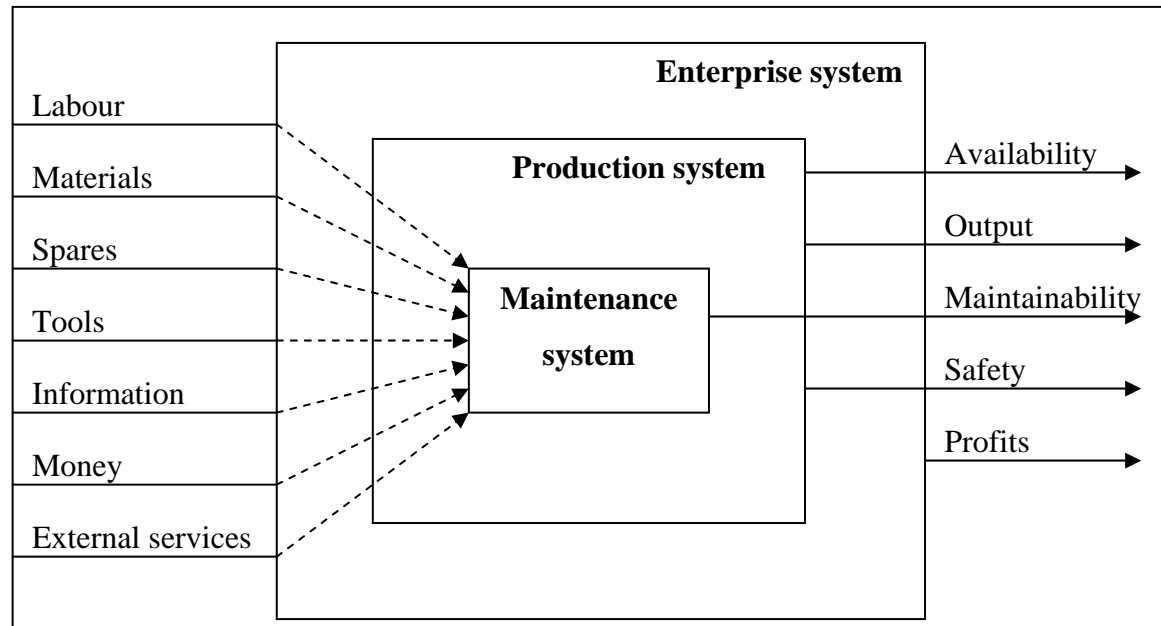


Figure 5. “Input-output model for the enterprise system” (Tsang, 2002, adapted from Visser, 1998).

3.2 Maintenance outsourcing

Maintenance outsourcing can be seen as a managed process of transferring maintenance activities to be performed by another external party. By outsourcing maintenance activities companies have typically striven for competitive advantage in the form of maintenance cost reduction. Equipment manufacturers have typically sold maintenance outsourcing solutions based on core business arguments. It is arguable that maintenance is considered to be non-core business for a pulp and paper mill, when at the same time operations and manufacturing are considered to be core business (Idhammar, 2005). The processes supporting the core business can be

strategic by nature and the company itself may have core competencies related to these supporting processes.

According to Allen and Chandrashekar (2000), service outsourcing can be broken into three major categories based on the contractor involvement. This generic categorisation is illustrated in table 2.

Table 2. “Level of Contractor Contribution” (Allen and Chandrashekar, 2000).

	Labour contracting	Mixed outsourcing	Complete outsourcing
Contractor provides...	Some employees	<u>Some or all of the following:</u> Employees Materials Process and systems Technology and equipment Facilities Management / supervision	Employees Process and systems Technology and equipment Materials Facilities Supervision
Host firm provides...	Some employees Process and systems Technology and equipment Materials Facilities Management / supervision	<u>Some or all of the following:</u> Employees Materials Process and systems Technology and equipment Facilities Management / supervision	Program management

In the following chapter the above categorisation is utilised in order to define the scope of the outsourcing services of materials handling equipment under study.

3.3 Outsourcing options for the forklift truck fleet

In the case of outsourcing forklift truck maintenance and operation, there are basically three different options, each with a distinct level of contractor contribution. These outsourcing options are:

- maintenance outsourcing (with a maintenance contract)
- maintenance outsourcing and assets management (with a maintenance leasing contract)
- maintenance, assets management and outsourcing of forklift truck fleet operation (complete outsourcing)

The above three outsourcing options with a contractor and a host involvement are illustrated in table 3.

Table 3. Three outsourcing options for the materials handling equipment.

	Maintenance outsourcing (labour contracting)	Maintenance + assets (mixed outsourcing)	Maint. + assets + oper. (complete outsourcing)
Contractor provides...	Maintenance staff, technology and equipment	Maintenance staff Materials Process and systems Technology and equipment Facilities Management / supervision	Maintenance and operational staff Process and systems Technology and equipment Materials, Facilities Supervision
Host firm provides...	Operational staff Process and systems Materials Facilities Management / supervision	Operational staff Management / supervision	Program management

The content and requirements of a service entity are altered considerably when a customer outsources the maintenance and assets management of a forklift truck fleet that consists of old forklift trucks possibly manufactured by a number of different

manufacturers. In this case the service provider takes over the fleet that consists of foreign forklift trucks, each having maintenance policies and spare part logistics that may not be familiar to the service provider. Providing customers with an adequate service level is an even more challenging task, if the customers have insufficient and unreliable history and product information related to their forklift trucks.

4 MATERIAL LOGISTICS OF MAINTENANCE

This chapter illustrates the content and elements of material logistics of maintenance. A method for describing the content of a distinct business service entity is also illustrated.

4.1 Material logistics of maintenance

According to Piispa (2005), the main function of a total maintenance service offering is to “*competitively ensure production operating rate as well as production speed and product quality with the technical and functional quality of the machines*”.

Figure 6 depicts a forklift truck maintenance service entity. In forklift truck fleet maintenance, the maintenance activities focus on an infrastructure in production, stock and dispatching areas.

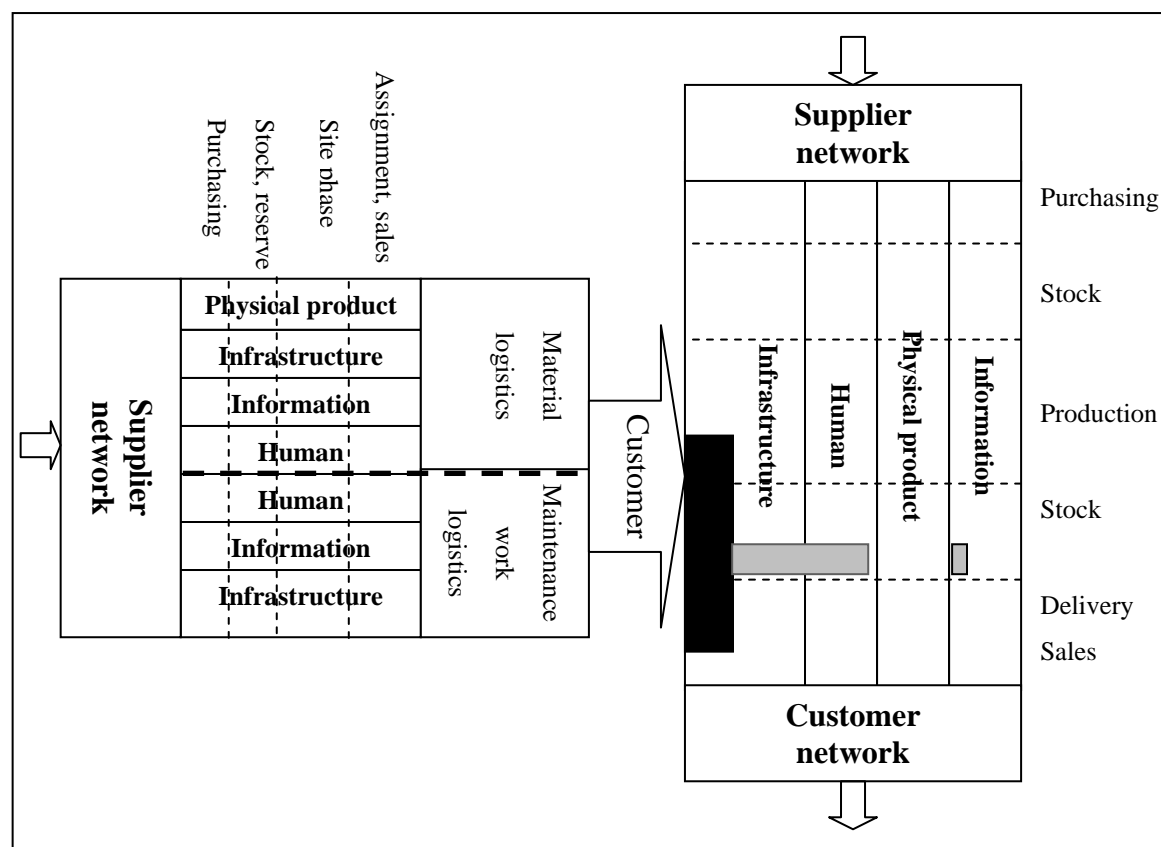


Figure 6. Content of the maintenance service entity, case forklift trucks (Piispa, 2005).

