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TIME –DRIVEN ACTIVITY BASED COSTING IN MANUFACTURING PROCESSES

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ABBREVIATIONS

ABC = Activity-Based Costing. Referred in this thesis by "ABC" or "activity based costing".

ABM = Activity-Based Management.

TDABC = Time-Driven Activity Based Costing

MTO = Make-To-Order. A production philosophy.

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ABSTRACT:

This study was made as an assignment for an industrial case company. The research problem of this study was that the case company did not have an activity based costing –study done before, and were interested about its possibilities to further analyze the cost structure and what different things done in the company cost.

The theoretical framework of the study consisted of different costing theories and methods, such as cost accounting, strategic cost management, traditional activity based costing, time driven activity based costing and kaizen costing. This built a framework for the empirical part of the study by defining what cost accounting is and how differently it can be approached with distinct methods.

The research material was collected by various methods, including interviews of key persons and production employees, record keeping of activity time consumption, cost data of the case company and timing of individual activities. Some of the interviews were participatory, and the information gathered from them was analyzed qualitatively.

On the basis of the data collected, the time driven activity based costing model for manufacturing processes was developed. With the model, the cost and capacity structure of the manufacturing processes could be viewed and analyzed in more detail than previously. With the data provided by the model, numerous areas of improvement were spotted and given suggestions in regard of potential cost reductions and activity enhancements.

KEY WORDS: Cost Accounting, Cost Management, Activity Based Costing, Time-driven Activity Based Costing, Manufacturing Process

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TIIVISTELMÄ:

Tämä tutkielma tehtiin toimeksiantona teollisuudessa toimivalle yritykselle. Tutkimusongelmana oli yrityksen puute mallintaa yrityksen kustannuksia toimintojen näkökulmasta, jonka vuoksi päätettiin pilotoida toimintolaskentamenetelmää yrityksen tuotannon toiminnoissa. Yritys oli kiinnostunut toimintolaskennan tarjoamista mahdollisuuksista analysoida kustannusrakennetta tarkemmin.

Tutkielman teoreettinen viitekehys koostui erilaisten toimintolaskentaan liittyvien teorioiden ja menetelmien esittelystä ja analysoinnista, kuten kustannuslaskennasta, strategisesta kustannuslaskennasta, perinteisestä kustannuslaskennasta, aikaperusteisesta kustannuslaskennasta ja kaizen –laskennasta. Tästä rakennettiin viitekehys tutkielman empiiriselle osuudelle määrittelemällä mitä on kustannuslaskenta ja kuinka eri tavoin sitä voidaan lähestyä erilaisilla menetelmillä.

Tutkimusmateriaali kerättiin erilaisilla menetelmillä, kuten avainhenkilöiden ja tuotannon haastatteluilla, toimintojen keston kirjaamisella, yrityksen kustannusdatasta ja toimintojen ajankulutuksen kellottamisella. Jotkut haastattelut ja havainnot olivat osallistavia, ja kerätty tieto analysoitiin laadullisesti.

Datan perusteella luotiin aikaperusteinen toimintolaskentamalli tuotannon toiminnoista. Mallin avulla kustannus- ja kapasiteettirakennetta pystyttiin analysoimaan tarkemmin kuin aiemmin. Mallin avulla tunnistettiin useita kustannustehokkuuden parantamisen kohteita.

AVAINSANAT: Kustannuslaskenta, Aikaperusteinen toimintolaskenta, Toimintolaskenta, Tuotantoprosessi

1. INTRODUCTION

In this chapter the theoretical background of the study will be introduced, followed up by a brief view of the research problem, research questions, objective of the study and finally an overview of the structure of the study.

1.1. Background and objective of the study

Cost management and cost accounting are very important parts of modern corporate management. In the construction and mining business it is even more crucial because of its incredibly competitive nature. New Asian manufacturers and service providers are eroding the market shares traditionally controlled by corporations from Europe and the rest of the western world. The main advantage of the new competition is smaller operating costs and thus cheaper prices. In order to thrive, established companies have to excel in being better than the competition; offer better service, superior reliability and quality and more value overall. Its value creation mechanisms, innovation management, process management and awareness of their cost structure must be of high quality since these companies can't compete with extraordinarily low product prices.

Companies need information about costs for financial and management accounting. Financial accounting is guided by different requirements and legislation, which are composed for instance by the Tax Administration. Management accounting is guided by the needs of the management of a company. The management might need information about the costs of products, services, customers and internal processes, to name a few. On the basis of this information, the management can make deliberate strategic decisions and improve daily operations of a company. (Kaplan & Cooper 1998: 2.)

Product- and activity costs have not been assessed very specifically in the case company. This must not be interpreted that managing costs is not regarded important in the case company. In fact, overall cost monitoring has been a key factor in its pursuit for competitive advantage, albeit it has been conducted on broader reporting levels. The company has achieved a profitable revenue growth over the last ten years, and growth targets have been

prioritized over other possible business targets. Over the span of these years, company management has educated themselves in different cost management techniques and methods and that's where the interest towards this pilot project stems from. The project is aimed to research better cost assessment practices in activities and improve process management in their daily activities that create value. This would help recognizing opportunities to lower costs.

1.2. Research problem and research questions of the study

The motive of this thesis is to deepen the knowledge of the case company's cost structure in their three main product lines: Product line A, product line B and product line C, which generate over 80 per cent of in house –manufactured products' revenue. A time-driven activity based costing model was developed for each one of these product lines.

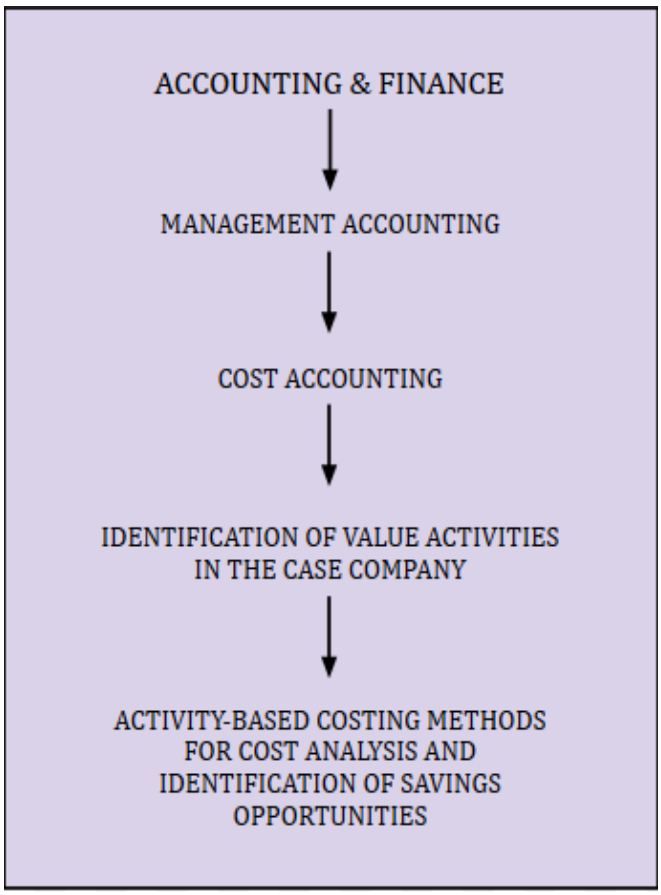

Figure 1. Theoretical framework of the study.

The theoretical framework of the study is illustrated in the figure above. This picture will act as the core of the study, showing how the study will progress from the literature review to the empirical analysis of the case company's activities.

The research questions of the study can be capsulized as the following:

1. How to pilot an activity based costing model in a company that has no previous experience of it?
2. What kind of cost information can the costing system provide about the activities of the case company?
3. Does the costing model identify cost reduction possibilities?

The answer to the first question will act as a framework to the other questions. The costing model built will be analyzed thoroughly and from this analysis questions 2 and 3 can be answered.

1.3. Research methods

This master's thesis was conducted as a qualitative case study based on the operations, interviews and data of a company in the construction and mining industry.

Table 1. Different ways to conduct empirical research (Soininen 1995: 15-16).

• Comparative: attempts to compare the phenomena at hand in different contexts either by searching for connections between different aspects of the phenomena or by searching for differences between different groups.
• Causal (also known as explanatory research): seeks to find connections between different variables. Causal research tries to find cause-and-effect relationships between these variables.
• Explorative: seeks to approach the phenomena in a new way, without the safe and familiar methods used before.
• Descriptive: attempts to describe the phenomena by numbers and/or verbally by answering the questions such as who, what, where and how much. One feature of descriptive research is a mapping of units', communities', processes', situations' and institutions' different aspects.

Hirsjärvi, Remes & Sajavaara (2014: 137) describe quantitative methods having the following aspects:

- conclusions from earlier research and theories
- presenting a hypothesis
- attempt to define concepts presented
- organizing variables and material into statistically viable forms

Hirsjärvi et al. (2014: 161, 165) have also pointed out some of the main features of qualitative research:

- a comprehensive approach to gathering data
- careful evaluation of the object of research
- The research plan takes its form as the research progresses. Plans change if circumstances change
- Qualitative research uses inductive analysis. The aim of the research is to find and reveal unexpected phenomena and results. The research does not try to test a theory or hypothesis. The starting point is in detailed and versatile examination of materials.
- The research is treated as a unique case and the data is interpreted as unique data

To conclude, the aim of qualitative research is to find or reveal facts, not verifying existing hypothesis or theories.

The nature of this study is qualitative research with quantitative features. The data used is collected mainly from interviews and discussions of the case company's management and key personnel. The study also uses some numerical data, collected from interim reports, income statements, balance sheets and previously conducted costing analyses. This study has some descriptive and explanatory features with the emphasis on describing and explaining the current state of cost structure and value chain activities in the case company. This study used also participatory techniques in data gathering, as the researcher participated in some of the activities studied to get a better understanding of how the process researched functioned.

According to Kiviniemi (2001:68), qualitative research has some distinct features: the data is usually collected by observing and by choosing a carefully selected sample of the data instead of random sampling. Kiviniemi (2001:68) adds that in qualitative research the material is interpreted in relation to its context, and that it is a holistic approach to handling data.

In figure 2 below are the typical characteristics of qualitative and quantitative research methods:

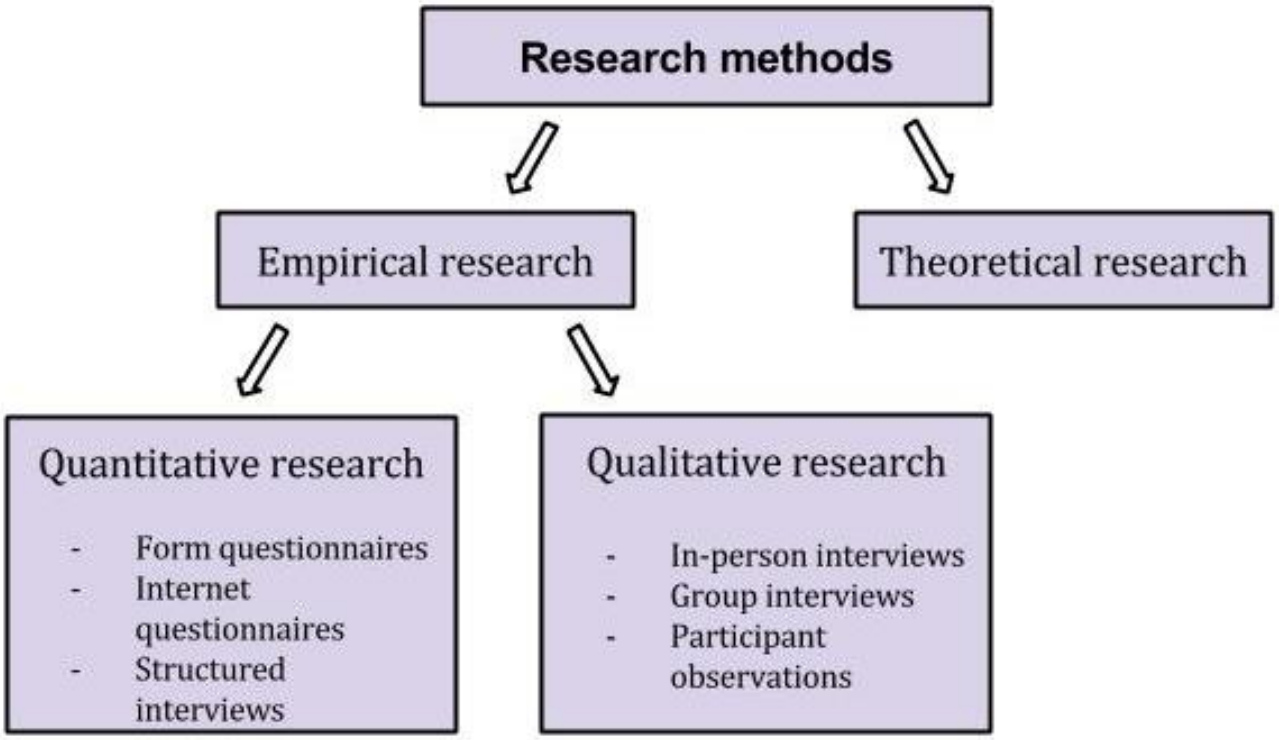

Figure 2. Differentiation and typical characteristics between qualitative and quantitative research methods. (Heikkilä 2001: 3-4)

1.4. Structure of the study

This study was kicked off in the May 2015 and it was finished in January 2016. The beginning of the study project was mainly used as gathering scientific literature and deepening knowledge about the topic. Data gathering for the empirical part started taking into account the timetable of the case company and the researcher. This was done to prepare for the empirical part of the research, as well as to build the theoretical framework of the topic.

The study is divided into theoretical and empirical parts. In the second chapter, the theoretical framework of the study is presented by introducing concepts of cost management and cost

accounting as well as different methods to conduct costing systems. In the third chapter, the case company is introduced. Chapter 4 consists of the costing system created for the case company. The chapter describes how the costing system was built. Chapter 5 presents findings, analyses the cost structure of the case company and presents suggestions for potential cost reduction targets. Chapter 6 concludes the study by arguing its successfulness and the concept of costing systems in general.

2. MANAGEMENT ACCOUNTING

Management accounting as a term might be confused with cost accounting. Horngren, Datar & Foster (2006:2) states that the line is not very clear; the main purpose to conduct cost accounting is to make better management decisions, and in some literature these terms might be interchangeable. The definition of cost accounting will be processed later in this chapter.

Distinguishing management accounting from financial accounting can be confusing for the unversed person, but they have profound differences which are easy to learn and comprehend. The main differences are listed in the table below:

Table 2. General differences of financial and management accounting paraphrasing Neilimo & Uusi-Rauva (2005:35).

