RESEARCH REPORT 150

Pasi Kivinen – Anita Lukka

VALUE ADDED LOGISTICAL SUPPORT SERVICE: LOGISTICS COST STRUCTURE AND PERFORMANCE IN THE NEW CONCEPT

PART 3

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ABSTRACT

The aim of this study is to present an Activity-Based Costing spreadsheet tool for analyzing the logistics costs. The tool can be used both by customer-companies and logistics service providers. The study discusses the influence of different activity models on costs. Additionally this paper discusses about the logistical performance across the total supply chain

This study is carried out using an analytical research approach and literature material has been used for supplementing the concerned research approach. Cost structure analysis was based on the theory of activity-based management.

This study was outlined to spare part logistics in machine-shop industry. The outlines of logistics services and logistical performance discussed in this report are based on the new logistics business concept (LMS-concept), which has been presented earlier in the Valssi-project.

One of the aims of this study is to increase awareness of different activity models on logistics costs. The report paints an overall picture about the business environment and requirements for the new logistics concept.

Key words: logistics costs, outsourcing, spare parts, logistical performance

PREFACE

Companies are simultaneously trying to find out ways, how their cost structure could be lowered, and how the fixed costs can be transformed to variable costs. On the other hand customers are expecting price reductions and high performance of operations where total quality plays an essential role. This external and internal pressure drives companies to find out new and innovative activity models in their daily operations.

In order to reach a fruitful collaboration between a customer-company and a logistics service provider it is both parties interest to understand the costs involved in the concerned logistics operations. And in the long run the parties' should try to find new activity models in finding innovative logistics solutions and cost efficiency.

This report presents one way to analyze the logistics costs in spare part logistics in metal industry. Logistical performance analyzes, not merely the general discussions about service level, but the report also takes into account the specialties in concerned area of business.

I wish to thank Tekes, the National Technology Agency for participating in funding of this project, and KONE for giving me a possibility to participate in this research project. I also want to thank the following Valssi-steering group members and their organizations for fruitful collaboration and support during the project: Heidi Lindroth (Tekes), Tapio Jämsä (KONE), Mikko Ilola (Metso Paper), Kari Suninen (Larox), Kenneth Palmgren (TNT Finland) and Kyösti Enqvist (ValLog).

I express special thanks to Anita Lukka (LUT) and Aarto Kivimäki for their important overall role in realization of Valssi-project.

Lappeenranta 30th of September, 2003

Pasi Kivinen

TERMS AND ABBREVIATIONS

ABB	Activity-Based Budgeting
ABC	Activity-Based Costing
ABM	Activity-Based Management
BSC	Balanced Scorecard
CIS	Commonwealth of Independent States
CRM	Customer Relationships Management
CSP	Customer Service Policy
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
EWS	Enterprise-Wide System
IS	Information System
IT	Information Technology
ITT	Invitation To Tender
KPI	Key Performance Indicator
LMS	Logistics Management System
PC	Personal Computer
PO	Purchase Order
SMS	Short Message System
UPS	Uninterruptible Power Supply
VMI	Vendor-Managed Inventory
WMS	Warehouse Management System
XML	Extensible Markup Language

CONTENTS

1 INTRODUCTION

1.1 Background

There have been a lot of discussions both in business and research world about the cost efficiency and the importance of logistics performance. Companies are constantly trying to find out ways, how their cost structure could be lowered, and how the fixed costs can be transformed to variable costs. On the other hand customers are expecting price reductions and high performance of operations where total quality plays an essential role. This external and internal pressure drives companies to find out new and innovative activity models in their daily operations.

Outsourcing of logistics partly or completely has become a normal way of doing business, and in trying to solve the above-mentioned challenges. Companies are concentrating especially their resources on core activities, and in metal industry the spare part logistics services are outsourced increasingly to external service providers. The decision whether a customer-company is willing to outsource its spare part logistics operation lies on expected economic savings among some other issues. It seems that, generally speaking, companies seem to have problems to calculate their real costs of logistics operation, or the calculation does not take into account all necessary cost factors. This may lead to difficult price negotiations and in the worst case the outsourcing will not be realized due to incorrect cost-calculation information.

In order to reach a fruitful collaboration between a customer-company and a logistics service provider it is the interest of both parties to understand the costs involved in the investigated logistics operations. And in the long run the parties' should try to find new activity models in finding innovative logistics solutions and cost efficiency.

1.2 Aim and Method of Study

The aim of this study is to present an Activity-Based Costing spreadsheet tool for analyzing the logistics costs. The tool can be used both by customer-companies and logistics service providers. The study discusses also the influence of different activity models on costs. Additionally this paper discusses the logistical performance across the total supply chain.

This study is carried out using an analytical research approach, and literature material has been used for supplementing the research approach. Cost structure analysis is based on the theory of activity-based management. The activity and cost specifications that are defined in the ABC-tool are based on empirical practices, and the applicability of the tool was tested among some of the companies involved in this project.

1.3 Outlines

This study was outlined to spare part logistics in machine-shop industry. The outlines of logistics services and logistical performance discussed in this report are based on

the new logistics business concept (LMS-concept), which has been presented earlier in this project.

1.4 Project Integrity

This study was realized as a part of Tekes funded project "Value Added Logistical Support Service – Valssi" in Lappeenranta University of Technology during 2001-2003. The following organizations and companies have participated in the project:

- Lapppeenranta University of Technology
- Tekes (the National Technology Agency)
- KONE Group
- Metso Group
- Larox Group
- TNT Group and
- ValLog Corp.

2 THEORY OF ACTIVITY-BASED MANAGEMENT

The origins of activity-based costing are in John Deere Component Works (JCW). The early method of ABC was used for counting costs of screw-machines (Turney, 1994, p.79).

As purveyors of useful information, traditional cost systems, with their one-size-fit-all approach, are totally inadequate for today's businesses: Not only are they unable to supply tools for controlling costs, they cannot provide managers with the information they need to run their businesses profitably. The only way to control costs is by identifying the relationships between expenditures and the activities that cause them, and that information is not and never was available from traditional cost systems.

As the most forward-looking companies around the world became more and more dissatisfied with the inability of traditional cost information systems to provide them with meaningful information, new ideas began to be developed to better provide data to support the emerging management programs (e.g. Total Quality Management) and especially to deal with the impact of overhead on true cost information. From these ideas came the concept of activity-based management (Wiersema 1995, p. 3).

Having product, customer, and supplier cost information is very relevant for top management. To develop the most profitable customer service strategies possible, companies must have information systems that provide insights into the probable impact that alternative service strategies will have on profits. Knowing which customers, markets, and distribution channels are profitable is critical for achieving long-term competitive advantage (O'Guin and Rebischke 1999, p. B5-3).

2.1 Introduction of Activity-Based Costing

Wiersema (1995, pp. 3-4) has listed a few arguments that are the benefits of using ABM:

- *It allows you to control costs.* ABM identifies *causes* of problems, and automatically alerts you to inefficiency. It doesn't rely on traditional time reporting or budgeting systems.
- *It furthers common objectives.* ABM fosters task-oriented team management. It eases communication by identifying relationships that are easily understood by all.
- *It furnishes decision support*. ABM provides you with the best available information for supporting all decisions involving costs, from buying new equipment to finding your competitive niche. Many practical applications in the form of case studies appear throughout the book.
- *It eliminates surprises*. With the information provided by an ABM system, month-end financial results can be predicted easily and accurately.
- *It enables you to create accurate product cost*s. By directly linking up with financial results, ABM ensures a valid and up-to-date product costing system.

Kaplan and Cooper (1997, p.1) have extended the use of ABM more clearly in services. Leading companies are using their enhanced cost systems to:

- Design products and services that both meet customers' expectations and can be produced and delivered at a profit
- Signal where either continuous or discontinuous (reengineering) improvements in quality, efficiency, and speed are needed
- Assist front-line employees in their learning and continuous improvement activities
- Guide product mix and investment decisions
- Choose among alternative suppliers
- Negotiate about price, product features, quality, delivery, and service with customers and
- Structure efficient and effective distribution and service processes to targeted market and customer segments.

The cost information data can be used for benchmarking internal processes and external service providers. The benchmarking can be performed within own business area or within other business areas. ABM approach in benchmarking is a practical tool for finding the "best practices" in concerned area of investigation. In case of LMS concept here the ABM is especially a practical tool for pricing the services and products.

Kaplan and Cooper (1997, pp.4-6) note the ABM enables the organization to accomplish its outcomes with fewer demands on organizational resources; that is, the organization achieves the same outcomes at a lower total cost. ABM accomplishes its objective through two complementary applications: *operational and strategic* ABM.

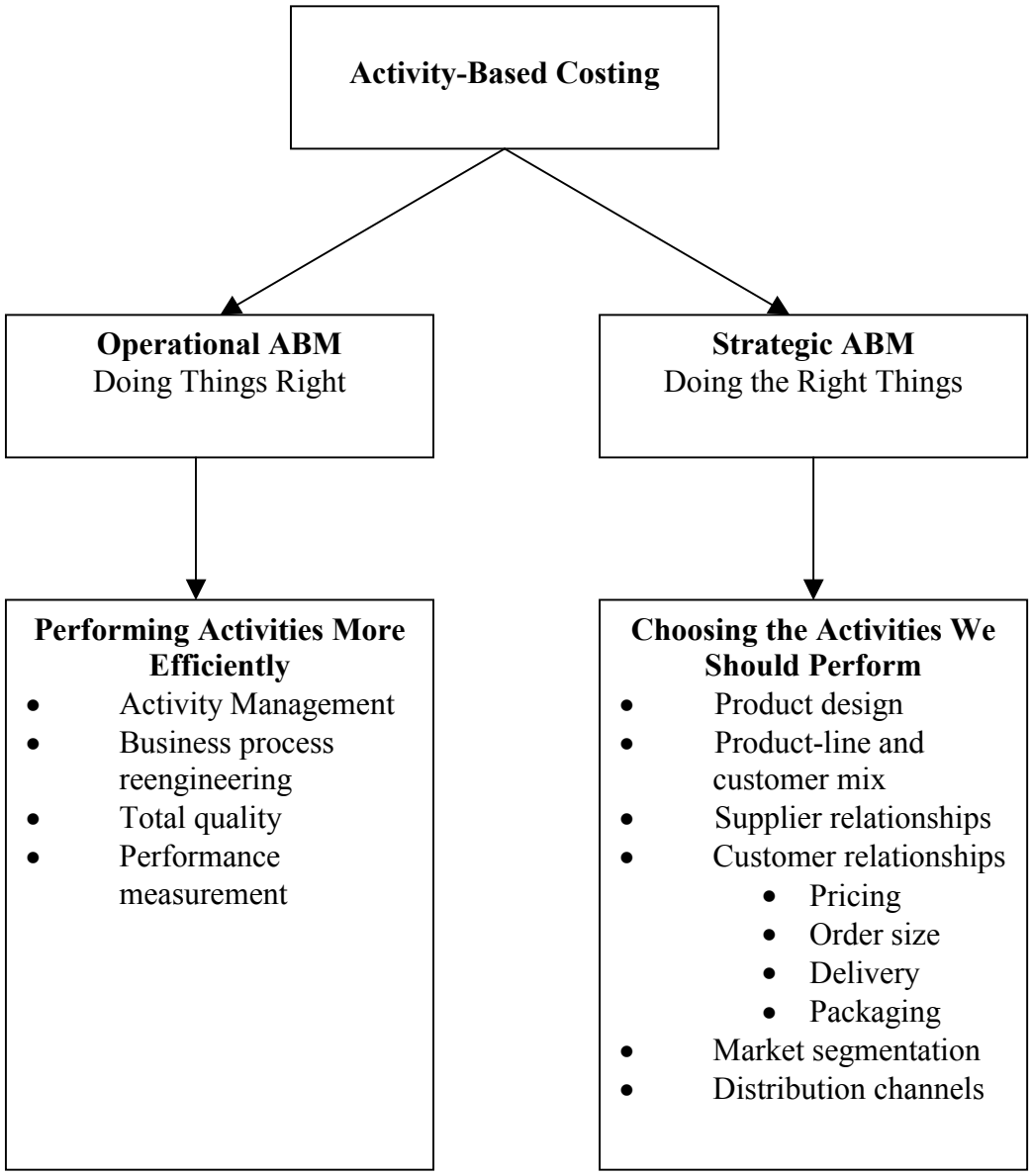

Figure 1. Using ABM for Operational Improvements and Strategic Decisions (Kaplan and Cooper, 1997, p. 4).

Operational ABM – doing things right – works to enhance efficiency, lower costs, and enhances asset utilization. Operational ABM can increase the capacity of resources (equipment and people) by reducing machine downtime, improving, or even eliminating entirely, faulty activities and processes, and increasing the efficiency of the organization's resources.

The benefits from operational ABM can be measured by reduced costs, higher revenues (through better resource utilization), and cost avoidance (the expanded capacity of existing resources obviates the need for additional investments in capital and people).

Strategic ABM – doing the right things – attempts to alter the demand for activities to increase profitability while assuming, as first approximation, that activity efficiency remains constant. The ABC model signals when individual products, services, and customers appear to be highly profitable, or unprofitable. Managers can also use ABC information to choose suppliers that are low-cost, not just low-price. Many companies use their ABC systems to provide product engineers and designers with better information at the best time to affect future costs.

Obviously, operational and strategic decisions are not mutually exclusive. Organizations will get the greatest impact when they reduce both the resources required to perform a given quantity of activities and, simultaneously, shift the activity mix to more profitable processes, products, services, and customers.

2.1.1 Process and Cost Assignment View

There are two perspectives of activity-based costing, which are depicted in the Figure 2. The Cost Management Systems Program and industry group, CAM-I developed a generic illustration of an activity-based costing model that added a dimension for performance improvement. Kaplan and Cooper (1997, p. 152-156) have also handled the Process and Cost Assignment View.

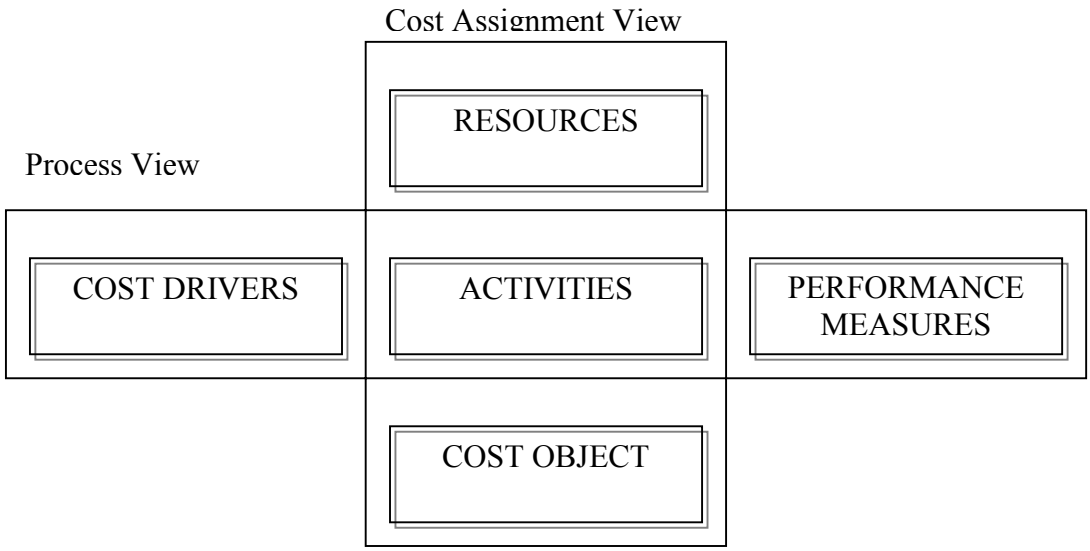

Figure 2. The two perspectives of activity-based management (Glad and Becker 1996, p. 24).

As the vertical perspective of Figure 2 depicts, resource driver assigns resources to the activities, and then the activities are assigned to the *cost objects*. ABC recognizes the cause-and-effect relationships of cost drivers to activities.

The horizontal perspective of Figure 2 indicates the process view of organization. The process focus in an organization facilitates the improvement of the business by re-

engineering the way business is controlled and by continuously improving the effectiveness of organization (Glad and Becker, p. 26-28).

Lumijärvi et al (1995, p.23-28) defines the ABC base model so that firstly the costs must be assigned to the concerned account object. An *activity* means the tasks that an organization performs. Secondly the *cost drivers* must be clarified. Cost drivers are factors that cause the activities. *Cost pool* description is used when cost of activities are discussed.

The Table 1 presents some samples about the activities and cost drivers.

Table 1. Sample activities and cost drivers (Lumijärvi et al. 1995, p.25).

Activity	**Cost driver**
Product design	- number of product's and product variations - number of raw-materials / parts
Handling of sales orders	- number of sales orders/order lines - number of customers
Control of manufacturing	- number of settings - number of batches
Quality control	- number of samples - number of analysis
Production	- throughput time - machine hours

According to Kaplan and Cooper (1997, p. 155) setting priorities for improvement of local processes is best performed within the framework of the Balanced Scorecard (BSC). The BSC approach to performance improvement identifies and highlights processes that are most critical for strategic success. It identifies those processes not only for their potential for cost reduction, but also for their ability to meet targeted customer expectations.

2.1.2 System Integration

In the mid-1990s, new hardware and software technology emerged that enabled companies to contemplate having an enterprise-wide system (EWS). An EWS can provide a company with an integrated set of operating, financial, and management systems. The EWS has a common data structure and a centralized, accessible data warehouse that permits data to be entered and accessed from anywhere in the world. With the new EWS technology, managers can bring together all their stand-alone ABC and operational improvement and learning systems into a single integrated system.

Perhaps the most important benefit of integration occurs when managers use their cost systems on a prospective basis – as part of an organization's financial budgeting

process. Existing cost systems treat budgeted expenses as given, independent of the ABM actions taken. The real payoffs from ABC and ABM, however, cannot, occur unless ABC information is an integral part of an organization's budgeting process. Activity-based costing gives organizations the opportunity to move from static to dynamic budgeting (Kaplan and Cooper, 1997, pp. 8-10).

2.1.3 Implementation of an ABC system

Lumijärvi et al (1995, pp. 24-25) state that practical experience has proved that before ABC project is started and implemented in practice it is good to get answers for the following questions:

- What is the scope and aim of ABC?
- For what purposes is the ABC system used?
- Does the project concern only an acute problem or does it concern the ERP system's development?
- What is the added value of new information: benefits and who can use it?
- What information is critical from the business control point of view?
- Is the information needed for analyzing products, services, customers, distribution channels, market areas or something else?
- Who needs the information?

Cooper and Kaplan (1991, p. 387) recommend that the following decisions have to be constructed to form the basis first:

- Should the system be integrated with existing system or should it be a stand-alone system?
- Should a formal design be approved before implementation?
- Who should take "ownership" of the final system?
- How precise should the system be?
- Should the system report historical or future costs?
- Should the system report historical or future costs?
- Should the initial design be complex or simple?

The first phase in implementation of ABC system takes approximately 3-5 months and generally the work produces following results (Lumijärvi et al. 1995, p. 28):

- Activities are defined
- Activity chains are described
- Cost drivers are defined
- Activity-based costs are counted and profitability
- Future steps are decided.

The most time-consuming part of implementation project is the data gathering, and the first phase is critical for the success of the project because it judges the reliability of results.

The second phase of project – integration of ABC as part of accounting - lasts from few months till several years.

The implementation plan can be executed for instance as suggested by Lumijärvi et al (Figure 3):

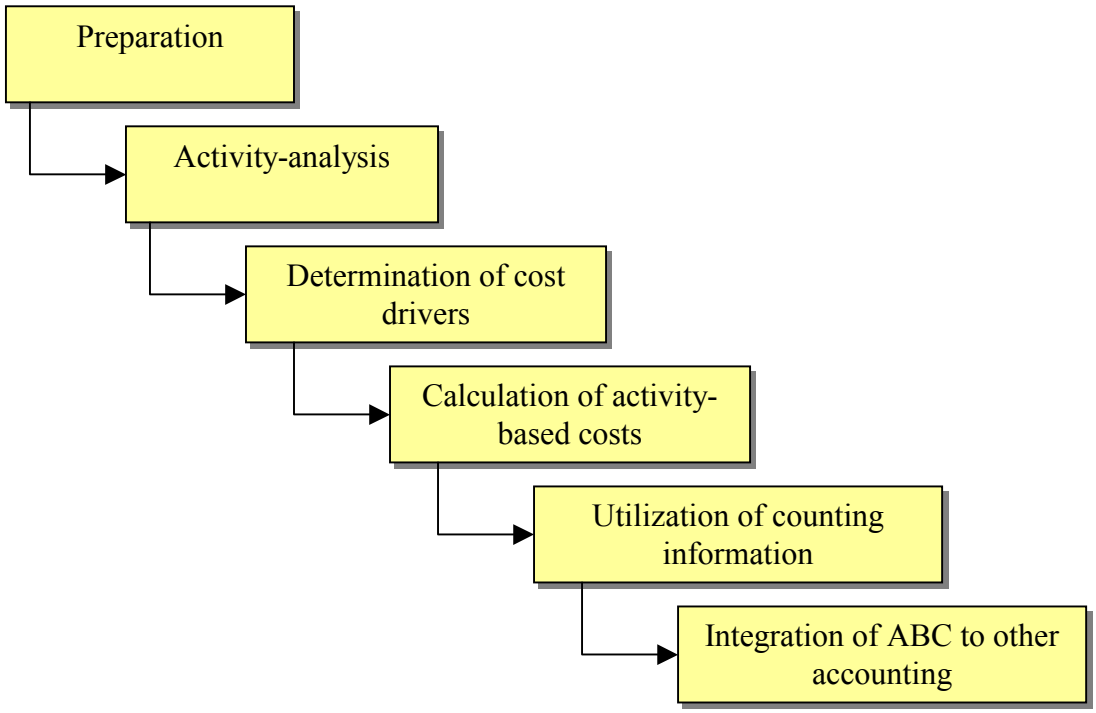

Figure 3. ABC implementation plan (Lumijärvi et al., 1995, p. 23).

2.2 Insourcing and Outsourcing – Make-or-Buy Decision

Wiersema (1995, p. 131) states that insourcing and outsourcing are about whether to make or to buy. By their nature, these decisions – equally applicable to manufacturing and service companies – are part of a long-term strategy that determines a company's most significant commitment of resources. Almost every operation comes about because of these decisions, which involve choosing what type of specialization is most beneficial.

Insourcing and outsourcing merit only the most realistic accounting techniques. Here, ABM should be made a definite priority.

2.2.1 Outsourcing under ABM

Outsourcing, the "buy" alternative, allows you to focus on what you are best. Cost analysis is a continuous striving to understand company's competitive advantage. One company's niche capabilities may augment the strengths of others. Just being able to recognize the costs involved can help in making these decisions.

With ABM budgets, cost records may be ignored in the make-or-buy decision. As a practical matter, only those activities that discontinue under outsourcing should be used in determining the cost to make. Additionally, with ABM it is possible to adapt activity analysis to make-or-buy decisions. With outsourcing, certain activities will discontinue, whereas others will continue at potentially differing rates. A sample about ABM approach is presented in the Table 2.

Table 2. ABM approach: Make-or-Buy Decision (Wiersema, 1995, p. 135).

Cost allocation	***Make***	***Buy***
Purchased material:		
Raw	150 000	
Finished		450 000
Process costs:		
Maintenance	10 000	
Operators	50 000	
Operator taxes and benefits	10 000	
Power	10 000	
Supplies	5 000	
Tooling	5 000	
Support costs:		
Accounting	10 000	5 000
Administrative	15 000	5 000
Inspection	15 000	10 000
Material handling	20 000	10 000
Supervision	10 000	5 000
Related taxes and benefits	15 000	10 000
Fixed costs:		
Equipment depreciation	75 000	75 000
Occupancy	90 000	90 000
Executive compensation	10,000	10 000
Total:	***500 000***	***670 000***
Loss from outsourcing	***170 000***	

Some activities and their associated costs continue consistently after the outsourcing process. “Variable” activities like material handling and inspection must occur whether the parts arrive raw or finished. Depreciation appears under both alternatives because it is a noncash expense representing allocation of an asset’s historical cost, which will not be saved through outsourcing (Wiersema, 1995, p. 131-135).

2.2.2 Insourcing under ABM

Insourcing means bringing in-house an operation that has previously been performed by a supplier or customer. It is the "make" alternative in a make-or-buy decision. As such, it usually involves acquisition of new equipment and people. The benefits of insourcing and other capital expenditures are at the heart of a new operation and create potential competitive advantages. But the decision should consider effects on the operation as a whole.

Costs associated with a new operation include the initial investment, fixed overhead, and variable (volume-related) costs. The ABM approach is a line-by-line before-and-after listing of costs, as shown in Table 3. Determing the appropriate projected amounts that will be incurred "after" bringing the operation in-house requires relating costs to their causes. This is where ABM activity drivers come in. It is possible to estimate the change the volume of certain drivers, and to follow-up what is the influence on other drivers and total costs (Wiersema, 1997, p. 134-143).

Table 3. Make-or-Buy Decision: Format (Wiersema, 1995, p. 140).

Cost allocation	***Buy***	***Make***
Initial investment:		
Equipment costs	N/A	€_____
Tooling purchases	N/A	€_____
Setup cost	N/A	€_____
Learning costs	N/A	€_____
Total		
Fixed overhead:		
Occupancy	€_____	€_____
Indirect labor	€_____	€_____
Other	€_____	€_____
Total	€_____	€_____
Variable:		
Direct material	€_____	€_____
Material-related costs	€_____	€_____
Direct labor	€_____	€_____
Labor-related costs	€_____	€_____
Normal inefficiency	€_____	€_____
Variable indirect labor	€_____	€_____
Equipment-related costs	€_____	€_____
Other operating costs	€_____	€_____
Total	€_____	€_____

The form covers the three cost categories of concern when making insourcing decisions: initial investment, fixed overheads and variable costs.

An ABM approach can be also used when making a *lease-or-buy* decision. One variable that the mechanical calculations cannot reflect is obsolence. Wiersema notes

that if an equipment is purchased forever, it is usually best to purchase, whereas if it is for three years, you'll probably do better lease.

2.3 ABC in Service Industries

Kaplan and Cooper (1997) state that while ABC had its origins in manufacturing companies, many service organizations today are obtaining great benefits from this approach as well.

A good example are the world-class logistics integrators who use the ABC approach for instance for analyzing the delivery routes, controlling process costs and customer profitability studies and pricing of services.

When the ABC model is extended outside the factory to include the activities of marketing, sales, logistics, purchasing and corporate staff, the service orientation of ABC becomes even more obvious. Service companies have exactly the same managerial issues as manufacturing companies. They need activity-based costing to link the costs of resources they supply to the revenues earned by the individual products and customers serviced by these resources. Because virtually all their operating expenses are fixed once resource supply has been committed, service organizations need the costing insights from ABC even more than manufacturing organizations (Kaplan and Cooper, 1997, pp. 228-229).