As illustrated in figure 6, the logistics of the maintenance function consists of two elements, namely

- 1) material logistics of maintenance and
- 2) logistics of maintenance work.

Material logistics of maintenance starts when a machine is installed and it comprises all the actions needed for material and related information deliveries to a customer. The aim of the material logistics of maintenance is to fulfill the material requirements of a distinct industrial equipment. (Piispa, 2003)

Logistics of maintenance work comprises the actual maintenance activities, such as installations, measurements and repairs, which can be performed either by internal or external maintenance staff. (Piispa, 2003)

Both of the above-mentioned elements include a physical flow of goods and an information flow enabling smooth, timely and cost effective movement of the physical goods. (Piispa, 2003)

Forklift truck suppliers have recently started to offer forklift truck operating services in addition to maintenance and assets management services. Figure 6 shows that forklift truck operating activities and related information flows belong to a completely different operation process than forklift truck maintenance activities. The forklift truck operating staff should be fully aware of the company's operation process and even know the requirements expressed by customer's customers. These issues will be discussed in greater detail in chapter 6.4.

4.2 Method for describing the contents of a business service entity

When outsourcing functions, whether by labour contracting or by a full-service contract, it is imperative to clearly define the scope of the entity that is to be outsourced. If the service provider and the host company do not understand each other correctly or use different terms when actually meaning the same thing, there is a risk

that all relevant matters are not discussed and agreed on properly. Because of this it is possible that when an unexpected event occurs, neither party knows whose responsibility it is to carry out the corrective measures.

In this study, the responsibilities of the service provider and the host company are defined on the basis of the presentation illustrated in figure 7. Tasks that are carried out throughout the maintenance logistics chain fall into the following three categories:

- operational,
- tactical and
- strategic tasks.

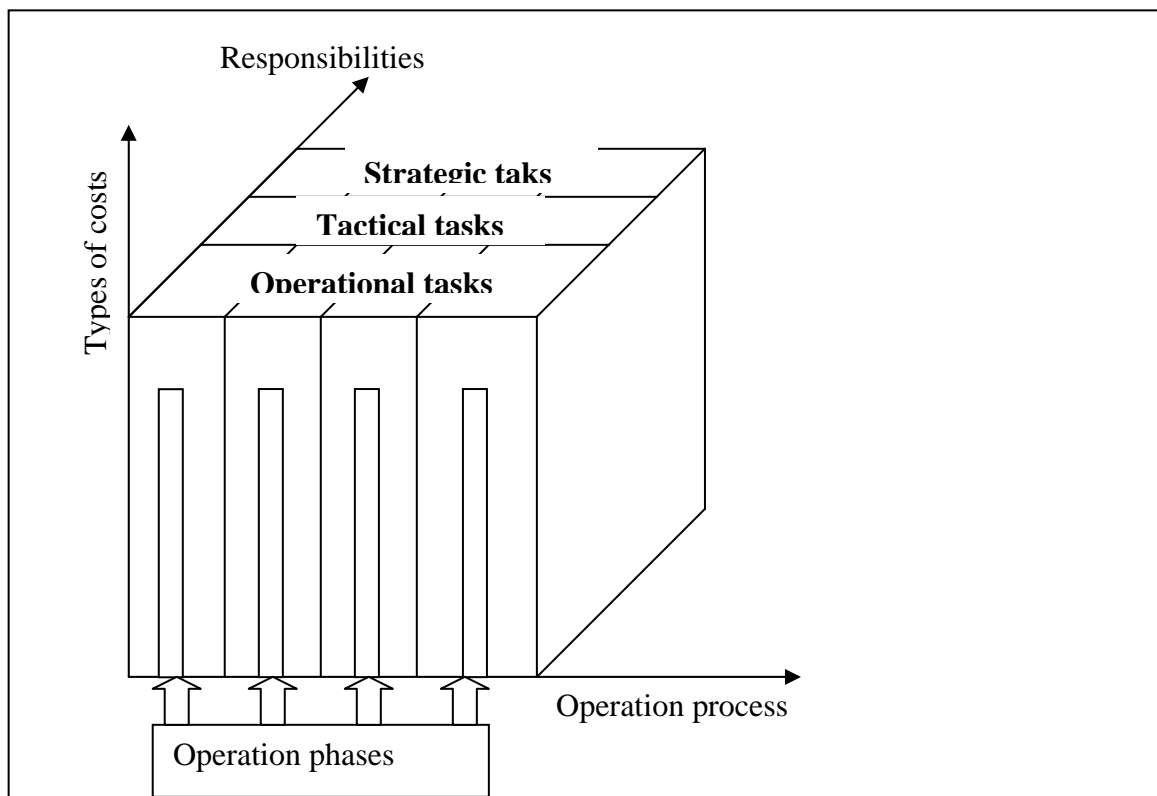


Figure 7. Method for describing the contents of a business service entity (Piispa, 2005).

Tactical and strategic tasks are information intensive and abstract by nature. The strategic tasks include e.g. different forecasting activities, target setting, business development activities, reporting, and human resource management. The tactical tasks include e.g. calls for bids, contract negotiations, collaboration with other in-house units and suppliers, and planning and control of operations. The operational tasks

include day-to-day tasks such as order processing, material handling, maintenance activities, warehouse operational tasks, and invoicing. (Piispa, 2003)

In this study, activities related to the material logistics of maintenance are considered to fall into the following processes:

- purchasing / sales process
- material transportation process
- material warehousing process
- information maintaining process

Activities related to the logistics of maintenance work are considered to fall into the categories of:

- planned maintenance measures and
- unplanned maintenance measures.

5 CASE 1: MATERIAL LOGISTICS OPERATION MODEL

This chapter discusses the operation model that is currently most typically used in the material logistics of maintenance. The discussion includes a basic layout view on the material logistics supply chain and a description of information flows between the suppliers, transportation service providers and customers.

A new operation model will also be illustrated. The illustration includes a basic layout view on a new material logistics supply chain, information flows when using the new model and the supplier's, service provider's and customer's responsibilities. Material logistics of the domestic delivery volumes of maintenance in a distinct paper industry company are also examined.

The new model will radically change the contractual relationships between suppliers, transportation service providers and customers. The logistics chain will become more visible for the customer, since in addition to procurement also material deliveries are basically managed by the customer (via the service provider).

5.1 Material logistics of the maintenance operation model currently in use

Currently materials and parts are purchased as delivered (DDU delivery clause), meaning that the price the customer sees and pays includes, in addition to the material itself, also material deliveries and insurancing. This way the customers have no clue whatsoever about the real price, transportation costs or costs of insurancing of the material. Reports about transportation and insurancing costs do not exist or at least are not revealed to customers.

The material logistics supply chain consists of three parties, namely the suppliers, transportation service providers and customers. These parties and their relationships are illustrated in figure 8.