	Financial Accounting	Management Accounting
1. Principles guiding the information	Obligated by legislation, Tax legislation, investor relations principles, financial reporting guidelines etc.	No general obligations, only internal obligations within the company
2. Target of accounting	- Legislative identity of the company - Financial identity of the company - Entire identity of the company	- The company as an entity - Business unit - Performance
3. Measurement of information	Monetary information	Monetary or non-monetary units of information. For example: quantity per hour
4. Time dimension of information	Past data for reporting	Past data for future projections, estimations

As with many other concepts, there is no clear definition to what management accounting is and it can be described from many different angles. Atkinson, Kaplan, Matsumura & Young (2012: 26) describe management accounting as "*the process of supplying the managers and employees in an organization with relevant information, both financial and nonfinancial, for making decisions, allocation resources, and monitoring, evaluating, and rewarding performance. The reported expense of an operating department, such as the assembly department of an automobile plant or an electronics company, is one example of management accounting information. "*

The Institute of Management Accountants (2008) has defined management accounting with the following words*: "Management accounting is a profession that involves partnering in management decision making, devising planning and performance management systems, and providing expertise in financial reporting and control to assist management in the formulation and implementation of an organization's strategy."* Similar definitions have been stated to describe Strategic Management Accounting (SMA): *"A form of management accounting in which emphasis is placed on information which relates to factors to the firm, as well as non-financial information and internally generated information"* (Chartered Institute of Management Accountants in the UK 2000: 50). Marketing Management and Management Accounting insights mixed with the framework of Strategic Management have contributed to the birth of the concept of SMA (Roslender & Hart 2003). SMA is also very orientated towards the future whereas traditional management accounting can be geared towards history coupled with a focus on singe decisions, single periods and single entities (Horngren, Bhimani, Datar & Foster 2005: 790).

Puolamäki (2007: 21-23, 60) states that management accounting supports management's long-term decision making, producing information about the structure of the business, competitive positioning and resource allocation, and also takes into account the subjective interpretations of information outside of the company. Näsi (2006: 60) approaches the subject from a need of change in financial administration. The role of financial management personnel has changed from a *"historians playing with numerical data"* to *"modern controllers, who often belong to the board of directors and who play an important role providing financial advisement and frequently act as change agents."*

Cost traceability to specific cost objects has tremendous benefits in various decision-making roles of an organization. For instance product costs, personnel hiring, production setup and

logistics contract negotiations all produce cost data that is crucial in the decision-making process. (Olsen 1998.)

2.1. Cost Management

Tanaka et al. (1993: 13) have said that for cost management to work, managers need to comprehend the concepts of cost, have basic knowledge of the factors which affect and drive costs and understand how their decisions change costs. Understanding these basic principles help initiating and making decisions which will improve the performance of the cost-effectiveness of an organization. Other implemented principles that successful cost management requires are continuous and integrated activity throughout the entire product and service life cycles of an organization and cost management policy integrated into the organization. These principles can result in growth, stability and strength to an organization. This demands a reliable flow of relevant cost information, which is presented to the relevant persons in a clear and useful fashion. (Tanaka et al. 1993: 13.)

Cost management can also be seen as a management philosophy; continuous cost control and reduction accompanied with careful consideration of customer needs adds up to a holistic management approach. Cost management influences all levels of the organization, implementing constant cost-awareness and consciousness to these levels. (Tanaka, Yoshikawa, Innes & Mitchell 1993; Horngren et al. 2006: 4.)

Cost management as a concept can be presented in many ways. Anderson (2005) argues that cost management has become a synonym to cost cutting in the media, which is usually initiated after disappointing financial reports and when sustainable profits are in danger to decline.

Sticky costs mean that management is not able to reduce costs when uncertainty remains in the business activities. Managers have to recognize the need of adjusting committed resources to changes in activity-based demands for those resources. Sticky costs behavior can reveal management's competence to execute deliberate decision making when assessing the economic consequences of their actions. (Anderson, Banker & Janakiraman 2003, Noreen

and Soderstrom 1997.) Anderson et al. (2003) conclude: *"costs decrease less with the declines in activity than the increase in activity."*

2.2. Cost Management in Lean organizations

As companies are more and more focused on their core competencies, they outsource a higher percentage of the total cost of their products and more substantial items that do not rely upon their core competencies (Gilley & Raheed 2000). There are many reasons why a company chooses to use an external supplier for these items. Nishiguchi (1994) names a few: supplier's superior cost efficiency, functionality and quality, and their ability to implement new technologies in a faster, more efficient way. Albeit many outsourcing decisions are made based on the factors above, there are more variables that stir the equation. Not all items that a company decides to outsource are products or process commodities. Many companies decide to outsource because they want to utilize knowledge that is proprietary to the supplier or the buyer (Cooper & Slagmulder, 1999).

It is often stated that the best opportunity for cost reduction and thus cost management is at the product development phase. Lean organizations have a great challenge in cost management in products since these organizations might have outsourced the majority of the value added in their product and most of the support activities. Lean organizations have developed cost management systems according to their own needs which help them to control cost-reduction activities through the whole life cycle of products. High dependence upon the suppliers have pushed the development efforts for cost reduction in interorganizational cost management programs (IOCM). (Cooper & Slagmulder 1998, 1999).

2.3. Cost Accounting

Horngren, Datar & Foster (2006: 2) describe cost accounting as a term used to describe a series of functions that measure, analyses, and reports financial and non-financial information relating to the costs of acquiring or using resources in an organization.

The evolution of cost accounting has been heavily influenced by the size, strategy, competition, organizational structure, market demand and agents of change (Boyns & Edwards 2006).These factors continue to be very important drivers in the modern world as well.

Traditional cost accounting has been a useful and easy-to-use cost accounting tool because it has been based on calculating the variable costs and thus has provided relevant information for short term decision-making (Lukka & Granlund 1996). The problem with traditional cost accounting has been that the costs are allocated solely on variable costs such as working hours, which might not be the right indicator to describe costs (Cooper & Kaplan 1988). Gupta & Galloway (2003) add that traditional cost accounting has to find different methods how to understand and classify costs so that the cost accounting model is as accurate as possible. Cooper & Kaplan (1988) predicted this already in 1988, when they wrote that traditional cost accounting models have to be adjusted because they do not give an accurate description of the costs of products and services.

As the figure on the next page illustrates, direct material and direct labor costs are allocated straight to the product costs, whereas overhead costs have to be allocated by cost pools in relation to the variable costs.

Overhead costs are costs that can't be allocated directly to the cost objects. For example rent costs and administration costs are overhead costs. Hence they have to be organized into cost pools so that the costs can be allocated to the end products.

Cost pools are groups of individual cost items. Cost pools can range from small to very large in sizes, for example from big manufacturing plant costs to small operative metal-cutting machines. Cost-allocation bases are usually organized jointly with cost pools. It can be argued that cost pools are to traditional costing what activities are to activity -based costing; the costs in the cost pools are further allocated to the cost drivers to estimate how costs are accumulated. (Horngren et al. 2006: 98; Dyson 2007: 320).

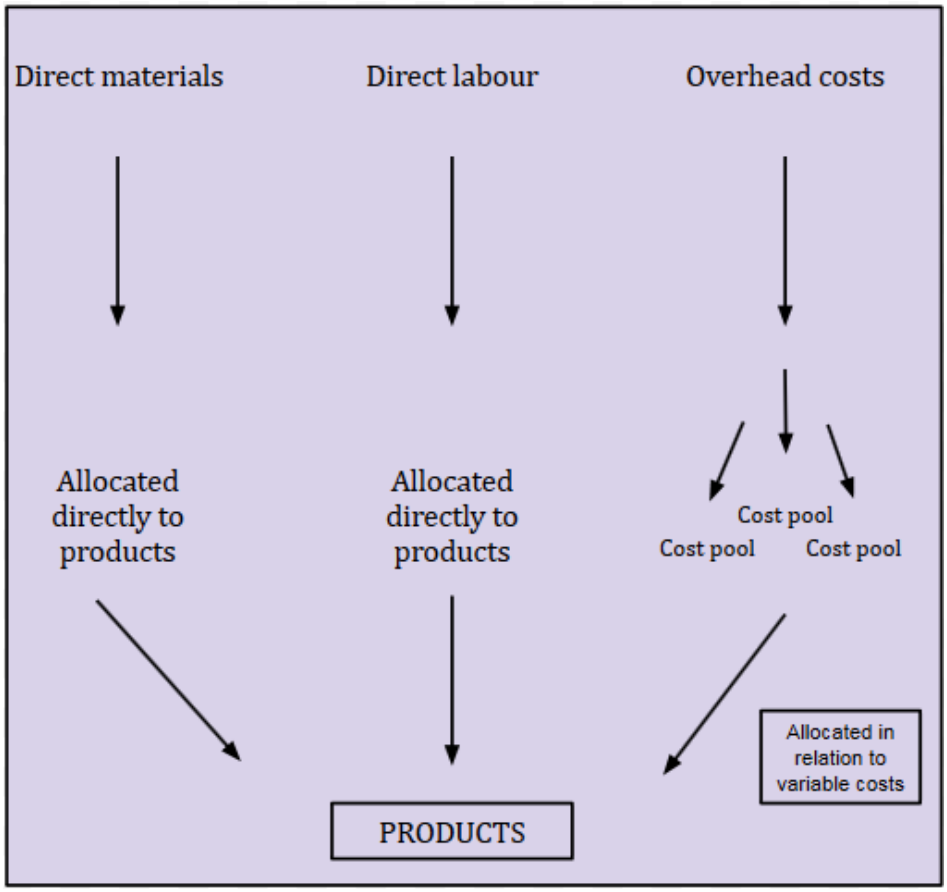

Figure 3. Traditional cost accounting system paraphrasing Alhola & Lauslahti (2000:213).

Cost allocation is a reference to assigning costs to a cost object. Cost-allocation bases tries to answer a simple question: How should an organization allocate costs to operate, for example metal cutting machines, collected in a single cost pool among different products? One option would be to allocate the costs on the basis of the number of machine –hours used to produce the different products. The cost-allocation base links in a systematic way an indirect cost or group of indirect costs .A cost-allocation base can be nonfinancial (such as the number of machine-hours), or financial (such as direct labour costs). Cost -allocation bases are the link that an organization uses to connect the overhead costs to the cost object (for example products and services). Organizations tend to use the cost driver of indirect costs as the cost allocation base. This is because cause-and-effect link between changes in

the level of the cost driver and the changes in the indirect costs. (Horngren et al. 2006: 98; Caplan 2007).

2.4. Activity-Based Costing

Activity- based costing (ABC) is a method developed in the late 1980's to tackle problems that traditional product cost analysis couldn't solve. Traditional cost analysis was seen as an outdated method, which wasn't able to target overhead costs fairly to a certain product. Activity- based cost analysis can produce a lot of useful information of a co mpany's functions and costs. It also offers options to improve the performance of a company. Activity-based management (ABM) has emerged as a management method from ABC, and it focuses on process analysis and improvement based on activity- based costing (Neilimo & Uusi-Rauva 2005: 144). Since its inception, it has been a popular topic and in the interest of many business schools, consultants and business media. It has been able to dodge and wiggle its way through criticism by constantly changing its features and core arguments (Innes & Mitchell 1998; Jones & Dugdale 2002).

ABC can be defined as a system of: *"calculating the costs of individual activities and assigning those costs to cost objects such as products and services on the basis of the activities undertaken to produce each product or service."* (Horngren et al. 2006: 145.) The core of ABC is the revealment of the business's true costs. For instance, suppose that 20 per cent of a particular firm's total sales volume is coming from an international retailer with whom the firm does business. In addition, the firm does business with a local retailer that contributes about 3 per cent of the total sales volume. Because of the bigger sales volume of the international retailer, it may look like the big international customer is more valuable than the smaller local one. This is not the whole truth. When the costs of doing business with each company are compared to the actual revenues earned by each company, the smaller retailer actually provides a higher total profitability of an account. Why does the smaller firm provide more comparable profit than the larger firm? It is because individual activities that are required in doing business with the smaller firm are less expensive than those needed for the larger firm. (Gooley 1995; Lin, Collins & Su 2001.)

Most of the articles about activity –based costing has been published in the 1980's and 1990's, and it has been a very popular research topic from different angels and from international and national aspects.

Activity-based costing went from theory to corporate practices faster than any other method before in the history of accounting. ABC has always been under the critical eye of potential improvements. One reason for this is that several academics and users of ABC have criticized the system to be too expensive, complicated, heavy and difficult to adjust to companies' unique needs. ABC critics have also pinpointed the problem of the amount of cost drivers. This might lead into useless and unproductive analyses (Wegman 2009). Dyson (2007:306) has claimed that ABC's methods of indirect cost management in product costs involves some pretty questionable procedures and there is much controversy within accounting academics whether these methods are useful or reliable. He concludes that the assessment of the usefulness of these methods should not be left to the accountants, and managers who take into account the results of these methods should voice their opinion of the methods for the best of organization. (Dyson 2007: 306.)

Activity-Based Costing sheds light to the operations in an organization and makes its activities more understandable. One can create a map of an organizations operations and simplify its processes. Once the activities have been mapped, operative and upper management have often stated that it's the first time they are given an understandable insight of what is going on in the organization. On top of that, with Activity-Based Costing one can see how much operations cost and what kind of activities and resources products, services and customers consume. (Lumijärvi, Kiiskinen & Särkilahti 1995: 20.)

In their book The Rise and Fall of Management Accounting, Thomas Johnson and Robert Kaplan (1991:12) discussed the problems management accounting faced: the information that it provides is too often too late, too unorganized and lacking focus to be informative and helpful for management decision making. This information was tied to universal accounting regime. Partially because of these problems, activity- based costing stated for its purpose gain ground and develop into a fully functioning operative management tool. (Johnson & Kaplan 1991: 12.)

One main reason why companies have moved from traditional cost accounting systems to activity-based costing is the over- and undercosting problem that comes with the broad

averaging -principle. Activity-Based Costing is one of the best tools to refine the costing system. It offers better measurement of the costs of indirect resources used by different cost objects-regardless of how differently the different cost objects use indirect resources. (Horngren et al 2006: 143.)

The popularity of activity –based costing was high in the 1990's. A big reason for that was the automation of production, which caused direct labor costs to decline and indirect labor costs to increase. This has also caused an increase in relative marketing and sales costs. Activity –based costing is particularly applicable in analyzing invariable indirect costs, which are what for instance marketing and sales costs generally are. (Srindhi 1992: 199; Jyrkkiö & Riistama 2004: 176.)

Horngren et al. (2006: 143-144) describe four principal reasons why companies usually need to refine their costing systems:

1. **Increase in product diversity.** Customized products are in higher demand in order to differentiate themselves from the competitors. Thus product portfolios have also expanded. Different products make different demands on the resources needed to produce them because of differences in volume, complexity and processes. The resources demanded by these different products need a more sophisticated costing system which is able to give more accurate cost measurements than a simple costing system. Indirect costs must be allocated to different products, and the straightforward approach of for example direct manufacturing labor hours as cost drivers will result in inaccurate and misleading product costs. (Horngren et al. 2006 :144.)

2. **Increase in indirect costs.** Process and product technology advancements have increased the indirect costs companies face nowadays. This is particularly true in formerly labor intensive manufacturing, where plant automation has decreased the need for human labor. The complicated technology in automated processes and diverse product ranges requires need committed resources for support functions, such as production scheduling and process engineering. Because direct manufacturing labour is not a cost driver of these costs, allocating indirect costs on the basis of direct manufacturing labour doesn't measure how resources are being used by different products accurately. (Horngren 2006: 144.)

3. **Advances in information technology.** Costing system refinements require more data gathering and analysis, which leads to the costing system to be more detailed. Advancements in IT and the simultaneous decline in data tracking costs has made cost –effective cost systems available. (Horngren 2006: 144.)