Service companies in general are ideal candidates for activity-based costing, even more than manufacturing companies. First, virtually all their costs are indirect and appear to be fixed. In many cases the service companies have virtually no material costs, and they have to supply all their resources in advance. All linkages between the costs of resources supplied and their use by individual products and customers must be inferred and estimated. ABC helps in operational cost and in measuring the costs and identifies the profitability of products and customers.

To summarize, why do service companies find it useful to understand the costs of activities, business processes, products, and customers? The demand for such cost information comes from three broad classes of managerial decision (Kaplan and Cooper, 1997, pp. 231-251):

- Managing products/services and customers
- Configuring the customer service delivery chain and
- Budgeting the organization's supply of resources.

2.4 Using ABC for Budgeting and Pricing

When managers have access to EWS systems, they can use their ABC model to provide information for important, ongoing managerial processes, including budgeting, what-if-analysis and pricing. By using ABC for budgeting, a practice called "activity-based budgeting" (ABB), managers determine the supply of resources to operating units and responsibility centers based on the demands for activities they are expected to perform. Kaplan and Cooper (1997, p. 301) state that activity-based

budgeting is an extremely important application; it is the process by which costs, previously thought to be fixed, are made variable.

What-if analysis enables managers to assess the consequences of major changes in product and customer mix.

Uusi-Rauva (1989, pp. 35-37) says that one task of management accounting is to collect cost information and to combine this information for different purposes. An important task is to support company's pricing of products. A basic fact is that a customer does not purchase costs but products. So basically it means that a customer is not interested in knowing how much are the manufacturing costs in the product.

On the other hand, for pricing and tendering process, it is necessary for the seller to know the product costs and the dependence of them on different issues. With aid of this information it is possible to make verifiable profitability calculations. The result of calculation is not a sales price but only a calculatory minimum.

The price of the product is one of the most important factors that have influence on sales volume. This claim is valid especially if a manufacturing company sells its own products. In case of a subcontracting company there may be only two options valid; either it gets a full volume or it loses the whole sales volume.

2.4.1 The Activity-Based Budgeting Process

The ABB process description in this chapter follows mainly the procedure presented by Cooper and Kaplan (1997, pp.301-313).

Kaplan and Cooper state that real sustainable payoffs from ABC and ABM cannot occur unless they become embedded in the organization's budgeting process. Activity-based budgeting offers the opportunity for budgeting process to be based more upon facts compared to traditional budgeting systems.

Activity-based budgeting is simply activity-based costing in reverse. The ABC process starts from assigning resource expenses down to activities, and, via activity cost drivers, down to objects like products, services, and customers. In activity-based budgeting, the analysis flows from down to top. Kaplan and Cooper note that activity-based budgeting follows the following sequence:

1. Estimate next period's expected production and sales volume by individual products (services) and customers
2. Forecast the demand for organizational activities
3. Calculate the resource demands to perform the organizational activities
4. Determine the actual resource supply to meet the demands and
5. Determine activity capacity.

The Figure 4 presents how the ABB reverses the causal relationship of an ABC model.

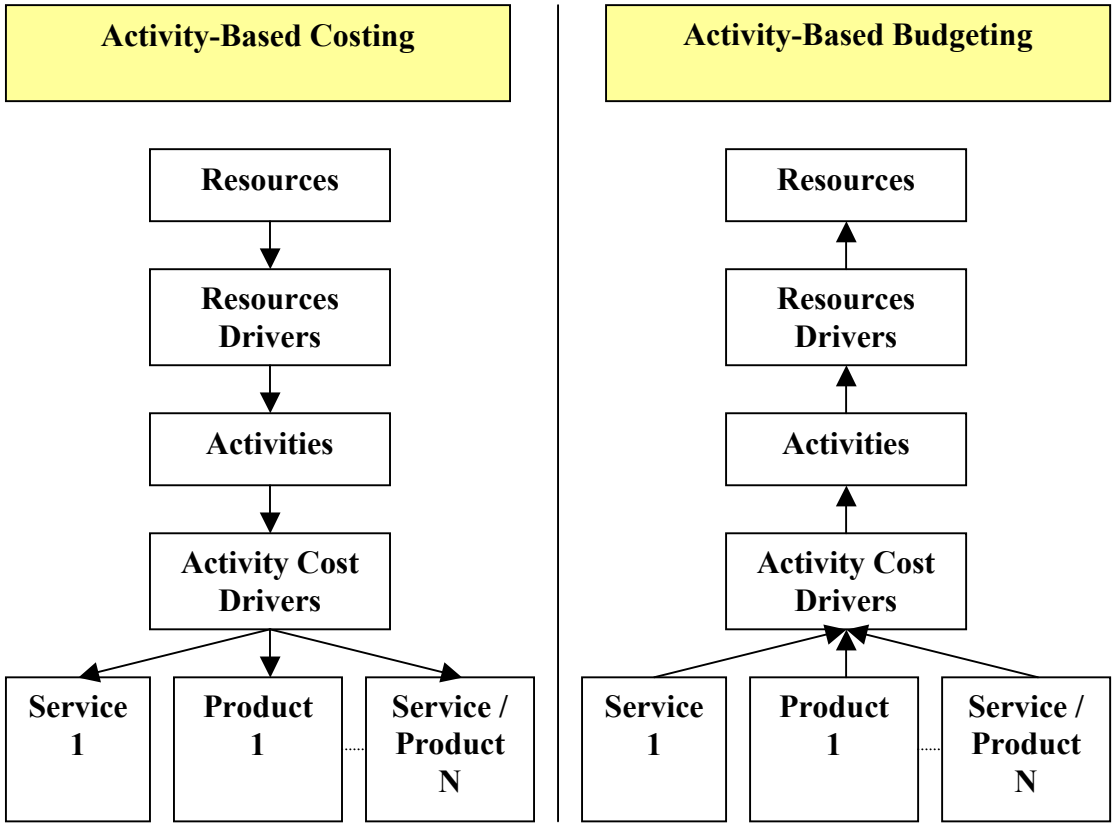

Figure 4. ABB Reverses the Causal Relationships of an ABC model (adapts partly ideas presented by Cooper and Kaplan, 1997, p. 303).

The organization starts with estimates of expected production and sales volumes and mix. The estimates include not only the products and services that will be sold, but also the individual customers (or customer types) expected to buy them. The budgeting exercise continues by forecasting the demand for organizational activities required to meet the forecasted volume and mix of products, services, and customers. Activity-based budgeting extends the conventional exercise by forecasting the demands for all the indirect and support activities: ordering, receiving, handling materials, processing orders, complaints, requests for technical support etc. The ABB exercise estimates the expected *quantity for all activity cost drivers* (see Table 4). The estimates of demand are required to be more specific in ABB approach.

Table 4. Sample Estimates of Demand in Warehousing.

Conventional approach		
Customer A Customer B Customer C	3 employees 4 employees 6 employees	€ 90 000 € 120 000 € 180 000
ABB approach		
Customer A	5 000 orders (inbound) 21 000 orders (outbound)	10 000 order lines 33 500 order lines
Customer B	8 900 orders (inbound) 35 000 orders (outbound)	18 000 order lines 47 000 order lines
Customer C	10 000 orders (inbound) 13 700 orders (outbound)	19 600 order lines 59 300 order lines

With knowledge of the expected *quantity* of demands for activities, the budgeting team then estimates the resources that must be supplied to perform the demanded level of activities. The forecast of resource supply is based on an understanding of the underlying efficiency of performing activities. With aid of demand it is possible to simulate how the changes in the demand for resources by multiple activities accumulates into changes in the total demand for different resources.

Table 5 shows a sample how the budgeting process converts the demand for resources to perform activities into an estimate of total resources of each type that must be supplied. In fact, the Table 5 presents only one demand of resources, so similar exercise hast to be done in order to calculate other concerned activities too.

Table 5. Sample Estimates of Resource Demands in Warehousing.

Customer A	
Budgeted order lines (inbound) / year	10 000
Capacity per person / year (lines)	15 000
Estimated spending of resources	1 person
Consumed resources	10 00/15 000=0,67 persons
Unused resources	1-0,67=0,33 persons

In general, each resource has a particular resource spending profile. The ABB process uses three basic profiles of resources: flexible, committed and committed-step function. Figure 5 presents the differences between spending profile types of resources. In short, it is important to understand and notice the spending pattern of different resources that provide the activity.

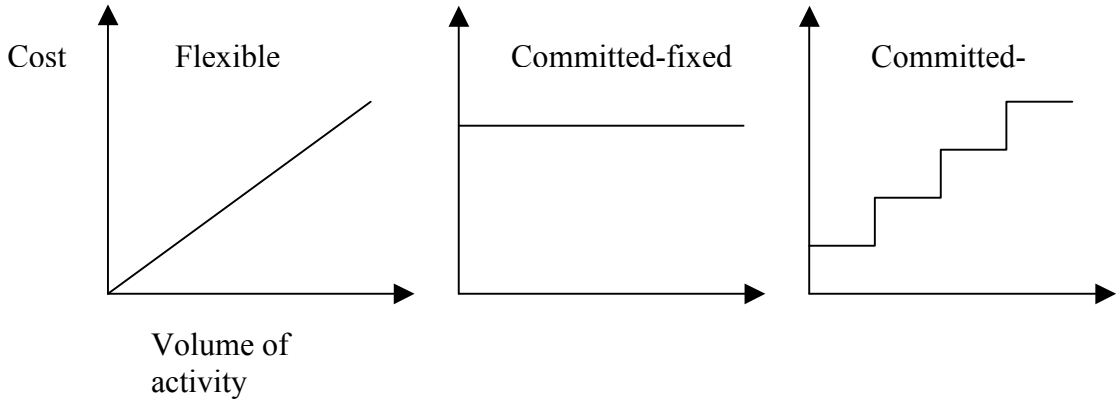

Figure 5. Different Resources Have Different Spending Patterns (Cooper and Kaplan, 1997, pp.308-309).

When all the resources an activity have been identified, the user can determine the practical capacity of the activity, which is the capacity of the resource that first constrains the ability of the firm to perform the activity. In ABB, there are two forms of capacity, one at the activity level and the other at the resource level. From efficiency point of view the ultimate goal of using ABB is to decrease the costs of performing an activity, and secondly any activity should be performed less often.

In practice ABB is not a simple exercise. The level of information has to be accurate, a lot of specified details of processes and figures need to be tracked, and they have to be easily available. When ABB is performed successfully, however, managers will have greater control over their cost structure, in particular more control over their so-called fixed costs.

How ABM and ABB lead to *Variable costs*? Kaplar and Cooper state that firstly demands for resources decrease as operational ABM improves the efficiency of activities and strategic ABM reduces the demand for activities, and secondly, budgeting and management processes must eliminate excess capacity spent on the resources.

2.4.2 ABC in Pricing

Wiersema (1995, pp. 150-151) states that essential to a pricing strategy is a normal profit idea, or the amount that goods and services are expected to contribute on average, to be determined through formal budgeting. Through awareness of markets, managers can make decisions on the value bill (billing customers according to a perception of value rather than according to standard rate) or achieve excess profit on certain niche items, or they may accept lower profits when trying to break into a new market. Markup decisions may be correlated also capacity availability.

Lyly-Yrjänäinen and Paranko have come on the conclusion that in logistics companies product profitability should not be calculated in the same way as is typical

in the manufacturing industry. Traditional activity-based product-cost calculations are mostly distorted by:

- Large share of batch level activities
- Great variation in delivery batch sizes between customers
- Different sales prices to different customers
- Variation in delivery batch sizes and even in sales prices of a particular product for one customer.

Thus, it is evident that product profitability cannot be calculated on the basis of average batch sizes and sales prices. The importance of batch level activities and great variations in batch sizes are the main reasons why the profit of every single sales position should be calculated separately. The ABC approach can also be applied in the customer-specific cumulative profits of the product, which create a strong basis for decisions concerning product and customer mix (Lyly-Yrjänäinen and Paranko, 2001).

Pricing for service businesses may be more complex than retail pricing. The equation, however, is the same: Cost + Operating Expenses + Desired Profit = Price

Applying ABC to service organizations requires a keen appreciation of costing for committed resources. Managers can use the ABC information to develop products and services that can be delivered to customers at prices that cover the costs of resources used, thereby enabling them to serve customers in profitable relationships (Kaplan and Cooper, 1997, p. 251).

Due to the fact that the logistics companies are operating in highly competed business environment the pricing of services becomes an important issue. Companies need to understand the nature of activity-costs as illustrated in Figure 4. The excess capacity cannot be included in the selling prices because it leads most probably to lost contracts. ABC-approach in pricing is also an important tool for analyzing which company-level support-activities are adding value and whether these activities are really needed. With the aid of activity descriptions and cost drivers it is possible to analyze the service provider's "full-cost" price of services and to benchmark it with market price. This gives a good base for profitable business relationship, because the pricing of services is challenging and the risk of under or over-pricing is high if all the cost factors have not been analyzed. ABC-approach an also be used for calculating the sales prices in case of changes in operational processes. With ABC it is possible to review the impacts of these changes.

2.5 Cost Management in Networking Environment

The LMS concept is based purely on networking operations. Therefore establishment of networks around LMS could lead into wider interest in network measurement.

An enterprise net can be defined as a group of companies taking part in the same supply chain. A firm network can be defined as groups of companies taking part in many supply chains across industries. Both academic and business worlds discussed

networking a lot in the 1990's. However, management accounting and especially cost management have not widely been studied in networks (Kulmala & Varis, 2001).

Cooper & Slagmulder (1999) have analyzed cost management practices that include both the customer-supplier relationship and product dimensions. "Interorganizational cost management is a structured approach to coordinate the activities in a supplier network so that total costs in the network are reduced (Cooper & Slagmulder, 1999, pp. 145-146). A firm is using interorganizational cost management if the next four points occur at the same time (Cooper & Slagmulder, 1999, p. 3):

1. The firm sets specific cost reduction objectives for suppliers
2. The firm helps its customers and/or suppliers find ways to achieve their cost reduction objectives
3. The firm takes into account the profitability of its suppliers when negotiating component pricing with them
4. The firm is continuously making its buyer-supplier interfaces more efficient.

Kulmala & Varis (2001, p. 6) state that there are three general requirements for cost management in networks:

I. A company should know the costs of its own operations
II. A company should share part of the cost information bilaterally with co-operating firms
III. Part of the information flow should be multilaterally open to all the companies in the network.

Obviously, there are different types of networks. Also the classification principles may vary. The following classification, by Pfohl & Buses (2000), is a very good basic approach.

Networks can be divided into four classes: strategic, virtual, regional, and operative. Virtual and regional networks include actors from several industries. The difference between these is the fundamental use of IT solutions and competencies: a virtual network consists of companies that have different competencies and in which contacts are mainly organized by IT. Regional networks rely on social interaction in a limited geographical area and member companies may have overlapping competencies. Operative network is defined by "relatively standardized transactions", emphasizing efficiency in operations. The specialty is that trust is not needed because of contracts that consider only a limited area of network members' operations and that are market-based. In a strategic network, "hierarchical" structure is led by strategic center" and "distribution of power asymmetrical. Typically strategic networks are organized around physical material processes (Pfohl & Buse, 2000).

In practice, real networks have combinations of several of these combinations. In case of LMS-concept the networks have mainly features from virtual and strategic approaches.

3 COST STRUCTURE OF SERVICES IN THE LMS-CONCEPT

This chapter handles the cost structure of services, which were defined in the Valssi-project's report 'Trends and New Concept Model' (Kivinen – Lukka 2002, pp. 55-58). In short, the logistics modular service concept includes the following processes (see also Appendix 1):

- Warehousing
- Manufacturing
- Transportation
- Customer service
- Procurement
- Quality control
- Reverse logistics
- Recycling logistics
- Logistics technology
- Packaging
- Consultancy and
- Value added services.

Appendix 1 includes the Activity-Based Costing tool. The figures presented in the tool are fictive and only for the sake of sample.

As discussed earlier in the chapter 2.5 the cost management in networking environment is an essential issue from cost efficiency point of view. Without a proper cost management system the LMS concept will not be successful. It is the advantage of both customer company and logistics service provider that the costs involved in the supply chain are known and mutually recognized. It gives a good basis for finding the balance between costs in order to achieve a 'win-win' partnership.

This chapter defines the activities and cost types of different service modules. The activity and cost specifications that are defined in each module are based on empirical practices. Also literature information sources have been applied.

As a general observation it can be mentioned that the accuracy requirements of product and service cost accounting vary case by case even within a company. The availability and reliability of basic data depends on a company's ERP-system and how accurately the information is reported into the system.

This Chapter does not include discussions about the overhead costs. In case of LMS-company these overhead costs could be for instance salaries of management and support organizations' personal costs (e.g. legal and accounting department). Bowersox and Closs (1996, p. 647) suggest that as a general rule to follow is that a specific cost should not be assigned to logistical factors unless it is under the managerial control of the logistical organization. But in pricing of logistical services a company has to be aware of these expenses, and finally the profit received from services should cover these costs. This management fee should be shared with all customers according to resources used.

3.1 Warehousing Service

The warehousing service is divided into two different processes; stock and consolidation process. *Stock process* means that the incoming goods are delivered from suppliers into a warehouse, where the goods are stocked and shipped according to orders received from customers.

Consolidation process means sorting and merging batch picks into individual order. This must be done when consolidating several (more than one) orders into one order. Consolidation is the extra work for sorting the orders.

3.1.1 Stock process

Stock process includes the activities found in most warehouses. Table 6 presents the descriptions of activities in stock process.

Table 6. Stock process activity list (adapts partly the activity description presented by Frazelle 2001, pp. 229-231).

Activity Type	***Description***
Receiving	Receiving is a collection of activities involved in (a) the orderly receipt of all materials coming into warehouse, (b) providing the assurance that the quantity and quality of such materials are as ordered, and (c) placing materials to area for next step of process.
Putaway	Putaway is an act of placing goods in storage. It includes the material handling, location labels and verification and product placement.
Storage	Storage is the physical stocking of goods while it is awaiting a demand. The storage method depends on the size and quantity of the items in inventory.
Order picking	Order picking is the process of removing items from storage to meet a specific demand. It is the basic service a warehouse provides for the customers.
Packing	Packing is done after the picking process. Packing is done for preparing a shipment ready for shipping. Packing may include the following tasks: checking order for completeness, packing goods in an appropriate shipping package, weighing shipments and accumulate orders by outbound carrier.
Shipping	Shipping may include the following tasks:

	- doing needed activities into the information systems - printing and attaching of waybills (freight notes) - preparing other needed shipping documents (e.g. packing lists and invoices) - forwarding activities.
Loading	Loading means the physical loading of trucks.
Inventory counting	Inventory counting includes the - preparing of inventory counting - physical counting work - booking the counting results into the systems

Table 7 presents the different cost types that have influence on the cost structure in stock process. A more detailed description is outlined in the right column.

Table 7. Stock process cost types.

Cost Type	***Description***
Labor cost	Direct labor cost in concerned activity including supervisors, warehouse and office employees (incl. social security fees). Includes bonuses and personnel training costs.
Equipment cost	Equipment costs include: - warehouse/office equipments' capital and leasing costs and - service/maintenance costs of equipment
IS cost	Information system (WMS) and technology costs are caused by: - IT and software investments - use and maintenance of them - programming of software
Running cost	Running costs include: - electricity, heating, water, waste water, fuel - waste service, cleaning, security, maintenance - insurance (house and equipment) - copying, printing - traveling - telephone charges - office accessories and others.
Land cost	Land costs include warehouse buildings and relevant yard's rent if it was rented.
Space cost	Space cost includes warehouse&office space and fixed furniture costs

Labor costs have to be directed to each activity according to resources used in each activity. The same principle can be used when calculating the equipment costs that are used in the warehouse. It may be difficult to exactly appoint the equipment, IS, and running costs into individual activities. Probably the most useful way to direct the costs here is to calculate the concerned costs in company/unit level, and then divide the total costs by total number of employees. The cost per employee is then directed to activities according to resources used in each activity. Land costs may not be applicable to be calculated for companies who are not willing, for any reason, to rent its excess premises to external markets. Space costs can be directed to each activity according to used area in individual activity.

After the total costs are calculated the activity-based calculation continues with identifying the cost drivers and driver quantities. It has to be understood here that there may be two interests in finding out the cost per transaction. Firstly, what is the cost with current way of working, and secondly, how much there is unused capacity in current operation. So, with aid of activity-based costing tool, it is possible also to simulate, what the costs per transaction would be, if the full capacity would be in use. Especially the logistics service providers have to calculate the selling prices without any inefficiency in prices in order to be competitive in open markets.

The calculation period can vary according to the needs of company. Typically, in order to achieve a reliable calculation result, the calculation period is 12 months, but it can be any period as long as all the figures are calculated by using same basic assumptions.

Appendix 1 "Warehousing" presents a model of activity-based costing tool for calculating the warehousing costs. As an end result the stock process table calculates the following figures:

- Cost of inbound order line and
- Cost of outbound order line.

Here the inbound line includes the costs of receiving, putaway and inventory counting processes. The outbound line includes storage, order picking, packing, shipping and loading processes. The graphical figures help also in analyzing and identifying the different sources and cost allocations.

Quite often a company does not have accurate cost information about the individual processes. In this case, it is possible also to calculate an approximate cost of inbound and outbound line. Firstly, the number of inbound order lines (receiving) and outbound (shipped) lines should be known for estimating the costs. Secondly, the different cost types (labor, equipment…) should be calculated in order to get the total sum of costs. Then the total cost can be split to inbound and outbound operation according to number of cost drivers. For instance, if the labor costs in warehouse are in total, say, €200.000, and the warehouse handles 20.000 outbound and 2.000 inbound lines. The cost of single line is 200.000/(20.000+2.000) = €9,09/line. This calculation procedure does not meet the accuracy principles of ABC, but at least it gives an indication about the cost level.

During the discussions, with participating companies, the following problem areas were observed during the data-gathering phase:

- Internal cost-allocation reporting methods vary from department to department
- There are discrepancies in reported costs
- Intra-company charges are not comparable with market prices
- Costs are not known in activity level because a lack of control system
- Costs are not reported in activity level because warehousing is not core-business for the company
- After deeper analysis the warehousing costs reported included for instance also activities from other LMS services (e.g. returns process).

As a conclusion, it is worth of mentioning that a world-class service provider should be able to control the costs on detailed activity level. So, as such, the success of LMS concept depends highly on the service provider's capability to control costs and develop real value-added processes.

3.1.2 Consolidation process

Consolidation process follows the same procedure as warehousing service. The only difference is that after the packing and before the shipping process an additional consolidation activity has to be performed (see Appendix 1 "Warehousing / Consolidation process"). Consolidation means sorting and merging batch picks into individual order. This must be done when consolidating several (more than one) orders into one order. Consolidation is the extra work for sorting the orders. The cost types are exactly the same as in normal warehousing process.

Cost driver of consolidation process is a parcel. In many cases a parcel is an appropriate unit for controlling the consolidation process, especially, if the consolidation does not require handling of goods on orderline level. If the extra work is caused by the fact the original parcels has to be opened and for instance re-packed (or any other extra handling by any means), it may be appropriate to use consolidated orderline as a cost driver.

3.2 Manufacturing Service

Manufacturing service includes the activities found in most machine-shop companies. A company may perform many of the activities by itself and some of the activities may be subcontracted from external markets.

In this study the manufacturing service is assumed to be a subcontracting function (service) without any own products. According to Uusi-Rauva (1989, pp. 62-63) a typical Finish machine-shop-product the share of assembly costs are 20-40 percents. Practical experiences show that in spare part manufacturing the share of human work may be even 60% of total product costs due to the fact the volumes are low and automation cannot be utilized during the production process.

Appendix 1 “Manufacturing” presents a model of activity-based costing tool for calculating the warehousing costs.

Table 8 presents the descriptions of activities in manufacturing process.

Table 8. Activity list of manufacturing service.

Activity Type	***Description***
Design	Design is an act of agreeing on design detail and then completing the drawings for next step of process.
Planning	Planning is a preparation phase for sourcing and production. The contribution of job planning is to ensure that the products are in time in production line for achieving the agreed delivery dates. Planning includes also the capacity-planning phase.
Sourcing	Sourcing is the process of purchasing or calling-off material for the production and assembly. It includes subcontracting arrangements.
Inbound operations	Inbound operations is a collection of activities involved in (a) the orderly receipt of all materials coming into production, (b) providing the assurance that the quantity and quality of such materials are as ordered, and (c) placing materials to area for next step of process.
Storage	Storage is the physical stocking of goods while it is awaiting a demand. The storage method depends on the size, quantity and frequency of use of the items in inventory.
Machining	Mechanical machining can include for instance the following tasks: Turning, milling, drilling, sheet bending and welding.
Assembly	Assembly means any assembling work done during the production phase.
Testing + quality control	Testing and quality control are performed in order to ensure the quality of end products. Performing functional and/or qualitative component tests during and/or after the production process can control quality.
Painting and finishing	Painting and finishing of products is done for protecting the products for damage and coating them in a suitable way.
Picking, packing and shipping	Picking, packing and shipping means that

	these activities are performed during any part of production process from the inbound process till the end products are shipped from productions premises.
Internal transportation	Internal transportation means the handling of goods during any part of production process.

Table 9 presents the different cost types that have influence on the cost structure in manufacturing process. A more detailed description is outlined in the right column.

Table 9. Manufacturing process cost types.

Cost Type	***Description***
Labor cost	Direct labor cost in concerned activity including supervision (incl. also social security fees). Includes bonuses and personnel training costs.
Equipment cost	Equipment costs include: - warehouse/office equipments' capital and leasing costs - machining equipment used in manufacturing process - service and maintenance costs of equipment - includes depreciation and interest cost
IS cost	Information system (WMS) and technology costs are caused by: - IT and software investments - use and maintenance of them - programming of software
Running cost	Running costs include: - electricity, heating, water, waste water, fuel - waste service, cleaning, security, maintenance - insurance (house and equipment) - copying, printing - traveling - telephone charges - office accessories and others.
Land cost	Land costs include warehouse buildings and relevant yard's rent if it was rented.
Space cost	Space cost includes warehouse&office space and fixed furniture costs.

Analysis of the costs in manufacturing can be calculated according to same principles that were used in Chapter 3.1.1. After the total cost of labor is calculated activities should be analyzed in greater detail. The calculation proceeds with directing the costs to activities. Similar calculation is done for other cost types as well. After the total costs are calculated the activity-based calculation continues with identifying the cost drivers and driver quantities. As an end result the manufacturing process table calculates the following cost figures:

- Design / hour
- Planning / hour
- Sourcing / purchase orderline
- Inbound operations / purchase orderline
- Storage / square meter
- Machining / hour
- Assembly / hour
- Testing + quality control / hour
- Painting + finishing / hour
- Picking, packing and shipping / hour and
- Internal transportation.

Again the empirical experiences among the participating parties showed that the cost information could not be tracked with aid of reliable sources. A useful source of information could be an information system or manual report. In the LMS concept the most feasible control system is the ERP-system. Nevertheless, the identification of total costs gives a good overview, for any company, about the manufacturing process as a whole.