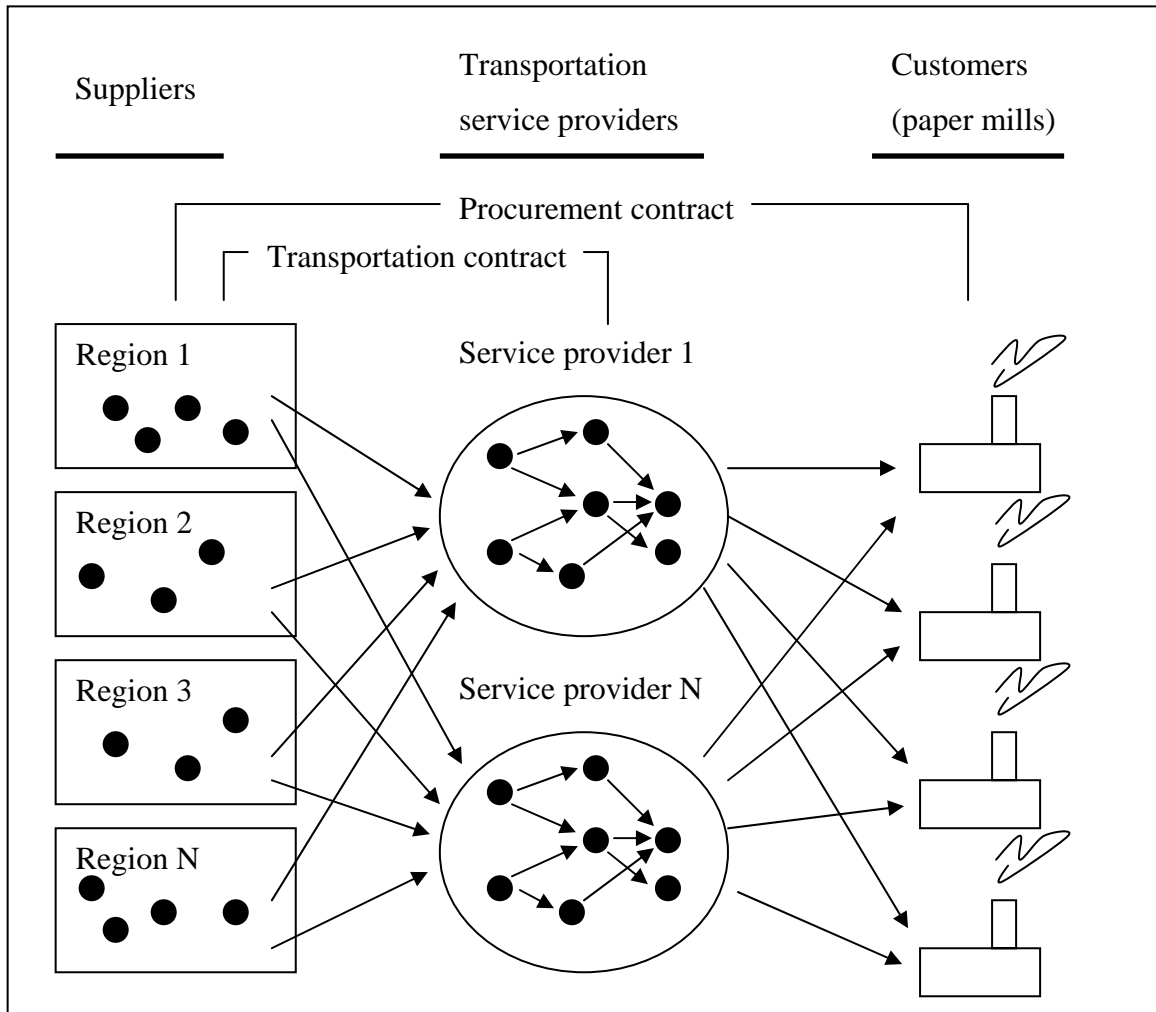


Figure 8. Material logistics of maintenance; supply chain and contractual relationships currently in use.

Currently the customers negotiate procurement contracts with the suppliers. The suppliers are responsible for delivering parts into the customers' facilities, and hence they negotiate transportation contracts with transportation service providers. The customers have no access into the real transportation and insurancing costs and they do not know whether the transportations are negotiated, planned and managed efficiently. A supplier's transportation service contractor may not e.g. have adequate delivery volumes to a distinct paper mill area. This may lead to inefficiencies and higher delivery costs if compared to the new model illustrated in this report, since in the new model one service provider manages all the deliveries from the suppliers' gates to various paper mills in Finland.

Also other problem areas can be identified in addition to the lack of proper cost reporting. Currently the deliveries are carried out and planned by the supplier. As a result, a large amount of small batch deliveries from single suppliers are received and handled by the customer. This causes a huge workload in material receiving operations if compared to the new material logistics of maintenance operation model where the material deliveries are planned, combined and received in controlled manner using a single service provider.

Figure 9 illustrates information flows between the three parties when using the conventional model.

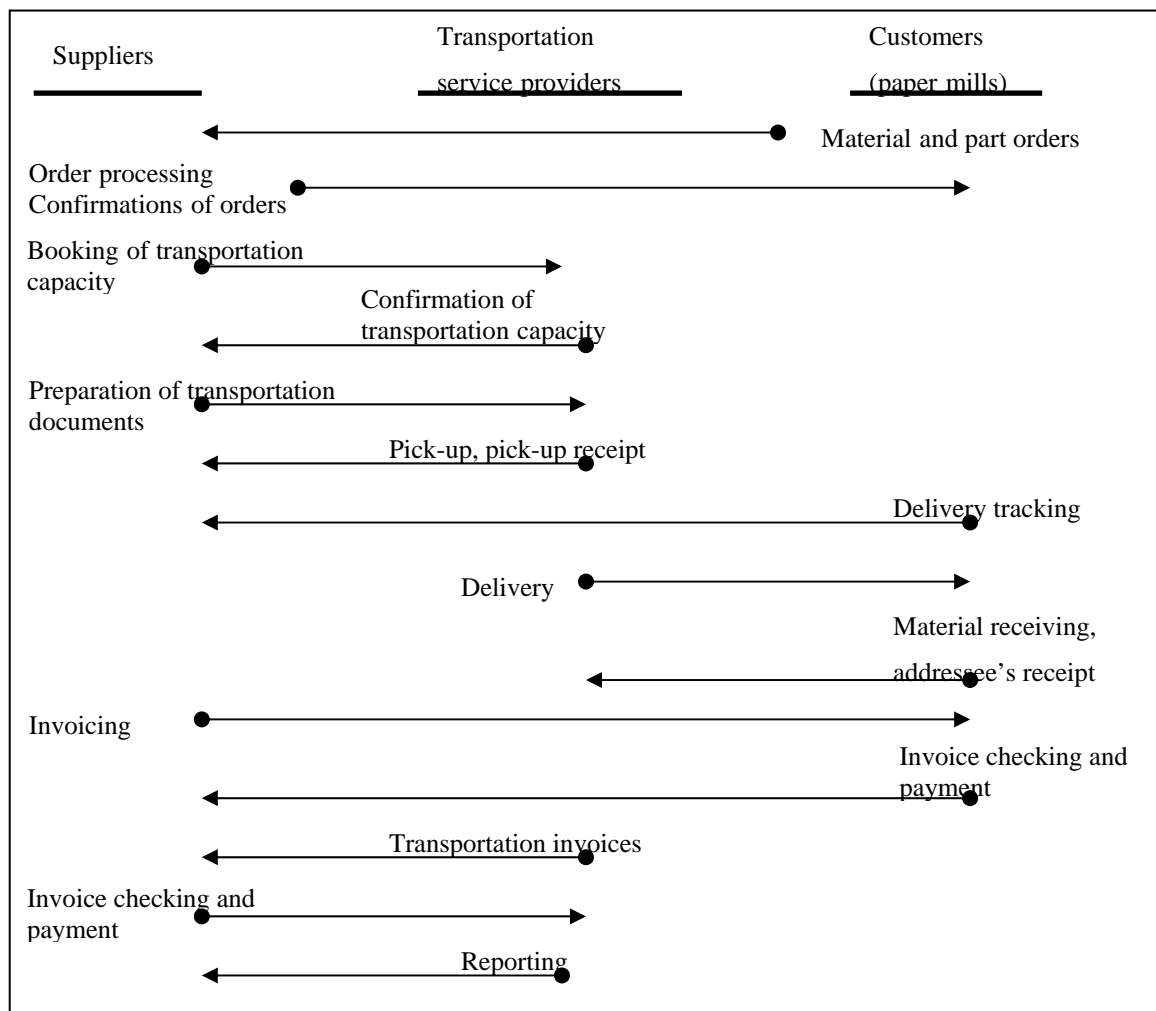


Figure 9. Information flows between parties using the conventional model.

5.2 New operational model for material logistics of maintenance

In this chapter a new operational model for material logistics of maintenance is presented.

5.2.1 Description of the new operational model

Figure 10 illustrates the basic layout view of a new supply chain structure of material logistics of maintenance.