4. **Competition in product markets.** Ever increasing competition in the markets, more accurate cost data helps managers to make strategic decisions, for example in pricing and in the product portfolio. This is very important in competitive markets where competitors capitalize on a company's mistakes. (Horngren 2006: 144.)

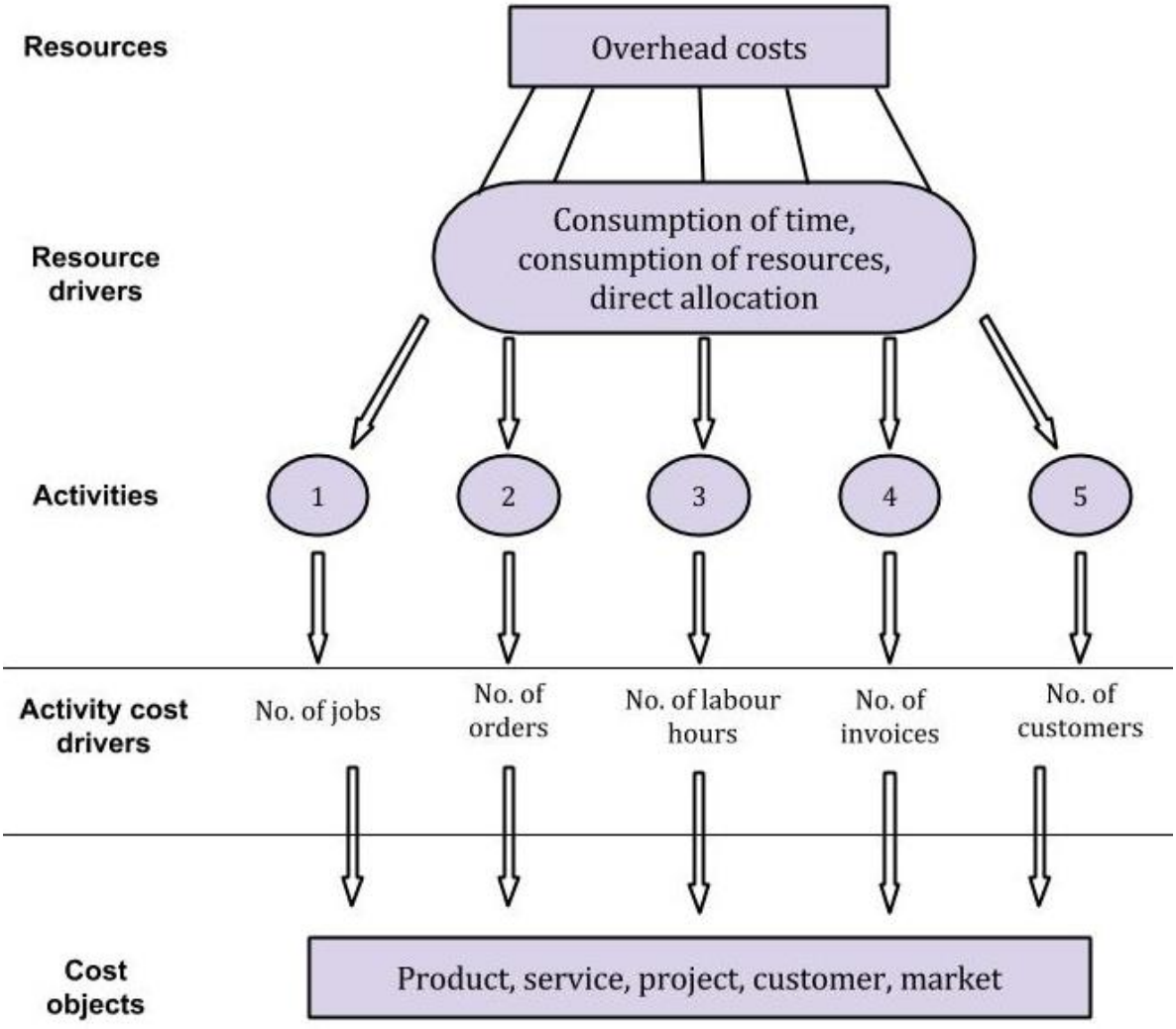

Figure 4. Activity –Based Costing model paraphrasing Lumijärvi et al. (1995: 53).

As Figure 4 above illustrates, there are various concepts that are important in ABC:

- **Resources.** In order to succeed in their business, companies need different resources, such as personnel, machines, premises and equipment. Resources are factors of production which make business activities possible. Resources are basically an indicator of how much cash has been used for each activity. (Alhola 1998: 46.)

- **Resource drivers.** Cost drivers are a crucial part of understanding activity-based costing. A cost driver is a factor that allocates the overall costs to activities and cost objects. Generally speaking one can divide cost drivers into two categories: resource drivers and activity cost drivers. Resource drivers allocate resources to activities. (Alhola 1998:46).

- **Activity cost drivers.** Activity cost drivers allocate resources from activities to cost objects. A cost driver can disclose what resources are used by certain activities and it is also a concept which is used to allocate costs. (Alhola 1998: 46, Alhola et al. 2000:214). Michael Porter (2008: 63) describes cost drivers in his classic book *Competitive Advantage* as *"the structural determinants of the cost of an activity, reflecting any linkages or interrelationships that affect it"*.

The difference between a cost driver and cost allocation bases that were described in the previous chapter is that a cost driver is an economic concept that relates to the economic reality of the business. A change in the cost driver (for instance the number of labor hours) changes the total cost of a related cost object. A cost allocation base is more abstract; it is an accounting choice made by managers and accountants. Many times the best option for a cost allocation base is a cost driver. (Caplan 2007).

Every organization that faces any complexity in their business knows that accurate cost assessment of outputs is close to a utopia. An approach based on activities provides means of associating resource consumption with products which is more vigorous and fine-tuned than the conventional methods of standard costing and broad averaging. Activity-Based Costing provides extra detail and visibility of output costs, which can lead to give managers an enhanced vision of costs and behavior. It also gives an opportunity to exploit a wide range of cost management possibilities. Management has to take into account that ABC is a defensible method and studies have shown that when comparing manufacturing and service

organizations it produces very different results which can raise a variety of issues for management. (Hopper, Northcott & Scapens 2007: 126.)

In addition to revealing a company's internal costs of activities, ABC can help in figuring out the true costs of doing business with a particular customer, supplier or distributor by comparing the revenues earned to the cost caused by each particular entity. One of the most influential factors of ABC awareness comes from the change in the nature of costs. In recent decades, manufacturing has transformed substantially and overhead costs have increased measurably. (Lin et al. 2001; Develin 1999.)

The essence of activity -based costing is finding a logical connection between products and costs. A good question to ask is: what does the product truly cost and what costs should be allocated to this particular product? By observing the subject from the needs of resources and resource utilization point of view, one can approach costs from a more accurate perspective. Activities have a crucial role in this. As a natural continuation from ABC is utilizing cost information for active management of costs and ultimately increasing the competitiveness of the organization. (Neilimo & Uusi-Rauva 2014: 144). As stated before, active cost tracing and analysis can give significant advantage to decision-making. This is particularly true in ABC, where one can trace cost directly to the cost objects utilizing the activities.

Studies have been conducted about the benefits of activity -based costing. One of the studies researched the benefits of ABC in manufacturing companies. All of the companies that participated in the study had benefited from implementing ABC. These companies also used ABC information heavily in management decision making. (Swenson 1995: 167-180.)

Shields (1995: 148-166) stated that 75 per cent of the 143 companies participated in his study had benefited from implementing ABC. Kennedy & Affleck (2001) made a study comparing the market value of British companies which had used an ABC model for three years to those without an ABC model. The market value of companies with an ABC model was 27 per cent higher to those without one. Over 800 companies participated in the study.

2.5. Time -driven activity based costing

Time -driven activity based costing (TDABC) is a slightly modified version of the traditional ABC described in the previous chapter. It was created by Robert Kaplan and Steven Anderson. Robert Kaplan was one of the pioneers of creating the traditional ABC as well, so he has had a strong influence in creating both methods.

Wegmann (2008) has argued that traditional ABC is a complicated and expensive system that is hard to implement, which leads to small to medium sized enterprises to abandon it as their costing system. Collecting data for the cost drivers is time consuming and the amount of drivers can grow easily, resulting in increasing implementation and maintenance costs.

From these disadvantages springs TDABC. There are only two estimates needed to start building a TDABC model. These are the cost per time unit of supplying resource capacity and the unit times of consumption of resource capacity by products, services and customers. (Kaplan & Anderson 2004.)

Time driven activity based costing eliminates the laborious and vague task of defining resource and cost drivers. In essence, there is only one driver which is time. This democratizes the cost driver selection process from traditional ABC; all activities have the same driver. There are a few exceptions to this, for instance the cost of warehouse space taken by a product is difficult to model through time. Complexity in processes and activities can be captured by creating time equations. (Kaplan & Anderson 2004.)

For instance, if the time to perform an order entering activity is 2 minutes with an old customer and 5 minutes with a new customer, and an additional 4 minutes if the product ordered is a special product, the TDABC model can form an equation such as the following:

$$X = 2y + 5z + 4r$$

Where:

x= total time required for performing the activity

y= quantity of old customer orders handled (if new customer, value is 0)

z= quantity of new customer orders handled (if old customer, value is 0)

r= quantity of special products ordered (if not special product, value is 0)

The time consumed by an activity is almost the only cost driver needed in TDABC. The assessment of the times consumed can be done either by interviewing employees or observing and timing the activity time. An activity is a work phase in a process needed to be completed in order to complete the process. The equation illustrated above is a process, where order handling, with a new or old customer, is an activity.

2.6. Capacity cost rates

One time unit's resource cost consists of all possible costs, which have been divided by the time available to perform an activity. By doing this, the cost of one time unit will be €/min, if the time unit chosen is minute. The TDABC analysis can be done on a monthly basis, or even on a yearly basis. Much depends on the nature of the business of the company. If there is a lot of volatility between quarters, a more frequent analysis may be beneficial. A big advantage of the TDABC model is the ease of doing modifications. The analysis can be done based on budgeted costs or on closed accounts, depending on the purpose. (Kaplan & Anderson 2004.)

The equation below describes the capacity cost rate equation:

$$Capacity\ cost\ rate = \frac{Cost\ of\ capacity\ supplied}{Practical\ capacity\ of\ resources\ supplied}$$

The practical capacity of resources supplied is meant to reflect the actual capacity that a resource is available for productive work. Kaplan & Anderson (2004) suggest using a figure representing 80-85 per cent of the time spent at work, if more accurate calculations are not made. In this study, more detailed calculations were made and can be found in chapter 4. For machine resources, Kaplan & Anderson suggest using 85 per cent of the theoretical

maximum capacity. More accurate machine resource calculations were also made for this study and can be found also in chapter 4.

The cost of the capacity supplied consists of all costs that the resource uses during the observation period. It is important to note that if the resources in a process observed are not similar, i.e. the cost of capacity supplied or practical capacity of resources supplied differ from each other, separate capacity cost rates must be calculated. For example, if completing a process or activity needs labor from both humans and machines, they must be calculated with separate capacity cost rates. The cost calculation formation of this study can be found in chapter 4 (Öker & Adiguzel 2010.)

Traditional ABC does not take into account the excessive capacity that process or activity might have very accurately. One reason is that TDABC uses practical capacity instead of theoretical capacity, which traditional ABC does not. Traditional ABC is usually completed in a survey based approach, which leads overestimation of the costs of performing activities, thus resulting in less accurate representation of capacity usage. For example, usually employees have to estimate how much time they spend on a list of activities, which have to result in 100 per cent. By doing that cost driver rates are calculated assuming that resource capacities are fully used, when in reality some part of their time is unproductive or idle. (Stout & Propri 2010; Öker & Adiguzel 2010)

2.7. Cost hierarchy

An important aspect to remember in activity –based costing is cost hierarchy. As common sense gestures, not all cost information is equal or as important as others. The differences between various cost types must be taken into account when forming a activity –based costing system. The cost accounting researchers have quite widely agreed on four different levels of activity cost pools. They can be found in virtually every company, defining cause-and-effect relationships and in different degrees of difficulty. (Horngren et al. 2006: 147; Ittner, Larcker & Randall 1997; Kaplan 1990.)

Unit-level costs are costs of activities performed on each individual unit of a product or a service, i.e. activities performed in proportion to the volume of units produced. Costs increase

when the product is produced in growing quantities. Machine working hours are categorized as unit –level costs. (Horngren 2006: 147; Ittner et al. 1997.)

Batch -level costs are costs that occur when activities are performed in proportion to batches, independent to the number of units produced in the batch. Quality inspection costs and machine setup costs are examples of batch -level costs. (Horngren et al. 2006: 147; Ittner et al. 1997.)

Product sustaining costs are the costs of activities performed to support individual products or services regardless of the number of the number of units or batches in which the units are produced. These costs are usually part of the product portfolio, for example design costs and marketing costs fall into this category. Design costs do not increase or decrease if the product manufacturing quantity changes. Horngren et al: 2006: 148; Ittner et al. 1997.)

Facility –sustaining costs are costs that cannot be assigned to any other category, because they affect the whole organization. These costs include facility rent costs and top management compensation fees, for instance. It can be hard to find a reasonable cause-and-effect relationship between these costs and the cost-allocation base. This lack of cause-and-effect results in companies reluctant to assign these cost to products, and instead simply deduct them separately from the operating income. (Horngren et al. 2006: 148; Ittner et al. 1997.)

These four levels are paramount in ABC by providing a framework for understanding cost behavior and hence forms a basis to understand product profitability and other cost implications. ABC trail blazers Cooper & Kaplan (1991: 271) have argued that costs should be assigned to different hierarchy levels so that managers can identify what costs are essential for different types of decision making. The idea behind hierarchical costs is that by segregating costs like this the activity-based costing system will only take relevant costs into consideration. (Ittner et al. 1997.)

2.8. Activity Analysis

Before resources and costs can be allocated to activities and further down to cost objects, the activities must be defined. This can be done by conducting an activity analysis. In an activity analysis, all of an organizations actions and processes are divided down to activities. As a result of the analysis one can discover an organizations current protocols in addition to the resources needed for different activities and how much these activities consume resources. In short, the activity analysis tells what is happening in the organization and how are the resources being utilized. (Alhola et al. 2000: 215.)

Activity analysis is a useful tool to map which activities consume the most resources. This is usually not the main objective in activity analysis, but often a resource consumption mapping can give the organization valuable information of its activities. For instance, if an organization emphasizes customer-orientation in its culture, one can evaluate how many of its most resource-hungry activities are directly related to the customer. It is surprisingly common that an organization which has such an emphasis does not have a single customer-driven activity in its top resource consumers. Most of the resources are consumed by internal processes and activities. Often an activity analysis gives upper management their first real overview of what is truly going on in the organization and how the activities are linked to each other. (Alhola et al. 2000: 215; Lumijärvi et al. 1995: 32.)

Activity analysis consists of different phases that most implementation methods use. First one must describe the activities and activity chains. After this, costs for these activities are calculated. As a final phase, activities are classified by their importance. Very often activities and activity chains are mapped by interviewing an organizations key personnel and management. A crucial part of a successful activity analysis is proper documentation of the different phases. Without this, the project becomes very difficult to manage.