3.3 Transportation Service

Transportation service has been split into two basic functions: Transport Management and Transport Organization. In general Transport Management means managing the strategic and supplier (carrier) based tasks and Transport Organization handles purely the operative tasks like calling-off a carrier, preparing waybills etc.

Appendix 1 “Transportation” presents a model of activity-based costing tool for calculating the transportation costs.

A basic assumption in this chapter is that a company does not have transport fleet of its own – the transport is based on outsourced supplies. Therefore, for instance fuel, maintenance, fleet insurance etc. costs are not mentioned separately when calculating the costs. The above-mentioned costs are assumed to be included in the freight costs through fees paid to carrier companies. Transport insurance, taxes and other international fees are also excluded from the calculations. In order to get the best benefit about the activity-based analysis, the calculation scope should involve both inbound and outbound processes. When calculating the transportation costs both inbound and outbound process should be observed.

3.3.1 Transport management

Transport management includes three main types of processes. These processes are:

- Carrier management
- Shipment management and
- Freight management.

Table 10 presents the descriptions of activities in transport management process.

Table 10. Activity list of transport management.

Activity Type	***Description***
Carrier management	Carrier management includes the following services/tasks: - carrier selection - carrier negotiation - carrier contracting - carrier monitoring and rating.
Shipment management	Shipment management is a collection of activities like routing, scheduling and load planning.
Freight management	Freight management consists of freight billing, bill checking and payments.

Table 11 presents the different cost types that have influence on the cost structure in transport management. A more detailed description is outlined in the right column.

Table 11. Transport management process cost types.

Cost Type	***Description***
Labor cost	Direct labor cost in concerned activity including supervision (incl. also social security fees). Includes bonuses and personnel training costs.
Equipment cost	Equipment costs include: - warehouse/office equipments' capital and leasing costs and - service/maintenance costs of equipment
IS cost	Information system and technology costs are caused by: - IT and software investments and leasing costs - use and maintenance of them - programming of software.
Running cost	Running costs include: - electricity, heating, water, waste water,

	fuel - waste service, cleaning, security, maintenance - insurance (house and equipment) - copying, printing - traveling - telephone charges - office accessories and others.
Space cost	Space cost includes: - office space and fixed furniture costs.

Analysis of the costs in manufacturing can be calculated according to same principles that were used in Chapter 3.1.1. After the total costs are calculated the activity-based calculation continues with identifying the cost drivers and driver quantities. As an end result the transportation process table calculates the following cost figures:

- Total cost/carrier and
- Total cost/shipment.

3.3.2 Transport organization

Transport organization is related more to operational tasks and issues as compared to Transport Management. A transportation mode and carrier must be selected for each shipment. The customer or external partner may do the decision. The decision impacts transportation and inventory carrying costs, in-transit times, delivery reliability, and overall customer service (Frazelle 2001, p. 197).

Table 12 presents the descriptions of activities in transport organization process.

Table 12. Activity list of transport organization.

Activity Type	***Description***
Operative contacts	Operative contacts with carriers, carrier selection for shipments and pick up calls.
Transport documents	Preparing and printing waybills including data transfer.
Other documentation	Preparing shipping certificates, and declarations and other special documentation.

The same table can be used for calculating the different cost types that have influence on the cost structure in transport organization as in case of transport management (see Table 10). The end result of calculations is the total cost per shipment.

Additionally, it is worth of calculating also the total freight costs of a company. These costs can be divided into two main groups:

- Inbound freight and
- Outbound freight costs.

An interesting figure is also what is the inbound freight costs divided by total purchase volume (Eur). A similar calculation can be done also for outbound freight in order to get an idea what is the share of outbound freight from total sales volume.

3.4 Customer Service

Underestimating the value of good customer response may harm significantly partnership relations. Customer demand is the fountainhead for all logistics services. The objective from the LMS-concept point of view is to satisfy the customer response requirements at the lowest possible cost.

Basically the customer service function should be the only interface to the LMS-company from the customers' point of view. The operative communication between the LMS-company and customer can be performed via any desired communication channel. Specialization in customer service is a fundamental driver of efficiency and performance. The logic of specialization is based on economies of scale and scope.

The customer relationships management (CRM) is not included in its full form here but the cost calculations are based on mainly managing daily operative communication. Appendix 1 "Customer service" presents a model of activity-based costing tool for calculating the customer service costs. Table 13 presents the different activity types of customer service function.

Table 13. Activity list of customer service.

Activity Type	***Description***
Call center	Includes any activity and/or service in modular service concept that is related to customer service function. Call center is the first place to contact and it can forward the calls any appropriate party concerned. E.g. excludes the actual processing of orders.
Order processing	The procedures of data capture and data processing that follow on from customer order. The orders may be received by any means e.g. mail, telephone, fax, Internet, ERP-system integration etc. Includes also the handling of invitation to tenders.
Invoicing	Billing activity of all services and products offered by LMS-company. Includes preparation of billing document, shipping the invoices to customers and control of receivables.
Duty service	Duty time service (office employees) that

	is performed outside of normal working hours/days. May also be a part of call center function.
Returns and claims handling	Administration and management of returns & claims process. Communication with customers about the corrective actions.
Fiscal representation	Includes any official representations that are needed for authorities e.g. intrastat reporting.
Customs activities	Any activity that is related to managing and administration of customs activities and forwarding of goods (import/export).

Table 14 presents the different cost types of customer service process.

Table 14. Customer service process cost types.

Cost Type	***Description***
Labor cost	Direct labor cost in concerned activity including supervision (incl. also social security fees). Includes bonuses and personnel training costs.
IS cost	Information system and technology costs are caused by: - IT and software investments and leasing costs - use and maintenance of them - programming of software.
Running cost	Running costs include: - electricity, heating, water, waste water, fuel - waste service, cleaning, security, maintenance - insurance (house and equipment) - copying, printing - telephone charges - office accessories and others.
Space cost	Space cost includes office space and fixed furniture costs.
Other costs	Includes e.g. traveling, meeting (contractual, managerial, operative), and consulting costs.

The costs can be calculated as presented earlier in Chapter 3.1.1. In order to get a correct overview about the “other costs” they should be allocated to each activity as correctly as possible.

An easier way is to calculate first the total costs of "other costs" and then divide it for each activity by the resources used in each individual activity. This calculation method does not give an accurate cost structure for individual activities; only customer service function's total cost structure is appropriately calculated. In an LMS-company the other costs should be able to be controlled on customer level for calculating the profitability of any customer.

After the total costs are calculated the activity-based calculation continues with identifying the cost drivers and driver quantities. Appendix 1 "Customer service" presents as an end result the following figures:

- Call center's cost/call
- Order processing cost/order line
- Invoicing cost/billing document
- Duty service/hour
- Returns and claims handling cost/order line
- Fiscal representation cost/report and
- Customs activities cost/shipment.

3.5 Procurement Service

Procurement service is divided into three major functions. This dividing adapts the principles presented by Aminoff et al (2002), where the procurement work is split into three categories: strategic, supplier-based and order-based procurement activities. The costs of these activities behave differently. For instance strategic procurement is steered by drivers like number of vendors and depth of group collaboration. In supplier-based work the costs are related to the number of vendors and items. In order-based activities, from costs point of view, significant drivers are the number of both orders and order lines.

Above-mentioned approach can be applied in the LMS-concept, because it takes into account the market-requirements that were studied in earlier report (Kivinen-Lukka, 2002) of this study. Customer-companies feel that strategic procurement must be kept in-house, but the supplier-based and order-based purchasing can be outsourced from an external-party, and they are not seen as core-activities among customer-companies.

Table 15 includes the activities of procurement processes.

Table 15. Activity list of procurement processes.

Activity Type	***Description***
Strategic procurement	
Planning, steering & development	Planning and steering of procurement strategy and policy, operative development and benchmarking of procurement activities.

Reporting	Planning and implementation of measurement methods and targets of procurement activities, distribution of reports.
Participation in management of company	Participation in mutual occasions, participation in management team's work.
Human resource management	Training and development of employees for improving skills and know-how, personal development discussions.
Supplier-based purchasing work	
Control of supplies	Preparing ITT's and comparison work, selection of potential supply sources, control the number of vendors in use.
Contracts	Contract negotiations, preparing and signing contracts.
Co-operation with other internal units	Organizing and implementation of internal collaboration.
Supplier co-operation and visits	Operative communication with supplier network for improving e.g. service levels, processes etc. Visits in vendors' premises for implementing procurement strategy in practice.
Controlling and reporting	Rating and controlling of vendors' performance. Performance reporting and analysis.
Order-based purchasing work	
Operative ordering	Making PO's and material-calls and forwarding them to vendors.
Transportation and forwarding	Arranging transportation and forwarding if applicable.
Invoice checking and payments	Checking of incoming invoices from vendors and administration of payment transactions.
Follow-up of orders	Operative follow-up of orders and entering order confirmations into system.
Trouble shooting	Includes activities that are done in case problems occur during order process e.g. technical clarifications.
Maintaining material database	Creating new items, deleting old ones, and optimizing item parameters in system.

Table 16 presents the different cost types in procurement process. The same cost types can be used for all three processes; Strategic procurement, supplier-based purchasing work and order-based purchasing work.

Table 16. Procurement process cost types.

Cost Type	***Description***
Labor cost	Direct labor cost in concerned activity (incl. also social security fees). Includes bonuses and personnel training costs.
IS cost	Information system and technology costs are caused by: - IT and software investments and leasing costs - use and maintenance of them - programming of software.
Running cost	Running costs include: - electricity, heating, water, waste water, fuel - waste service, cleaning, security, maintenance - insurance (house and equipment) - copying, printing - telephone charges - office accessories and others.
Space cost	Space cost includes office space and fixed furniture costs.
Other costs	Includes e.g. traveling, meeting (contractual, managerial, operative), and consulting costs.

Cost calculations in procurement process can be calculated according to same principles that were used in Chapter 3.1.1. Probably the most useful way to calculate the "Other costs" is to do it first in company/unit level, and then divide the total "other costs" by total number of employees. The cost per employee is then directed to activities according to resources used in each activity.

There are many key figures that could describe the efficiency of procurement activity. Below presented some of the key figures:

- Cost of strategic purchasing per supplier
- Cost of supplier-based purchasing per supplier
- Cost of order-based purchasing per PO or PO line
- Total cost of procurement function per supplier or
- Total cost of procurement function per PO or PO line.

Appendix 1 "Procurement service" presents a model of activity-based costing tool for calculating the procurement costs.

3.6 Quality Control Service

Bowersox and Closs (1996, pp. 668-669) state that effective logistics performance measurement and controllership are necessary to allocate and monitor resources. In the LMS concept the quality control is needed across the entire supply chain. The main groups of quality control function are:

- Key Performance Indicators
- Quality inspections
- Quality analysis.

The KPI's should measure internal and external performance of the LMS-company/concept. There may different types of KPI-reports like status, trend and Ad Hoc reports. There may be needs to perform also quality inspections and analysis at any stage of logistics process. A potential activity of quality control service function could be the compiling of different types of testing documents that are used for controlling product quality and reliability. The basic idea in the concept is that quality control function would be also responsible for overall quality of the LMS-company. In practice it should define the quality policy in corporation-level. Quality control function should be also responsible for implementing corrective actions together with operative organization.

Table 17 includes the activity types and description of quality control processes.

Table 17. Activity list of quality control processes.

Activity Type	***Description***
Key Performance Indicators (KPI's)	Measuring and reporting of internal and external performance through the complete supply chain.
Quality inspections	Performing physical quality inspections any stage of logistics process.
Quality analysis	Performing analysis for improving quality of products, services or processes.

Table 18 presents the different cost types that have influence on the cost structure in quality control process. A more detailed description of cost types is outlines in the right column.

Table 18. Quality control cost types.

Cost Type	***Description***
Labor cost	Direct labor cost in concerned activity (incl. also social security fees). Includes bonuses and personnel training costs.
Equipment cost	Equipment costs include: - office and testing equipments' capital and leasing costs - service and maintenance costs of equipment
IS cost	Information system and technology costs are caused by: - IT and software investments and leasing costs - use and maintenance of them - programming of software.
Running cost	Running costs include: - electricity, heating, water, waste water, fuel - waste service, cleaning, security, maintenance - insurance (house and equipment) - copying, printing - telephone charges - office accessories and others.
Space cost	Space cost includes : - laboratory&office space and fixed furniture costs.
Other costs	Includes e.g. traveling, meeting (contractual, managerial, operative), and consulting costs.

Costs of quality control process can be calculated according to same principles that were used in Chapter 3.1.1. The "Other costs" can be calculated so that first count the costs in company/unit level, and then divide the total "other costs" by total number of employees operating in quality control function. The cost per employee is then directed to activities according to resources used in each activity.

The following key figures describe the total cost of quality control activity:

- Total cost / report
- Total cost / inspection
- Total cost / analysis.

Appendix 1 "Quality control" presents a model of activity-based costing tool for calculating the quality control costs.

3.7 Reverse Logistics

The objective of reverse logistics varies from company to another but the basic idea is to guarantee a controlled and environmental aspects considerable material flow after a product is removed from its current use or it is returned for any other reason. Typically reverse logistics is utilized in for instance in case of:

- Customer returns
- Modernization projects (old product is demolished)
- Product is exchanged in relation to normal maintenance work and
- Component restoring (factory-restoring).

In this study the reverse logistics means the administration tasks that is related to above-mentioned activities, sorting, storaging and transportation of reverse materials/goods.

Table 19 includes the activity types and description of reverse logistics.

Table 19. Activity list of reverse logistics processes.

Activity Type	***Description***
Administration	Managing and controlling of reverse logistics information manually or with aid of Information Systems through the complete supply chain so that the goods movements can be also tracked and traced real time. Administration includes activities like material recalls from customer, order tracing, data entry, supervision, pick-up arrangements etc.
Sorting	Sorting means the physical work that it needed for sorting the goods in a warehouse, laboratory or other unit. Sorting is done for preparing the reverse materials for further treatment or use.
Storage	After sorting process some of the materials may need stocking when waiting for further treatment or use.
Freight costs	A target of reverse logistics is to utilize the reverse transportation. Transport of materials causes some expenses when they are collected from target location and transferred back to any facility for further treatment or use.

Costs of reverse logistics process can be calculated according to same principles that were used in Chapter 3.1.1. The “Other costs” can be calculated so that first count the costs in company/unit level, and then divide the total “other costs” by total number of

employees operating in reverse logistics function. The cost per employee is then directed to activities according to resources used in each activity.

Appendix 1 "Reverse Logistics" presents a model of activity-based costing tool for calculating the reverse logistics costs.

3.8 Recycling Logistics

As discussed in Chapter 3.7 reverse logistics as an activity concentrates on recalling the reverse materials for further treatment or use. With aid of recycling logistics processes products that are unsuitable for refurbishment, repair or resale can be broken down into their component parts and recycled. When no alternative course of action is appropriate, products need to be disposed of either by scrapping at landfill or through incineration. Hazardous products must be separated from other waste and disposed of responsibly.

In this study the recycling logistics means the administration tasks that is related to recycling activities, physical work for preparing materials for re-usage and further refinement. It includes also delivering materials to energy combustion location or waste handling process.

Table 20 includes the activity types and description of recycling logistics.

Table 20. Activity list of recycling logistics processes.

Activity Type	***Description***
Administration	Administration includes activities like maintaining material database, controlling that environmental legislation is followed along the process, supervision, pick-up arrangements etc.
Re-usage and recycling preparations	Re-usage and recycling preparations means the physical work that it needed for breaking down of components/packages, further refinement, sorting the material for delivery to energy combustion location, waste handling process or any other further treatment.
External recycling and waste treatment fees	Fees that must be paid to external parties about recycling and waste treatment services.
Freight costs	Delivering the recycling materials to any target location for further treatment or use.

Costs of reverse logistics process can be calculated according to same principles that were used in Chapter 3.1.1. The "Other costs" can be calculated so that first count the costs in company/unit level, and then divide the total "other costs" by total number of employees operating in reverse logistics function. The cost per employee is then

directed to activities according to resources used in each activity. Probably the most useful way to report the external recycling and waste treatment fees and freight costs is to allocate them in "other costs".

Appendix 1 "Recycling logistics" presents a model of activity-based costing tool for calculating the recycling logistics costs.

3.9 Logistics Technology

Information technologies have dramatically transformed the way companies use their supply chain operations to achieve competitive differentiation. In order to be successful a LMS company has to use IT to support its business strategies and priorities. In doing so it should generate tactical efficiencies, create operational excellence and enhance decision-making capabilities across its supply chains.

This chapter is not a comprehensive treatment of logistics technologies, but it is intended to give basic guidelines for understanding costs involved in these technologies. It is difficult to prepare an exact ABC-tool for analyzing the costs of logistics technologies because the selected technologies and scope vary case by case which leads to a fact that activities and activity drivers must be specified also case by case.

The logistics technology services that are required from LMS-company are listed below (Kivinen-Lukka 2002, pp. 54-55):

- Software (ERP system for managing the supply chain)
- System integration
- Wireless and mobile solutions
- Automatic identification technologies
- E-commerce marketplace
- Data transfer solutions and
- Internet solutions.

In case a logistics service provider supplies its own WMS or ERP-system for managing the customer's logistics supply chain the parties have to decide which *software* modules must be used. Some samples about the modules are listed below:

- Sales and ordering
- Procurement
- Materials management
- Warehouse management
- Quality
- Management information (reporting)
- Distribution management and
- Financing / invoicing.

A practical and commonly used cost driver about charging the usage of service provider's system is cost per transaction. A transaction can be for instance an orderline or inventory counting transaction.

System integration is needed for connecting customer's ERP-system to for instance WMS-module. The scope of *system integration projects* varies from project to another. The main costs involved in system integration are:

- Project management and co-ordination (includes project planning)
- Hardware costs (e.g. PCs, printers, server, router, UPS)
- Programming of software
- Telecommunication connections (lines)
- Maintenance of hardware, software and network
- Cabling and installation of network and
- 24 hours systems management and customer service (technical call center).

There are a lot of different *wireless and mobile solutions* available in the market. These new technologies can be utilized in variety of logistics processes. Additionally, if a standard wireless or mobile application cannot be utilized, it is possible to develop a customer-specific solution with a service provider. So in practice the main cost objects in wireless and mobile solutions are the software application and telecommunication fee (messages).

Efficient *automatic identification* is based on good quality barcodes. Each application requires a different solution, which is why there is wide range of label printers available in the market. A labeling system also requires software to run the printers and consumables to print on. The most common tool in Automatic identification is a hand-held barcode reader. With aid of automatic identification equipment it is also possible to collect logistics data. The basic idea of collecting data on the move is to collect and save the data directly into a computer whenever there is new information. The data is then transferred to i.e. a materials management system, in which the electronic data is available in real-time and up-dated for everyone using the system. The maintenance and after sales support cause also costs in automatic identification processes.

In case of LMS-concept an *E-commerce marketplace* could include for instance following activities or services: E-contact forum, information channel/source, possibility to make invitation of tenders, marketing channel, establish professional collaboration groups etc. A common practice is that the user of these e-commerce web sites does not need to pay any fees about using the E-services. Only the companies who market their service in these web pages pay a fee to the party who maintains the web site.

The *Internet* provides excellent possibilities to companies to join in different integrated networks and which may offer significant tools for improving productivity and competitiveness. The Internet provides a variety of web-based solutions like supply management, inventory management, distribution management and sales/marketing tools (part catalogues) etc. In operative exchange of order/delivery processes a cost driver is a transaction (e.g. EDI/XML message). The service provider

who links and exchanges the messages to an understandable format from ERP-systems point of view charges this transaction (e.g. order line) cost.

3.10 Packaging Services

The role and importance of logistics packaging relates to damage protection, material handling and information transfer. Packaging has a significant impact on the cost and productivity of the logistical system. The purchase of packaging materials, the institution of automated or manual packaging operations, and the subsequent need for material disposal are the most obvious costs. What is not readily apparent, however, is that purchase and disposal costs are borne by firms at opposite ends of a distribution channel, and that productivity gains generated by efficient packaging are spread throughout a logistical system. As a result, the impact of packaging is easily overlooked or, at minimum, underestimated (Bowersox and Closs 1996, pp. 435-436).

Bowersox and Closs have categorized into two types: *consumer packaging* (marketing emphasis), which focuses on customer convenience, market appeal, retail shelf utilization, and product protection, and *industrial packaging* (logistics emphasis), where the package is designed for efficient logistical processing for instance with aid of package standardization and efficiency.

The third important logistical packaging function is *communication*. This function is increasingly critical to *content identification, tracking*, and *handling instructions* as they become more powerful and necessary to total channel success. The most obvious communications role is identifying package contents for all channel members. Typical information includes manufacturer, product, type of container, count, and universal product code (UPC) number. The carton information is used to identify product for receiving, order selection, and shipment verification. Additionally, a well-controlled material-handling system tracks product as it is received, stored, retrieved, and shipped. This control of all movements reduces product loss and pilferage and is very useful for monitoring employee productivity. The final role of logistics packaging is to provide handling and damage instructions.

In the purchase of packaging materials, the same cost-calculation approach that was presented in chapter 3.5 can be utilized. In cost-calculation of material disposal activities the approaches presented in chapters 3.7 and 3.8 can be applied.

This chapter discusses on packaging related activities like packaging development & standardization, packing in outbound phase, individual packaging and product labeling. Table 21 presents the descriptions of these activities more in details.

Table 21. Activity list of packaging processes.

Activity Type	***Description***
Packaging development and standardization	Development and design work that is related to increasing economical (logistical) efficiency and environmental friendly packing materials usage.
Individual packaging	Products are packed in appropriate and applicable delivery lots and packages. This activity is done typically by a vendor or in the warehouse in inbound phase. This activity excludes the actual labeling of products.
Outbound packing	Packing in outbound phase with standard or non-standard packing materials.
Co-packing	Co-packing is needed if there is a need to change or hide the brand of original supplier.
Labeling	Product information labels are needed for identification and tracability purposes. Product information may include any other information that is needed. Labeling can be split into deeper details of processes like content identification, tracking (scanning) and handling instructions (e.g. special product handling instructions) if needed. Labels are attached on the individual packages.

Table 22 presents the different cost types that have influence on the cost structure in packaging process.

Table 22. Packaging cost types.

Cost Type	***Description***
Labor cost	Direct labor cost in concerned activity (incl. also social security fees). Includes bonuses and personnel training costs.
Equipment cost	Equipment costs include: - office and packaging equipments' capital and leasing costs - service and maintenance costs of equipment.
IS cost	Information system and technology costs are caused by: - IT and software investments and leasing costs - use and maintenance of them - programming of software.
Running cost	Running costs include: - electricity, heating, water, waste water, fuel - waste service, cleaning, security, maintenance - insurance (house and equipment) - copying, printing - telephone charges - office accessories and others.
Space cost	Space cost includes : - office space and fixed furniture costs. - warehouse space used for this activity.
Other costs	Includes e.g. internal and external training costs, traveling cost, consulting costs, packing tools and machines, packaging material costs.

Costs of packaging process can be calculated according to same principles that were used in Chapter 3.1.1. “Other costs” include for instance internal and external training costs and traveling costs. Appendix 1 “Consultancy” presents a model of activity-based costing tool for calculating the consulting costs.

3.11 Consultancy

This chapter discusses the three main consultancy services that were required from the LMS-company. These services are listed below:

- Benchmarking
- Outsourcing process and
- E-procurement.

Benchmarking is a continuous systematic process for evaluating the products, services, and work processes of organizations that are recognized as representing best practices for the purpose of organizational improvement. Benchmarking involves finding out how you compare to others, identifying best practice and based on this information implementing changes within the company to lead to improved performance. The overall aim of benchmarking is to improve and increase competitiveness. Benchmarking takes the guesswork out of decision-making. Many companies typically base future plans on either historical performance or on subjective guesswork. Information gathered from benchmarking studies allows companies to base their decisions on facts and to make changes and define strategies within the company that will lead to improved performance and increased competitiveness (Spendolini 1992, p.2).

In case of LMS-concept the benchmarking is required especially for evaluating best practices and cost efficiencies of warehouse and transportation service providers. However, the LMS-company should offer benchmarking in all services of LMS-concept by itself or through its specialist network. Benchmarking can be split roughly into following basic activities and cost allocations:

- Preparations of benchmarking process
- Selecting the benchmarking partners
- Data collection
- Analyses and
- End report.

Outsourcing process of spare part logistics here follows the principles discussed more in details in Valssi-report/Part 2 (see Kivinen 2002). Consultancy in outsourcing process may differ from project to another. The approach here is only one possibility to consult in process of externalization. Outsourcing consultancy process could include for instance following activities:

- Defining logistics mission and strategy
- Defining critical success factors
- Defining basic data
- Invitation to tender preparation
- Site visits
- Evaluation of offers and service partners
- Agreement and
- Implementation project.

E-Procurement in this study is an Internet-based purchasing system or customer' and suppliers' ERP-systems integration that is done through interfacing. E-Procurement offers electronic purchase order processing and enhanced administrative functions to buyers and suppliers, resulting in operational efficiencies and potential cost savings. The E-Procurement Service features the most modern business and commercial practices most current technical capabilities offered by new technologies that will provide cost-saving opportunities to both suppliers and customers. E-procurement consulting process can be split for instance into following basic activities and cost allocations:

- Analyses about the current stage
- Defining e-procurement mission and strategy
- Defining e-processes
- Defining needed technology and systems
- Risk analysis
- Defining project plan and priorities
- Evaluation of offers and service partners
- Agreement and
- Implementation project.

Table 23 presents the different cost types that have influence on the cost structure in consultancy process.

Table 23. Consultancy cost types.

Cost Type	***Description***
Labor cost	Direct labor cost in concerned activity (incl. also social security fees). Includes bonuses and personnel training costs.
Equipment cost	Equipment costs include: - office and packaging equipments' capital and leasing costs - service and maintenance costs of equipment.
IS cost	Information system and technology costs are caused by: - IT and software investments and leasing costs - use and maintenance of them - programming of software.
Running cost	Running costs include: - electricity, heating, water, waste water, fuel - waste service, cleaning, security, maintenance - insurance (house and equipment) - copying, printing - telephone charges - office accessories and others.
Space cost	Space cost includes : - office space and fixed furniture costs.
Other costs	Includes e.g. internal and external training costs and traveling cost

Costs of consultancy process can be calculated according to same principles that were used in Chapter 3.1.1. Appendix 1 “Consultancy” presents a model of activity-based costing tool for calculating the consultancy costs. Cost driver of each activity is

"hour-rate". It may be too general approach in some cases. For instance in outsourcing process there is activity called 'site visits'. A more accurate cost driver is 'number of site visits' that has to be performed. But from budgeting point of view the LMS-company should be able to estimate how much time the site visit(s) and all other activities require. As a conclusion of this it is recommended to use any other cost driver that is seen applicable in concerned situation.