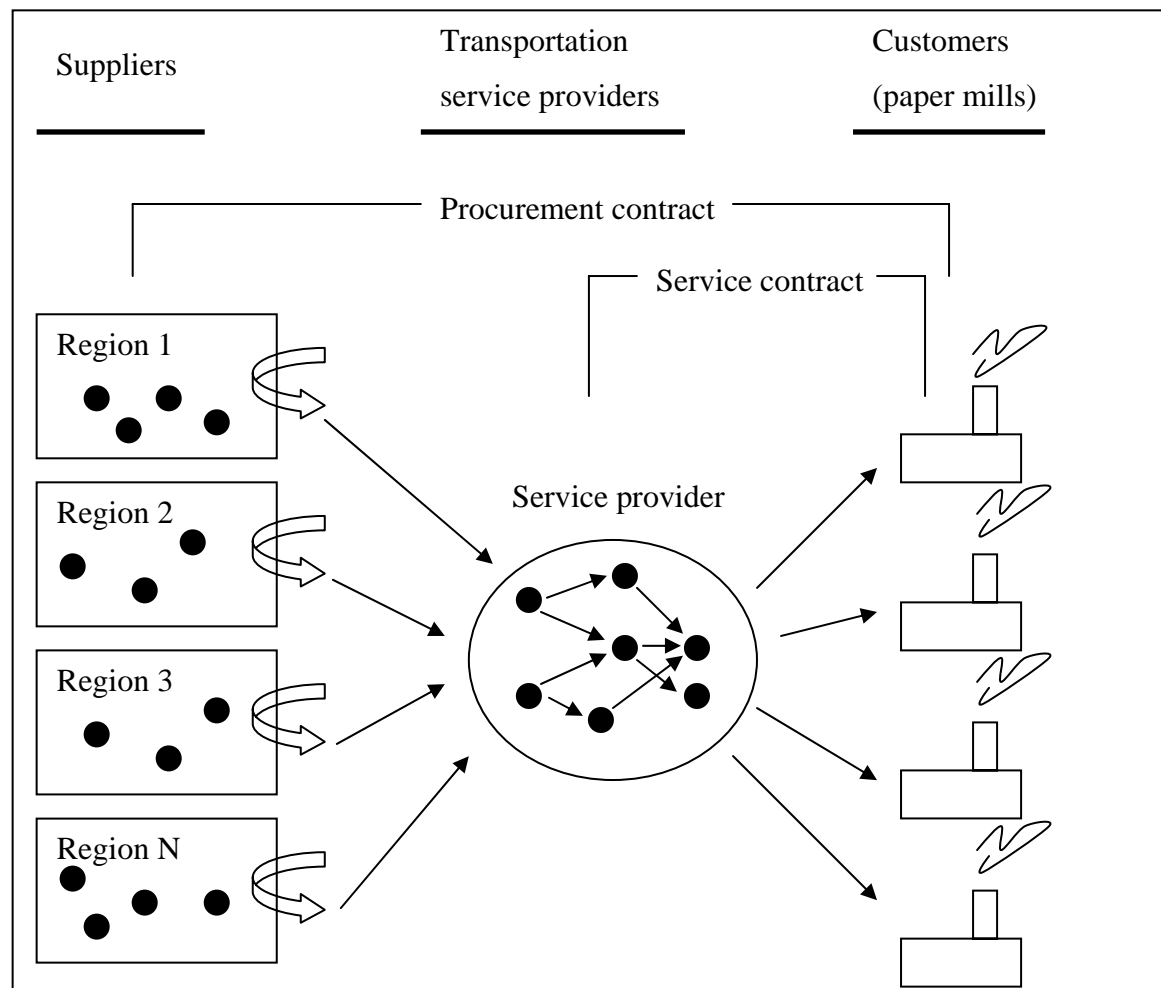


Figure 10. Material logistics of maintenance, new model and contractual relationships.

Basically the material transportations are no longer managed by the suppliers. As illustrated in figure 10, a single service provider manages both material pick-ups from the suppliers and material deliveries into the customer's facilities. This affects the

conventional contractual relationships between the parties along the material logistics supply chain. Both contracts (i.e. procurement and service contracts) will be negotiated by the customer, the procurement contract with the suppliers and the service contract with the single service provider.

The procurement contracts are negotiated as before, but the content of the procurement contract is altered. New issues that should be added into the procurement contract include e.g. definition of new material pricing methods, new delivery clauses and instructions for communication between the supplier and the service provider. A more detailed view on the new procurement contract is illustrated in chapter 5.6.

The service contract is negotiated between the customer and the service provider. The service contract describes e.g. clear pricing methods for distinct services and communication methods in the supplier – service provider interface. A more detailed view on the service contract is illustrated in chapter 5.5.

5.2.2 Information flows of the new operational model

Figure 11 illustrates the information flows between the material logistics of maintenance parties when using the new operational model.

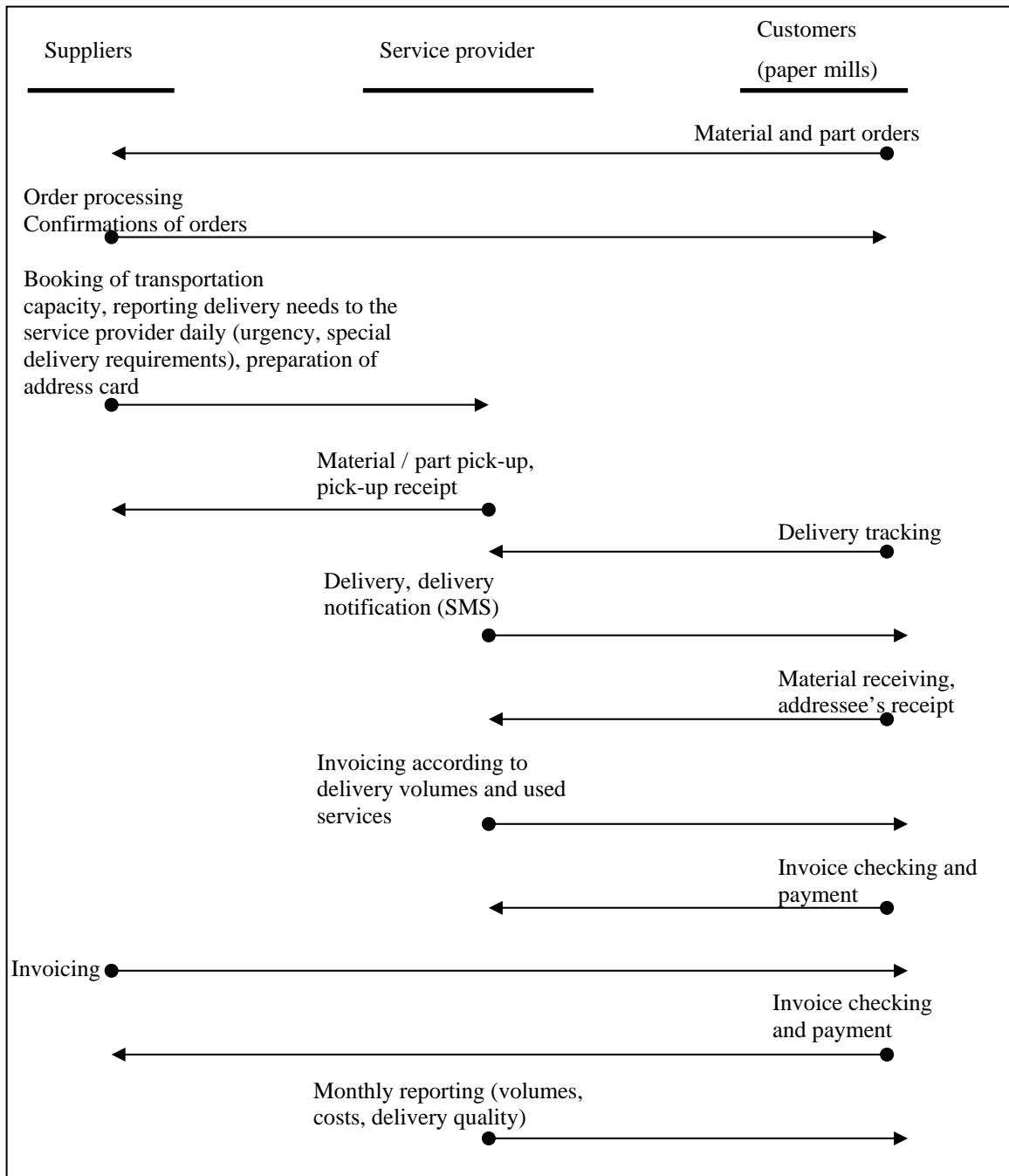


Figure 11. Information flows between the parties using the new model.

5.2.3 Responsibilities in the new operational model

The supplier's strategic level responsibilities concerning the material logistics of maintenance when using the new operation model include:

- delivery control, planning and development
- contract negotiations with paper mills
- material-related information management
- customer-related information management
- transportation service provider-related information management
- demand forecasting

The supplier's operative level responsibilities concerning the material logistics of maintenance when using the new operation model include:

- order receiving and reception entries, delivery of order confirmation
- preparation of pick-up list, pick-up entries
- packaging
- delivery preparation, preparation of delivery documents
- reporting to the transportation service provider concerning the materials and parts to be delivered
- invoice preparation and sending

The service provider's strategic level responsibilities concerning the material logistics of maintenance when using the new operation model include:

- contract negotiations
- supply chain management and optimisation
- development of tailored customer solutions
- supplier-related information management
- customer-related information management
- reporting to paper mills
- development of IT-systems

The service provider's tactical level responsibilities concerning the material logistics of maintenance when using the new operation model include:

- staff supervisory tasks, resource allocation
- planning of daily operations, resources and volumes
- customer-related information maintenance (for customer level reporting)

The service provider's operative level responsibilities concerning the material logistics of maintenance when using the new operation model include:

- hauling arrangements
- receiving transportation orders, order confirmations
- moving of orders on a transportation fleet
- material and part pick-ups
- material deliveries through terminals and trunk lines, combining deliveries
- local deliveries to customers
- invoice preparation and sending

The customer's strategic level responsibilities concerning the material logistics of maintenance when using the new operation model include:

- contract negotiations with the suppliers and the service provider
- procurement control, planning and development
- supplier-related information management
- service provider-related information management
- warehouse and inventory management
- material requirement planning
- material-related information management

The customer's operative level responsibilities concerning the material logistics of maintenance when using the new operation model include:

- order processing
- delivery tracking
- material reception
- invoice processing, checking and payment

5.3 Material delivery volumes of the case paper industry company

In order to gather knowledge on the annual domestic maintenance-related material delivery volumes and origins, and on a number of material suppliers of a Finnish paper industry company, a field study was carried out. Figure 12 locates the paper industry company's mills and the logistics service provider's sorting centers.