The amount of activities included in the analysis depends entirely on what is wanted from the analysis. There is little point in including 150 or more activities, if the purpose of the analysis is to figure out whether the cost objects are profitable or not. In this case it could be sufficient to include “sales and sales analysis” into one activity instead of breaking it down to several, almost task-level activities. (Lumijärvi et al. 1995: 39.) There has also emerged some evidence that the activity analysis is actually the most beneficial part of activity based

costing because of its relative simplicity to conduct and everyday operations information it provides to management (Rautesalo 2002: 57).

2.9. Differences between activity- based costing and traditional costing methods

Traditional costing methods are premised on calculating costs of products. This means that indirect costs are divided into cost pools and further on to products by using allocation factors based on volumes such as machine hours, labor hours and direct materials. However, volume based allocation creates inaccuracies to the calculations if the costs are not measured by volume based metrics in the activities. Activity- based costing focuses on allocating indirect costs more accurately. By allocating the costs to separate activities, an organization is able to manage the activities and factors that cause the majority of the costs in a more effective way. The basic idea behind traditional cost methods and activity-based costing is the same; both consist of a cost allocation process of two phases, but the allocation philosophy is different. (Brimson 1992: 24-25, Maynard & Zandin 2001: 354-256.)

Activity-based costing emphasizes the deep understanding of the activities of an organization, processes and sources of costs it provides over the costing method itself and its techniques. An activity- based costing system does not reveal anything else than what possible problem occurs in an organization. Its success is heavily influenced by the utilization of the information provided. (Brimson 1992: 46.)

Horngren et al. (2006:156) have listed signs that can indicate whether an organization can gain advantages and reap the most benefits from implementing ABC. Usually management decides the level of detail of the costing system by contemplating the costs of the costing system versus the expected benefits of making better decisions based on information produced by the costing system. Below are some these signs:

- Significant amounts of indirect costs are allocated into only a few cost pools.
- The personnel in charge of operations do not agree with the accounting personnel about the cost structure of manufacturing, marketing, products and other important activities.

- Most of the indirect costs in an organization are identified as output unit-level costs. This means that few indirect costs are described as batch-level costs, facility-preserving costs or product-sustaining costs.
- Disproportionate profits in different product groups: products that a company is well suited to produce seems to be making small profits, and less suited products are making big products.
- Products make different demands on resources because of differences in process steps, size of batches, complexity and volume. (Horngren et al 2006: 156.)

Compared to ABC, there are two profound disadvantages in traditional costing methods: The inability to provide accurate cost information about individual products, processes and customers, and the insufficient information it produces to support upper management decision-making. (SAS Institute 2007: 3-4.) This is because of the negligence standard costing methods have towards the cause and effect -principle of cost accounting, which results in a blurred understanding of product-based costs and profitability. (Neilimo & Uusi-Rauva: 2014: 144.)

What usually causes the inaccurate cost information of traditional costing methods is the over-simplified way overhead costs are allocated to products, especially in relation to direct labor costs, paid salaries or hours worked. However, many overhead costs do not have a direct cause and effect –connection. In cases like these the cause and effect –principle might have been overlooked which can result in a distorted picture of product costs and profitability. This is particularly true in companies producing many different products. The situation might be even worse in companies where direct labor costs might have decreased in relation to other costs, for example when labor has been transferred from people to machines. This change has increased the overhead costs. Some of the products might be subsidizing others in the costing system. What is more, a company might have used cost centers that are too broad. This could have happened if the cost centers were defined for supervising responsibility areas, not for following product costs. This kind of wrong implementation of cost management tools might have led to arbitrary allocation of overhead costs. (Neilimo & Uusi-Rauva 2012: 144.)

A natural starting point to start allocating company costs to activities and products is the premise of products being the root of all costs in a company. From this basis one can consider the best way to calculate costs with respect to the cause and effect –principle. A lot costs are

divided into fixed and variable costs, mainly because of the old principle in income statement publishing. This might be a deceptive point of view because fixed costs change with the time span of observation. For example rental costs and interest rates change over time. (Neilimo & Uusi-Rauva 2014: 144.)

2.10. Activity-Based Management

Activity-Based Management (ABM) is often the next natural step for an organization after implementing Activity-Based Costing. In fact, many academics argue that these concepts are intertwined so that one can't live without the other. ABC provides the information and data for ABM to prosper. From a practical point of view, the relationship between ABC and ABM quite very similar to other ways that management philosophies and their auxiliary principles' relationships, such as Total Quality Management (TQM) and the PDCA – cycle (Plan, Do, Check, Act). The PDCA –cycle and ABC both serve a bigger purpose than their own output of information; they are tools for decision making processes which value and utilize a certain type of information. Obviously there are a myriad of other factors that management has to consider besides activity costs and process quality which affect the decision making in many ways.

Horngren et al. (2005: 791) have mentioned that external factors relating to the customer, technological advances and the market have given rise to several new management accounting innovations such as Activity-Based Management and it can be categorized as a dimension of Strategic Management Accounting.

According to Laitinen (2001: 12-13), Activity-based costing is not useful for an organization before it is implemented as a part of an organization's decision making. Activity -based Management is essentially making use of the cost information extracted from Activity -based Costing. ABM is a systematic approach of managing activities as a part of the business process (Cokins & Capsusneanu 2011).

Activity –based management has been seen as having problems in improving its value measurement features; it hasn't been able to measure value-added from the customer's perspective. A change in this would change the focus of ABM from costly activities to the

activities that create the most value. Costly activities aren't always the easiest to improve, either. ABM has been seen as a way for cost minimization, not value maximization. For it to thrive, emphasis for value maximization should be on value-added activities, and search for cost minimization from activities that do not add value. (Ashton, Hopper & Scapens 1995: 105.)

What is very worthwhile noting is that it is entirely possible to apply ABM practices without an activity –based product costing system, and indeed many companies do that. This does however require identification and cost management of activities in the company, but activity cost pools are not linked to individual product lines. These companies often identify the related cost drivers for activity cost pools in order to achieve a better understanding of their overhead cost behavior. This type of activity -based information is the basis of the cost management system which ideally leads to classification of activities, where real surprises and valuable information of activity resource consumption is often found. (Ashton et al 1995: 128-129.)

2.11. Possible drawbacks encountered with ABC systems

When considering different theories and methods of doing things, it is important to present the possible disadvantages of the particular method used. Without careful analysis of strengths, weaknesses, opportunities and threats one can't make an informed decision of usable methods. Activity –based costing has some managerial and operational implications that need to be addressed properly.

According to numerous surveys and studies the biggest stepping stone in ABC implementation is its excessive complexity. Over-complicating the system should be avoided with great determination. When designing and implementing the system one must always choose between model accuracy and model complexity. After a certain stage increasing accuracy does not provide additional value to decision making. Common sense is a virtue also in activity –based costing. (Lumijärvi et al. 1995: 60.)

Datar & Gupta (1994) have come to a conclusion that increasing activities, cost pools or cost drivers does not increase result accuracy. It is apparent to them that direct allocation and activity definition errors increase in correlation with the model complexity. Also Cooper (1990) has had similar statements, and adds that one must have enough activities and cost object to analyze, but every target must be well justified.

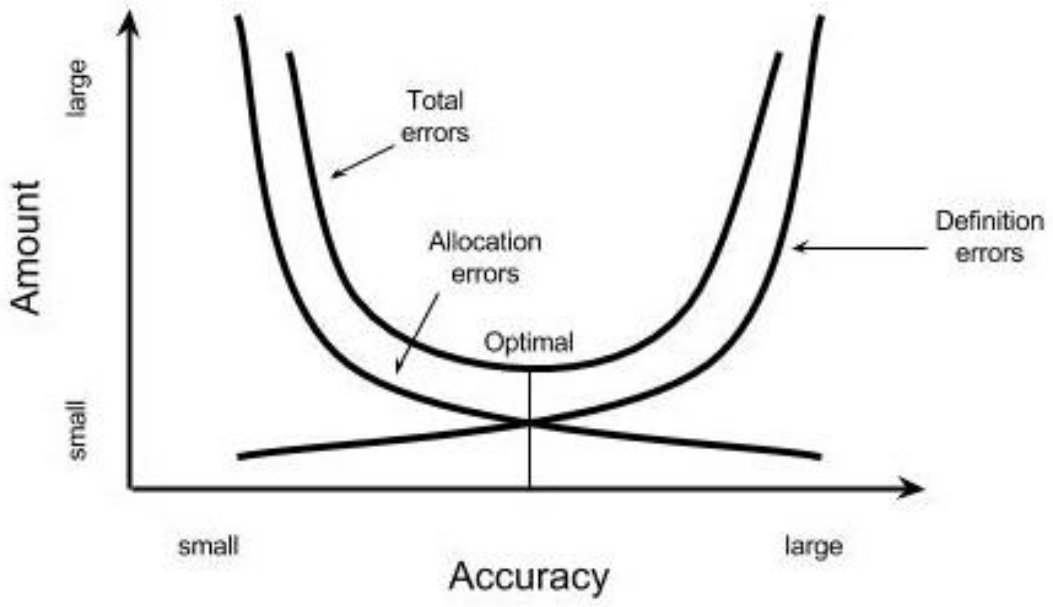

Figure 5. Choosing the optimal amount of drivers and activities paraphrasing Cooper (1998: 217.)

Rautesalo (2002) surveyed a large number of Finnish companies in his master's thesis *"Researching management accounting: case activity -based costing"* in order to look into the state of activity –based costing systems in these companies. He argued that the two biggest reasons for ABC systems to fail are excessive emphasis on its technical aspects and project initiatives coming outside the organization. Focusing on technical aspects easily overshadows organizational factors in cost system implementation. This can be a significant issue, since international literature and research suggests that organizational factors play a bigger role in ABC implementation success than technical factors. This is tightly bound to the other big failure reason of outside initiatives; if the willingness and commitment within the organization is not in place, outside consultants have a thin chance to succeed. The best

chances for the ABC project to succeed and add value to decision making is often when the old cost accounting system used in the organization is not able to answer questions that need to be answered. Without this internal driver, useful results were scarce. (Rautesalo 2002; Shields 1995; Nicholls 1992.)

A lot of disappointments encountered with ABC are results of ill-advised project planning and poor preparation for the costing system. Below are some of the most common mistakes and shortcomings that management teams across the world have often overlooked working with activity –based costing.

1. Lack of perfect cost data

Every cost accounting system has its flaws, and ABC is not an exception. Imperfect data is a major contributor to inaccurate results. It is virtually impossible to track and attach every thinkable resource cost to a particular activity. Depending on the company, hundreds or even thousands of activities happen every day. Some activities might not be measured or even identified without significant efforts. Therefore it may not be worthwhile to calculate the costs for such activities. Nevertheless, conducting ABC analysis with the largest resource – hungry activities does help to reveal true costs. The lack of prefect cost data can discourage management from using costing systems, but more important should be to acknowledge this flaw rather than let the disadvantages overpower the advantages in decision-making. (Harrison & Sullivan 1995; Lin et al. 2001.)

2. Loss of customer focus

Focusing on cost management can deter the concentration of management from other important aspects of business, such as customer focus. For example, the whole output of logistics is customer service. The cost information that ABC provides should be geared towards customer service as much as profit potential improvement. There have been studies concluding that management might focus too much on costs at the expense of customer service. (Harrison & Sullivan 1995; Develin 1999: Lin et al. 2001.)

3. Effect on internal policies

Activity –based costing and cost management methods in general shed light into the very activities that employees perform each day, thus giving answers to questions regarding a company's overall performance. These answers may not be beneficial or received well by everybody in the company. Employees might start to fear for their jobs or the loss of customers. Change resistance can be a big issue if drastic re-organization of day-to-day operations is necessary. Detailed plan of action once the cost information is provided by the costing system is important for successful implementation. (Morton 1997a, 1997b; Develin 1999; Lin et al 2001.)

A worthwhile note about the problems of ABC is from Ashton et al. (1995: 135): many problems associated with ABC are problems with costing systems in general. For instance lack of staff time, scarce IT –resources and resistance of personnel reflect the more general issues of making any changes to the management accounting system. (Ashton et al. 1995: 135.)

2.12. Value chain analysis as a cost reduction tool

Kaplan and Cooper (1998) have stated that: "*ABC information can be used across the entire value chain, to reduce the total costs of production and support, not just the obvious costs of direct materials, labor, and machining."*

Govindarajan & Shank (1992: 180) have described the essence of value chain analysis in the strategic management accounting context as follows: "The chain of activities that runs from basic raw materials to end-use customers into strategically relevant segments in order to understand the behavior of costs and the sources of differentiation". Value chain analysis is also seen as an important part of supply chain relationships. It is particularly useful in optimizing, coordinating and analyzing linkages between activities in the value chain. This is done by focusing on the interdependence that can be found between these activities. In general, an organization can gain competitive advantage by either keeping value produced constant while reducing costs, or by increasing value produced while keeping costs constant. (Porter 2008; Govindarajan & Shank 1993).

A value chain perspective to cost management requires the organization to recognize their product in the value chain activities, expanding from suppliers to end customers. The accounting information produced must enable improvement of internal cost management performance. It is important to acknowledge that the emphasis is not solely on competition, but also on the interaction that organizations have with their suppliers. (Govindarajan & Shank 1993.)

What traditional accounting systems lack from the perspective of strategic value chain analysis planning has been discussed by Hergert & Morris (1989): Traditional accounting systems do not focus on critical activities but on responsibility centers. Also, they are not well suited for giving a good reflection of the economics of performing an activity and they are unable to give out data about important cost drivers. Lastly, traditional accounting systems are poor in assessing the interdependence of subunits (which for example activities are). This is a flaw in the systems because the performance and cost of one subunit is very often dependent of the performance and cost of other subunits. (Hergert & Morris 1989.)

The issues that were mentioned in the chapter above can be addressed with management accounting practices, such as strategic cost management and activity-based costing. Strategic cost management was developed for embedding accounting information into companies' strategies and its further development. As research in the area developed, strategic cost management was introduced under the umbrella of strategic management accounting, which consists of key strategic dimensions in competitor analysis, strategic positioning analysis and analysis of the value chain in which an organization operates. Strategic cost management has introduced methods where management accounting information can be of use to give support for decisions related to these different strategic dimensions. The exploitation of linkages with buyers and suppliers can be addressed by performing a value chain analysis, and this a crucial component of strategic management accounting. Activity-based costing has offered a solution for some of the issues of performing a company -internal value chain analysis because of its nature of allocating costs to activities and identifies the specific drivers of those costs. (Shank 1989; Govindarajan & Shank 1992, 1993; Lord 1996; Dekker 2002).

2.13. Kaizen costing

Management accounting is not an exact science. The data collected about costs and processes are good estimates at best, strategies and plans change and assumptions might prove to be inadequate. Kaizen costing is a management accounting philosophy which emphasizes the importance of continuous improvement in cost management, and it is based on the same principles that lean management is.