3.12 Value added services

This chapter discusses shortly about the four main value-added services that were required from the LMS-company, and that were used as the case in this study These services are listed below:

- Recycling of align tray
- Shaft rope cutting
- Cable cutting and
- Logistics management in CIS countries.

The above-mentioned activities are customer-specific service requirements. They have not been specified in deeper details of processes, therefore a deeper analysis should be made.

Recycling of align tray is actually in larger extent a logistics management task where the return of align tray should be managed from product return and recycling point of view. Also managing the information flow is an important process factor. Shaft rope and cable cutting need also additional activities that have to be performed (e.g. attaching clips and other accessories). Ropes and cables have to be cut-to-length according to customer requirements, so the cost driver is a single cutting. Logistics management in CIS-countries can be based only on consultancy service for logistics activities in CIS-countries or it can include practical material handling operations like for instance bonded-warehousing and distribution in that area.

As a conclusion it can be said that, for calculating the activity costs, a clear process flow-chart must be prepared in order to create a useful ABC-tool.

4 INFLUENCE OF DIFFERENT ACTIVITY MODELS ON COSTS

Typical features of spare part business are irregular demand, dynamic changes in volumes and a competitive environment. Typical competition factors in spare part business are especially quality, delivery time, price, delivery performance and flexibility. Product assortment is often wide.

Pricing products and services is one of the most challenging factors in the LMS-business concept. Before setting prices, a service provider has to understand logistics market, distribution costs and competition. Typical for current international logistics business is that the marketplace responds rapidly to technological advances and international competition. LMS-company operates in highly competed business arena. Therefore the LMS-company must keep abreast of the factors that affect pricing and be ready to adjust quickly.

The aim of this chapter is to present a practical approach to understanding of different activity models on costs. This chapter does not attempt to be an in-depth discussion of pricing analysis. Rather, it is intended to provide a basic review of the different activity model possibilities involved in the LMS-concept. One of the aims is also to increase awareness of different activity models and how the decisions that are made influence on total process costs.

4.1 Different Activity Models

Logistical supply chain involves several vendors in the LMS-concept. The aim, to reduce the total costs in the supply chain, puts pressure on the logistics chain to organize the purchasing of products and services in more efficient way.

Aminoff et al. (2002) have analyzed in NETMAN-project different activity models in the interface between supplier and customer (purchaser). They have divided the activity models as summarized in Table 24. The cost information in this Chapter is based on case-calculations in NETMAN-project.

Table 24. Different activity models in purchase of materials (based on source: Aminoff et al., 2002, pp. 4-16)

Activity model	Process and features
Traditional activity model	Customer orders materials from supplier. Supplier keys order into system. Order is forwarded to stock and it is picked, packed, shipped and transported to customer. Customer receives the material, checks it and stores it. Supplier sends invoice to customer, checks it against inbound booking and pays the bill. Activity includes claim handling and follow-up of orders.
Consolidated invoicing activity model	In consolidated invoicing the invoicing and payment is done by consolidating several orders into one invoice. This reduces process costs and influences on interest benefits and losses.
Good-quality activity model	In good-quality activity model there are no mistakes in deliveries, because the items are well marked for making the inbound process easier. The improvement of quality reduces the process cost. - Purchasing does not include follow-up of order, claims and returns, which reduces costs of order-based purchasing by 17%. - Reception of goods saves 48% of costs compared to traditional activity model. - Decreases of claims and returns process reduce process costs. Quality in general improves.
Automated activity model	Preparation and forwarding of PO's, creation of sales order, invoicing and payment activities are automated with aid of IT. This requires good quality process in inbound activity (see above). IT costs are in total 14% of total costs, which is the cost of automation.
VMI 'for need' activity model	Vendor (supplier) manages the inventory and is responsible for supplementing the stock according to the needs. Vendor does not have a physical stock at its premises. Customer does not own any stocks. Customer pays the material bills according to material usage. In this activity model: - Customer does not have purchasing costs, only paying material bills is left. - Vendor is responsible for order-based costs in purchasing and material call-offs, which accounts about a half of purchaser's work. - The reception of goods is done with same costs as in good-quality activity model.
VMI 'to stock' activity model.	This differs from VMI 'for need' so that customer has a physical stock. Vendor supplements the stock and optimizes it. Normally the vendor pays material bills according to usage, or it can be done in another way too. This model is often applied in low-value materials. Normally an intention is to deliver more than 20 order lines at a time. Cost functions are the same as in VMI 'for need'. Benefit comes from well-timed delivery-lots and consolidated invoicing. This model demands exact control of capital-tight in stocks.

The approach, presented above, is based on order-structure where is in average 5 orderlines in one order, and it does not take into account capital costs & interests involved in these activity models.

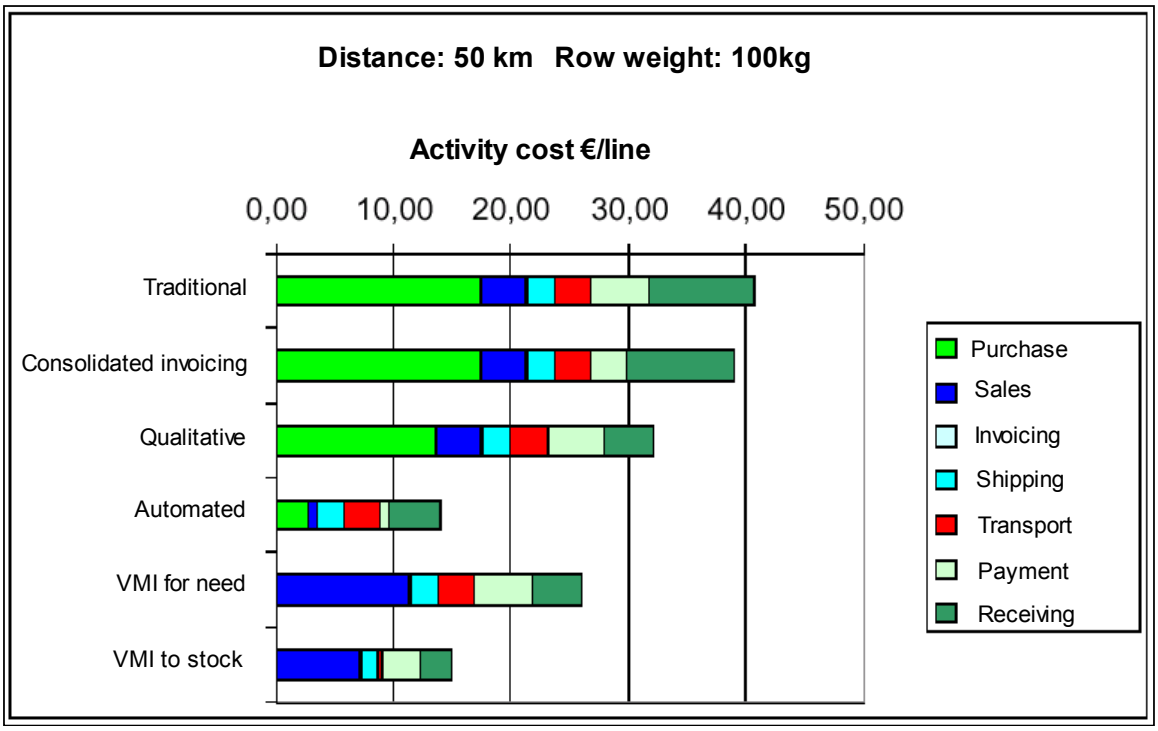

Figure 6. Cost-comparison of different activity models (Aminoff et al., 2002).

Aminoff et al. (2002, pp.14-15) conclude that after cost-comparison of different activity models:

- Automation and VMI reduce activity costs significantly, even more than by 50% or by one-thirds compared to traditional activity model.
- Qualitative activities reduce the costs by almost 25%, but the influences on quicken throughput-times and reduction of disturbances may be even more significant.
- Consolidated invoicing does not reduce costs singly remarkably, but as part of other cost-reduction actions it is worth of realizing.
- Feasibility of VMI 'for need' and VMI 'for to stock' models' has to be evaluated according to needs. These models are influenced by:
    - Value of items (stock value)
    - Difficulty in forecasting needs
    - Changes of item assortments and risk of scrap in stock.
- Activity models are not alternative, but they can be used
    - Simultaneously
    - Parallel, when orders and/or items have different activity models according to their characteristics.
- In qualitative activity model customer should participate in paying the costs because it gains the biggest benefits.

- In automated activity model both customer and vendor benefit in same relation (simplified and speeded routines), when the influences of quality are not taken into account.
- In VMI-activity models customer's (purchaser) work is reduced by one-third or by one-fourth but sales activity doubles. This has to be taken into account in pricing.
- VMI 'to stock' activity model can reduce remarkably also transportation costs due to increase of delivery-lots.
- When operational costs decrease potentially e.g. in automated and VMI-activity models, relative share of transportation costs increase. This emphasizes the importance of effectiveness, planning and purchasing of transport services.

4.2 Influence of Order-structure on the Costs

The calculations presented in Chapter 4.1 were based on average order structures. The amount of orderliness in one order has a significant meaning from total costs point of view (Maununen 2000). For instance, if an average order includes only one orderline instead of five lines, then the cost per one orderline increases 2 or 3 times bigger.

Figures 7 and 8 visualize and comprise the differences between traditional and automated activity model.

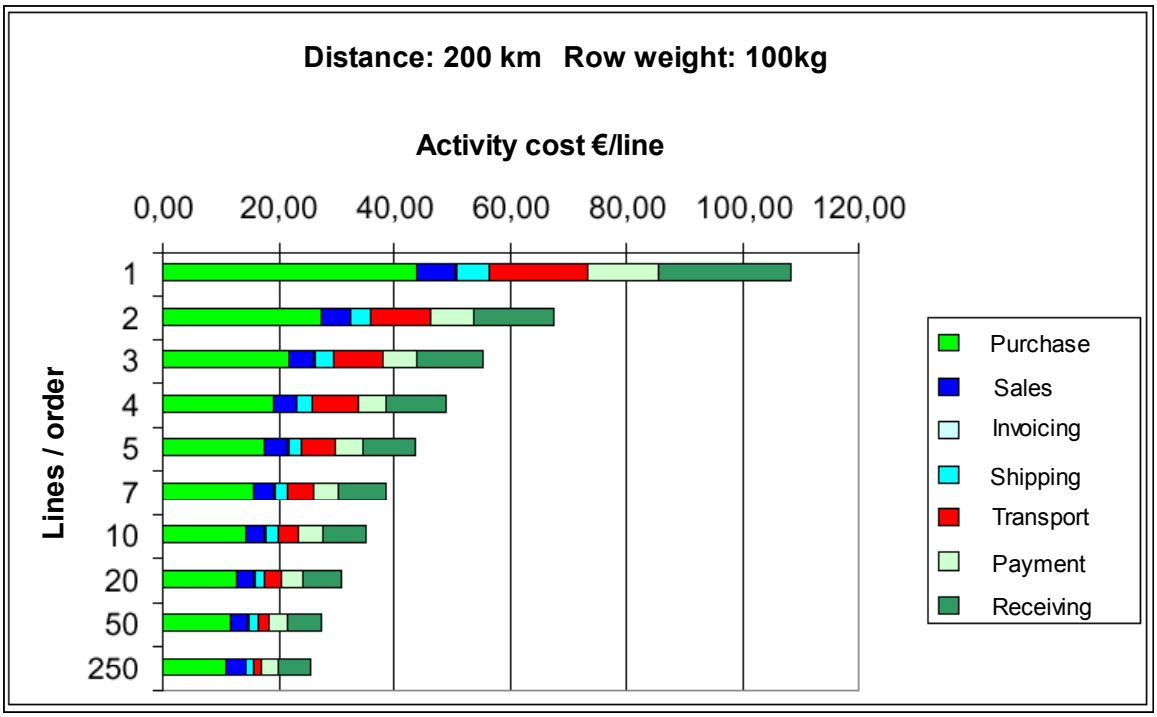

Figure 7. Influence of order structure in traditional activity model (Aminoff et al., 2002).

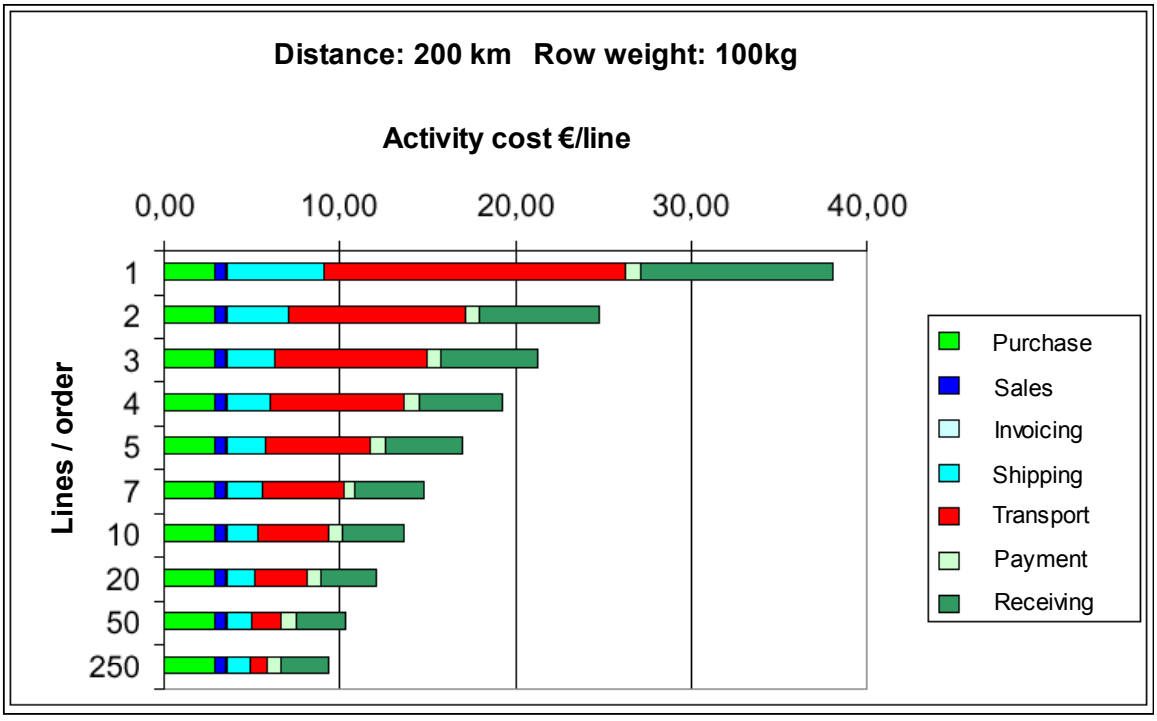

Figure 8. Influence of order structure in automated activity model (Aminoff et al., 2002).

4.3 Cross-Docking Activity Model

This Chapter discusses about different possibilities to deliver goods from vendor's, purchaser's and customer's (end-destination of goods) point of view. All cost-elements are the same that were used in Chapter 4.2. In case of LMS-concept the purchaser can be the service provider of warehousing services, but the same modeling approach can be used even if the warehouse activity is not outsourced but operated the by the company itself.

The model comprises following delivery options:

(a) Deliveries through purchaser's stock
(b) Direct deliveries from vendors to customer and
(c) Cross-Docking deliveries (Figure 8).

In deliveries through purchaser' stock the goods are shipped from different vendors to purchaser's stock. After reception of goods the goods are temporarily stored and sorted for order picking, packing and shipping activities. The goods are shipped to the customers.

In direct shipping, vendors bypass the warehouse completely and ship directly to the customers. By bypassing the warehouse completely, all the warehouse handling steps are eliminated, as well as the opportunities to mishandle products accordingly. In direct deliveries the orders and payments traffic go through purchaser.

In cross-docking activity model:

- Loads are scheduled for delivery into the warehouse from vendors
- Loads are sorted by the vendor in accordance with customer orders (readily, marked and packed)
- Inbound materials are sorted immediately into their outbound orders
- Outbound orders are transported immediately to their outbound dock
- There is no receiving staging or inspection
- There is no product storage.

Ross (2000, p.521) defines Cross-Docking as method of moving products from the receiving dock to shipping without putting it into stock.

Figure 9 presents an activity model of Cross-Docking.

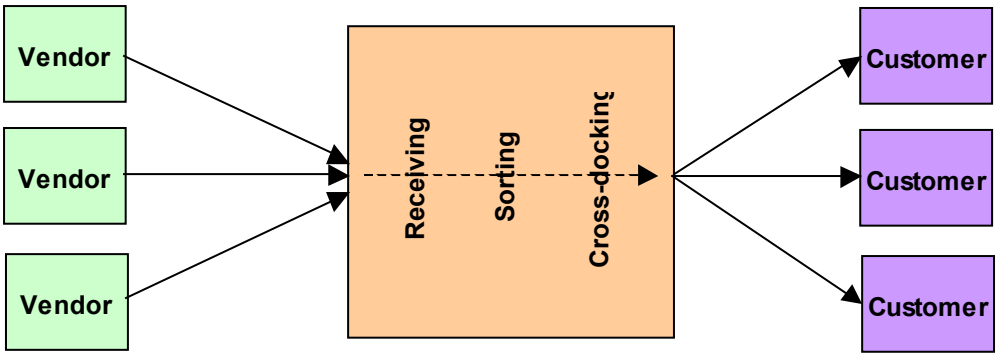

Figure 9. Cross-Docking process flow.

Figure 10 presents the Cross-Docking activity model, when there are 10 orderlines in customer order and weight of one line is 100kg. Purchasing and distribution distance is 100 km and in direct shipping 200 km.

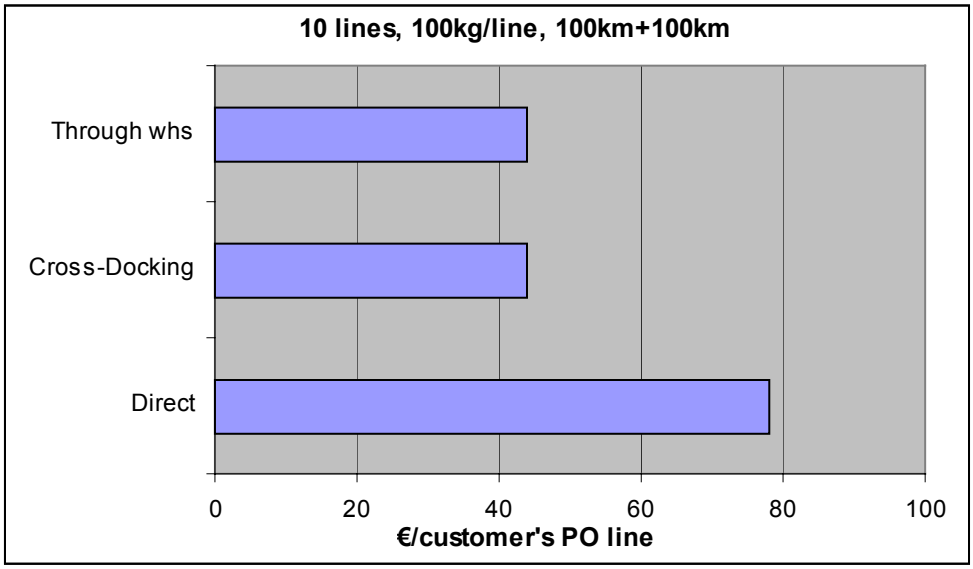

Figure 10. Activity costs in Cross-Docking, 10 lines, 100kg/line, 100km+100km (Modified from Aminoff et al. 2002)

Figure 11 presents the Cross-Docking activity model, when there are 50 orderlines in customer order and weight of one line is 5000kg. Purchasing and distribution distance is 100 km and in direct shipping 200 km. In direct delivery the shipping lot is 5000kg.

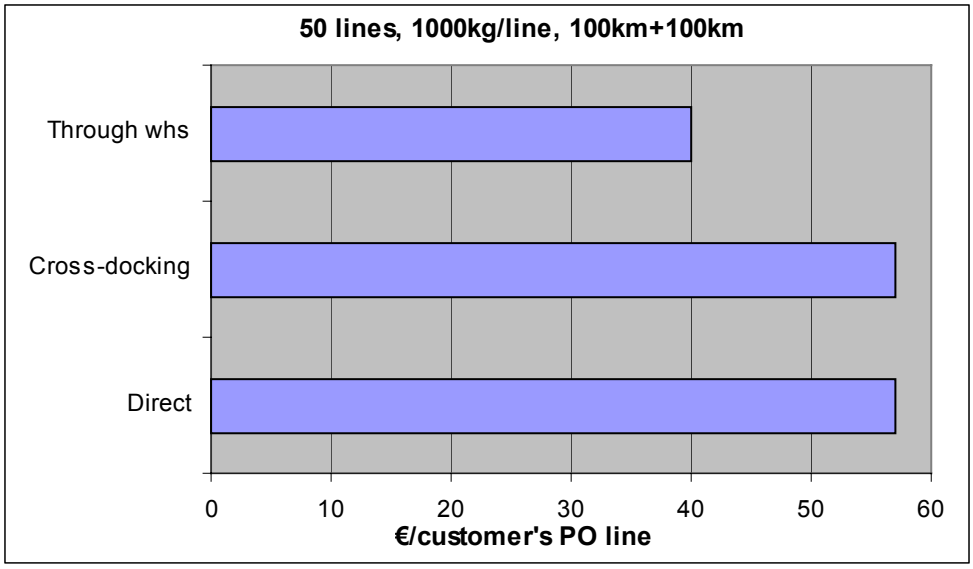

Figure 11. Activity costs in Cross-Docking, 50 lines, 1000kg/line, 100km+100km (Modified from Aminoff et al. 2002)

The following conclusions can be done from different delivery route options (Aminoff et al., 2002):

- Cross-Docking and delivery through purchaser's stock (whs) are from activity costs point view equal. Costs of inventories (interests) and warehouse space put Cross-Docking on preference.
- Cross-Docking is a preferred option if there is no need to stock the goods.
- Stocking may be needed due to:
    - Goods' availability problems
    - Long delivery times.
- Transport costs are often equal in deliveries through stock and in Cross-Docking. In direct deliveries the transport cost are higher. Merely from transport economies point of view the Cross-Docking is a good activity model.
- In case the delivery lots in direct deliveries increase, it cheaper activity model compared to Cross-Docking. In sample case the lots exceeding 5000kg could be transported directly.

4.4 Impact of Batch Size on Product Costs

A basic assumption in this chapter is that the LMS-company does not manufacture anything by itself but subcontracts all the products from external vendor network. Therefore the traditional product cost calculations of manufacturing industry and its specific features are not considered in this study. For instance traditional cost calculation uses standard or average batch sizes when assigning batch-level costs to units. The complexity of LMS-concept and its logistics processes makes this approach inadequate.

As discussed in Chapter 2.4.2, the importance of batch level activities and great variations in batch sizes are the main reasons why the profit of every single sales position should be calculated separately.

Table 25 illustrates how the costs of a product X purchased in a standard purchase lots behave when the sales batch size increases. In order to calculate the activity costs assigned to a product, the costs of the activities related to inbound logistics (€ 19.00) need to be divided by the number of units in the purchase batch (10) and the costs of the activities related to outbound logistics (€ 78.00) by the number of units in the sales batch (1-20). Table 26 shows also the purchase price of product X. The total cost of a single unit is calculated by summing up the activity costs and the purchase price. The table clearly shows how the costs of the activities related to outbound logistics to be assigned to a single unit decrease from € 78.00 to € 3.90 when the sales batch size increases from 1 to 20 (Lyly-Yrjänäinen and Paranko, 2001).

Table 25. The Impact of the Sales Batch Size on the Costs to be Assigned to a Single Unit (Lyly-Yrjänäinen and Paranko, 2001).

Product X	Purchase price:	€ 13.00
	Cost of inbound logistics:	€ 19.00
	Cost of outbound logistics	€ 78.00

Purchase batch size	Sales batch size	Cost of inbound logistics	Cost of outbound logistics	Total cost
10	1	€ 1.90	€ 78.00	€ 92.90
10	2	€ 1.90	€ 39.00	€ 53.90
10	5	€ 1.90	€ 15.60	€ 30.50
10	10	€ 1.90	€ 7.80	€ 22.70
10	20	€ 1.90	€ 3.90	€ 18.80

The calculation shown in Table 26 illustrates how the costs assigned to a unit behave when sales batch increases. This gives a clear feeling about the impact of batch size on product costs.

4.5 Capital Cost of Inventories

The capital-cost of inventories depends on three issues (Lehmusvaara and Nenonen):

- Term of payment in purchasing
- How long the goods will be stored and
- How long is the term of payment for customer.

Figure 12 illustrates the above-mentioned process more in details.

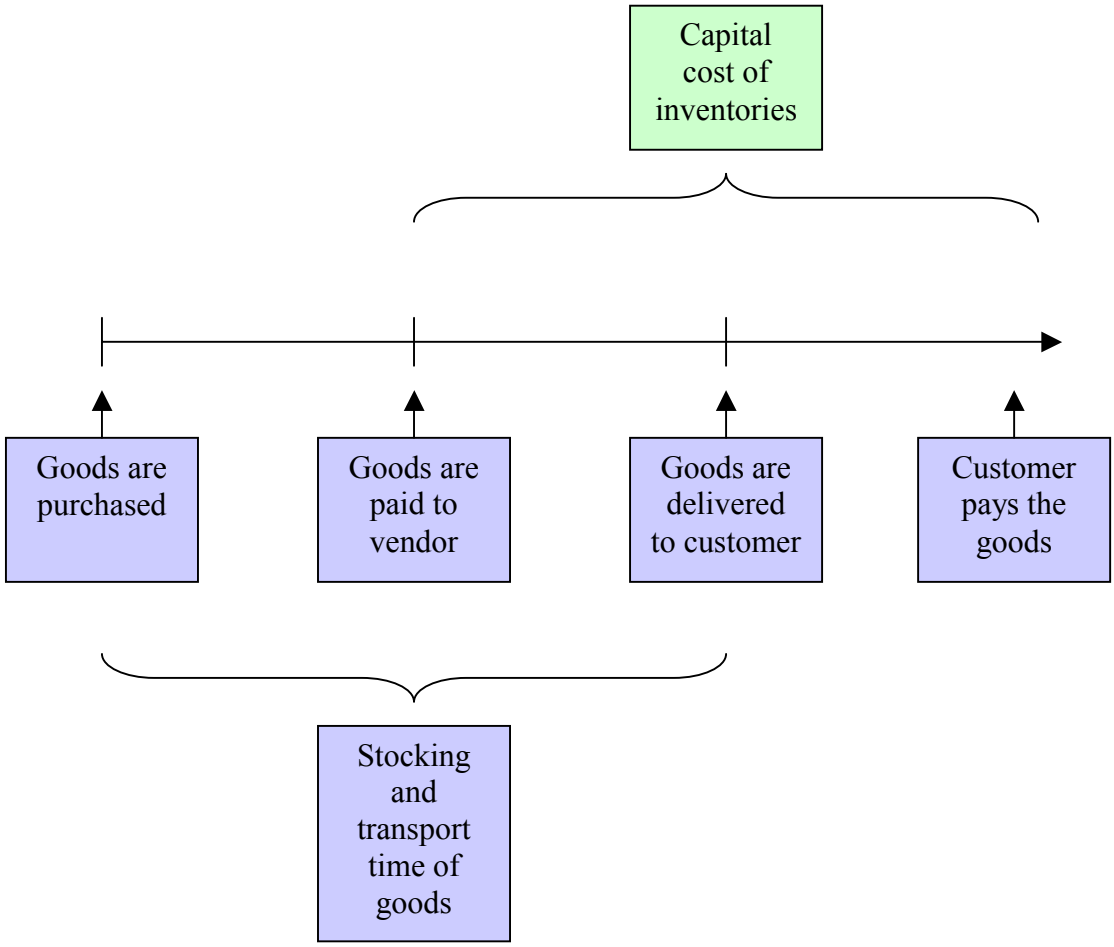

Figure 12. Capital cost of inventories and stocking & transport time of goods (Lehmusvaara and Nenonen).