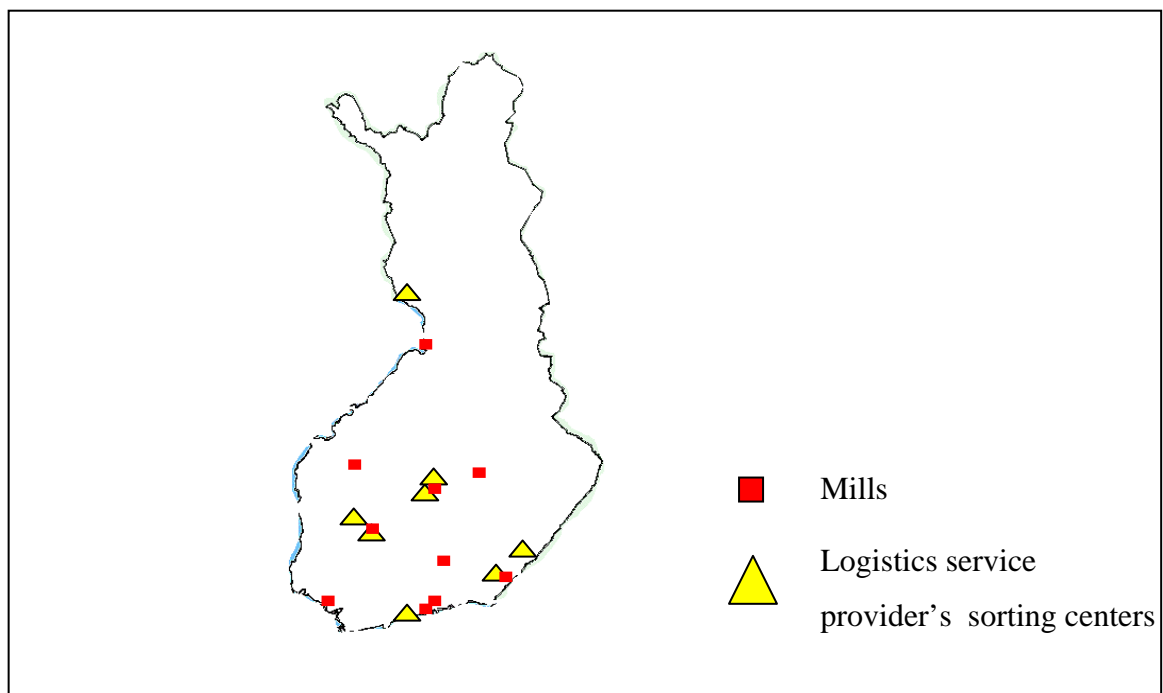


Figure 12. Locations of the paper mills and the logistics service provider's sorting centers.

The material deliveries were examined per the service provider's sorting center area, since material pick-ups can be easily managed by arranging pick-up rounds from

suppliers and by delivering materials into the customer's facilities via the service provider's sorting center and terminal network.

The annual domestic maintenance-related material and part delivery volume from the suppliers to the paper company's mills was some 20,000 deliveries. Around 72% of the total delivery originated from the logistics service provider's sorting center areas.

The number of domestic maintenance-related material suppliers per mill ranged between 50 and 400 suppliers. The number of annual material deliveries per mill ranged from 100 to nearly 5000. The three major domestic delivery sources were Tampere, Jyväskylä and Helsinki, covering some 50% of the total number of annual material deliveries.

5.4 Sources of added value of the new operational model

The new operational model creates added value for the customer in the form of:

- improved cost reporting,
- improved delivery tracking per supplier,
- improved delivery reliability tracking per supplier,
- reductions in material receiving workload and
- transportation cost savings.

The service provider is able to provide the customer with cost and other delivery-related information that was not available earlier. For example each supplier's delivery reliability can be tracked accurately, since the service provider's material pick-up times are visible and can be reported to the customer.

The workload in the customer's material receiving operations can be dramatically decreased due to the service provider's ability to pickup, combine and deliver materials and parts into the customer's facilities in a controlled manner (tens of small deliveries per day vs. one or two big combined deliveries).

Transportation cost savings are derived from the service provider's ability to plan and control the customer's material delivery volumes as a whole. By integrating the customer's material delivery volumes into the service provider's nationwide logistics system, the transportation costs per a single material delivery can be reduced as compared to the conventional material logistics operation model and its large amount of single deliveries.

5.5 Content of the service contract

The following issues should be agreed on properly and included in the service contract:

- anticipated delivery volumes
- availability of delivery capacity
- starting points and destination addresses of deliveries, addresses in sufficient level of detail (e.g. gate)
- service pricing (logical service items including e.g. transportation, control, reporting, additional services), clear arguments for cost generation
- time of day when deliveries are accepted by the addressee (e.g. hours of business at the warehouse)
- acceptable delivery delays caused by the service provider and methods for tracking delivery delays
- delivery frequencies
- terms of payment
- insurancing responsibility, statutory insurances should also be listed
- fixed term reporting on focus areas, adequate level of detail
- cost of reporting service
- service level agreements / commitments
- responsibilities in the supplier / service provider –interface, the supplier's responsibilities include;
 - o reporting to the service provider concerning material deliveries and their urgencies

- preparation of documents, should be described and agreed on in the procurement contract
- materials and parts should be packed and moved to a place that is agreed on in the procurement contract

5.6 Content of the new procurement contract

The following issues should be agreed on properly and included in the procurement contract:

- materials and parts under the contract
- new pricing methods (stock item prices can be negotiated beforehand, non-stock item prices will be negotiated when ordered), the pricing effect of a new delivery clause (DDU before, new EXW or FCA) should be clearly defined
- ordering method, preferably written
- locations of material and part pick-up points, definition of pick-up practices and methods
- terms of payment
- new delivery clause, EXW or FCA
- delivery times (the part that is dependent on the supplier)
- sanctions in the case of delivery delays
- returns in the case of incorrect materials or parts (the service provider transports, the supplier pays)
- instructions on how to contact and inform the service provider (e.g. GSM or e-mail)
- instructions on how to deliver addressee information to the service provider (e.g. address card preparation), what information should be included in the transportation documents (addressee's contact information, GSM number), "payer other than sender" as an additional service
- responsibilities in the supplier / service provider interface
 - daily reporting to the service provider concerning deliveries and their urgencies

- preparation of transportation documents as illustrated in the procurement contract
- material and part packaging and transfer to a pick-up point agreed on in the procurement contract
- the service provider is responsible for materials when a pick-up receipt is made

5.7 Different service products of material logistics of maintenance

In the material logistics of maintenance in paper industry, four different service products can be identified. These service products are:

- regular material pick-ups,
- one-time material orders,
- exceptional situations and express material deliveries, and
- special material deliveries.

All of these four service products have different requirements for the interfaces between the parties. These requirements should be defined and properly communicated e.g. in procurement and service contracts.

Special material deliveries include e.g. deliveries of large parts (motors and cylinders). For special deliveries it is imperative to clearly define e.g. proper handling methods, lifting points, transportation methods and other requirements derived from the special characteristics of the material.

6 CASE 2: FORKLIFT FLEET OUTSOURCING SOLUTIONS

In the following chapters the tasks and responsibilities are discussed according to the framework illustrated in figure 7. The present state (i.e. the state before any outsourcing solution) is presented in the beginning of each chapter. After this, the following outsourcing solutions and their impact on the responsibilities are evaluated:

1. maintenance outsourcing,
2. maintenance and asset management outsourcing and
3. maintenance, asset management and operations outsourcing.

The effects of the solutions on investment productivity is evaluated. The above-mentioned solutions are means to improve the productivity of the host company's investments. Factors that have an effect on investment productivity are illustrated in the following chapter.

6.1 Investment productivity

When capital assets are used efficiently, the following benefits can be achieved (Järviö, 2004):

- reductions in investment requirements (efficient equipment use enables the company to operate with lesser investments), and
- improvements in the company's profitability and competitiveness (efficient use enables improvements in the investment productivity)

Factors affecting the productivity of investments are illustrated in figure 13.

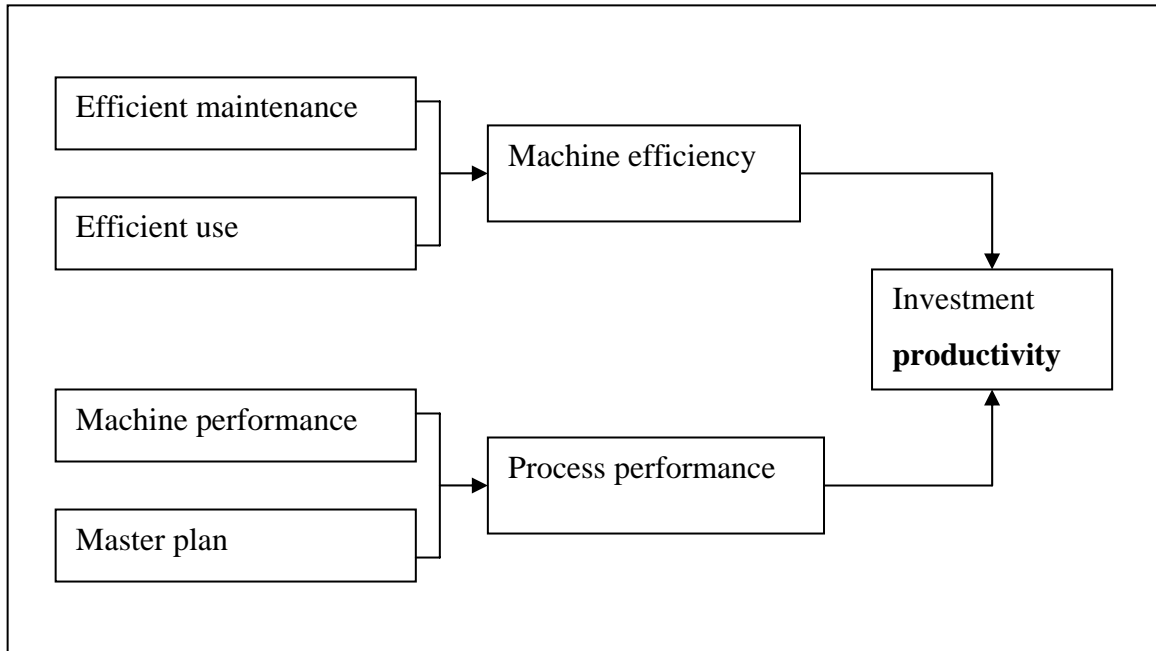


Figure 13. “Factors affecting investment productivity”(adapted from Järviö, 2004).