Kaizen costing identifies cost lowering actions and maps their cost impacts in situations where without separate actions costs would increase higher than the targeted costs in an organization. Kaizen is Japanese and means "improvement", and in a business context it has become a synonym of continuous improvement in all business activities, including identifying savings opportunities in these activities. Applying the kaizen –philosophy requires that all personnel of a company are executing its principles (Anttila & Fogelholm 1999:127; Koskinen & Vehmanen 1997: 355). One way of looking at kaizen costing is that it tries to force cost reductions through learning effects in the whole product lifecycle. Kaizen brings learning -based cost savings into processes when they would normally not be necessarily expected (Burrows & Chenhall 2012). Nevertheless, one must not assume that learning in an organization arises by itself; already in the year 1974 Abernathy & Wayne (1974:110) noticed that learning-generated efficiencies only happens by strenuous ongoing multi-disciplinary work efforts.

Kaizen costing differs from traditional costing systems quite distinctly. Whereas standard costing systems are all about cost control and avoiding variances, kaizen costing focuses on reducing existing costs to a certain target level. Traditional costing systems often assume that managers and engineers designing these systems have the best knowledge of cost reduction. Kaizen costing concepts believe that workers and those who are closest to the process know best. In an ideal kaizen system workers are given responsibility and permission to act if processes are inefficient and costs can be reduced. (Atkinson et al. 2012: 298-299.)

In standard costing practices, cost variance is measured by comparing actual costs to standard costs. In kaizen costing, variance analysis is conducted by a continuous comparison of target Kaizen costs to actual cost reduction amounts. (Atkinson et al. 2012:299.)

Criticism against kaizen costing is usually the same that target costing suffers from. The pressure to find savings and cost reductions can be too much and energy is wasted in the pursuit of trying to save on every imaginable cost. Japanese automotive companies address the problem by having a grace period before new manufacturing process implementation. This is so that personnel have time to learn the new procedures before cost targets and kaizen costing is introduced to the processes. The kaizen philosophy is also all about incremental, continuous improvements which might lead to shortsightedness in assessing the overall performance of the process. (Atkinson et al. 2012: 298).

3. INTRODUCTION TO THE CASE COMPANY

The case company operates as a manufacturer in the construction and mining business, providing consumable products. It does not manufacture machinery for its target segments, which provides shelter from macro cycle fluctuation in its target segments. The case company is a growth –hungry company, which is proved from its net sales development presented in figure 6.

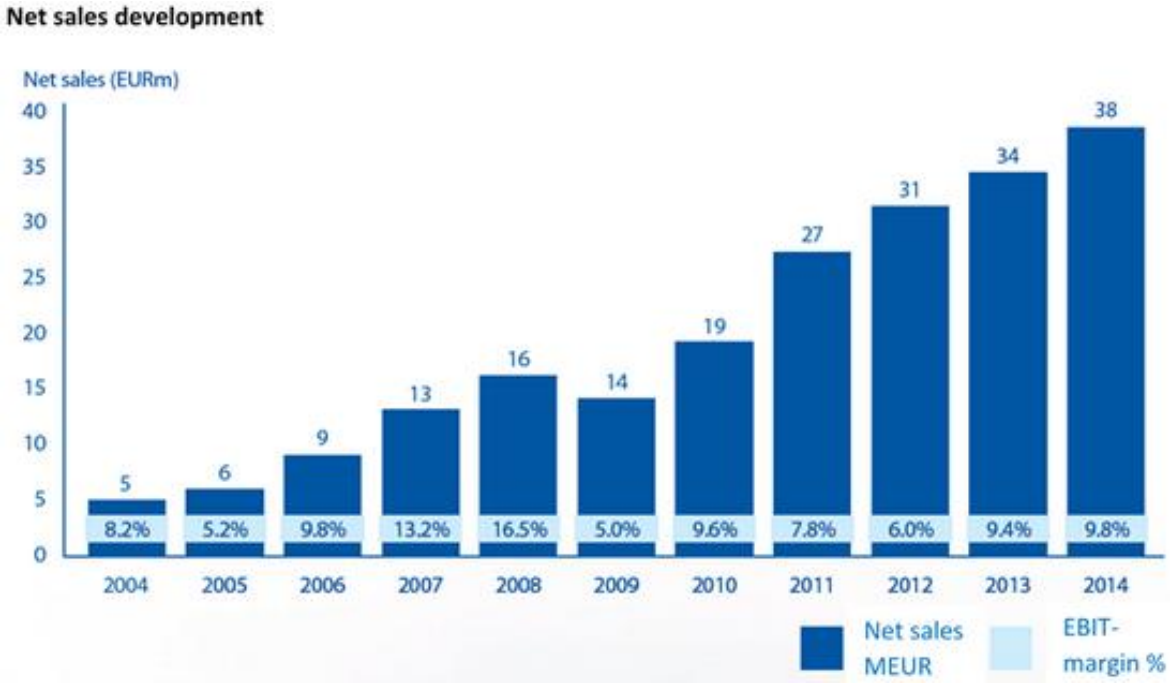

Figure 6. Development of case company net sales 2004-2014.

3.1. Value chain of the case company

The value chain is an important visualization tool in the case company to assess and show the most important main activities the company has in creating value. As the industry where the case company operates in is highly competitive, value chain activities have to be effective and cost-efficient. Pricing must be in line with the quality of the product to achieve a satisfied

customer. The value chain of the industry consists of many operators and entities, and understanding the industry value chain provides a framework for understanding value chains of separate companies in the industry. In the construction business, the project owner is ordering the execution of a project from a main contractor, which uses several subcontractors to implement for instance the drilling operations. Identifying the real customers and decision makers in the chain regarding the case company's products is critical for successful business. The case company mainly operates with dealers who supply main contractors with construction equipment.

> *"Gaining and sustaining a competitive advantage requires that a firm understand the entire value delivery system, not just the portion of the value chain in which it participates. Suppliers and customers and suppliers' suppliers and customers' customers have profit margins that are important to identify in understanding a firm's cost/differentiation positioning, because the end-use customers ultimately pay for all the profit margins along the entire value chain" (Govindarajan & Shank 1993: 49).*

Mikko Mattila (2010: 8) analyzed in his MBA thesis "Potential M&A Partner Analysis" the case company's value chain in the construction business. It is important to allocate marketing efforts to all of the entities in the value chain. The emphasis of these efforts vary depending on nature of the projects.

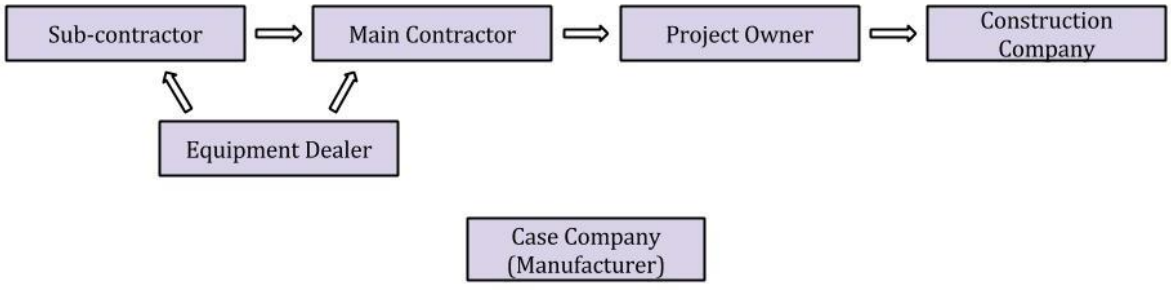

Figure 7. Value chain in the case company in the construction business paraphrasing Mattila (2010:8).

3.2. Current costing practices in the case company

The current cost accounting practices of the case company are presented based on the views of the financial controller. Also the premises for further development of the cost accounting system are discussed.

Before this project, the case company did not have ABC –model for cost tracking or allocation. Basically all the cost information that the company has and has collected is the information in the income statement and balance sheet, analyzed in various ways. The case company also does a lot budgeting analysis to forecast the future. The standard cost prices of goods manufactured are updated whenever some significant changes happen in production costs, such as changes in material or commodity prices. The controller's assessment in an interview was that before this project the case company has scarcely data that could be applied for an ABC –model. The amount and type of the cost drivers that could suit the case companies' needs was discussed in depth. (Interview 2.9.2015.)

3.3. Product groups

In this subchapter the product groups of the case company are presented.

3.3.1. Button Bits

Figure 8. Button Bits.

The button bit product line covers construction, quarrying, and mining drill & blast applications from soft to hard rock conditions. Button bits are divided into threaded bits and tapered bits, depending on the method of affixing. Button bits are compound products in the case company's offering. Button bits are the "tip of the spear" in rock drilling, shattering the rock with percussive hammering, applying force and rotation at the same time in order to drill the hole into the rock.

3.3.2. Ground Drilling

Figure 9. Ground drilling tools.

Ground drilling products are for drilling applications in softer conditions than hard rock. These conditions can vary significantly from soft ground soil to big rock boulders beneath the surface, so the tools must have versatile features suitable for different conditions. The product line offers various casing systems for drilling, where applications include for example piling, anchoring, thermal and water well drilling and underwater drilling. Casing system are an integral part of the offering since the majority of ground drilling applications

need some sort of casing, for instance when thermal heat is pumped to the surface from the well for household heating.

3.3.3. Shank adapters

Figure 10. Different shank adapters.

Shanks adapters are used for transmitting power from the drilling machine to the drill bit. In between the shank adapter and the drill bit there is the drilling rod. The shape and spline design of the shank adapter always depends on the manufacturer and model of the drilling machine. Because of this the product family is very large. Every manufacturer uses its own spline designs in their drilling machine to which the shank adapter has to fit. What is more, the length and thread designs are subject to customer preferences and drilling machines. The threads must be of the same design as in the drill rods connected to the shank adapter. (Sokka 2012.)

3.3.4. Rods

Figure 11. Different drilling rods.

Drilling rods are longest part of the drill string that transfers the power from the drilling machine to the drill bit. They can be designed as round and hexagonal, depending on the application it is used in. As in components of the drill string, the threads and other properties must fit each other which leads to a large product offering. Rods can be offered in male-male and male-female thread ends. Male-female –threaded rods are usually more practical because they eliminate the need for coupling adapters.

3.3.5. Couplings

Figure 12. Couplings.

Couplings are a rather simple product line. They are used to connect two products together, and they are divided into three categories: coupling sleeves, coupling adapters and bit adapters. For example, with a coupling one can connect two male threaded rods together.

4. TIME –DRIVEN ACTIVITY BASED COSTING IN MANUFACTURING ACTIVITIES

As for the case company, the ABC project stemmed from a model paraphrased by the company executives and financial people for the underlying purpose of ensure future growth. ABC is a tool in this quest and should provide a deeper understanding of the day-to-day cost structure of the case company.

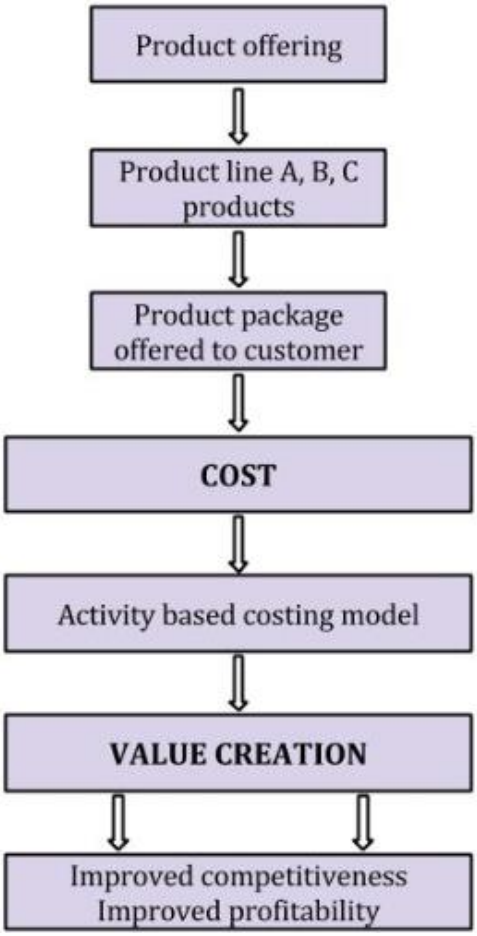

Figure 13. Case company value chain for competitive edge.

Figure 8 shows why and how the case company sees activity -based costing as a tool for sustaining and improving their competitive edge in the marketplace. Value created by its core

processes and activities can be measured and controlled with ABC, and this is essential in a market saturated by low-cost competitors.

4.1. Introduction to model building premises

This project was born from different needs that hadn't been met in the case company. The case company wants to ensure future growth and prosperity with various tools and methods available. Activity –based costing has been discussed and researched in the case company before, but the development of it has stopped at the difficulty of finding and defining cost drivers which are both informative but simple. Also, management could not find sufficient resources to push the previous ABC -research projects further. (Interview 2.9.2015.) Defining cost drivers needs accessible cost information and knowledge about how to form this information, and this declined the enthusiasm to proceed with the research.

The information gathering process started with a discussion with the case company's financial controller, who opened current cost accounting processes and techniques used in the company. (Interview 2.9.2015.) The aim of the discussion was to build a premise of the current situation in the company for further development of the ABC model. After this discussion, time -driven activity based costing was considered to be a serious contender as a suitable model. The traditional ABC was concluded to be too complicated to implement accurately, and the case company had previously had trouble to define relative cost drivers for the traditional ABC model. With the TDABC model, drivers were not a problem anymore.

The method used for calculating and allocating costs in in-house manufacturing processes is time –driven activity based costing, abbreviated TDABC. This was chosen after assessment discussions, where key criteria were simplicity and easy modification for possible future process changes and expansion. TDABC can achieve significant flexibility advantages compared to traditional activity based costing or other costing systems.

The pilot project described in this thesis was limited to manufacturing processes of the case company. Depending on its applicability in day-to-day activities and value added in decision making, the pilot model may be expanded to other processes in the company and overseas operations. In the initial discussions of the project, expandability was one of the attributes

needed from the final model. In the end, this was one of the reasons TDABC was chosen as the used method, because it provide highly scalable capabilities. Also, the case company wanted to test out how an activity –based costing model would suit manufacturing activities and the case company in general.

Kaplan & Anderson (2007: 67-84) have described an implementation process of four phases for time -driven activity –based costing:

1. Preparations
2. Data definition & analysis
3. Building the pilot model
4. Expansion throughout the company

As this thesis focuses solely on building the pilot model and assessing the costs related to the pilot departments, steps of phase number four will not presented in this thesis. Kaplan & Anderson's (2007) book "*Time –Driven Activity –Based Costing –A simpler and more powerful path to higher profit*s" was used as the guideline for building the TDABC model for the case company.

4.2. Preparations

The main target for the preparations phase is to develop a game plan for the TDABC study. This includes actions like developing model structure, estimating project costs, determining data requirements and availability and selecting the team composition. (Kaplan & Anderson 2007: 66.)

In this study, the project team was composed of myself as the thesis researcher, the CEO of the case company and the financial controller of the case company. In addition to these, there were multiple employees and managers involved especially in the data collection phase of the project, as the TDABC method needs assessment from various experts of the processes under scrutiny. Timetable for the project was approximately six months. The timetable was subject to the workload of other projects running at the case company, so flexibility was key in the preparations phase.