As an example the following case is studied in depth. By improving logistical activities a company can influence on terms of payment in purchasing and sales activities and, additionally, on the required stocking time of goods. Below a sample calculation about the capital cost of inventories.

- Term of payment 14 day net
- Value of delivery lot 5000 €
- Inventory turn 2 (availability is then 180 days)
- Term of payment in sales 21

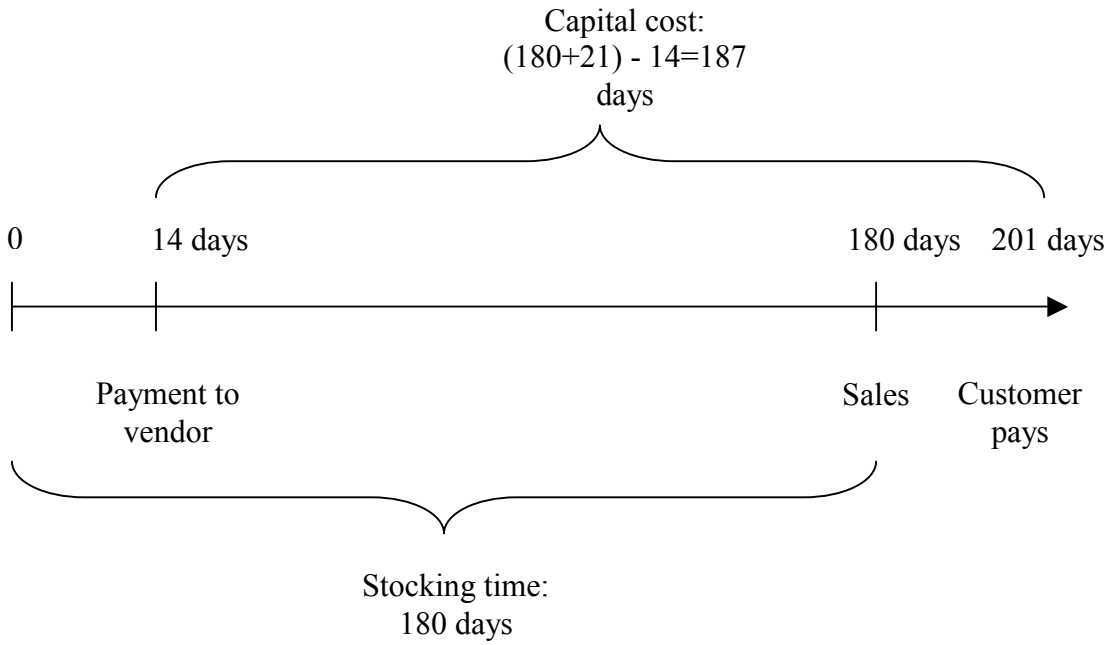

Figure 13. Sample calculation about the capital costs of inventories.

In the sample case the capital cost of inventory is 5000 € for 187 days. Then the capital cost is:

$$\frac{\text{(capital cost) 187 d}}{\text{360 d}} \text{ X (value) 5000 € X (interest) 7 \% = 181,8 € (capital cost)}$$

So the capital cost in the sample case is 181,8 €, which presents 3,6% of value of delivery lot. By improving the activity model following:

- Term of payment 30 day net
- Value of delivery lot 5000 €
- Inventory turn 10 (availability is then 36 days)
- Term of payment in sales 21

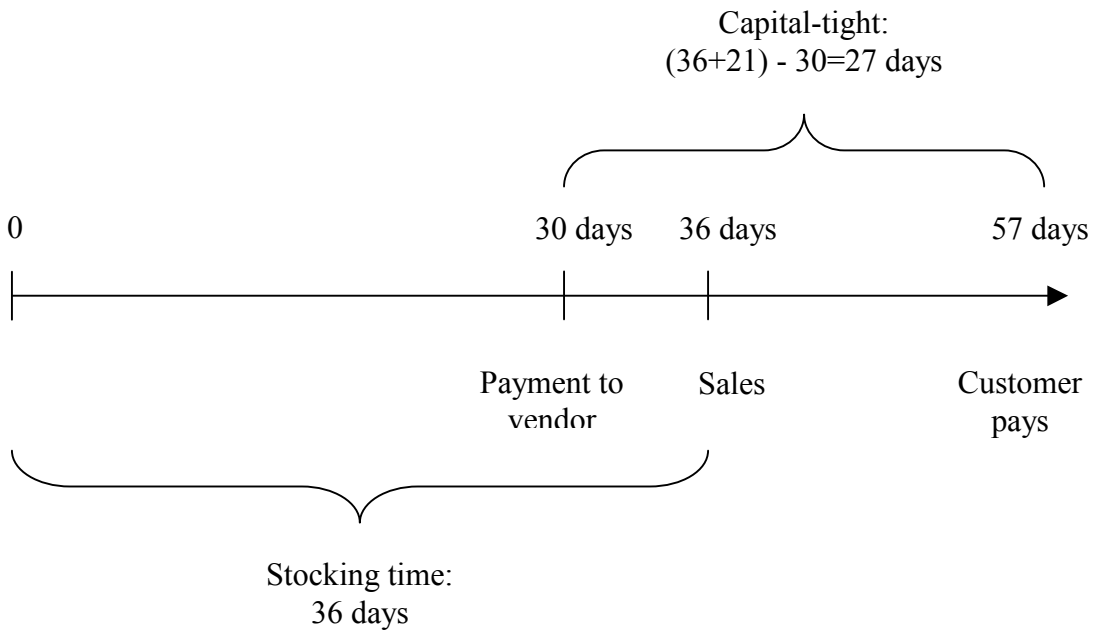

Figure 14. Sample calculation after changing activity-model on the capital-tight in inventories.

Calculation:

$$\frac{\text{(capital-tight) 27 d}}{\text{360 d}} \text{ X (value) 5000 € X (interest) 7 \% = 26,25 € (capital cost)}$$

The capital cost in the sample case now is 26,25 €, which presents 0,5% of value of delivery lot. As illustrated, with aid of calculations, the improvement of stock turn, lengthening of terms of payment with vendors decreases the capital costs. In optimal conditions the value of goods would be sold before a company has to pay the material bill to vendor. It would mean that an interest-cost would change actually to interest-profit. This would require quick delivery times, high stock turns and long terms of payment from vendors and practically cash-payments from customer.

It should be also remembered that the stocking of goods causes also cost in terms of space. Seasonal changes in volume may be also an important factor in defining stocking costs. Inventory carrying costs can include also costs coming from taxes, insurances and obsolence of items.

4.6 Relation Between Price Reduction and Sales Volume Increase

One of the fundamental ideas of LMS-concept is to deliver gain both to the LMS-company and to the customers through high volumes (economies of scale). Due to the fact that the LMS-company is an “extra” player in the supply-chain the sales margin is

most probably quite low. Another reason for low margin is that the LMS-company does not own the product designs but is only a distributor of products. This fact puts high pressure on product prices.

Table 26 visualizes, the changes in sales volume in case of price reduction (sp=sales profit and pr=price reduction). Sales profit here is sales revenue-costs of purchases (materials and other variable costs).

Table 26. Relation Between Price Reduction and Sales Volume Increase.

	10 (sp%)	15	20	25	30
1 (pr %)	11	7	5	4	3
2	25	15	11	9	7
3	43	25	18	14	11
4	67	36	25	19	15
5	100	50	33	25	20
6	150	67	43	32	25
7	233	88	54	39	30
8	400	114	67	47	36

So, for instance, in case the sales profit of a company is 30%, the price reduction of 3% requires 11% increase in sales volume in order to be on same level in profitability compared to situation before price reduction. This calculation method does not take into account possible changes in material costs that may happen due to increase of sales revenue.

Figures are calculated according to following principles:

Calculation factors:

- Sales profit 30%
- Price reduction 1%

$$\frac{\text{pr } 1\%}{(\text{sp}30\% - \text{pr}1\%)} \text{ X } 100\% = 3{,}4\% \rightarrow 3\%.$$

As a conclusion, it is worth of mentioning that the LMS-company should be very careful with giving discounts in case a product's sales revenue increases. Too big discounts may lead to unprofitable operations. On the other hand sales volume increase may cause also reduction in materials purchase price, which should be taken into account in considering sales price discounts.

5 LOGISTICAL PERFORMANCE

This Chapter discusses about logistical performance of the LMS-concept. The overall goal of logistics is to achieve a targeted level of customer service at the lowest possible total cost. To large extent the logistical performance can be measured in terms of costs and quality of services. The costs were discussed in Chapter 3 and 4. This Chapter concentrates on analyzing the quality of processes and services that LMS-company offers.

Benchmarking is a means to set the standards for the outer limits of the gap chart. A benchmark is typically a quantitative assessment of some aspect of performance of an enterprise. Benchmarking is the process of gathering and sharing those assessments and developing an improvement plan of action based on the assessment. Logistics performance gap analysis can be used to compare and benchmark the performance the performance of internal and/or external organizations. It can be used for highlighting a company's strengths and weaknesses. Normally this is done through external and formal audit process to quantify the opportunity for improvement and to prioritize the initiatives in logistics process improvements. True world-class performers are strong in all areas. Middle-class performers are typically strong in cost/productivity and weak in service indicators, or weak in cost/productivity and strong in service indicators (service-oriented). No-class performers, weak in all areas, may not be in business much longer (Frazelle 2001, pp.64-65). Figure 15 illustrates this classification of logistics organizations.

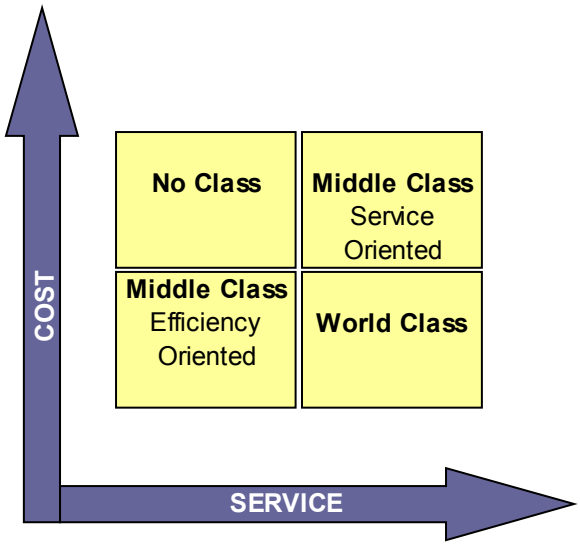

Figure 15. Logistics organization cost-service classification (Frazelle 2001).

Logistical performance of the LMS-company should be measured across the total supply chain. Figure 16 illustrates how important it is to measure the performance of total supply chain. It is not enough that only selected parts of processes are monitored and controlled. The fact is that an end customer is only interested in total performance of processes.

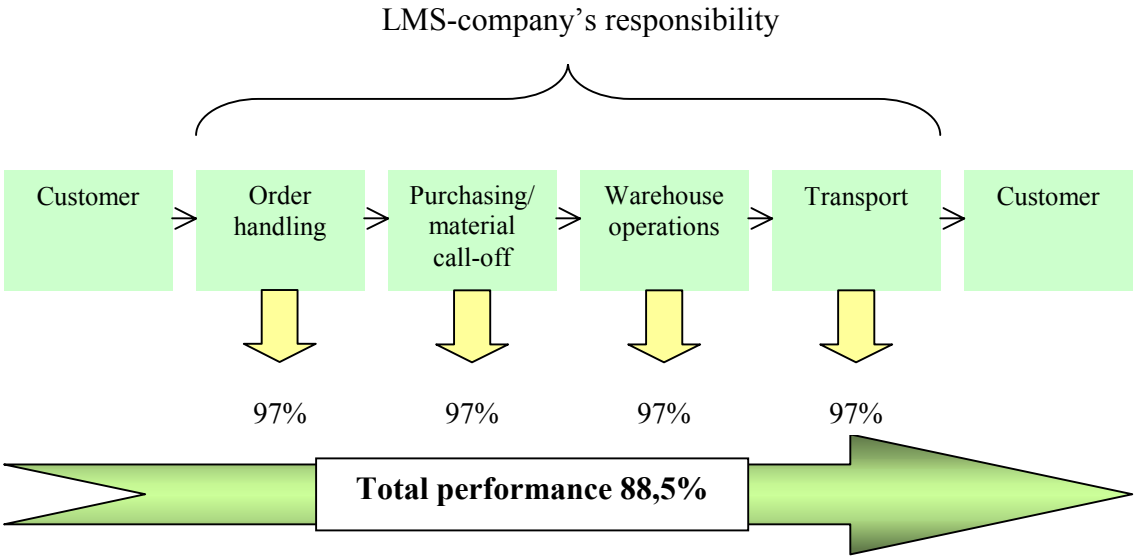

Figure 16. Total performance of a sample process in a period of time.

Figure 16 illustrates a sample process, where a customer orders order-bound material from the LMS-company. Purchasing department makes a material call-off from a supplier, which delivers the material to a warehouse for further treatment of material. Then the LMS-company (or other service provider) ships the goods to customer by using an external transportation company. Say, that during a period of time, the performance of these individual processes is 97% in average, which is reasonably good level. But, when we sum up these performance figures, the total performance of this process from the end customer point of view is only 88,5%. This figure is calculated as follows:

((97/100) x (97/100) x (97/100) x (97/100)) x 100% = 88,5%

In practice this may mean several days or weeks delays in deliveries, and most probably the end result is a dissatisfied customer, which starts to seek alternative vendors.

The measurement of logistics has, on the other hand, different kinds of needs, which need to be observed when considering the measurement system. The system and approach selected has to be agreed between the LMS-company and customers before implementing any measurement systems. The measurement system should take into account following parties' interest for measuring the logistical performance:

- Customer company (outsourcer)
- Service providers (suppliers) and subcontractors
- End customers and
- LMS-company (logistics integrator).

5.1 Supply Process

Sourcing policy of a company plays an essential role in successful supply process. Supply process here means the supply of products and services from vendors and service providers to the LMS-company. The physical supply concept has been discussed also in Valssi-report Part 2 (Kivinen and Lukka 2002, pp.10-11).

The terms purchasing, procurement and strategic sourcing are often used interchangeably in discussions about the buying activities of companies. As Owens et al (1998, pp. 285-286) state that however, they are not identical concepts. Purchasing applies to the transaction functions of buying products (and services) at the lowest possible price. Procurement is a broader activity; it involves the materials management of goods and services in addition to purchasing transactions. Strategic sourcing takes the process further, focusing on developing channels of supply at the lowest total cost to the company, not just the lowest purchase price. Strategic sourcing realigns the organization with the aim of focusing the most time and energy on strategic purchases that can provide advantages in quality, speed or cost effectiveness. Owens et al claim that, in many cases, strategic sourcing enables the total cost of goods and services procured to be reduced by more than 15 percent, which adds tremendous impact to net income and market value.

A very important internal component for implementing a strategic sourcing approach lies in the knowledge and skills of the sourcing personnel. They must have required level of skills appropriate to the type of sourcing they are carrying out. Some of the different types of skills required to carry out strategic sourcing are listed below (Owens et al):

- *Marketing and strategic analysis* (identify and evaluate best suppliers, industry cost structures and understand pricing)
- *Information gathering and technical knowledge* (technical and commercial awareness, continuous seeking of information, developing information networks outside the company)
- *Performance-evaluation skills* (assessment of services, innovation ability, quality and lead-time accuracy, total-cost reduction practices)
- *Product-development skills* (joint development programs with suppliers on products and services)
- *Negotiations skills and partnership development* (day-to-day operation management skills, managing a partnership requires legal proficiency and negotiation skills, maintain and monitor the relationship).

Supplier service policy is a set of guidelines for choosing suppliers (supplier certification and classification criteria), monitoring supplier performance including planning and controlling of purchase processes. By implementing partnership relations with suppliers it is possible to utilize common practices and improve information flows.

From practical operations point of view, the paperwork attached to shipments must be clear. For instance packing list should include at least following information:

- Name of supplier

- Name of receiver
- Delivery address
- Date of dispatch
- Purchase order number
- Material identification number
- Material's technical specification
- Quantity ordered and delivered
- Way of transport
- Carrier's name and waybill number
- Weight and volume
- Number of packages.

Another important detail is the marking of goods supplied into warehouses (distribution centers). A warehouse service provider does not have technical knowledge about their customers' products. Therefore all the products coming into the warehouse should be individually packed and marked with relevant information. In ideal situation the goods are marked with stickers or other type of tags already at the supplier's premises. A single package should include relevant delivery lots. This procedure saves a lot of resources and time in inbound process. Practical experiences have showed that the implementation of this type of procedure may be very difficult if there are too many suppliers involved in the supply process. When the number of suppliers exceeds 100, it may be difficult to implement the individual packaging and marking procedure. Therefore there may be situations that a warehouse service provider should offer above-mentioned service. Figure 17 illustrates one possibility to organize the individual packaging and marking process at warehouse service provider's premises.

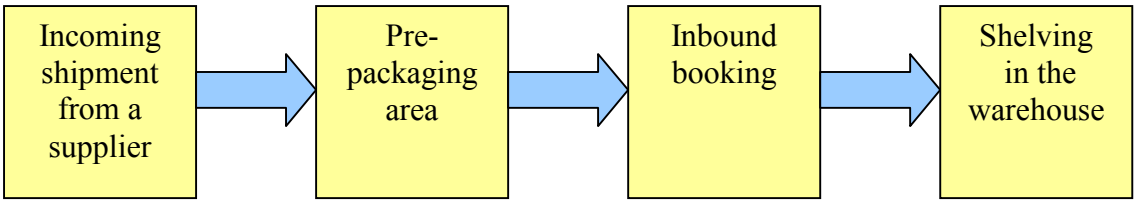

Figure 17. Individual packaging in supply process.

In outsourced logistics it is essentially important to control and measure the quality of shipments, contents and paperwork coming into warehouse. The inbound control process should produce basic information for rating the suppliers, and it should also be a practical tool for purchasing to give feedback about the supply process performance internally and to suppliers. In company level, the implementation of feedback process and corrective action system is a key factor for controlling and improving performance of supply chain processes.

The quality of output provided by Information systems has a notable role in integrating the customers and service provider network in the LMS-concept.

Integration enables the visibility of processes, collaborative forecasting and replenishment and supply chain collaboration & optimization. Special attention must be paid to the quality of interface data transfer and transaction control.

In the supply of services, a service provider has to be flexible because the services cannot be "stocked". Without a proper assignment, basic information and collaboration it is difficult to provide services in time.

5.2 Operations Process

Operations processes consist of company's internal handling and stocking phases and controlling activities related to them. Operations management focuses on managing the processes to produce and distribute products and services. Related activities include managing purchases, inventory control, quality control, storage, internal logistics and evaluations. A great deal of focus is on efficiency and effectiveness of processes. Therefore, operations management often includes substantial measurement and analysis of internal processes. Ultimately, the nature of how operations management is carried out in an organization depends very much on the nature of products or services in the organization, for example, retail, manufacturing, wholesale, etc.

In case of LMS-concept the operations is performed in every 12-service modules presented earlier in this study. Because LMS-company is expected to purchase most of the operations processes (like manufacturing, warehousing and packaging), its main tasks will be mostly controlling of operations processes. Following activities are key areas of operations management from service modules point of view:

- Control of vendor network
- Customer service management
- Managing information in supply chain
- Development of logistics technologies
- Managing and developing consultancy services and customer-specific solutions.

Additionally the following areas are important from LMS-company's point of view:

- Finance & treasury (control of financial efficiency of operations and processes)
- Quality and environment
- Human resource management
- Legal affairs
- Communication and public relations and
- Information technology.

Product assortment is often wide in spare part business. Differences in product volumes are another typical feature in spares business. Therefore, for managing the product range, it is important to define the importance groups of products according ABC-classification. For instance the strategic products in A-group could have a

service level target of 100%. Other groups should have target levels as well. A quite commonly used classification criteria is (Sakki 2001, p.101):

- A-products = first 50% of sales/consumption
- B-products = next 30% of sales/consumption
- C-products = next 18% of sales/consumption
- D-products = last 2% of sales/consumption
- E-group = products that do not have consumption or have not been sold.

These target levels should of course be defined together with the customer companies because it is especially their interest to decide the targets - they are the experts in their area of business.

With aid of reserve (safety) stocks it is possible to influence on the service level. When the consumption's standard deviation is known, it is possible to forecast the amount of reserve stocks. Formula for calculating the safety stock is (Sakki 2001, pp.125-126):

$$B = k \times s \times \sqrt{L}$$

Where k is factor of safety, s is standard deviation and L is purchasing (delivery) time. For instance if s=27 pieces and delivery time is four weeks, a 95 % service level is achieved by having 89 pieces safety stock (1,64 x 27 x √4). For achieving a 99 percents service level, the safety stock must be 126 pieces.

Table 27. Desired service level versus corresponding factors of safety (Sakki 2001, p. 126).

Factor of safety	Desired service level
0	50%
0,67	75%
1,28	90%
1,64	95%
1,88	97%
2,05	98%
2,33	99%
2,57	99,5%
3,09	99,9%

It is worth of reminding that in practice it is possible to influence on service level also in other ways like by shortening delivery times, smaller (quicken) delivery lots and in general by increasing collaboration between the companies.

In outsourced operations it is essentially important that the parties have agreed on practical processes, responsibilities and procedures for corrective actions etc. Working manual is a commonly used and practical method to communicate these issues. The manual should be available for all parties concerned. There will be many processes taking place in each area or function of LMS-organization. Therefore, for managing these processes the external partners have to work according to common

procedures. A common set of guidelines clarifies how the process inputs and outputs are defined, controlled and monitored. Depending on the strategy and size of LMS-company the implementation of total quality management and environmental programs may be solutions for managing an organization (LMS).

Practical experiences have shown that typically, in outsourced operations, the incoming material flow may face following problems from operational work point of view:

- Delivery problems (lost shipments or items)
- Quality problems of products' (originally caused by the manufacturer)
- Problems in booking the orders in system (failure to book in time due to capacity problems or system does not function properly)
- Stock balance problems (may be caused by the loss or data interface problems)
- Transportation problems (goods are damaged during transportation)
- Missing shipping documentation or
- Failures to deliver in time.

The performance of incoming material flow has a significant value for the operational processes. Therefore the performance has to be measured and monitored and a corrective action system has to in place for improving supply chain processes.

Picking and packing processes influence on the output of operations. For instance following problems may occur in outsourced operations:

- Picking failures (wrong quantity, wrong item, incomplete order etc.)
- Packing failures (packing does not correspond to requirements, causes damages)
- Shipping problems (failures to deliver in time for instance due capacity problems)
- Incomplete shipping documentation or
- Problems in stock balances of items

Again, a corrective action system together with a employees' continuous training program is a practical way to avoid occurring of these problems in the future.

Liability of information systems and technology are the base of successful operations. Back up and restoring procedures must be taken care of. Firewalls and Virus prevention secure should be centrally managed for corporations challenged by the ever-increasing security threats in today's complex network environments. In general, it can be said that the efforts put on reliability of IS and IT is worth of doing. Downtime of systems may have significant influences on performance of logistics operations – especially from end-customers' point of view.

There are nowadays several standards for communication between organizations. EDI has been the strongest standard and it is widely used. In the last few years, XML has rapidly become the first choice for defining data interchange formats in new e-Business applications on the Internet and in communication between enterprises. Application integration inside companies today is difficult, because so many different

applications are in use. Future business (as in LMS case) is going to require massive amounts of application integration across multiple organizations (Hemilä 2002, p.55).

Integration between networked companies is dependent on the resources and business strategies: do it yourself or contract out. The easiest way is to use operators, because they have usually already concepts and interfaces in many systems, and then the operators are response for the data transfer. On the other hand the use of operator services create continuous maintenance costs, but results in carefree connections and data transfer. They can also provide reports for controlling the performance of data transfer. Maintenance contracts with an operator partner usually ensure the newest standards in data transfer and very versatile connections and interfaces to the business partners. Likely the use of using integration operators will increase in the future because companies are concentrating in their core business. In case of LMS-company the operator services should be contracted out in order to be able to offer world-class integration services.

Competitive advantage of LMS-company should be an outstanding customer service. The following issues should be taken into account in managing and controlling of customer service:

- Customer service policy
- Customer satisfaction monitoring
- Operational organization
- Reporting and corrective action system and
- Account management.

Customer service policy is the first step in proactive customer and demand management. The guidelines for customer service should be included in the logistics contract, which is done between the LMS-company and the customer. The contract defines the service targets, objectives and service requirements for each process etc. Frazelle (2001, p.79) defines that customer service policy (CSP) usually reflects the culture and logistics maturity of the company, and it can be labeled as the following:

- **Ad-hoc**; There is no CSP.
- **Well-defined exuberance**; The CSP is stated but not quantified.
- **One-size-fits-all**; There is a stated and quantified CSP but no segmentation.
- **Mature**; The CSP is stated, quantified, and segmented by customer and item classes.

Once the customer service policy has been established, monitoring the performance to it and overall customer satisfaction are keys to maintaining customer relationship. Regular customer satisfaction studies can be used for prioritizing logistics initiatives and to maintain constructive customer communications. Call center and order entry are the interface point with the customer, and it often makes the overall impression to the customer. The order entry system should provide online inventory visibility and order tracking. From customers' point of view a single contact point is preferred regardless of logistics service or process concerned. This has to be taken into account also in managing different accounts (customers). Continuous communication in all levels of organization is also a necessity for successful partnership.

In a complex logistics environment one part of customer satisfaction is the how a logistics service provider reacts when problems occur in any part of processes. Implementation of a corrective action system is an approach to improve quality of activities performed. A corrective action is a change in the way, how things are done, that eliminates a root cause of a problem in order to prevent similar problems occurring again. Corrective action system can be part of for instance quality assurance system.

- Specify the problem
- Identify and analyze root causes
- Prepare a detailed action plan
- Eliminate the problem by implementing the necessary corrective actions and
- Monitor continuously.

A well-organized and functioning corrective action system creates trust on operations internally and externally through continuous improvement process.