Efficient maintenance means that the maintenance staff is capable of preparing and carrying out proper maintenance strategies in order to maintain the performance of the machine on an adequate level. *Efficient use* refers to the operating staff’s capabilities to use the machines properly and efficiently. *Machine efficiency* is derived from efficient maintenance and use. (Järviö, 2004)

In order to adapt to the ever changing operating environment and to preserve *machine performance*, the machines should be upgraded and modernised. *Master plan* describes both machine production-related objectives and main maintenance policies through the life cycle of the machine. *Process performance* is derived from the performance of the machine and the master plan. The machine performance upgrades and master plan also have positive effects on the efficiency of the machine through its life cycle. (Järviö, 2004)

6.2 Maintenance outsourcing

The responsibilities of a supplier and a host company concerning an unplanned maintenance work process before maintenance outsourcing are presented in table 4.

Table 4. Responsibilities in unplanned maintenance work before maintenance outsourcing.

SUPPLIER		HOST COMPANY
<u>Strategic level</u>		<u>Strategic level</u> Maintenance target setting Maintenance work planning and control Human resource management Maintenance operations development Reporting
<u>Tactical level</u>	INTERFACE	<u>Tactical level</u>
Collaboration with customers		Collaboration with suppliers Collaboration with in-house units Maintenance operations follow-up
<u>Operative level</u>	INTERFACE	<u>Operative level</u>
Collaboration with customers		Collaboration with suppliers Collaboration with in-house units Fault diagnosis Definition of material requirements Preparation of acquisition proposals Inbound material verifications Maintenance operations Maintaining of maintenance information

The responsibilities of a supplier and a host company concerning a planned maintenance work process before outsourcing are presented in table 5.

Table 5. Responsibilities in planned maintenance work

SUPPLIER		HOST COMPANY
<u>Strategic level</u>		<u>Strategic level</u> Maintenance requirements forecasting Maintenance target setting Maintenance work planning and control Human resource management Maintenance work development Reporting
<u>Tactical level</u>		<u>Tactical level</u>
Collaboration with customers	INTERFACE	Collaboration with suppliers Collaboration with in-house units Maintenance operations follow-up
<u>Operative level</u>		<u>Operative level</u>
Collaboration with customers	INTERFACE	Collaboration with suppliers Collaboration with in-house units Definition of material requirements Preparation of acquisition proposals Inbound material verifications Planned maintenance operations Maintaining of maintenance information

The host company's role in the maintenance process after the maintenance outsourcing will be basically:

- maintenance target setting,
- maintenance work process jointly with the maintenance service provider,
- evaluation of reports and follow-up data provided by the service provider,
- follow-up meetings with the service provider in order to develop and improve the existing outsourcing solution and
- collaboration with the service provider in the case of equipment breakdown.

By outsourcing the forklift truck fleet maintenance, the host company ultimately seeks investment productivity. The service provider is responsible for providing the host company with efficient maintenance service, as illustrated in figure 14.

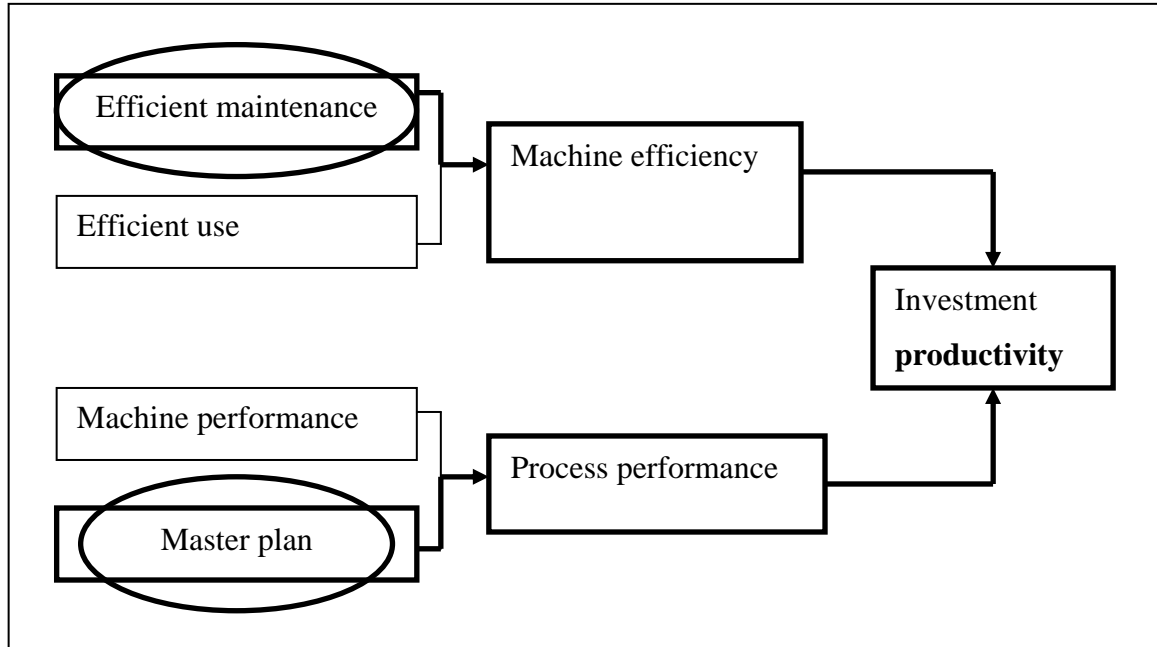


Figure 14. “Factors affecting investment productivity” (adapted from Järviö, 2004), CASE: maintenance outsourcing, emphasis added by the present author.

The master plan describing the machine production-related objectives and maintenance policies through the life cycle of the machine will be prepared jointly with the host company and the service provider.

An important responsibility for the service provider is collaboration with the host company’s in-house units, namely production and stock personnel. These units should be kept up to date concerning delays caused by unexpected breakdowns.

The service provider is also responsible for maintaining information related to maintenance and materials usage. These reports, provided by the service provider, are clearly a source of added value for the host company, since maintaining information on forklift truck -related maintenance and materials usage is typically neglected by the host company’s in-house maintenance personnel.

Whether maintenance is contracted or performed in-house, it is critical to define the communication methods and practices between the operating personnel and maintenance staff. When equipment failure occurs, information should be forwarded from the operating personnel to the maintenance staff promptly with no delays. Typically the operating staff provides the maintenance personnel with a rough description of the failure. Based on this information, corrective measures are performed by the maintenance personnel. Hence the amount and quality of collaboration between the parties determines the length of the breakdown time.

6.2.1 Maintenance outsourcing impacts on the material purchasing / sales process

The responsibilities of the supplier and the host company concerning the purchasing / sales process before maintenance outsourcing are presented in table 6.

Table 6. Responsibilities in the sales / purchasing process.

SUPPLIER		HOST COMPANY
<u>Strategic level</u>		<u>Strategic level</u>
Demand forecasting	INTERFACE	Requirements forecasting
Target setting		Target setting
Sales planning and control		Purchasing planning and control
Human resource management		Human resource management
Sales operations development		Purchasing operations development
Reporting		Reporting
<u>Tactical level</u>		<u>Tactical level</u>
Contract negotiations	INTERFACE	Contract negotiations
Responding to the call for bids		Preparing the call for bids
Potential customer surveys		Supplier and bid comparisons
Collaboration with customers		Collaboration with suppliers
Collaboration with in-house units		Collaboration with in-house units
Delivery planning		Planning of material receiving activities
Sales activity follow-ups		Purchasing activity follow-ups
<u>Operative level</u>		<u>Operative level</u>
Order receiving and processing	INTERFACE	Order preparation and sending
Invoicing		Order (post-)recording
Delivery arrangements, follow-up		Delivery follow-ups
Reclamation processing		Preparation of reclamations
Control of material documentation		Control of material documentation
Sales order processing		Payments according to invoices

After maintenance outsourcing, the host company does not typically have responsibilities related to the actual material and part purchasing process. The responsibilities are mostly related to the evaluation and control of the outsourced maintenance service. The host company's role in the purchasing process interface after maintenance outsourcing will be basically:

- evaluation and control of the outsourced service,
- revision of the maintenance outsourcing contract based on experiences in the outsourcing solution,
- evaluation of reports and follow-up data provided by the service provider,
- follow-up meetings with the service provider in order to develop and improve the existing outsourcing solution,
- preparation of reclamations and
- review and payment of bills.