One important aspect that needs to be decided in the preparations phase is the purpose of the TDABC costing system. Usually the system is used for assessing costs in a certain department, product profitability analysis or customer profitability analysis. In this study, the purpose was ultimately to use the TDABC cost information gathered of the manufacturing processes to evaluate product line profitability. Even though the project was a pilot project, Kaplan & Anderson (2007: 67) recommend keeping in mind the possible future scaling of the system to other departments of the company.

4.3. Data definition & analysis

Data was collected in different phases. First the cost data of manufacturing processes was collected. After that, activity time estimates were collected. Finally, the production data of units manufactured was collected. The collection methods of the different data areas are described in the following subchapters.

4.3.1. Collecting costs data

Allocating costs in a fair and accurate way is the most important, most laborious and the most challenging part of any costing system. Following the original TDABC model building process, costs should be divided by departments that perform different activities.

The case company had previously used a standard costing method to calculate manufacturing costs of their products. The standard costs also provide a base for the market prices of the products. This provided an opportunity for the project researcher to use the raw data in these calculations in the TDABC model. The raw data used for the standard costing system includes essentially all the same cost data that a TDABC model needs.

The cost data was inspected and verified by the production foreman and financial controller of the case company, and determined accurate and reliable for the pilot project purposes.

Because of the piloting nature of the project focusing only on manufacturing processes, not all of the costs of the company needed to be assessed and included in the final model. The costs included in the model were:

1. **Capital costs of production machines per year**. This includes the annual depreciation amount of the purchase values of the machines and annual interest for these purchases.

2. **Manufacturing facilities costs per year.** This includes the annual costs of manufacturing plant: utilities costs, electricity costs per production machine and costs of space used by different manufacturing departments. Every cost category was allocated according the usage of these resources by different manufacturing departments.

3. **Tools, equipment and consumables used by manufacturing departments per year.** Different manufacturing departments use tools, equipment and consumable parts that generate costs. These cost increase linearly if production numbers increase and machines are used more. Every cost category was allocated according the usage of these resources by different manufacturing departments.

4. **Service and maintenance costs per year.** The manufacturing machines need service and maintenance in a regular fashion. Like consumables costs, these cost increase with the increase of capacity usage also.

5. **Employee costs.** This includes the salaries of production personnel and the additional costs affiliated with personnel; retirement funds, holiday salaries and employment costs. Most of these additional costs are compulsory by Finnish employment law.

Costs were divided into 19 different cost departments within 3 production lines. These departments have different cost structures and produce different products. What is more, they consume resources differently; some consume more human labor and others consume more machine labor. Because of this not just capacity cost rate could be used in the whole manufacturing plant, every cost department has its own calculated capacity cost rate.

4.3.2. Collecting activity time data

Collecting activity time data was done by interviewing employees who perform the activities every day. Additionally, employees had kept production department throughput time minutes, which provided accurate data of the robot department's time of completing production batches. An example of the minutes held by the employees can be found in appendix 1. Time consumption of some activities were captured by using a stop watch. Because the most complex activities were rather difficult to time accurately, time estimates from the most experienced employees were used to evaluate the time consumption of these activities. Kaplan & Anderson (2004) have stated that the estimates needn't to be precisely accurate; 5-10 error margin is acceptable. TDABC highlights and corrects these errors through time.

Activity estimates were assessed and scrutinized multiple time to be certain that it represents an accurate average of the time really consumed by the activity. If performing an activity took exceptionally long because of an unexpected problem or robot malfunction, it was not taken into consideration when calculating and presenting the activity times in the final TDABC model.

In total, 55 activities in the manufacturing processes were identified, assessed and estimated by time consumption.

4.3.3. Collecting production data

Production data was collected from various sources. The ERP –system was used for to collect information about all the products produced during the year of 2015. This includes all in-house manufactured products, which amounts to over 200 000 units.

The data had to be processed somewhat to get production amounts of various production phases and different production lines. This was important to get accurate quantities of activities performed. For example, the size of products determine whether it is buttoned by human labor or by an automated robot. The ERP –system provided data only for product

group production in general, so the researcher had to filter units produced by size to understand how many were buttoned by hand and how many by robot. This was done for the button bits production line only. As for the ground drilling product lines, the data had to be filtered into rings and pilots, which was a bit simpler. They have only one manufacturing method each, so calculating quantities for manufacturing phases was rather straightforward.

As the production is conducted in batches, a challenging part of the research was to assess the average batch sizes of units in different production phases. The case company is a very customer-driven organization, and the production strategy is for the most part Make-to-Order. This results in big fluctuations in batch sizes, and a lot of urgent re-prioritizing in production queues. Nevertheless, by extensive production phase time keeping in the form of time recording by employees, average batch sizes, activity times and activity quantities were able to be formed in a sufficiently accurate manner. Accuracy and complexity capturing can always be improved, but it requires more time and resources for the research project, and future continuous improvement efforts.

A couple of production phases were particularly challenging to model into average batch sizes and activity times, so that the calculations would reflect the real state of the process phase. The painting phase has a big capacity reserve, and production runs are conducted as products are pushed from previous production phases. As the drying of the products takes up over 95 per cent of the phase's total time used, and it doesn't in reality consume any resources while drying, the drying phase was discarded of the activity analysis. Also, the products go into the painting machine in racks, which can hold a various amount of products depending on their size and weight. The average batch size was determined by calculating the theoretical maximum capacity of a rack for small, medium and large sized products. This was then divided by three to get the average size of rack. By surveying the employee conducting the painting machine, we got the average size of a batch, which was six racks. With this information, different activity quantities in the painting phase could be calculated.

The other tricky production phase was the blackening phase. The problem was essentially the same as in the painting phase; the drying of products consumes the most of the total phase time, but consumes none of the resources. Also, the batch size varied greatly since the blackening is done for both pilot and ring products, and both product groups are mixed in the crate that goes through the blackening process. As pilots can consume space in the crate up to twentyfold to rings, the batch sizes can be from 4 to hundreds of units. As for the

blackening process, after surveying the employees conducting the blackening line the average size was determined to be 50 units. Record keeping for the batch size was applied as well, which further strengthened the assessment of 50 products on average. Rings are produced in much larger quantities than pilots, which contributes to the increase of the blackening batch size.

In total, 12 different batch sizes had to be defined and assessed for an accurate picture of batch sizes processed through different production phases.

4.4. Calculating capacity cost rates

Calculating capacity cost rates was one of the most important steps of the project in order to get accurate information of the costs in different departments. Two calculations were needed: the practical capacity of resources supplied per year, and the cost of the capacity supplied per year.

If a business process uses only one type of resource for all its activities, only one capacity cost rate would be perfectly enough. Because the manufacturing departments in the case company use multiple resources, for example different machines with different maximum capacities, not to mention a mixture of human labor resources involved in activities, the capacity cost rate had to be calculated separately for each department. The resources supplied are not the same for each activity performed.

29 different capacity cost rates were identified and calculated for 17 different manufacturing process departments in the case company. The 17 different manufacturing departments are usually described as “cost centers” in activity –based costing literature. A few manufacturing process departments had to have 3 different capacity costs calculated: A capacity cost rate for human labor (L), a capacity cost rate for machine labor (M) and a capacity cost rate for both of them combined, called Line capacity cist rate (Line CCR). The Line CCR was applied when an activity used both machine and human labor simultaneously. For example, conducting the induction buttoning line in the induction buttoning department requires both human and machine labor. In such a case, the variable of resources supplied in the capacity cost rate equation is the resource which determine the pace of work, i.e. isn’t capable of

performing more if resources are not added. In this case, it is human labor since the induction buttoning lines have only been allocated one human labor year per line. (Kaplan & Anderson 2007: 40.)

All capacity cost rates calculated for human labor in different manufacturing process departments had to have a resource allocation assessment made. This was a particularly challenging part of the study, because the employees at the production floor are quite flexible and human labor are allocated based on the need of the make-to-order manufacturing process, which means that the supply of resources is not consistent for all manufacturing departments. In total, the yearly resources supplied of all 19 employees at the production floor were allocated to manufacturing departments. Nevertheless, the human labor resources were allocated based on the assumption that the demand for all product lines studied is consistent, and reflect an average situation of production needs of products. The TDABC model was created flexible in this matter; the user can easily change the allocation multiplier to examine the effects that allocation changes have on the cost structure.

The practical resources supplied for human labor was calculated as described in table 3 below.

Table 3. Practical capacity of labor resources supplied per year per employee (L).

Days	365
Days -weekends	261
Working days (minus weekends & public holidays)	253
Paid working minutes per day	450
Paid work per year (min)	**113850**
Coffee breaks per day (min)	20
Coming to work and leaving work -time (min)	10
Other breaks (chatting, bathroom etc.)(min)	15
Annual vacation (min per day)	52,3

Non-productive paid working time per day (min):	97,3
Non-productive paid working time per year (min:	**24616,9**
Practical capacity of labour resources supplied per year per employee (Paid work per year – non-productive paid working time per year (min):	**89233,1**

When calculating the practical capacity of human labor (L), all possible breaks that decreases the amount of time used for productive work were taken into consideration, as required by the TDABC model. This means breaks bound by labor law, time used for arriving and leaving work and other breaks that decrease working time. Also, the annual holiday that is entitled for workers in a permanent working relationship was taken into consideration. The premises were that workers are granted 30 days of holiday, and working days per month is 21,5. The calculation for the annual holiday was the following:

$$Annual\ holiday = \frac{30}{21{,}5 * 12} * \frac{7{,}5h}{d} * 60\ \text{min} = 52{,}3\ min/d$$

The cost of supplied capacity, the numerator for the capacity cost rate calculation, was calculated with the following equation for the human labor rates:

$$Cost\ of\ capacity\ supplied\ (L) = \ hourly\ wage * 7{,}5h * days\ of\ paid\ work$$

The employee hourly wage includes all expenses related to employing a person, which means that the expense is much higher than just the hourly wage paid for the employee.

For the machine labor (M), the cost capacity rates were calculated in a slightly different manner. The practical capacity of resources supplied per cost department was calculated with the following equation:

$$Cost\ of\ capacity\ supplied\ \ per\ cost\ department(M) = yearly\ depriciation\ of\ machine\ investment + yearly\ cost\ of\ facility\ costs + yearly\ cost\ of\ equipment\ \ used + \ yearly\ maintenance\ costs$$

The depreciation of machine investments is divided for several years, subject to the machine. Also an annual interest rate is in the calculation. Yearly facility costs include electricity consumed and rent costs allocated subject to the space consumed by the machine. Yearly costs of equipment used includes equipment needed for production to function. Yearly maintenance costs include maintenance costs to keep the machines working properly.

The practical capacity of resources supplied for machines (M) was calculated with the following equation:

$$Practical\ capacity\ of\ resources\ supplied\ (M) = utilization\ of\ capacity * machine\ operating\ ratio$$

This equation provides the amount of time the machine is in production, doing productive work. It takes into account budgeted maintenance stalls and the fact that case company's production has a lot of unused capacity, of which a big part is projected for future growth of production. Put simply, the practical capacity for resources supplied for machines is the time the machine has practical capacity to produce output, under the circumstances of the case company.

Table 4 is an example of the capacity cost rates calculated for the hand buttoning line. The second row is the multiplier for human labor allocated to this department: two employees are allocated to this production department. Capacity cost rates for all departments were calculated the same way as the example. The capacity cost rate is calculated by dividing the cost of capacity supplied by the practical capacity of resources supplied.

Table 4. Capacity cost rates for the hand buttoning line.

Hand buttoning department			
Hand buttoning department time allocation:	2		
	Cost of capacity supplied (€)	Practical capacity of resources supplied (min)	Capacity cost rate
M	x_1	x_2	0,378914094
L	y_1	y_2	0,837388901
Line CCR	z_1	z_2	0,953930993

4.5. Describing the manufacturing processes

The manufacturing processes studied have similarities, but differ radically from each other in the activity time consumption. In picture 9, the manufacturing process with activities are described. As there are only few differences in the processes between the three production lines studied, only the product A line is dissected in detail in this chapter. Activity times are not analyzed in this chapter. As with complex industrial processes often, this is a simplification of the manufacturing process, with as much complexity captured as reasonably possible. It is impossible to foresee all the problems and abnormalities that might occur in

the process with a lot of automation and human labor combined, albeit the processes of the case company can be considered reliable and resilient.

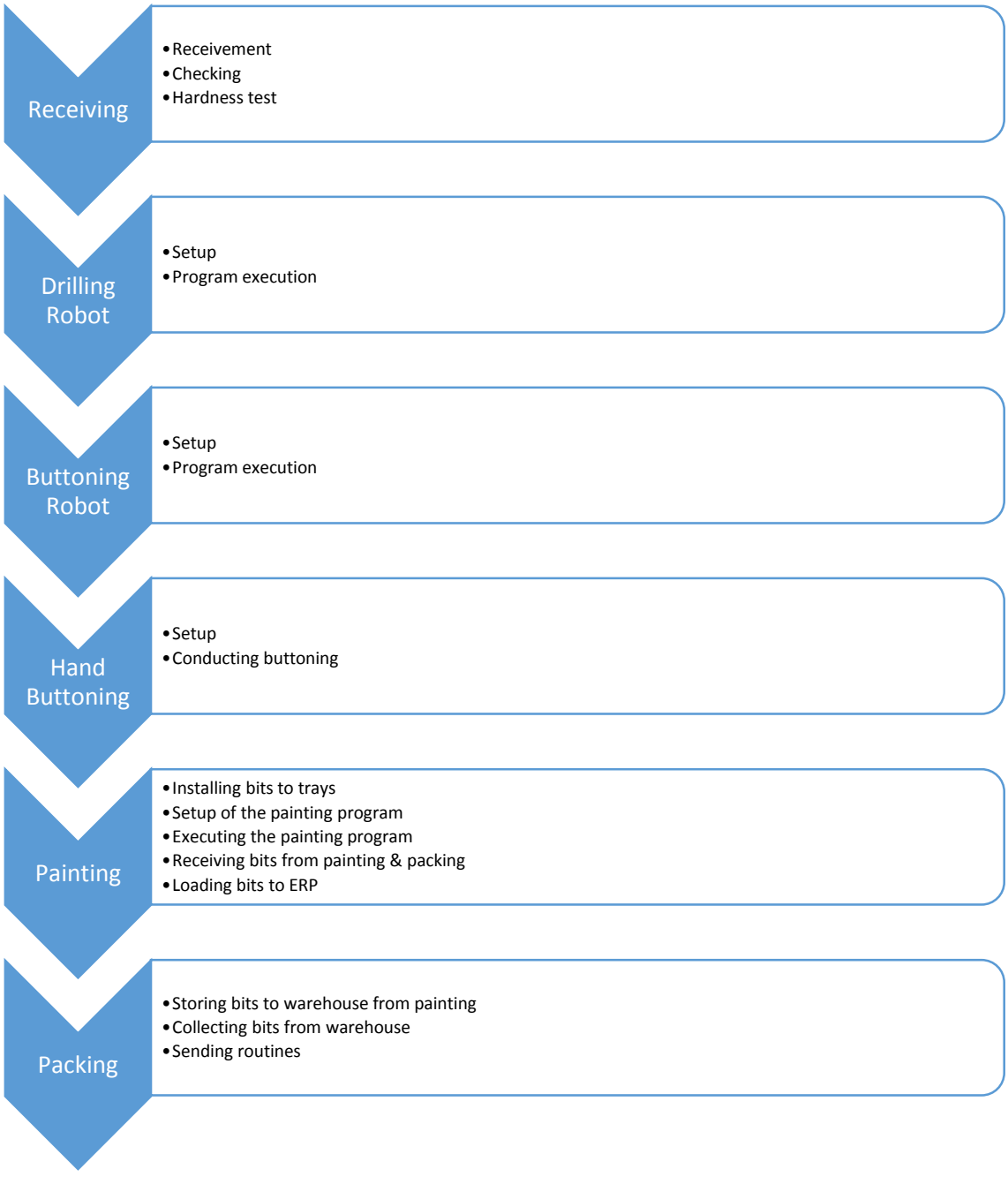

Figure 14. Manufacturing process of the product A line with activities.