5.3 Distribution Process

Applying a new supply chain perspective to current distribution operations reveals that the product-delivery systems of 10 years ago are obsolete today. Customers are demanding improved levels of service at the lowest possible cost as they struggle to control their own costs and fine-tune their internal flow of products and information. The distribution facility of the future needs to represent the vital link in the supply chain that adds value to the overall chain (Marvick and White 1998, pp.354-368).

Depending on the customer needs, distribution facilities are required to fulfill various roles in the supply chain. The facility types vary depending on the role that the facility is playing in terms of services and functions provided – including bulk storage, mixing, assembly, consolidation, break-bulk distribution, cross-docking and flow-through distribution facilities.

Important aspects for spare part distribution in the LMS-concept are for instance following details:

- Selection of appropriate mode of transport (depends on delivery times, service level, costs etc.)
- Identify 24h delivery coverage
- Control of actual delivery time compared to promised delivery time (service level)
- Efficiency of forwarding process
- Two-way electronic data-transfer between concerned ERP-systems and transport (and forwarding) companies for improving process transparency
- Delivery close to end-user or end-usage location (new channels of distribution)
- Continuous process simulation for improving (end-to-end) process efficiency
- Increase of reverse logistics needs due to environmental legislation regulations.

There may be several reasons why different transport companies are used in distributing goods to end-destination. For instance there are limitations in volumes and weight with certain transport companies, service coverage of 24h deliveries and performance (service level) differs from company to another etc. There may be also remarkable saving potential also in cost efficiency between different companies in terms of freight costs and distribution concept. It is useful to analyze and prepare instructions and rules for operational activities about the selection of carriers.

Especially end-customers are interested in total performance of supply chain. Therefore the estimated delivery time, which is a promise given by customer service has to be controlled whether the promise was kept or if it failed. In case of failure in delivery time it is important to inform to customer that a shipment will arrive delayed beforehand rather than afterwards. Another aspect is that for implementing continuous improvement strategy the performance of carriers has to be analyzed and corrective actions has to be made together with the partners.

Compatibility of data must be achieved across the transport partners. This helps also in tracking of shipments through each stage of delivery. If the data is not compatible at each delivery point, it will need to be reprocessed at that phase, resulting in a duplication of effort, greater chance of errors, mishandling and slowing of both the product and the information. Additionally the goods' arrival information should be integrated with the ERP-system via for instance electronic data interchange (EDI) or over the Internet.

Cultural and geological differences in forwarding process have remarkable influences on delivery time. A local presence, knowledge of local circumstances, complete paperwork and good relations to local authorities in destination country make possible quicker and more reliable delivery at less cost.

Control of deliveries to end-destination is an essential part of logistics performance. Especially the customers are interested in the information related to timing and quality of delivery. In principle, the non-conformance of distribution can be divided into three main categories according to the origin of problems. The following categories are especially relevant from the transport companies' point of view:

- Consigner (shipper)
- Consignee (receiver) and
- Force major.

Consigner's non-conformances occur for instance due to following reasons:

- Shipment packed but not shipped in time (from warehouse)
- Incomplete shipment information (data transfer)
- Wrong delivery address
- Wrong airway bill on the package
- Missing shipment documentation (causes delays in e.g. customs)
- Receiver not at "home" etc.

From transport company point of view the client's failure can be divided into two categories: Sender's and receiver's failures.
Consignee's con-conformances occur for instance due to following reasons:

- Delayed delivery (e.g. wrong line haul)
- Partial delivery
- Failure in paperwork or documents
- Package damaged or lost during transportation.

A Force Major reason can be for instance:

- Customs delay
- Accepted delay (e.g. bad weather, strike)
- Other Force major reason.

Different types of transport modes do have different conditions and operational environment; therefore every mode has to be controlled separately. For instance the implementation of an in-night delivery to service-engineer's car means that the transport carrier during the night car has to locate easily the car otherwise the goods cannot be delivered into the car. Same type of problems may occur in case of deliveries to a locker-point. Below listed some issues which may cause non-conformance in deliveries close to end-user (in-night deliveries to service cars or locker-points):

- Parking problems in city centers
- Mobility of engineers
- Delivery address in case of holidays
- Availability of keys (driver)
- Authorization for signing the goods etc.

In general, the practical experiences have shown that a pro-active approach in sending information to customer about the possible delays of deliveries is an essential part of customer service. Customer should get the information about the delays before he recognizes it by himself. The message about the possible delays could be informed for instance by phone, e-mail or SMS-message to mobile phone. The message can include any relevant order information. Of course a SMS-message (text message) could be sent also in case the shipment will be delivered in time. It can be used a communication method for telling the customer when is the expected delivery time to end-destination.

It is important to have the goods receipt information in ERP-System as soon as the delivery has been made. Therefore the carriers and customer systems should be integrated for communicating the following shipment arrival information:

- Date and time of goods arrival
- Who signed the goods (receiver)
- Airway bill number
- Condition of goods etc.

From customers' point of view the overall service level consists of several factors. The Figure 18 presents issues that are surely the interests of customer-companies to control.

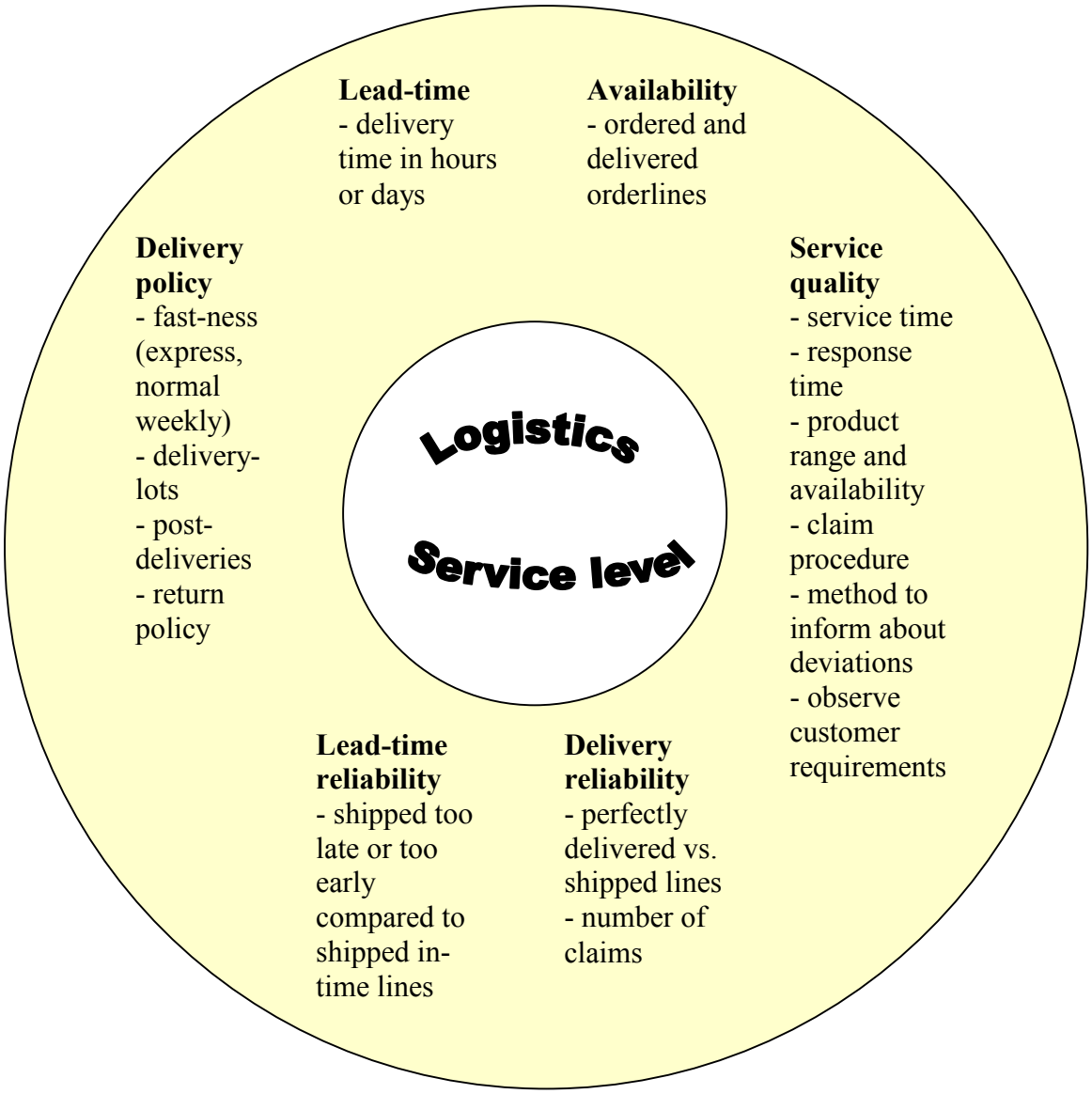

Figure 18. Service level factors.

It can be concluded from the Figure 18 that the logistics service level is wholeness where every individual feature of service has a significant meaning and influence on total performance of a logistics company. In another words, a world-class logistics service provider cannot ignore any of these single performance aspects in its daily operations. Unsatisfactory performance in any area of logistics processes may lead to uncontrollable operations also in later stages of processes.

In general the LMS-company should pay attention to the performance of total supply chain by controlling and measuring them constantly.

Another important aspect is that a close to 100% total service level cannot be realized without implementing a forecasting and collaborative planning with customers and vendor network. Collaborative planning improves for instance visibility of supply chain, capability to pro-activeness, mutual understanding of process capabilities and reduction in capital-tight.

6 CONCLUSION

The Valssi-project has presented in earlier research reports the basics of LMS-concept and its service modules. This study presents the processes of these 12 service modules in depth. The processes have been described in more detailed level (activities). In fact, these activities form the core of LMS-concept. The developed activity-based costing tool visualizes the different cost types involved in the new logistics concept with aid of graphics. Also the cost types of activities include detailed descriptions. *The contents of service module contents can be utilized for establishing the LMS-type of company.*

The activity-based costing approach suits very well in the LMS-type of logistics concept. The tool can be utilized in the LMS-concept for instance in following activities:

- Budgeting
- Pricing of products and services
- Controlling of cost and operations efficiency
- Analyzing the 'Make-or-Buy' decision and
- Managing of resources (for avoiding over/under capacity).

Customer-companies can utilize the ABC-tool for analyzing and internal logistics efficiency and for benchmarking the results with other companies. Logistics service providers can utilize the tool for calculating and controlling its internal cost-efficiency and pricing of the service & products.

The aim of this reports has been to present a practical approach to understanding of different activity models on costs. It intends to provide a basic review of the different activity model possibilities involved in the LMS-concept. One of the aims is also to increase awareness of different activity models, and how the decisions that are made influence on total process costs. The literature references that were used in this study give practical tips for planning the LMS-based operations. Additionally, the literature references prove that automated processes are more cost-effective compared to traditional/manual ways of transferring information. This is an important factor to recognize because the LMS-concept is purely based on automated information flows. The literature research findings supplement the implementation of ABC-tool that was developed in this study

For achieving a profitable and a 'win-win' co-operation between the LMS-company and customer-company it is the both parties interest to consider also the impact of batch sizes on product cost and the capital cost of inventories. In many practical cases the importance of these details have been totally forgotten. In fact, there are significant saving potentials involved in these issues. It can be assumed that every company can get benefits by implementing the delivery-lot approach and controlling the capital cost of inventories. When the automated information flows (ERP-integration) are in place, remarkable savings can be achieved.

The chapter about logistical performance emphasizes how important the total performance of supply chain is from the total service level point of view. This study

proves that in case of LMS-concept all the three main logistical processes have to measured and controlled. These processes are:

- Supply process
- Operations process and
- Distribution process.

The contents of logistical performance discussions in this study give practical hints for the customer-companies and service providers about the service level related factors across the total supply chain. In networked business environment the total logistics service level is all parties concern. Additionally, the research presents a few ways to measure and control the logistical supply chain performance from the different processes point of view.

Logistics service level is wholeness where every individual feature of service has a significant meaning and influence on total performance of a logistics company. A world-class logistics service provider cannot ignore any of these single performance aspects in its daily operations. Unsatisfactory performance in any area of logistics processes may lead to uncontrollable operations also in later stages of processes. In case of LMS-concept it means that the LMS-company has to implement a total quality approach.

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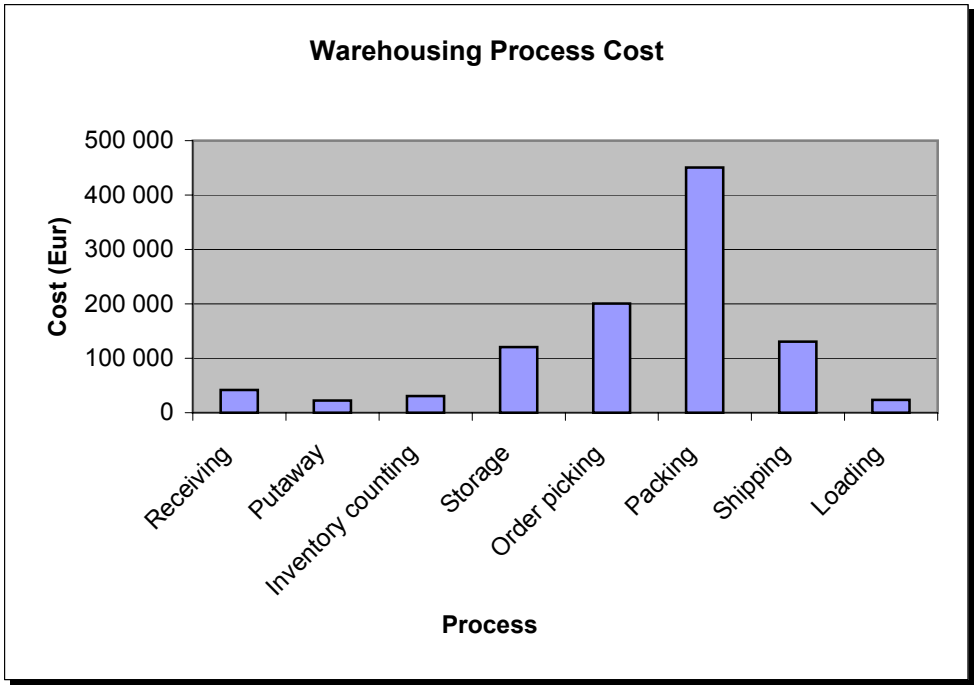
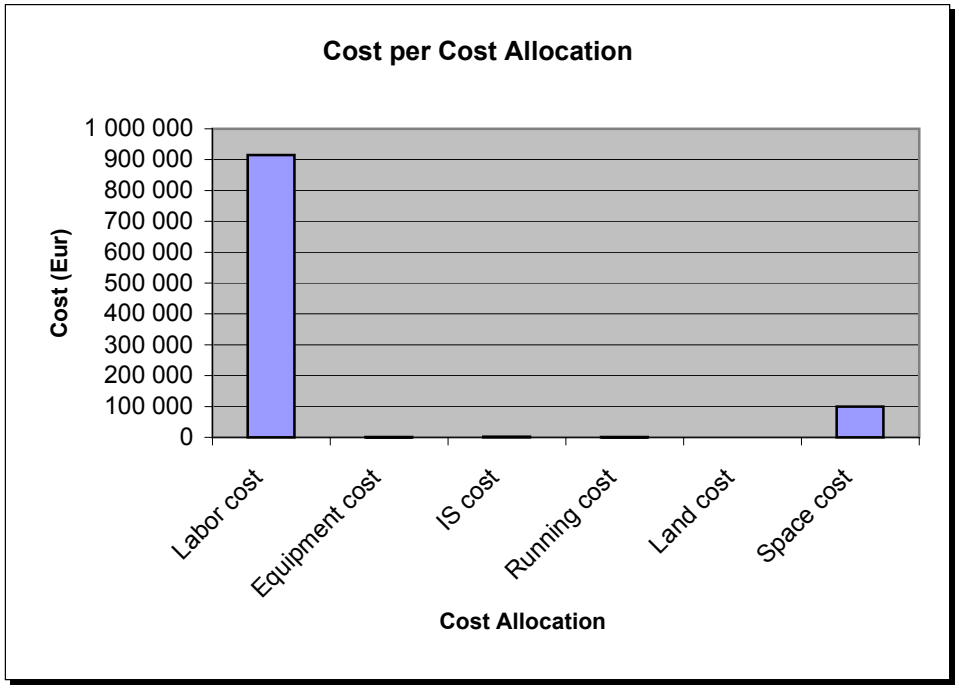
Stock process

Activity \ Cost	Labor cost	Equipment cost	IS cost	Running cost	Land cost	Space cost	Total cost	Driver quantity	Cost per transaction	Cost driver
Receiving	40 000	1 400	200	100	300		**42 000**	30 000	1,40	per inbound line
Putaway	22 000		200	100			**22 300**	30 000	0,74	per inbound line
Inventory counting	30 000		200	100			**30 300**	10 000	3,03	per SKU
Storage	20 000		200	100		100 000	**120 300**	10 000	12,03	per SKU
Order picking	200 000		200	100			**200 300**	270 000	0,74	per outbound line
Packing	450 000		200	100			**450 300**	270 000	1,67	per outbound line
Shipping	130 000		200	100			**130 300**	100 000	1,30	per sales order
Loading	23 000		200	100	200		**23 500**	250 000	0,09	per package
Total (Eur)	**915 000**	**1 400**	**1 600**	**800**	**500**	**100 000**	**1 019 300**	1 019 300		
% of Total	89,8 %	0,1 %	0,2 %	0,1 %	0,0 %	9,8 %	**100,0 %**			
Cost / inbound line	3,15									
Cost / outbound line	3,42									

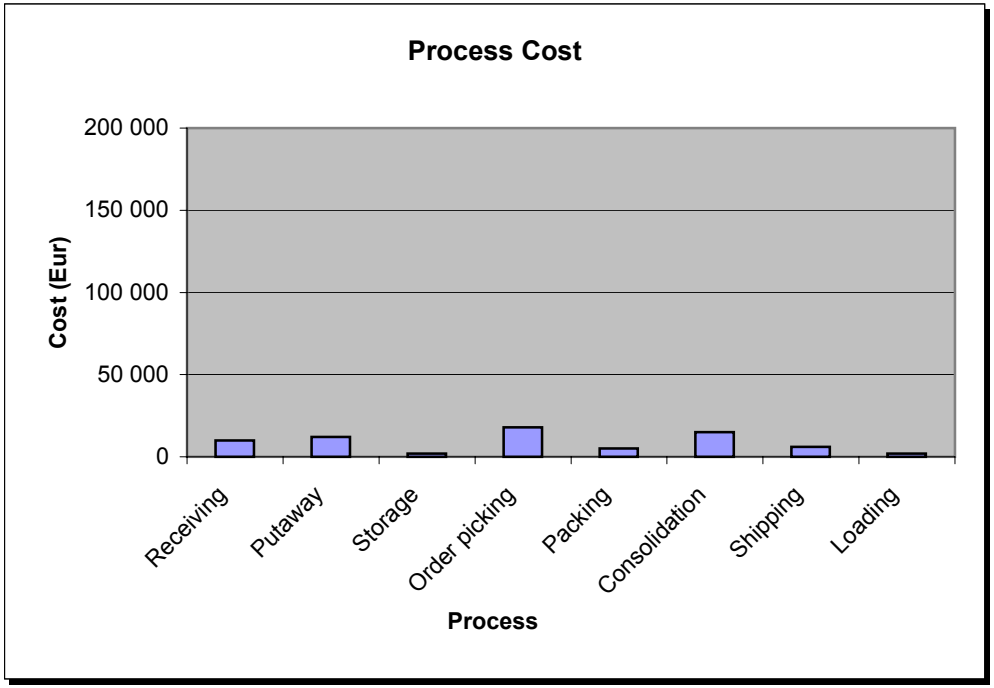


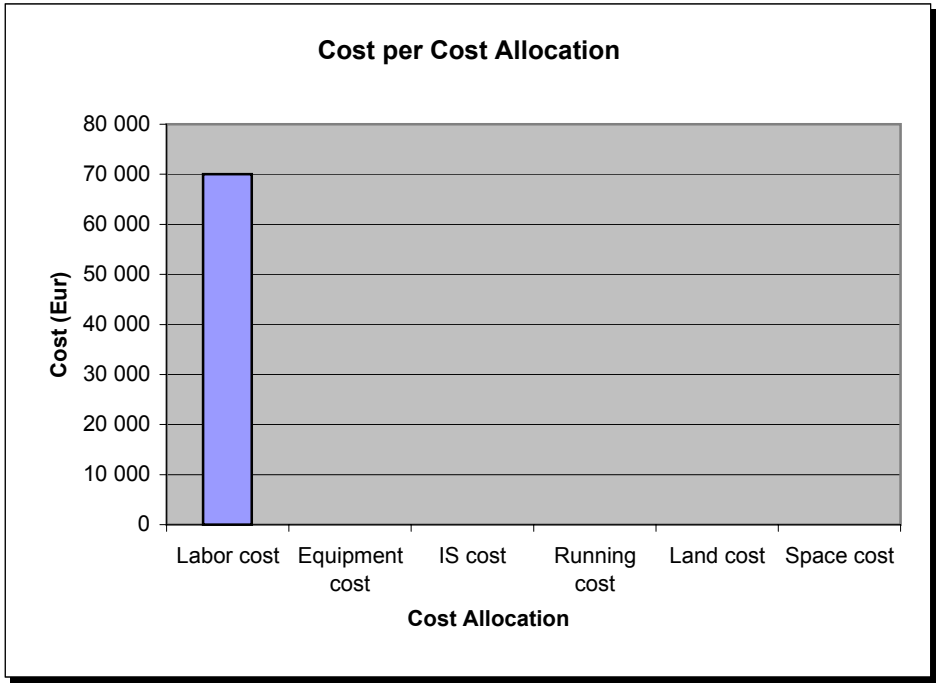


Warehousing

Consolidation process

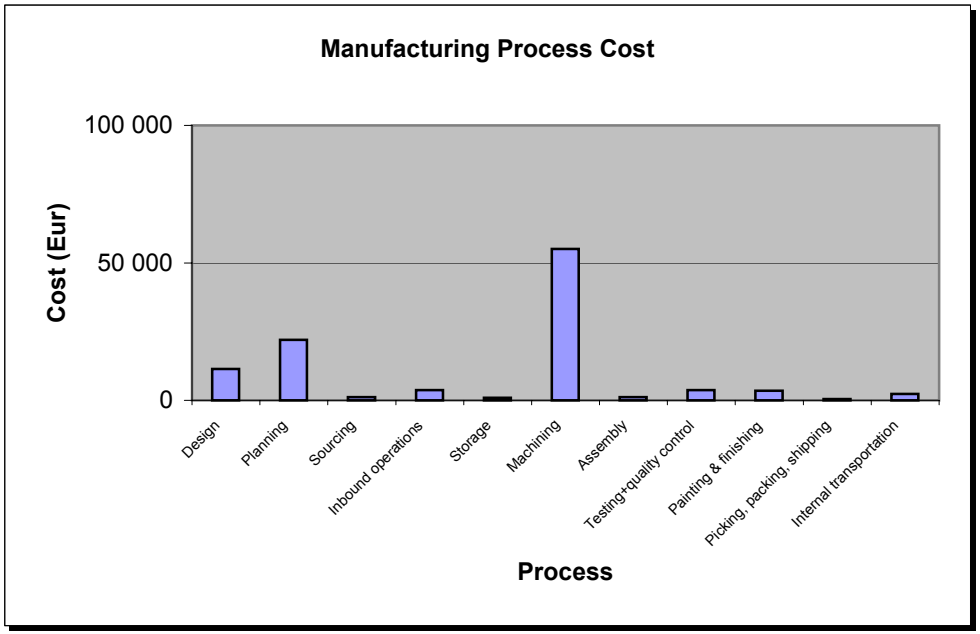
Activity \ Cost	Labor cost	Equipment cost	IS cost	Running cost	Land cost	Space cost	Total cost	Driver quantity	Cost per transaction	Cost driver
Receiving	10 000						**10 000**	2 000	5,00	per inbound line
Putaway	12 000					-	**12 000**	2 000	6,00	per inbound line
Storage	2 000						**2 000**	700	2,86	per SKU
Order picking	18 000					-	**18 000**	2 000	9,00	per outbound line
Packing	5 000						**5 000**	2 000	2,50	per outbound line
Consolidation	15 000						**15 000**	2 000	7,50	per consolidated parcel
Shipping	6 000						**6 000**	1 000	6,00	per sales order
Loading	2 000						**2 000**	2 500	0,80	per package
Total (Eur)	**70 000**	**0**	**0**	**0**	**0**	**0**	**70 000**	70 000		
% of Total	100,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	**100,0 %**			
Cost / sales order	70,00	0,00	0,00	0,00	0,00	0,00	**70,00**			
Cost / inbound line	11,00	0,00	0,00	0,00	0,00	0,00	**11,00**			
Cost / outbound line	22,00	0,00	0,00	0,00	0,00	0,00	**22,00**			