The service provider's role in the sales process interface after maintenance outsourcing will be basically (in addition to the responsibilities listed in table 6):

- generation of reports and follow-up data concerning service performance, maintenance costs and service quality,
- follow-up meetings with the host company in order to develop and improve the existing outsourcing solution and
- revision of the maintenance outsourcing contract based on experiences in the outsourcing solution.

6.2.2 Maintenance outsourcing impacts on the material transportation process

The responsibilities of the supplier and the host company concerning the transportation (supplier side) and warehousing (host company side) process before maintenance outsourcing are presented in table 7.

Table 7. Responsibilities in the transportation (supplier's) and warehousing (host's) process.

SUPPLIER	HOST COMPANY
<u>Strategic level</u>	<u>Strategic level</u>
Requirements forecasting	Operations forecasting
Target setting	Target setting
Transportation planning and control	Operations planning and control
Human resource management	Human resource management
Transportation operations development	Warehouse operations development
Reporting	Reporting
<u>Tactical level</u>	<u>Tactical level</u>
Preparation and evaluation of the call for bids	Operations planning and control
Contract negotiations	Collaboration with in-house units
Collaboration with the transport company	Operations follow-ups
Collaboration with in-house units	
Transportation operations follow-ups	
<u>Operative level</u>	<u>Operative level</u>
Operative planning and control	Material receiving operations
Preparation of transportation documents	Material forwarding
Transportation operations follow-ups	Stocktaking
	Maintaining of warehousing information

After maintenance outsourcing, the host company does not typically have any responsibilities related to the warehousing process of materials and parts. All the host company's responsibilities illustrated in table 7 will be performed by the service provider.

6.2.3 Maintenance outsourcing impacts on the information maintaining process

The responsibilities of the supplier and the host company concerning the information maintaining process are presented in table 8.

Table 8. Responsibilities in the information maintaining process.

SUPPLIER		HOST COMPANY
<u>Strategic level</u>		
Human resource management		Human resource management
Target setting		Target setting
Operations planning and control		Operations planning and control
Operations development		Operations development
Reporting		Reporting
<u>Tactical level</u>		
Planning and control of information maintaining activities	INTERFACE	Planning and control of information maintaining activities
Collaboration with in-house units		Collaboration with in-house units
Collaboration with customers		Collaboration with suppliers
<u>Operative level</u>		
Collaboration with customers	INTERFACE	Collaboration with suppliers
Maintaining of technical information		Maintaining of technical information
Maintaining of contract information		Maintaining of contract information
Maintaining of customer information		Maintaining of supplier information
Maintaining of logistics information		Maintaining of logistics information
Maintaining of accounting info		Maintaining of accounting information

After maintenance outsourcing, the service provider is responsible for maintaining maintenance-related technical information such as materials usage data and historical data of the machine. The host company will be provided with data concerning e.g. the maintenance efficiency and maintenance costs of a single forklift truck.

6.3 Assets management outsourcing

The responsibilities of the supplier and the host company concerning the forklift truck fleet assets management are presented in table 9.

Table 9. Responsibilities related to assets management.

SUPPLIER		HOST COMPANY
<u>Strategic level</u>		<u>Strategic level</u> Capacity requirements forecasting Target setting (e.g. availability) Fleet planning and optimization Fleet development (e.g. by upgrading) Reporting
<u>Tactical level</u> Collaboration with customers	INTERFACE	<u>Tactical level</u> Collaboration with suppliers Collaboration with in-house units Fleet follow-ups Planning and control of fleet operating practices
<u>Operational level</u> Collaboration with customers	INTERFACE	<u>Operational level</u> Collaboration with suppliers

Other areas of responsibilities and areas of special knowledge requirements related to assets management are e.g.:

- management of value generation (the value factors of capital assets for the company's business),
- management of total cost calculations (operating costs and capital costs),

- management of investment profitability calculations (e.g. determination of economic working life),
- management of capital asset financing and
- management of capital asset accounting and taxation information.

Also these areas include such tasks as planning and development, as well as operative routine reporting tasks. The tasks also include stakeholder contacts with e.g. financiers, auditors, owners and the tax collector.

Forklift trucks have an essential role in the company's core business process (i.e. in warehousing and dispatching) in the form of materials handling and transfer operations. The capital assets can be outsourced to an external party, but the responsibilities and knowledge requirements will still remain. By outsourcing, the capital asset risks and responsibilities are managed by an external party. If the capital assets have an essential role in the company's operations process, also the maintenance activities and capital asset management should be considered as vital.

Asset management can be outsourced through the service provider's financial services, namely through operating lease, financial lease or maintenance lease arrangements. The service provider's fleet planning and optimisation services may be used to optimise the fleet so that the tasks are carried out most efficiently (i.e. right amount of forklift trucks fine-tuned for the host company's processes)

The host company seeks efficiencies in asset management and ultimately on investment productivity by outsourcing the asset management tasks to the service provider. When outsourcing asset management with a maintenance lease, the service provider will be responsible for efficient maintenance operations and the performance of machines. These issues were explained in greater detail in chapter 6.2. In addition to technical aspects, the host company seeks also financial efficiencies, as illustrated in figure 15.

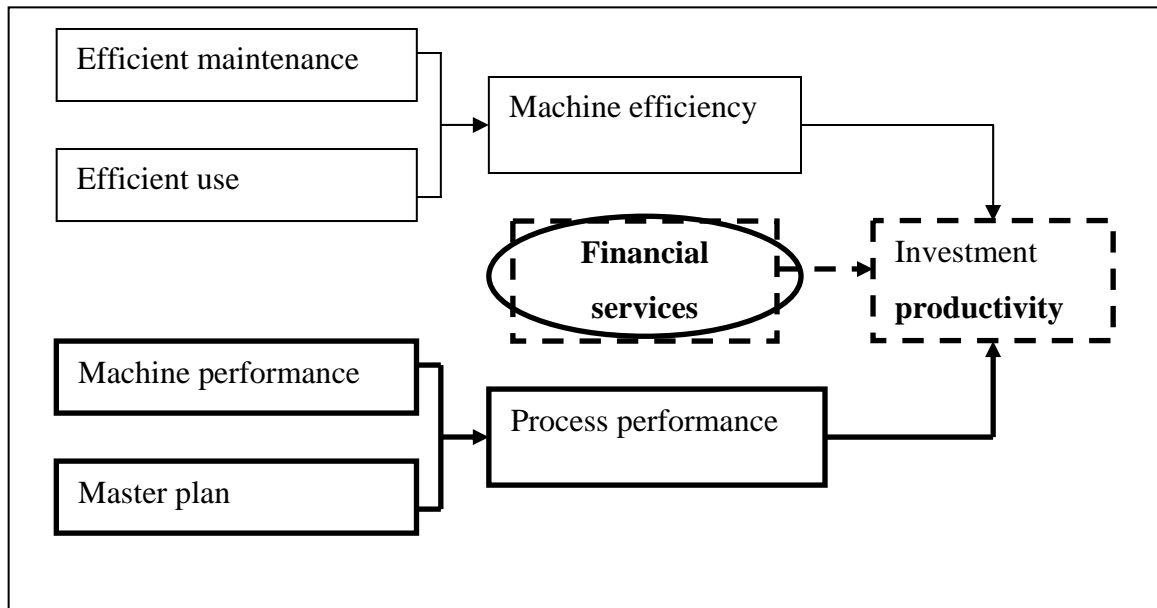


Figure 15. “Factors affecting investment productivity” (adapted from Järviö, 2004), CASE: asset management outsourcing, financial services and emphasis added by the present author.

Using financial services the host company does not any longer have pure investments in the forklift truck fleet. Its capital assets related to the forklift truck fleet are freed (through the service provider to a financial institution’s assets) and available for more profitable targets. Efficiencies are derived from the reduction of fixed assets (because of today’s quarter economy) and sharing of financial risk between the host company and the financial institution.

The leasing arrangements improve the machine performance, as the service provider provides the host company with a forklift truck fleet that consists of reasonably new forklift trucks.

In the case of the maintenance lease, the master plan describing both machine production -related objectives and maintenance policies through the life cycle of the machines will be prepared jointly with the host company (e.g. capacity requirements), the service provider (maintenance policies) and the financial institution (economic working life).

6.4 Outsourcing of the forklift truck use

The responsibilities of the supplier and the host company concerning the use of the forklift trucks are presented in table 10.

Table 10. Responsibilities related to the use of forklift trucks.

SUPPLIER	HOST COMPANY
<u>Strategic level</u>	<u>Strategic level</u> Human resource management Target setting Operations planning and control Operations development Reporting
<u>Tactical level</u>	<u>Tactical level</u> Collaboration with in-house units Planning and control of operation practices
<u>Operative level</u>	<u>Operative level</u> Use of forklift trucks Reporting in a case of malfunction Routine maintenance works Preparation of outbound deliveries (ordering from stock, reporting) Preparation of transportation documents Loading of trucks Reporting

The use of forklift trucks has a vital role in the company's core business process, namely in warehousing and dispatching phases that take place after the actual

production process (grey area in figure 6, page 15). From the operation process point of view the core competency areas of warehousing and dispatching operations are warehouse logistics and outbound logistics.