The product A units arrive to the case company's factory from the sub-contractor, where they have been mechanized to form their outer dimensions from raw material. Upon receiving, the unfinished units are checked for visual damage and paperwork is filled. Also, the amount of units arrived is checked. The products are also checked with a hardness meter to ensure that the products are of high quality. After this, the product batch goes to the drilling robot, which drills holes into the product for the hard metal buttons to be inserted. This phase needs human labor also in the setup of the robot. Setup is needed when the product handled by robot changes. After the holes have been drilled, the product go to either robot buttoning or hand buttoning, depending on their size. This phase is similar to the drilling phase regarding the robots, including setup and executing the buttoning program. Hand buttoning is done by human labor.

The second to last sub-process of the production line is the painting process. It consists of five activities. First an employee loads the products into the trays which go into the painting machine. Then the painting program needs setting up. After the setup, the trays move automatically into the painting machine, which paints the bits automatically for as long as new trays needing painting are available. After painting, the trays move into the drying line where the wet paint is dried. Finally, an employee unloads the trays, packs the products into their respective packages and uploads the products into the ERP –system.

Manufacturing process visualization and modelling for the TDABC model was done by various methods. The researcher participated in the production activities for two days to gather personal experience of the activities done and how much time it takes to perform them. This also provided good insight on how much more productive an experienced employee is compared to a novice. All activity times in this study are based on the premise that an experienced employee performs them. The case company has very experienced employees in general, longest employee relationships have lasted for 30 years.

In addition to participating, a production employee guided the researcher through the manufacturing processes, explaining what happens at each phase and answering questions. This is where the mapping of the processes and activities mostly happened. After this, questioning and surveying regarding the times of each activity could be started.

4.6. Building the pilot model

When studying ABC projects published in cost accounting literature, one can't help but notice that almost all ABC models in organization around the world have begun with a pilot project of a certain process. After the pilot process the management have decided whether the model adds value to decision making, and whether it should be expanded into other functions of the organization. A pilot approach saves a tremendous amount resources, both labor and financial, and usually gives a good enough insight of activity –based costing's possibilities. Partly because of these experiences, the case company's TDABC model was a pilot conducted in one department only.

The model for the case company was done with a spreadsheet software. Commercial providers of specific ABC software exist, but they were deemed to be too much for this study from a financial point of view. A spreadsheet model is the most cost effective way to create and maintain an ABC model.

An ABC model can be created in a couple of ways; as a snapshot or as continuously updating model. A snapshot means that the results that the model provides are of a certain point of time in the organization. A continuous model would update itself when there are changes in activity times or when a new employee is hired, for instance. Obviously the continuous model provides more accurate information of the current situation of the organization, but is much more laborious to maintain and more expensive. A snapshot can get outdated quite quickly, albeit that would require for example changes in the resources supplied to the process or production amounts. Usually a snapshot model's information provided remains relevant for long enough time to justify using it instead of a continuous model.

The case company TDABC model is a snapshot model, which illustrates the cost structure of the case company's manufacturing processes of the year 2015. The other options were not really considered after the comparison regarding implementation costs and resources needed for implementation and maintenance. What is more, the model created is relatively easy to update for further use. Since the model is a spreadsheet model, the structures and data equations behind cells and sheets needed a lot of work to be built. This was done for this study, so the only the key cells providing data for the cell equations needs to be updated to get new information. The model is also useful for what if –type of analysis; the user can

change a certain variable, for instance the activity time needed for conduction sending routines in the packing department, and examine how it affects the cost of the activity and the whole department.

The production amounts, which are an ingredient of calculating batch sizes and thus activity times and yearly calculations, were withdrawn from the ERP –system at the last week of 2015, giving a very accurate picture of the year's production figures.

Other key ingredients needed for building the model were discussed in the previous chapters. These are process definition & analysis, activity definition & activity analysis, activity times, cost data of manufacturing processes, batch sizes, labor costs and resources supplied by machines, machine costs and resources supplied by machines, capacity cost rates calculated from the previous labor & machine variables and estimates and assumptions regarding a few special activity cases.

The assumptions mentioned above are estimates that were needed when the process defined was particularly challenging to collect precise data from. For example, the packing process has an assumption that 30% of all shipments consist of 2 pallets or more. This adds 5 minutes to the time needed to perform the activity chain. The 30% assumption was estimated after discussions with warehouse employees, who perform the activity every day, so it can be said that the assumption is reasonably accurate. Another example is from the product C drilling activity, where additional setup time is needed when the product batch drilled is not the same as the previous one. This adds 30 minutes to the setup time needed, and 33 per cent of setups performed need additional setup time. This was also estimated after discussions with an employee working with the drilling machine. In total, there were 3 activities that needed assumptions like these to be made. If the assumptions are noticed to be inaccurate in the future, the model can be easily updated with new information. This supports the advice given by Kaplan & Anderson (2004) that the data doesn't need to be 100 per cent accurate from the beginning; TDABC –model will fix itself through time.

What the final model provided is presented in the following table 5. The table does not present all data points received, but the full table can be found in appendix 3. The cost information could not be presented because it was deemed as confidential business information. In this example, the number are fictional but provide an illustration how the model works. The processes and activities are authentic of the case company, but not all of

them are presented here in the example model. All activities and processes can be found in the full model in appendix 3. All of the data cells are coded with equations which handle data entered about the manufacturing activities. Data is entered into a separate sheet. A similar spreadsheet was created for all three product lines.

Table 5. Case company TDABC –model example.

Process	Activity	Qty	Unit time	Total time	Time cap. %	Cost driver rate	Cost/product	Total assigned cost	Cap. cost rate
Receiving	Receiving	750	10	7500	8 %	2,3	0,02 €	1 725,00 €	0,23
	Checking	750	5	3750	4 %	1,15	0,01 €	862,50 €	0,23
	Hardness test	750	8	6000	7 %	1,84	0,01 €	1 380,00 €	0,23
Drilling dprt.	Setup	650	3	1950	2 %	2,1	0,01 €	1 365,00 €	0,7
	Program execution	2100	50	105000	58 %	45,5	0,96 €	95 550,00 €	0,91
Painting	Installing products	300	10	3000	3 %	6,9	0,02 €	2 070,00 €	0,69
	Program execution	2900	9	26100	15 %	3,42	0,10 €	9 918,00 €	0,38
Total							1,13 €	112 870,50 €	

The example above had assumptions of 100 000 products going through the line. Labor resources supplied were 89 000 minutes, and machine resources supplied were 180 000 minutes. The program execution –activities were conducted by a machine, all else by human labor. How the data for table 5 has been calculated is explained in table 6.

Table 6. Cost information data of the TDABC model.

Column	**Explanation**
Qty (Quantity)	Amount of activities performed
Unit time (min)	Time consumed performing activity 1 time
Total time	Quantity*Unit time
Time cap. % (Time capacity usage %)	Total time/Resources supplied
Cost driver rate	Total assigned cost/Quantity
Cost/product	Total assigned cost/products produced
Total assigned cost	Total time*Cost capacity rate
Cost capacity rate	Cost of capacity supplied/practical capacity of resources supplied

As we can see from table 5, the cost for producing one product is 1,13 euros, and the total assigned cost for these activities is 112 870,50 euros.

In this chapter, the TDABC model building process has been discussed. Also, the model was presented through an example model and the data it provides has been illustrated.

5. COST REDUCTION AND IDENTIFYING POTENTIAL SAVINGS IN THE MANUFACTURING PROCESSES

The objective of this chapter is to present the cost information provided by the TDABC model. Since the model itself and the cost information is a source for competitive advantage for the case company, authentic figures could not be presented. Instead, the results of the study are discussed on a broader scope, for instance main findings of the manufacturing costs and development areas in the process that could achieve cost savings are presented.

The purpose of this study was to pilot a TDABC model in a core process of the case company, assess its usefulness, scalability and ultimately the cost information that it provided from the process. Considering the scale of the study, the aim was to keep the model light and easily updateable so that the threshold for developing and using it in the future would remain low.

When interpreting results, Lumijärvi et al. (1995: 60) and numerous other academics have stressed the importance of remembering the nature of activity –based costing and, in fact, all costing systems. Absolute accuracy is impossible to achieve. This biggest reason for this is that for example cost allocated to products are always estimates in multiple product companies. Quite often the operations of an organization are simply too complicated to be modeled perfectly, and thus perfect cost allocation fails as well. Nevertheless this is a secondary issue, since decision making doesn't require an absolute truth; it is better to be reasonably correct than absolutely wrong. (Lumijärvi et al. 1995: 60.)

The case company's cost structure in its manufacturing processes is overall quite low. The production processes are modern and highly automated, although there are still production phases and lines were human labor does the value adding phase of the process, and does not merely prepare machine setups and supervise.

What needs to be taken into consideration is the heavy investments made upfront for these automated processes. The case company has a strong growth strategy and their goal is to grow double in size in terms of revenue in the upcoming years. This shows as excessive idle capacity at the moment in manufacturing processes, and it could be seen in this study as well. The company has resources to roughly double its production to address demand spikes and

future growth. The TDABC model is a tool for capacity analysis also, when comparing total activity times performed to resources supplied for a specific activity or process.

As previously stated in this study, the case company is a customer-driven company, and its manufacturing processes are driven by orders received. A necessity for this is agility, and agility needs extra margin in capacity. Also, especially the bigger customers are often willing to purchase large quantities of products, but want to be delivered in smaller batches. This puts extra strain on the production management in terms of optimizing capital tied to inventory and production batch sizes. The case company can produce over double the amount of products that it did on average in the time inspected, if necessary.

The excessive capacity should not be seen as a big problem, since it has a clear strategic purpose. Nevertheless, there are some points in the manufacturing process were savings or additional revenue could be achieved without compromising agility nor future growth aspirations.

The painting department's painting machine is a highly capable production machine, which according to this study operates on only quarter of its capacity supplied at the moment. While the activities in department needing human labor are run already at high capacity utilization, human labor resources supplied can be easily increased if necessary, especially when the human labor in total also operates under capacity. The labor force working at the production floor is highly skilled and versatile, and allocating human labor resources where they are needed the most is easy. This is an advantage that serves agility.

The painting machine could be used for providing sub-contracted services to increase capacity utilization and bring additional revenue to the company. The machine could handle various kinds of products needing painting, as long as they fit size and weight requirements.

Lumijärvi et al. (1995: 59) have stated that when the ABC model is focused on calculating the costs of products or product lines, the amount of cost drivers can be relatively small. When 80-90 percent of product costs are modeled accurately, one can consider the results to be reliable. This also keeps the model easily modifiable and expendable. Activities that accumulate 2-3 per cent of total costs can be merged into larger activities and achieve almost identical results. (Lumijärvi et al. 1995: 59.)

In this study, all activities measured were kept individually in the model even though a few of them didn't make up 3 per cent of the whole cost structure of the product line's activities. This was done to illustrate the difference that machine labor and human labor have. Activities that had the lowest absolute costs were the receiving process activities for each product line. These are small tasks usually performed while employees have time from more important tasks. Nevertheless according to the study, receiving all the raw material for all product lines account for a quarter of the practical working capacity of an employee for a year. This is an example of the kind of potentially interesting information a TDABC –system can provide; quantified data about every-day operations, which has likely not been analyzed before. Cost reduction could be achieved by synchronizing raw material arrivals for the same day, and thus cutting the time needed to checking every pallet separately. However, receiving activities comprise a very small part of total costs. A machine labor solution could make the process automated, but would require a lot of training for the suppliers, and the advance investments would be large.

Eliminating bottlenecks would streamline the production lines and shorten the throughput time, resulting in saved time and costs in production. Fortunately, the current bottlenecks are not in the most crucial activities that cause the most costs. For example, the blackening line can cause waiting because of its inefficient drying phase. Due to space limitations, expanding the drying line is unlikely. However, the drying process itself could be speeded by intensifying the ventilation and using warmer air flow. This is a development area which went under further investigation after discussions related to this study.

5.1. Batch size analysis

Since the case company's manufacturing processes and the supply chain as a whole operate from a mainly make-to-order basis, batch sizes are an important variable that affect costs, lead time and ultimately customer satisfaction. Signs of that lowering batch sizes could be beneficial to decrease lead times without increasing manufacturing costs significantly were found in the study.

Unfortunately comprehensive batch size analysis was problematic to conduct in this study. Theoretically it sounded as a rather simple analysis, but the issue was that all the measured activity times are subject to the batch sizes. Changing the batch size also affects the activity times. Nevertheless, a few what if -scenarios were iterated just to give an impression what speeding up the processes could do for costs in a theoretical framework.

After conducting a what if –analysis on the batch sizes of the products, it was revealed that for example in the drilling processes a 40% decrease in batch sizes accumulated only a 5 % increase in costs allocated for that department. This was mostly due to the increased number of setups needed, increasing the use of labor resources. This is noteworthy, and could be a potential target for additional research.

However, some processes on the manufacturing floor react to batch size decreasing much differently. When decreasing the sending size of products to half of what it was in the study, costs of the packing department increased by 64 per cent. Employees have to handle more picking tickets, delivery notes, trips to warehouses and discussions with delivery persons. This accumulates into more labor and more costs.

According to these hypothetical scenarios, lowering batch sizes in some activities could be beneficial to decrease lead times without increasing manufacturing costs significantly, especially if altering batch sizes do not affect activity times linearly. This also advocates on the behalf of continuous process and activity development, as well as lean practices. Continuous improvement cases should be encouraged and further researched. In fact, the case company is implementing new lean practices at the moment for their manufacturing operation, including waste reduction and a certified environment system.

6. DISCUSSION & CONCLUSIONS

In this chapter, the results of the study are discussed and analyzed. Also the successfulness of the study is assessed. The conclusions –subchapter concludes the study by presenting what was studied and how the most important results were achieved.

6.1. Discussion

This chapter assesses the validity and reliability of the study. It also concludes the study and argues its successfulness and the concepts of costing systems in general.

Piloting is a cost efficient and a motivational way to try out ABC. It provides experience and courage to implement a more holistic system in future development projects. It is also worthwhile noting that in a multi-product and service organization it is not always expedient to analyze all customers or products. (Lumijärvi et al 1995: 25-27.)

If an organization has only a few product lines which are produced in a similar way and volume, only a few cost drivers are needed as well. When product lines and activity chains become more complicated, more cost drivers are needed. This increases the cost of the costing system itself because the data needed to be processed increases. (Lumijärvi et al. 1995: 60.)