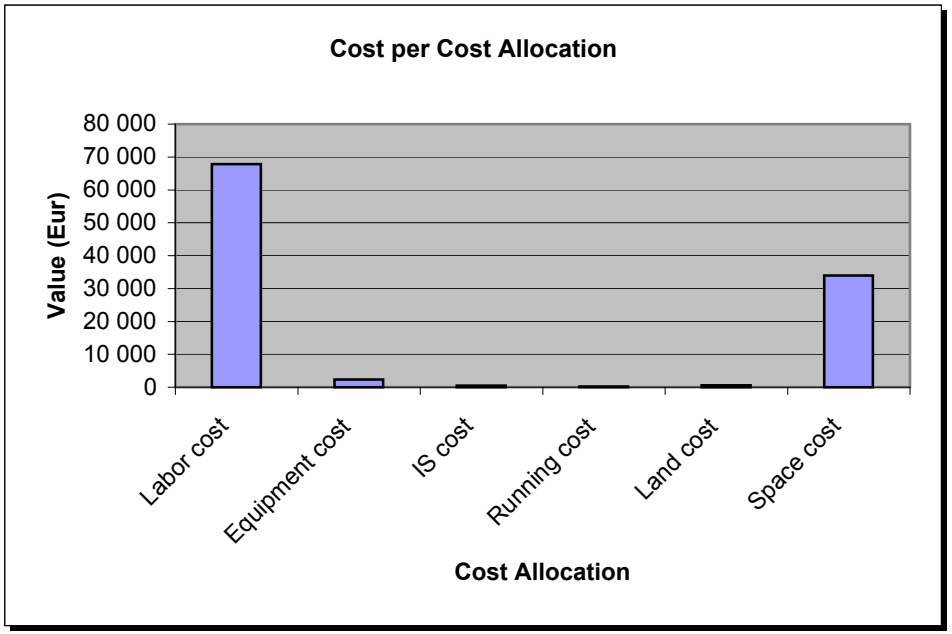




Manufacturing

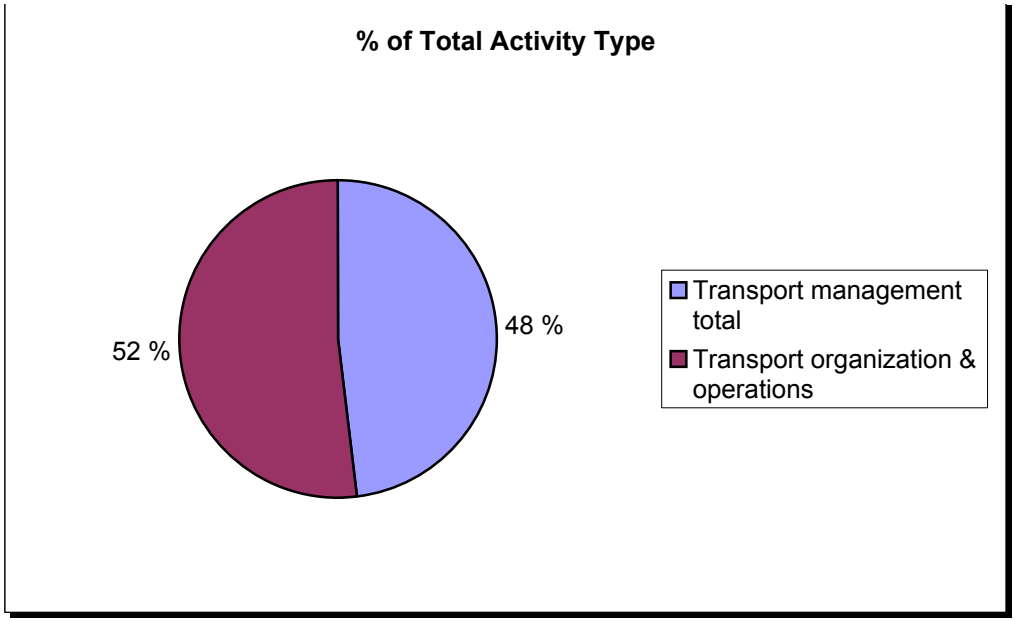
Activity \ Cost	Labor cost	Equipment cost	IS cost	Running cost	Land cost	Space cost	Total cost	Driver quantity	Cost per transaction	Cost driver
Design	10 000	1 400					**11 400**	3 000	3,80	per hour
Planning	22 000					-	**22 000**	3 000	7,33	per hour
Sourcing	1 222						**1 222**	123	9,93	per PO line
Inbound operations	3 333		435		9		**3 777**	500	7,55	per PO line
Storage	344	0		8	567		**919**	234	3,93	per square meter
Machining	20 000	879	89	67		34 000	**55 035**	10 000	5,50	per hour
Assembly	1 000	67		45		-	**1 112**	270 000	0,00	per hour
Testing+quality control	3 666	6		33			**3 705**	270 000	0,01	per hour
Painting & finishing	3 456	4					**3 460**	100 000	0,03	per hour
Picking, packing, shipping	456						**456**	234	1,95	per hour
Internal transportation	2 345						**2 345**	250 000	0,01	per hour
Total (Eur)	**67 822**	**2 356**	**524**	**153**	**576**	**34 000**	**105 431**	105 431		
% of Total	64,3 %	2,2 %	0,5 %	0,1 %	0,5 %	32,2 %	**100,0 %**			

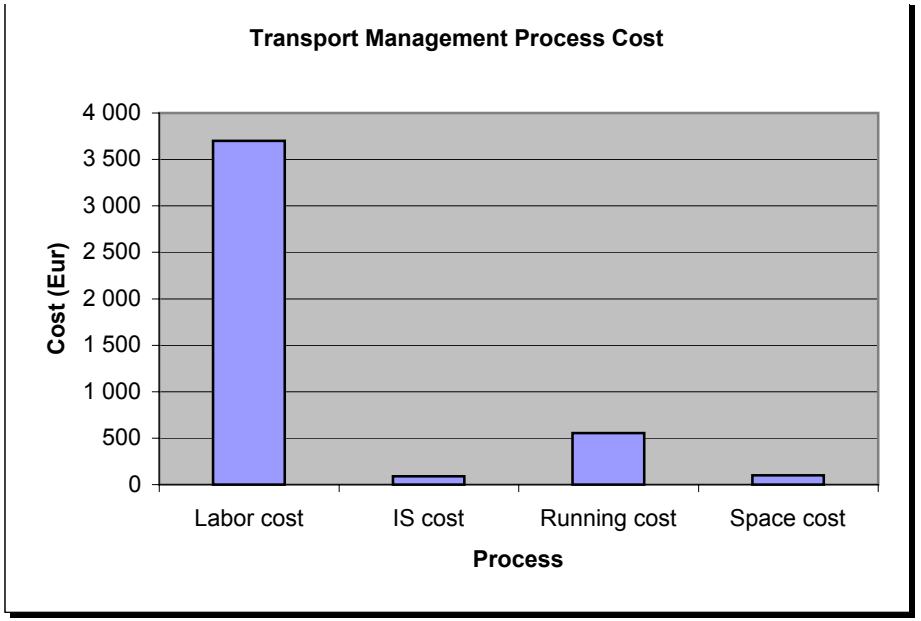


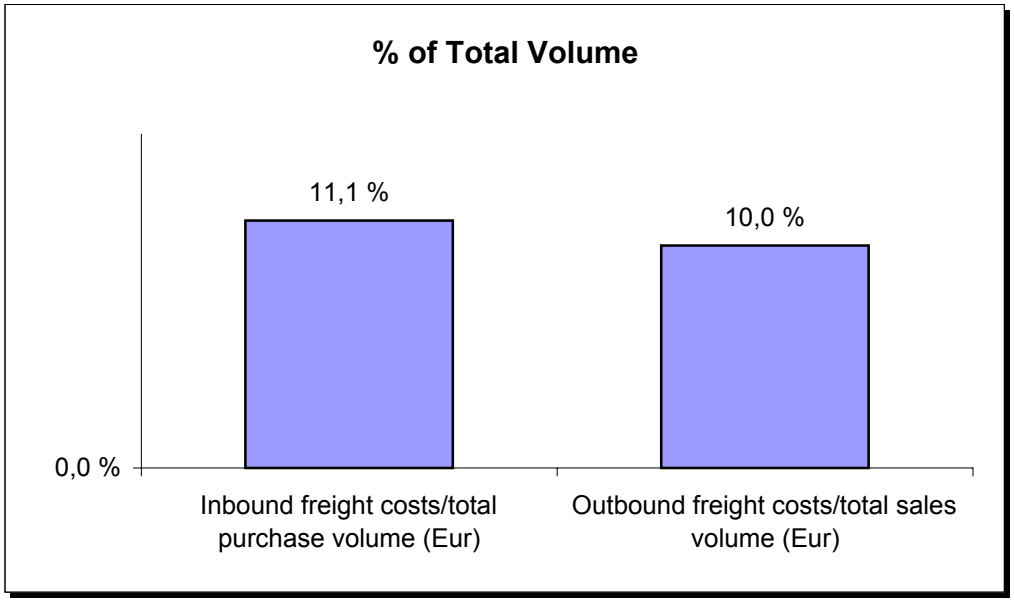


Transportation

Activity \ Cost	Labor cost	IS cost	Running cost	Space cost	Total cost	Driver quantity	Cost per transaction	Cost driver
Transport management								
Carrier management	2 000		55		2 055	50	41,10	per carrier
Shipment management	700				700	100	7,00	per shipment
Freight management	1 000	90	500	100	1 690	100	16,90	per shipment
Transport management total	**3 700**	**90**	**555**	**100**	**4 445**	**48,0 %**	% of Total	
Total cost/carrier	**88,9**							
Total cost/shipment	**44,45**							
Transport organization&operations								
Operative contacts	2 000		789	89	2 878	100	28,78	per shipment
Transport documents	1 255	44	55		1 354	100	13,54	per shipment
Other documentation	500	22	22	44	588	100	5,88	per shipment
Transport organization & operations	**3 755**	**66**	**866**	**133**	**4 820**	**52,0 %**	% of Total	
Total cost/shipment	**48,20**							
Freight costs								
Inbound freight costs					50 000	2000	25,00	per PO line
Outbound freight costs					500 000	270 000	1,85	per outbound line
Inbound freight costs/total purchase volume (Eur)	**11,1 %**							
Outbound freight costs/total sales volume (Eur)	**10,0 %**							

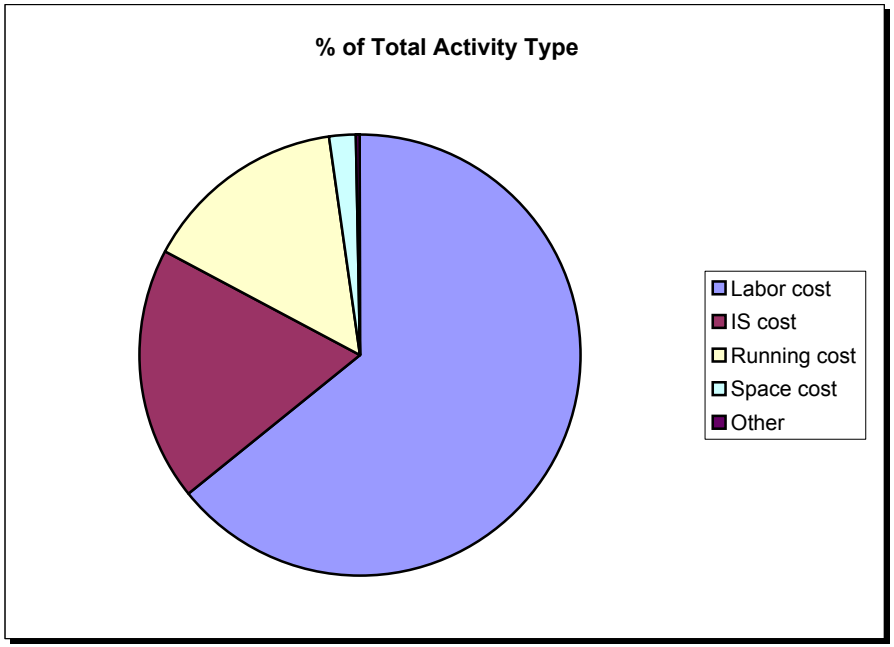

% of Total Activity Type
52 %
48 %
Transport management total
Transport organization & operations

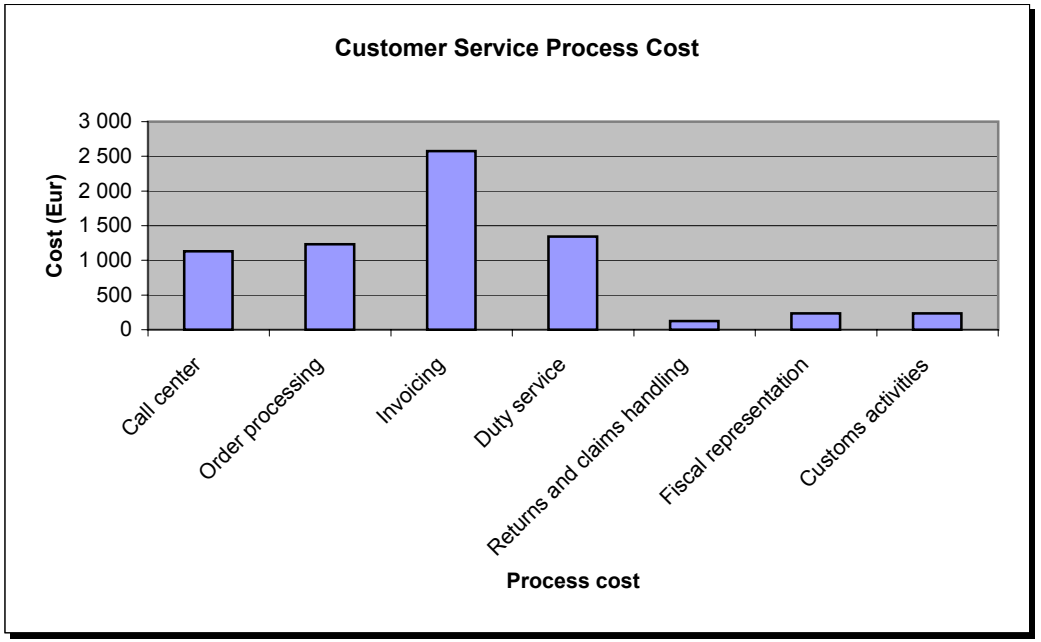

Transport Management Process Cost
4 000
3 500
3 000
2 500
2 000
1 500
1 000
500
0
Cost (Eur)
Labor cost
IS cost
Running cost
Space cost
Process


% of Total Volume
11,1 %
10,0 %
0,0 %
Inbound freight costs/total purchase volume (Eur)
Outbound freight costs/total sales volume (Eur)

Customer service

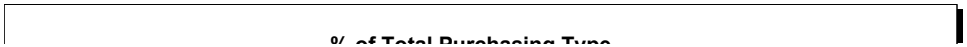
Activity \ Cost	Labor cost	IS cost	Running cost	Space cost	Other	Total cost	Driver quantity	Cost per transaction	Cost driver
Call center	1 000	44	33	33	23	1 133	200	5,67	per call
Order processing	1 234					1 234	190	6,49	per sales order line
Invoicing	1 234	1245		98		2 577	12	214,75	per billing document
Duty service	345		998			1 343	12	111,92	per hour
Returns and claims handling	123					123	145	0,85	per order line
Fiscal representation	234					234	2	117,00	per report
Customs activities	235					235	21	11,19	per shipment
Customer service total	**4 405**	**1289**	**1031**	**131**	**23**	**6 879**			
% of Total	64,0 %	18,7 %	15,0 %	1,9 %	0,3 %	100,0 %			
Call center's cost/call	**5,00**	**0,22**	**0,17**	**0,17**	**0,12**	**5,67**			
Order processing cost/order line	**6,49**	**0,00**	**0,00**	**0,00**	**0,00**	**6,49**			
Invoicing/billing document	**6,49**	**6,55**	**0,00**	**0,52**	**0,00**	**13,56**			
Duty service/hour	**28,75**	**0,00**	**83,17**	**0,00**	**0,00**	**111,92**			
Returns and claims handling cost/order line	**0,85**	**0,00**	**0,00**	**0,00**	**0,00**	**0,85**			
Fiscal representation cost/report	**117,00**	**0,00**	**0,00**	**0,00**	**0,00**	**117,00**			
Customs activities cost/shipment	**11,19**	**0,00**	**0,00**	**0,00**	**0,00**	**11,19**			



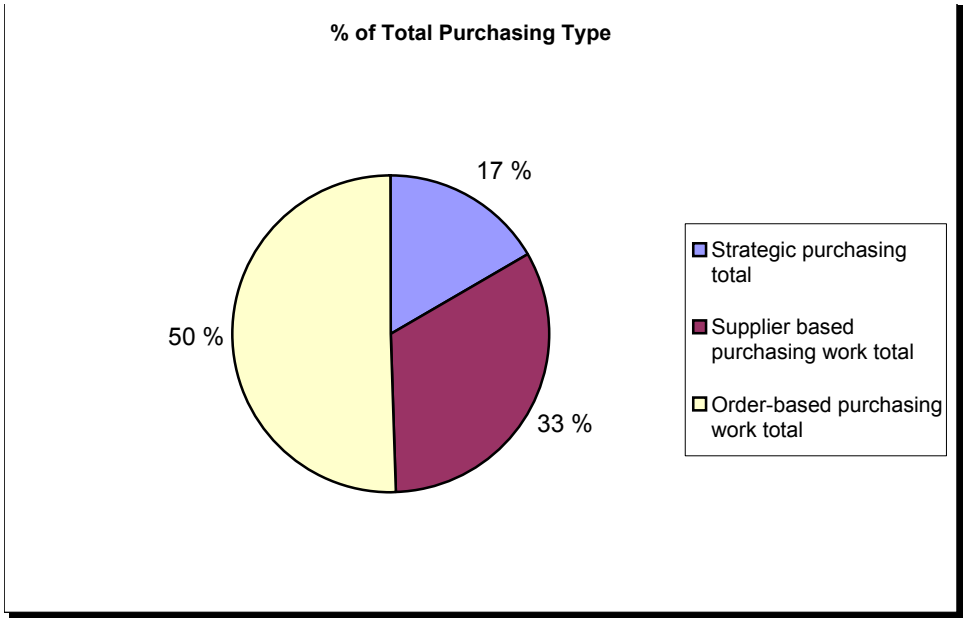


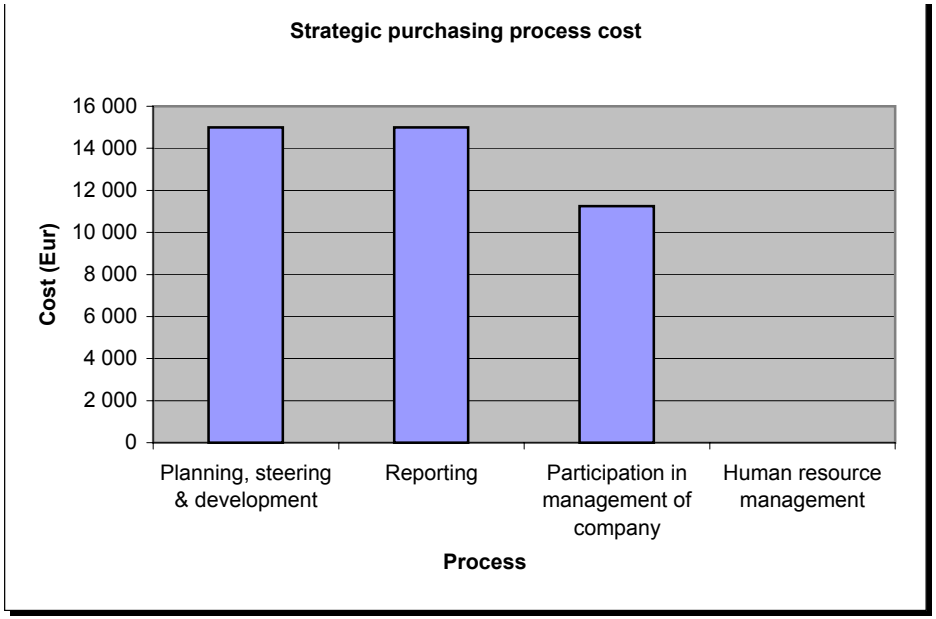
Procurement

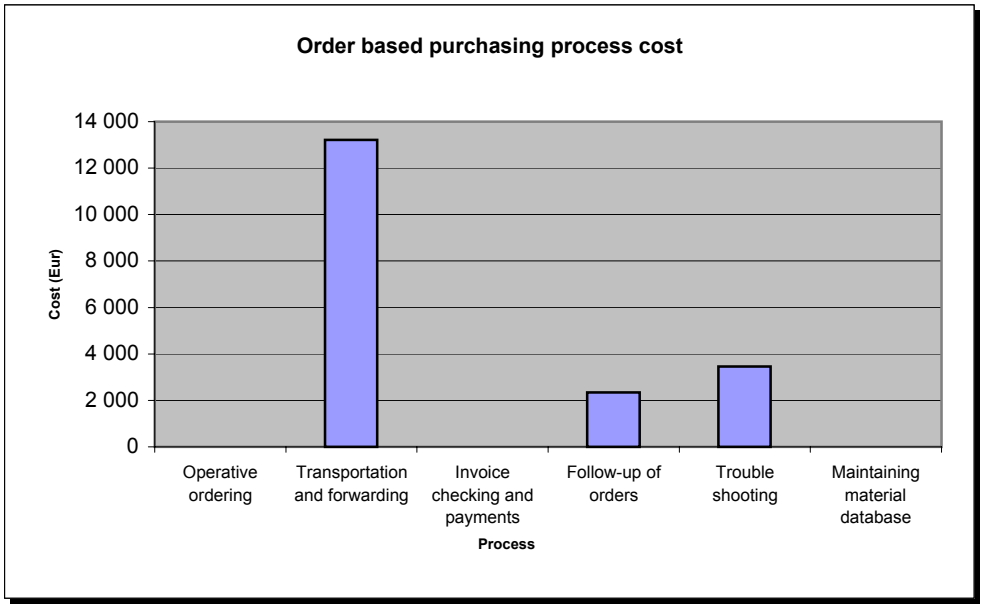
Activity \ Cost	Labor cost	IS cost	Running cost	Space cost	Other costs	Total cost	Driver quantity	Cost per transaction	Cost driver
Strategic procurement									
Planning, steering & development	2 344					15 000	160	93,75	per vendor
Reporting	543		887	1 000	98	15 000	160	93,75	per vendor
Participation in management of company	545	878				11 250	120	93,75	per hour
Human resource management							10		per person
Strategic purchasing total	**3432**	**878**	**887**	**1000**	**98**	**6295**	**16,7 %**	% of Total	
Supplier-based purchasing work									
Control of supplies						0	200	0,00	per vendor
Contracts						0	200	0,00	per vendor
Co-operation with other internal units	11 333					11 333	5	2 266,60	per unit
Supplier co-operation and visits			998			998	200	4,99	per vendor
Controlling and reporting						0	200	0,00	per vendor
Supplier based purchasing work total	**11 333**	**0**	**998**	**0**	**0**	**12 331**	**32,8 %**	% of Total	
Order-based purchasing work									
Operative ordering						0	1 000	0,00	per PO
Transportation and forwarding	13 221					13 221	1 000	13,22	per PO
Invoice checking and payments						0	2 000		per PO line
Follow-up of orders		2 342				2 342	2 000		per PO line
Trouble shooting				3 455		3 455	2 000		per PO line
Maintaining material database						0	5 000		per item
Order-based purchasing work total	**13 221**	**2 342**	**0**	**3 455**	**0**	**19 018**	**50,5 %**	% of Total	
Total cost	**27 986**	**3 220**	**1 885**	**4 455**	**98**	**37 644**			
% of Total	74,3 %	8,6 %	5,0 %	11,8 %	0,3 %	100,0 %			
Total cost / PO	**37,6**								
Total cost / PO line	**18,8**								
Total cost / supplier	**188,2**								