From the manufacturer's and its customer's points of view it is imperative that the customer requirements are adequately met, meaning that the service levels in warehousing and dispatching operations are on an adequate level. Products should also be stored, handled and transferred without negative effects on product quality. In addition, from the customer's point of view it is important that the operation process serving the customer is fine and reliable and that there are no problems concerning communication between the manufacturer and the customer.

When outsourcing the use of forklift trucks, the service provider takes over the host company's responsibilities presented in table 10. The host company typically seeks ways to improve the machine efficiency and ultimately investment productivity by contracting the use of its forklift truck fleet, as illustrated in the figure 16.

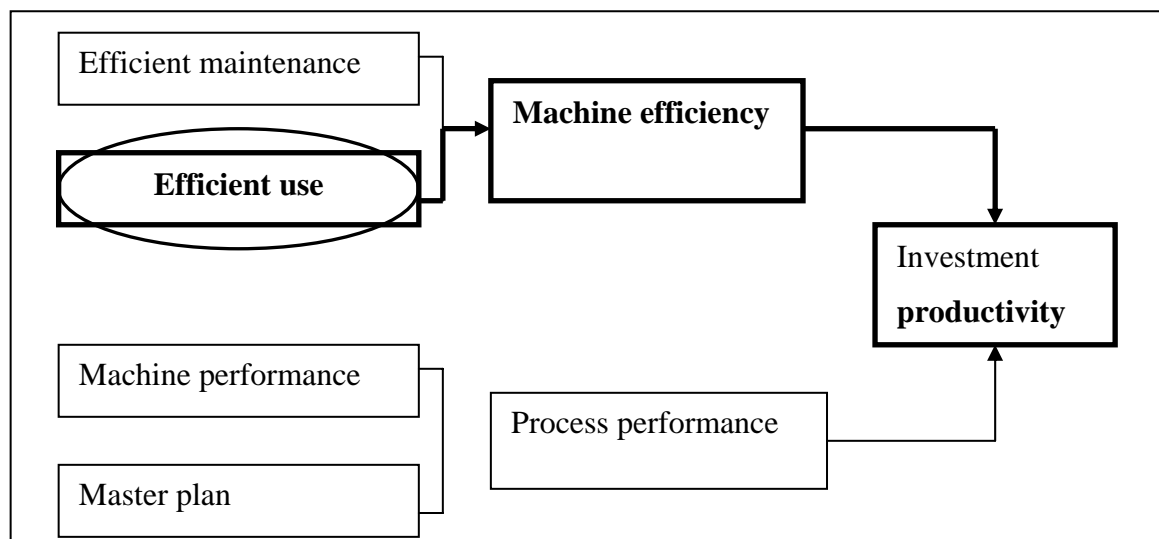


Figure 16. "Factors affecting investment productivity" (adapted from Järviö, 2004), CASE: outsourcing of the forklift truck use, emphasis added by the present author.

When examining the efficient use of a forklift truck fleet only from a technical point of view, it may be considered to require e.g. technically proficient, rapid and economical use, and operating practices that keep the condition of the machine better.

These technical issues can be rather easily contracted by the host company and performed by the service provider.

In addition to the technical issues, the forklift truck fleet operator must have 1) a deep understanding on the host company's processes both in terms of material and information flows, 2) capabilities to participate in information flow operations (information inputs and outputs), and even 3) an understanding on different requirements expressed by the host company's customers. Overall, the emphasis in issues related to the use of forklift trucks should be correct handling methods and rapid deliveries, and fast and reliable delivery related information flows. These issues are far more demanding and complex than pure technical issues and pose a real challenge for any service provider. After all, the host company may seek ways to improve the efficiency of the forklift truck use - also beyond pure technical aspects.

7 CONCLUSIONS

This research report concentrated on outsourcing issues of the forklift truck fleet and on a new operational model for material logistics of maintenance.

A new model for material logistics of maintenance solving some problems related to the conventional operational model was illustrated. This model changes contractual relationships dramatically along the material logistics supply chain and increases the customer's visibility and power on material logistics delivery costs that have so far remained a mystery. The contents of the altered procurement contract and the new service contract were described. Information flows between the parties and the responsibilities of each party were also illustrated both with the conventional and the new operational model.

The sources of added value in the operational model for material logistics of maintenance were identified. The new model provides the customer with information that has not been available earlier. Added value is generated in the new model through improved cost reporting, improved delivery tracking, reduced workload in materials receiving operations and transportation cost savings.

Forklift truck fleet outsourcing solutions were examined in order to illustrate the responsibilities of the host company and the service provider both before and after the outsourcing. The customer buys outsourcing services in order to improve its investment productivity. The mechanism of how these services affect the customer company's investment productivity were illustrated.

Maintenance outsourcing and capital assets management outsourcing are with no doubt solutions that provide customers with added value by improving investment productivity. Outsourcing the forklift truck use seems to be a challenging task. Although the service providers may have technical competency and knowledge to operate forklift trucks efficiently and economically, it is also crucial to have a deep

understanding on the host company's processes, on the product characteristics and even on the requirements expressed by the host company's customers.

Outsourcing should be evaluated from company's operational process point of view, not just by concentrating on a single function or task. In the case of complete forklift truck fleet outsourcing, it could be useful to evaluate a single logistics service provider (having a clear core competency) that takes over the host company's finished product warehousing and dispatching activities. In this case the service provider's service offering should include the ownership of infrastructure, the use of forklift trucks and total management of capital assets. This way the forklift truck manufacturer's customer will be the logistics service provider, not e.g. a paper mill. The role of the forklift trucks will become extremely strategic, as the forklift trucks will be a part of the logistics service provider's core business. This may lead to a more deeper collaboration than the forklift truck manufacturer could ever have achieved with a paper industry company.

REFERENCES

Allen, S., Chandrashekar, A. (2000) Outsourcing Services: The Contract Is Just The Beginning, *Business Horizons*, Mar/Apr 2000, volume 43, issue 2.

Axelsson, B., Wynstra, F. (2002) *Buying Business Services*, John Wiley & Sons Ltd, West Sussex.

Berry, L.L., Parasuraman, A. (1991) *Marketing Services*, The Free Press, New York.

Finland Post Group homepage

(<http://www.posti.fi/english/business/outsourcing/ordersupplychain/logius/>),

20.7.2005

Grönroos, C. (1998) Marketing services: the case of a missing product, *Journal of Business & Industrial Marketing*, volume 13, number 4/5, MCB University Press.

Grönroos, Christian (2001a) Palveluiden johtaminen ja markkinointi, WSOY, Porvoo.

Grönroos, C. (2001b) The perceived service quality concept – a mistake?, *Managing Service Quality*, volume 11, number 3, MCB University Press.

Idhammar, C., Contract Maintenance or not? (part 1), viewed from:

(<http://www.idcon.com/article-cont1.htm>), 17.4.2005

Järviö, J. et al (2004) Kunnossapito, 1st Edition, KP-Media Oy, Rajamäki.

Kalmar Industries home page, products and services, services

(<http://www.kalmarind.com/show.php?id=636>), 15.4.2005

Kotler, P. (1997) *Marketing Management*, 9th Edition, Prentice Hall, Upper Saddle River, NJ.

Kotler, P. (2000) *Marketing Management*, 10th Edition, Prentice Hall, Upper Saddle River, NJ.

Lehtinen, J., Karvinen, M., Korhonen, K. (2002) PALKE – Palvelun tuotekehitysprosessi logistiikkayrityksessä, tutkimusraportti RTE 3747/02/2002, VTT Rakennus- ja yhdyskuntatekniikka, Espoo

Linde Forklifts homepage, service & support
(<http://www.linde-forklifts.com/en/p0097/p0002.html>), 15.4.2005

Normann, R. (1992) *Service Management*, Liber, Stockholm.

Piispa, T. (2005) Lecture material, Vuorimiespäivät, 1.4.2005

Piispa, T. (2003) Kunnossapidon materiaalilogistiikka käsitteenä – Kirjallisuustutkimus ja käsitteen määrittely verkostotalouden näkökulmasta, KPLOG osaraportti 1 versio 5, Teknillinen korkeakoulu, TAI Tutkimuslaitos, Espoo.

Rosenbloom, B. (1999) *Marketing Channels: A Management View*, 6th Edition, Dryden Press.

TNT Logistics homepage
(http://www.tntlogistics.com/en/services_technology/supply_chain_services/),
20.7.2005

Toyota Industrial Equipment home page
(<http://www.toyotaforklift.com/>), 15.4.2005

Tsang, A.H.C. (2002) Strategic dimensions of maintenance management, *Journal of Quality in Maintenance Engineering*, volume 8, number 1, MCB UP Limited.

Visser, J. K. (1998) Modelling maintenance performance: a practical approach, *IMA Conference*, Edinburgh.