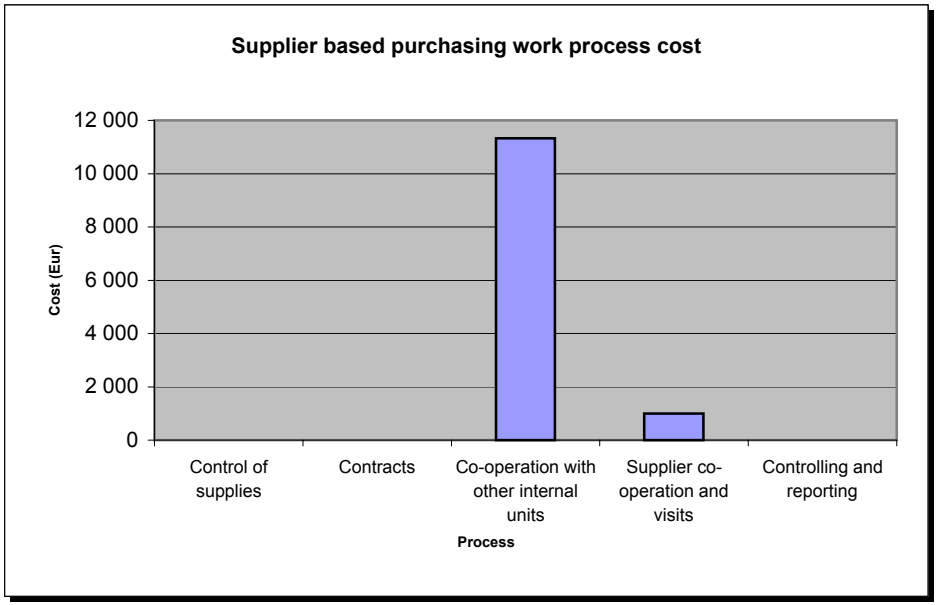


Procurement



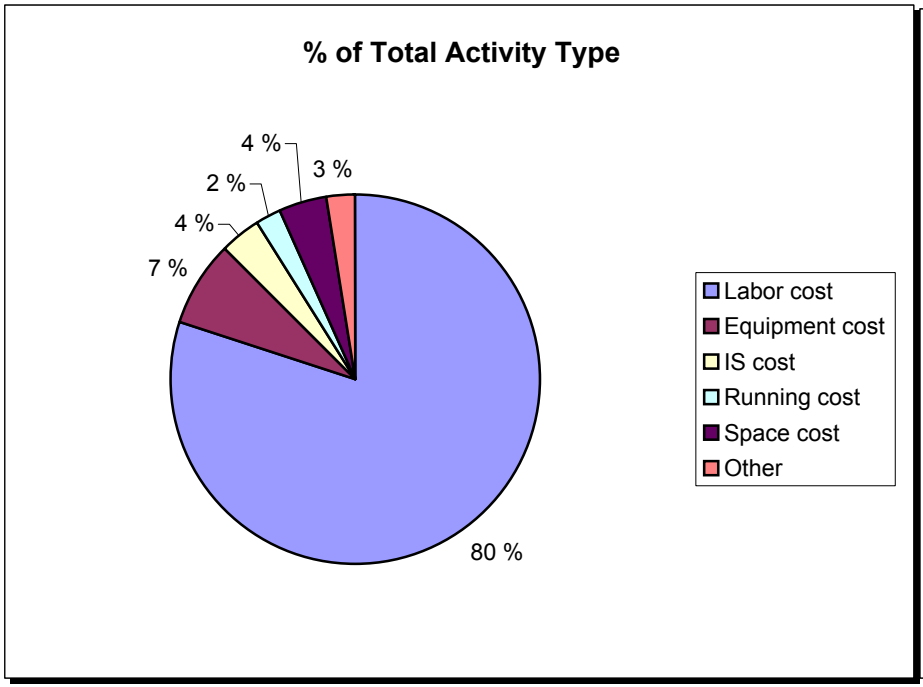


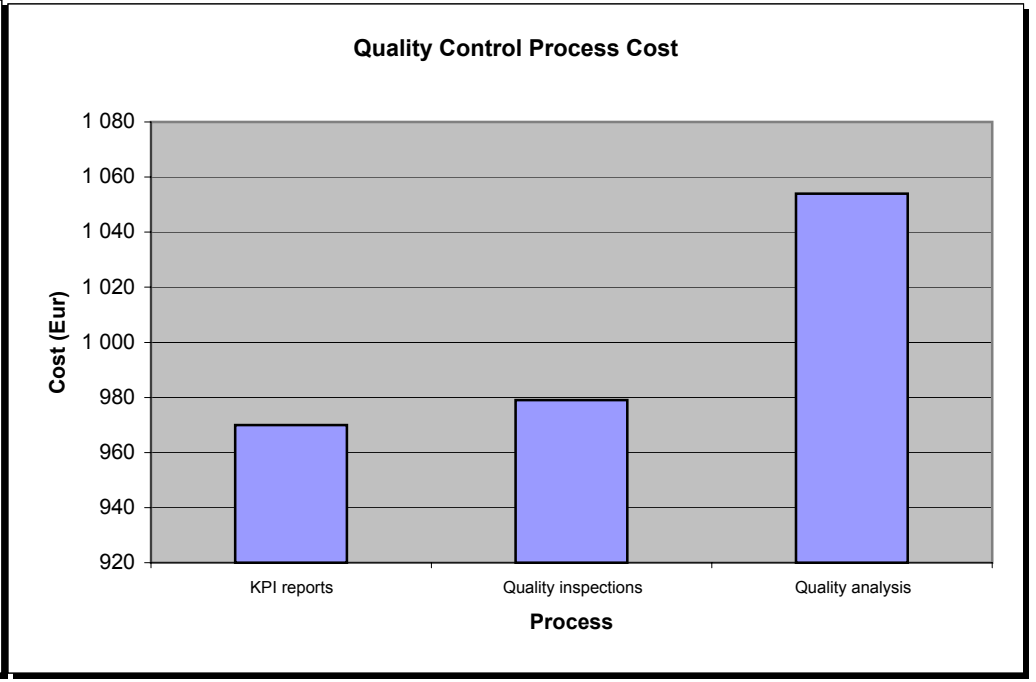




Quality control

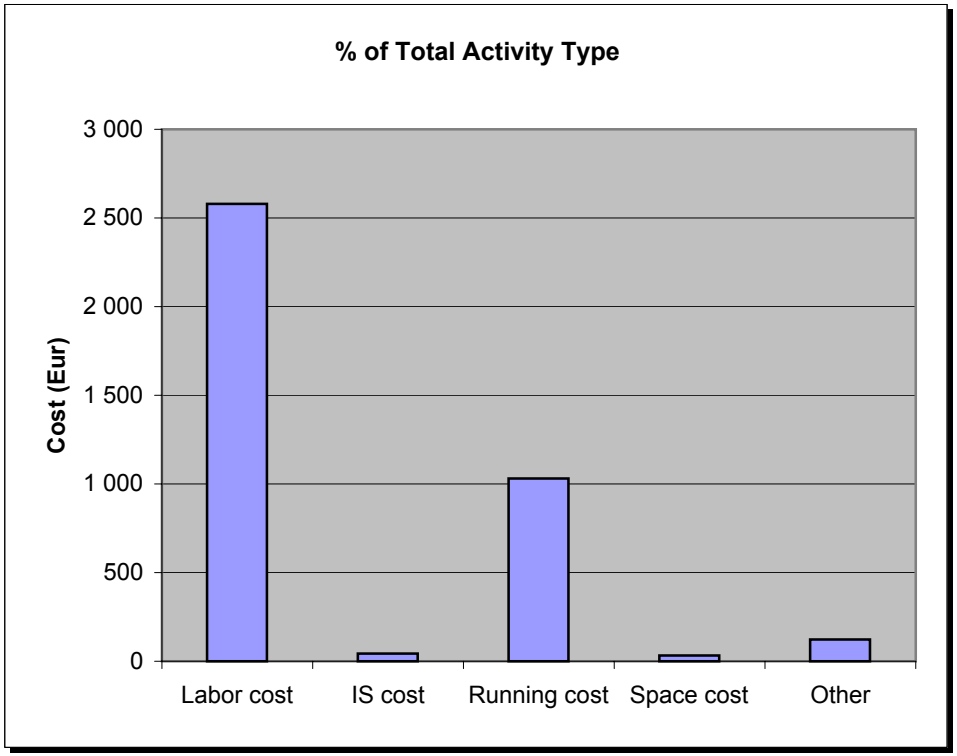
Activity \ Cost	Labor cost	Equipment cost	IS cost	Running cost	Space cost	Other	Total cost	Driver quantity	Cost per transaction	Cost driver
KPI reports	700	75	54	65	76		**970**	25	38,80	per report
Quality inspections	800	75	23		5	76	**979**	30	32,63	per inspection
Quality analysis	900	75	34		45		**1 054**	20	52,70	per analysis
Quality Control Service Total (Eur)	**2 400**	**225**	**111**	**65**	**126**	**76**	**3 003**	3 003		
% of Total	79,9 %	7,5 %	3,7 %	2,2 %	4,2 %	2,5 %				
Total cost / report	**38,8**									
Total cost / inspection	**32,6**									
Total cost / analysis	**52,7**									

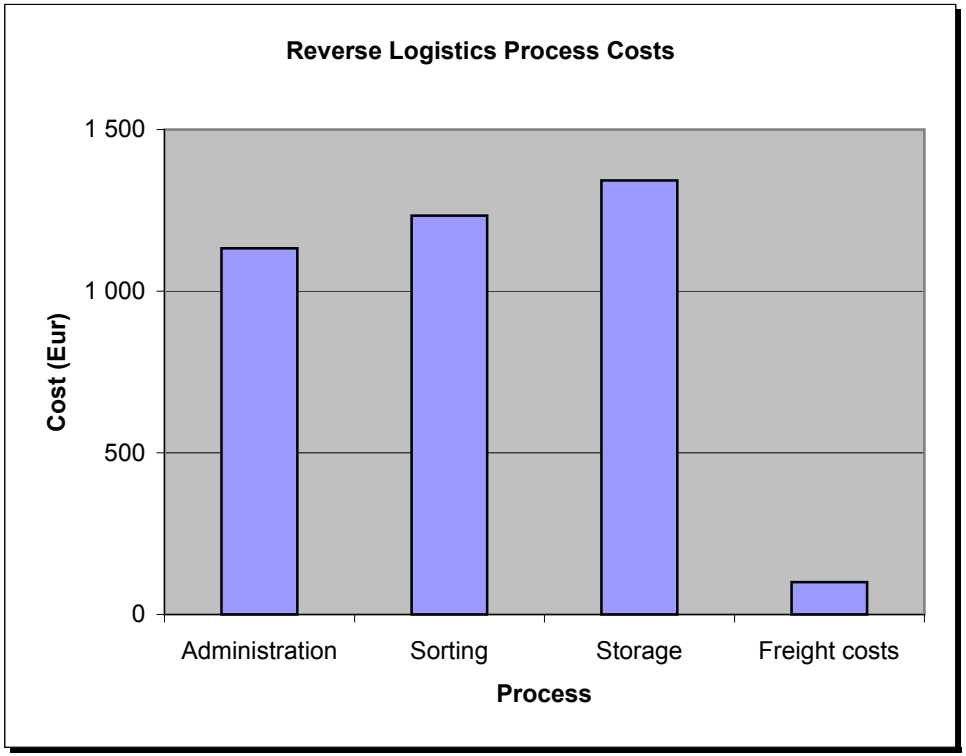




Reverse Logistics

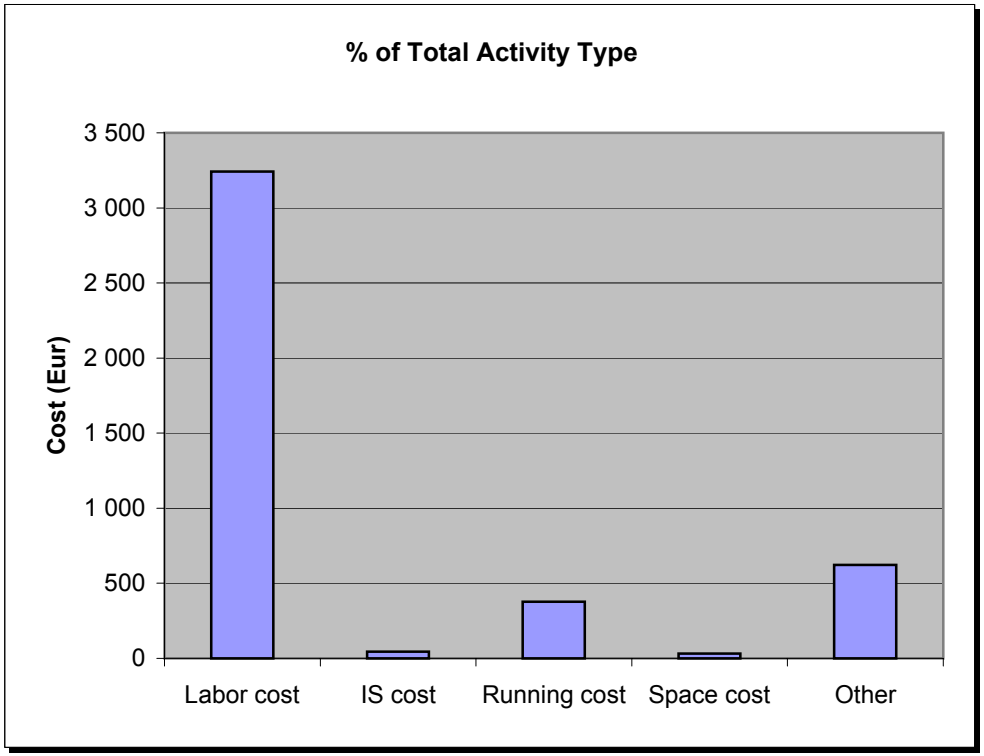
Activity \ Cost	Labor cost	IS cost	Running cost	Space cost	Other	Total cost	Driver quantity	Cost per transaction	Cost driver
Administration	1 000	44	33	33	23	1 133	200	5,67	per order line
Sorting	1 234					1 234	190	6,49	per order line
Storage	345		998			1 343	12	111,92	per storage unit
Freight costs					100	100	1000	0,10	per kg
Reverse logistics total	**2 579**	**44**	**1031**	**33**	**123**	**3 810**			

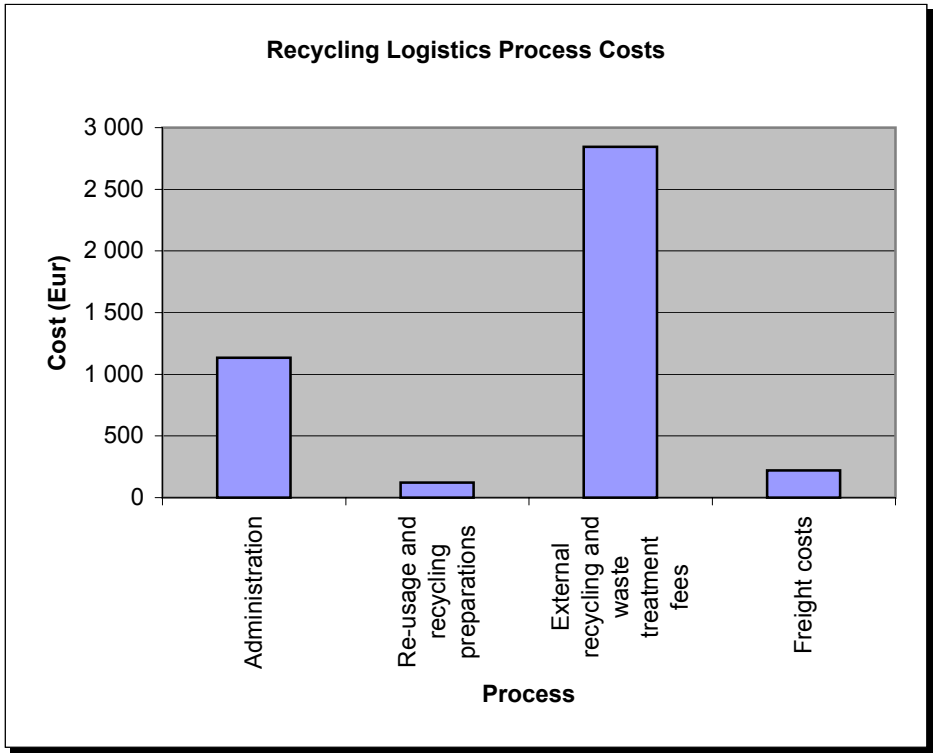




Recycling logistics

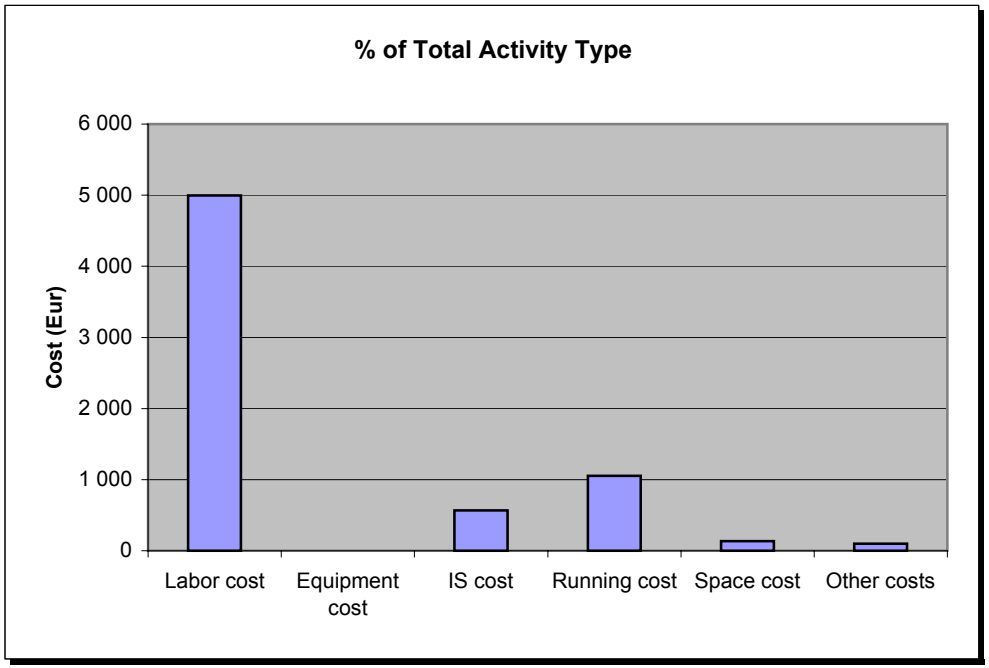
Activity \ Cost	Labor cost	IS cost	Running cost	Space cost	Other	Total cost	Driver quantity	Cost per transaction	Cost driver
Administration	1 000	44	33	33	23	1 133	200	5,67	per order line
Re-usage and recycling preparations	123					123	145	0,85	per hour
External recycling and waste treatment fees	2 000		345		500	2 845	1 000	2,85	per kg
Freight costs	120				100	220	1 000	0,22	per kg
Recycling logistics total	**3 243**	**44**	**378**	**33**	**623**	**4 321**			

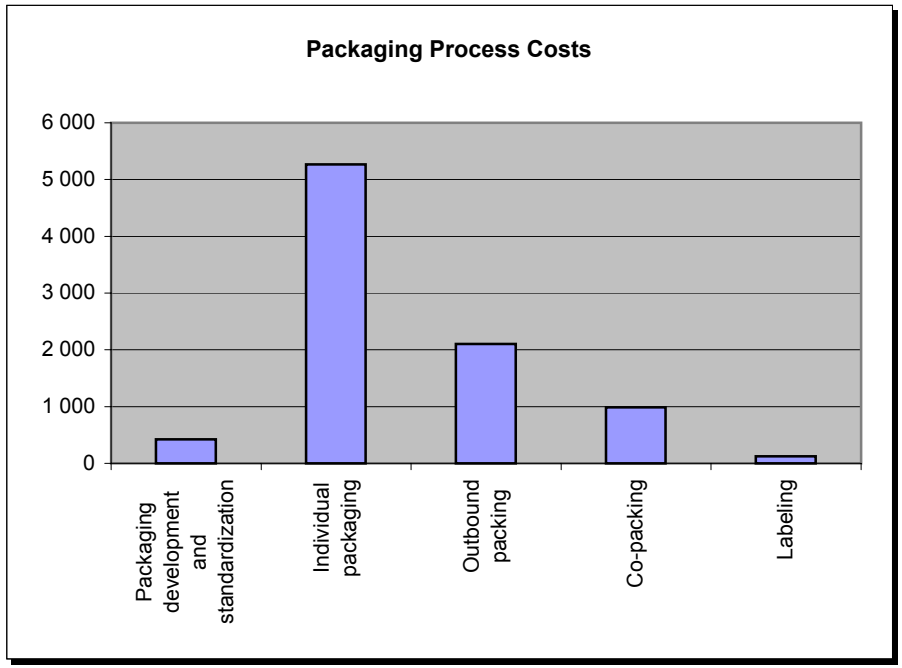




Packaging

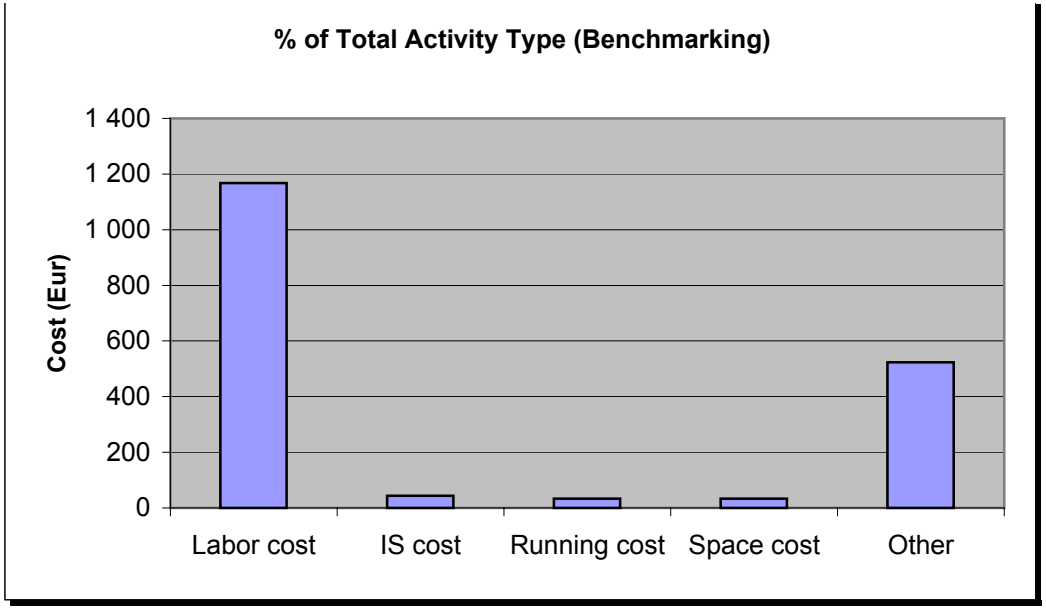
Activity \ Cost	Labor cost	Equipment cost	IS cost	Running cost	Space cost	Other costs	Total cost	Driver quantity	Cost per transaction	Cost driver
Packaging development and standardization	290	55		55	23		423	200	2,12	per package
Individual packaging	3 000	679	567	998	23		5 267	500	10,53	per package
Outbound packing	1 240	765				98	2 103	200	10,52	per package
Co-packing	345	555			89		989	1000	0,99	per label
Labeling	123						123	200	0,62	per package
Packaging service total	**4 998**		**567**	**1 053**	**135**	**98**	**6 851**			

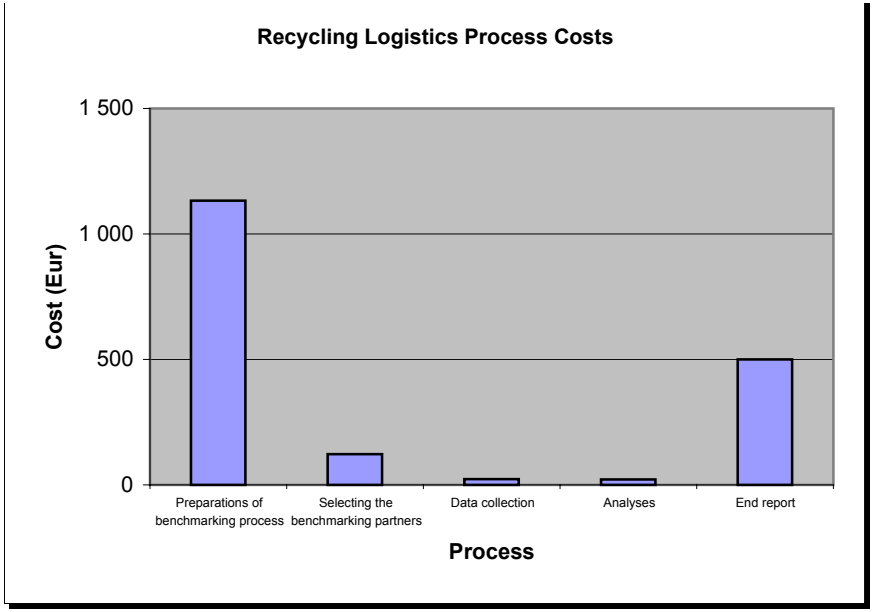


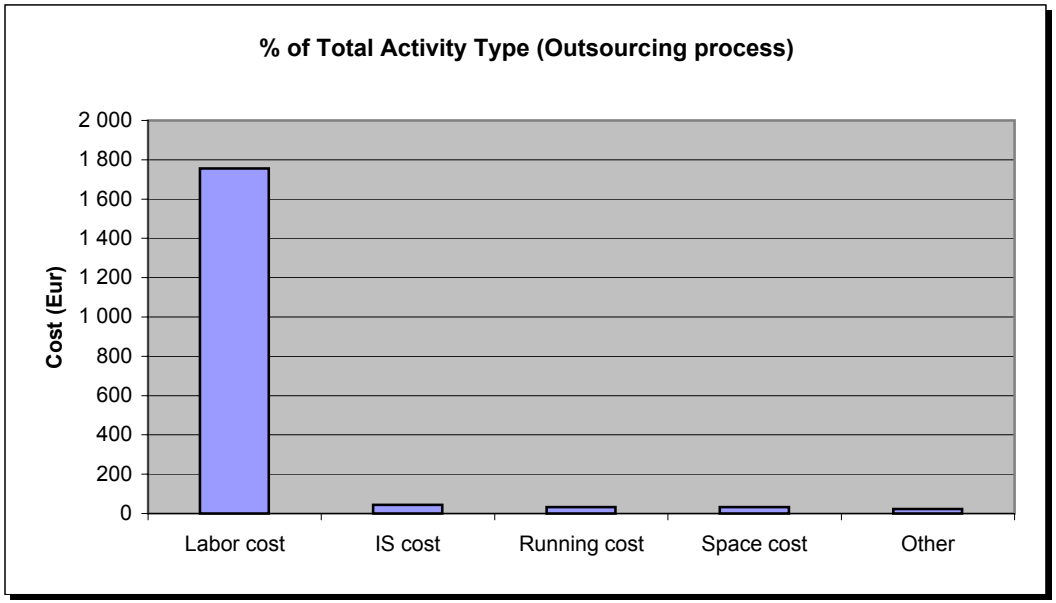


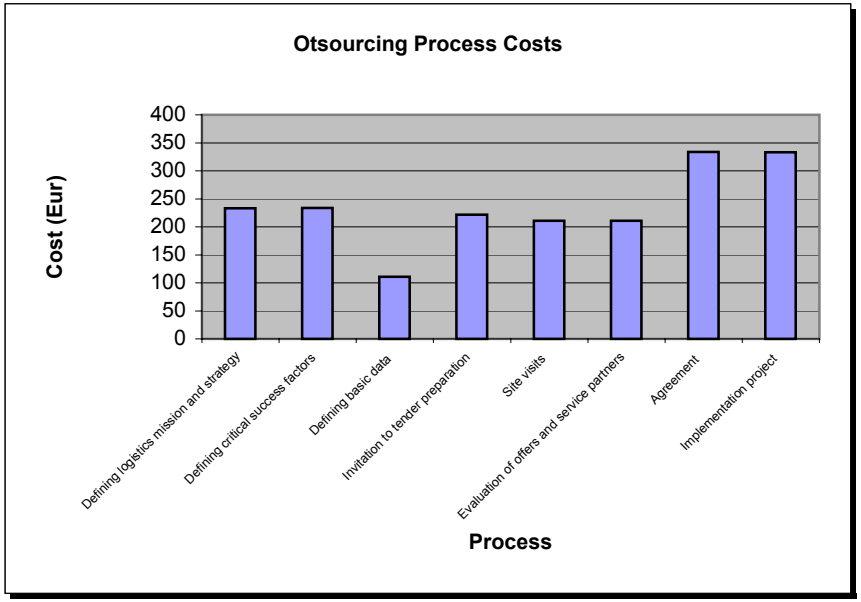
Consultancy

Activity \ Cost	Labor cost	IS cost	Running cost	Space cost	Other	Total cost	Driver quantity	Cost per transaction	Cost driver
Benchmarking									
Preparations of benchmarking process	1 000	44	33	33	23	1 133	45	25,18	per hour
Selecting the benchmarking partners	123					123	32	3,84	per hour
Data collection	23					23	34	0,68	per hour
Analyses	22					22	65	0,34	per hour
End report					500	500	22	22,73	per hour
Benchmarking total	**1 168**	**44**	**33**	**33**	**523**	**1 801**			
Outsourcing process									
Defining logistics mission and strategy	100	44	33	33	23	233	2	116,50	per hour
Defining critical success factors	234					234	4	58,50	per hour
Defining basic data	111					111	3	37,00	per hour
Invitation to tender preparation	222					222	4	55,50	per hour
Site visits	211					211	2	105,50	per hour
Evaluation of offers and service partners	211					211	3	70,33	per hour
Agreement	334					334	44	7,59	per hour
Implementation project	333					333	90	3,70	per hour
Outsourcing process total	**1 756**	**44**	**33**	**33**	**23**	**1 889**			
E-procurement									
Analyses about the current stage	100	44	33	33	23	233	2	116,50	per hour
Defining e-procurement mission and strategy	234					234	4	58,50	per hour
Defining e-processes	111					111	3	37,00	per hour
Defining needed technology and systems	112					112	4	28,00	per hour
Risk analysis	222					222	4	55,50	per hour
Defining project plan and priorities	211					211	2	105,50	per hour
Evaluation of offers and service partners	211					211	3	70,33	per hour
Agreement	334					334	44	7,59	per hour
Implementation project	333					333	90	3,70	per hour
E-procurement total	**1 868**	**44**	**33**	**33**	**23**	**2 001**			


% of Total Activity Type (Benchmarking)
Cost (Eur)
1 400
1 200
1 000
800
600
400
200
0
Labor cost
IS cost
Running cost
Space cost
Other


Recycling Logistics Process Costs
Cost (Eur)
1 500
1 000
500
0
Preparations of benchmarking process
Selecting the benchmarking partners
Data collection
Analyses
End report
Process


% of Total Activity Type (Outsourcing process)
Cost (Eur)
2 000
1 800
1 600
1 400
1 200
1 000
800
600
400
200
0
Labor cost
IS cost
Running cost
Space cost
Other


Otsourcing Process Costs
Cost (Eur)
400
350
300
250
200
150
100
50
0
Defining logistics mission and strategy
Defining critical success factors
Defining basic data
Invitation to tender preparation
Site visits
Evaluation of offers and service partners
Agreement
Implementation project
Process


% of Total Activity Type (E-procurement)


% of Total Activity Type (E-procurement)

Consultancy