According to this study, decreasing cost drivers to a minimum can be as beneficial as Lumijärvi presents. The more cost drivers are involved in the process, the more variables are needed and problems start to occur from increased complexity, which in turn increases costs of the system. Also comparativeness becomes an issues itself. Nevertheless, easy comparability is a rare luxury in today's business operations, but should be pursued whenever possible. The use of only time drivers is worth considering to achieve cross-organizational comparability and effectiveness.

The case company has had to adjust to the reactive nature of their business, and are pursuing a more proactive touch to their daily operations. With the right prioritizing, declination in disorganized practices can be achieved. With the TDABC model, the case company was able

to identify activities which bind the most resources, and reach optimal efficiency by streamlining and prioritizing their activities better.

The processes and activities in this study were analyzed through time drivers. This contributed to the research project once their benefits were realized, because the case company's had previously tried to brainstorm feasible cost and resource drivers with little success. This decision to use only time drivers and TDABC really opened the research process from seemingly perpetual iteration to a streamlined process with a clear vision. Considering an implementer or consultant outside of the company needing a costing system could be an idea worth considering to provide a fresh and out-of-the-box insight to the difficult cost driver selection process, if the company does not want to use TDABC and its suggested time drivers.

It is notable that the case company has a significant number of automated activities that were relatively easy to estimate accurately because of the repetitive nature of the automated activities. Highly automated activities also makes finding cost savings more difficult, since the costs are very much linearly fixed to the utilization rate of the machines. From a purely manufacturing cost cutting point of view, according to this study the case company should pursue a higher utilization rate of the machines which equals more production and lower costs per product made. When assessing this conclusion one must remember that the production facilities of today are designed to withstand future growth targets. This shows as excessive capacity at the moment. Simply stating that growing production amounts to cut unit costs is beneficial is not a conclusion analyzed from all of angles of the business environment. The business environment is very competitive and production driven management could result in products made which have no market demand and massive inventory tying capital and inflicting capital costs.

Cost management is not an exact science which gives undisputable truths of world phenomena. It has various schools of thought, and no method can be deemed superior to another. Preferable cost management systems can be different in manufacturing industries versus service industries. For example in our case company, material and sub-contracting costs make up for the vast majority of overall costs. Considering this premise, it is no wonder that the case company has used standard costing practices to allocate costs to products. Material costs hardly change under activity performance. By using pilot projects companies can get valuable test information about different systems with relatively small investments.

According to this study, TDABC suits manufacturing processes reasonably well. However, an argument can be made against the additional value it provides in machine operated activities. Traditionally cost and capacity calculations for machines are made as calculating machine hour costs. This includes the costs that operating the machine include altogether divided by the running hours the machine does productive work. The TDABC model basically does the same thing, although usually utilizing a minute as the standard time unit instead of an hour. A lot of the potential added value provided by TDABC depends on how accurate the machine hour costs are in a case company. Also, machine cost hours only calculate the running cost of the machine, not taking into account the production activity times. Granted, activities are usually very simple to measure for machines, as the time for providing an output should be identical among same products, and thus easily implemented to machine hour model as well.

Some companies have specialized resources that require their own unit cost calculations, and do not fit well under cost center calculations. This is a double edged sword when considering what TDABC can provide in such a case. Done in the simplest way possible, TDABC would only have one capacity cost rate for a process. As it was in this study too, different resources contributing to a process with several activities rarely have very similar resource capacities or cost of capacity supplied. This either ends in over-simplifying the cost structure of the cost center, or complicating it by creating own capacity cost rates for all different resources. The latter was the case in this study. The information it provided was accurate which was important, but resulted in 29 different capacity cost rates, which is hardly ideal in terms of simplicity. Referring to chapter 2.11., ABC systems are a compromise between accuracy and simplicity.

A TDABC model provides much more value when it used for analyzing activities done by humans. Human labor performance is more prone for fluctuations in activity times, and the activities human labor usually performs are much more demanding in a myriad of ways: dexterity, prioritizing, social interaction and creativeness are just some of the features where human labor remains superior over machine labor, at least for the time being. The effect robotization will have on human labor and thus on human labor cost management is rather interesting; if robots perform the majority of activities, will there be a need for activity costing, since machine hour rates can provide all the information?

According to this study, TDABC has a lot of potential in revealing and analyzing the true costs in activities performed by humans. These activities are often overlooked in cost accounting, while machine costs are often well acknowledged. The activities performed by humans are harder to measure and quantify. This is where TDABC has a clear advantage over traditional ABC. Using only time drivers works well in human labor activities as it treats all activities the same way, making them comparable to each other. A traditional ABC systems mix various drivers, for example cost per order transaction and cost per kilometers traveled. These might cause confusion in comparison efforts. Also, a completion –based cost driver, such as cost per order transaction, does not capture the difference between transactions that take a long or a short time. Nonetheless, it is management's responsibility to understand what drivers to use and interpret for maximum applicability to decision making. Sometimes time drivers are not the superior option to measure costs of an activity.

Having said that, the accurate cost revelations of TDABC really only applies best for lower –level performing tasks, which are repetitive and have a clear start and an ending. These activities are easy to quantify, and the resources allocated and consumed are detectable and easier to calculate. The higher one goes in the organization levels, the more difficult it becomes to put an accurate price on a single activity, though there is no reason that one couldn't use activity based costing systems to calculate the cost of strategic research work, customer meetings or board meetings through time or other drivers, for instance. Even more, one can argue that cost monitoring of these activities is equally important than lower level activities which are completed thousands of times during a year, especially if the cost structure of a company is objectively top-heavy. This also shows an example of just practices through the company, though the costs information is probably not shared across an organization.

Nevertheless, activities performed higher in an organization have more far-reaching effects and consequences than lower level activities, which focus more on day-to-day performance. The real cost implications of decisions and actions in higher levels of an organization become realized in a longer time frame. Also high level management involves a lot of invisible work which is essential in good management. For example leadership, encouragement and relations work with interest groups are difficult to quantify and convert into numbers.

The human factor needs to be taken into consideration when converting things that humans do into numbers, especially when money and costs are involved. People tend to overestimate

their own performance and capabilities when asked. One does not want give a slacking impression of their own work, which could result in looking bad in the eyes of their superior. TDABC modeling tries to diminish this factor by using the practical resource capacity – concept and by timing the activities by hand as much as possible, instead of surveying.

The most important thing to remember when making conclusions about TDABC's results is that whether it is used for higher or lower levels of an organizations activities, corporate culture ultimately dictates what is done about the results, especially if the results have surprising findings in them. Ability to see the findings and the necessary corrective measures in the long term in all levels of an organization is paramount for future success.

In the end, the usefulness and applicability of any costing system stems from the needs of the organization. This has been pointed out in numerous studies as and this study validates this argument as well. It is difficult to make a generalization that what kind of costing is overall superior, or how a certain system works in a certain industry. In this case, we can conclude that a TDABC system works well in manufacturing processes, providing more value for decision making in human labor activity costing than machine labor activity costing.

Future model development could take place in the manufacturing processes, where it can be deployed to capture more complexity in the form of developing more sophisticated time equations. Another potential target could be expanding the system to cover another department or process in the case company. For instance order handling is a process where TDABC is could be tremendously informative and create value for process development.

6.2. Conclusions

This study was made as an assignment to an industrial company operating in the mining and construction business. The goal was to pilot activity based costing in the case company. After initial planning, the time -driven approach of activity based costing was chosen as the most suitable option for the case company. Manufacturing was chosen as the most suitable core process to pilot the costing method.

Three research questions guided the study process. The first question aimed to find an answer on how a company can pilot an activity based costing system without previous experience. The second question was about the potential information a costing system can provide to the case company. Lastly, the third question asked whether the costing model identifies cost reduction possibilities.

In the theory section of the study, different costing methods and cost management principles were presented and discussed. These include cost accounting, standard costing, cost management, strategic cost management, kaizen costing and different versions of activity based costing. The aim of the theory section was to lay ground on understanding the field of cost accounting and its key principles dictating much of the literature.

In the empirical section of the study, time -driven activity based costing was put into practice in the manufacturing process in the case company. Activities, capacity cost rates and manufacturing cost departments were identified by observation, key person interviews and studying case company processes. Cost data was gathered from the case company's balance sheets and previous standard costing data. Activity times were gathered by timing activities and process chains individually. In total, 55 activities, 29 capacity cost rates and 17 manufacturing cost departments were identified and analyzed according to the principles of time -driven activity based costing.

The costs of the activities were analyzed in a per produced unit basis as well as total costs per year of the activity. The analysis revealed some cost cutting targets, but mostly it revealed the excess capacity that the manufacturing processes have. This has a strategic reason: the case company is targeting aggressive growth and has invested significantly in sufficient capacity for the future and state-of-art production technology. It was suggested that the case company could sell some of the production capacity of certain manufacturing departments to third party companies, since some of the manufacturing phases are rather generic and could be applied to other purposes as well.

Decreasing cost drivers to a minimum could be beneficial to the case company, as the leading scholars in the field of study recommend. Decreasing cost drivers weakens the accuracy of the costing models, but this downside is compensated greatly with increased simplicity and lower costs of the system itself, as well as increasing comparability of cost departments. Since the biggest hindrance of implementing activity based costing systems is the perceived

complexity of maintaining it, simplicity might be the property that companies should be pursuing before accuracy.

The TDABC model was also able to identify activities which bind the most resources and improve the efficiency of these activities and reduce disorganized practices. What is more, the time-driven approach was found to be more suitable for the case company than traditional ABC, which saved a lot of time in the research project.

It could be argued that the TDABC model provided the most value when applied on activities performed by humans instead of machines. Human labor performance is more volatile, and standardized averages of activity times can only be achieved with timing of activity durations. When machines perform the same task thousands of times in the exact same way, humans can may perform their tasks in a fast or slow way, depending on a myriad of reasons. With the TDABC model, the case company was able to get new information about how long does certain activities take by humans on average, and apply the capacity cost rate to determine the cost of these activities.

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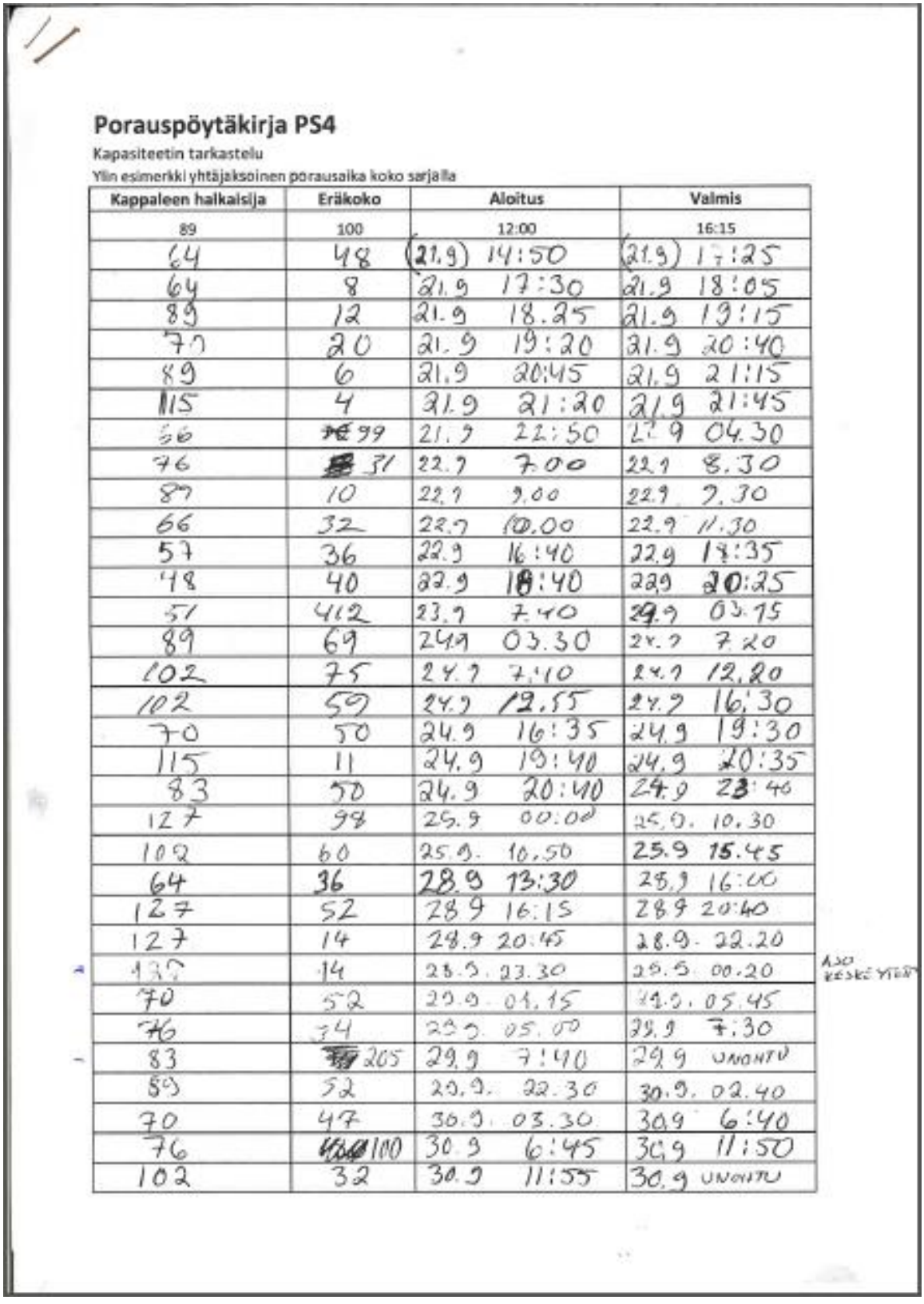
APPENDICES

APPENDIX 1. Drilling phase's time record.



Porauspöytäkirja PS4

Kapasiteetin tarkastelu

Ylin esimerkki yhtäjaksoinen porausaika koko sarjalla

Kappaleen halkaisija	Eräkoko	Aloitus	Valmis
89	100	12:00	16:15
64	48	(21.9) 14:50	(21.9) 17:25
64	8	21.9 17:30	21.9 18:05
89	12	21.9 18.25	21.9 19:15
77	20	21.9 19:20	21.9 20:40
89	6	21.9 20:45	21.9 21:15
115	4	21.9 21:20	21.9 21:45
56	99	21.9 22:50	22.9 04.30
76	31	22.9 7.00	22.9 8.30
89	10	22.9 9.00	22.9 9.30
66	32	22.9 10.00	22.9 11.30
57	36	22.9 16:40	22.9 18:35
48	40	22.9 18:40	22.9 20:25
57	412	23.9 7.40	24.9 03.15
89	69	24.9 03.30	24.9 7.20
102	75	24.9 7.10	24.9 12.20
102	59	24.9 12.55	24.9 16.30
70	50	24.9 16:35	24.9 19:30
115	11	24.9 19:40	24.9 20:35
83	50	24.9 20:40	24.9 23:40
127	98	25.9 00:00	25.9. 10.30
102	60	25.9. 10.50	25.9 15.45
64	36	28.9 13:30	28.9 16:00
127	52	28.9 16:15	28.9 20:40
127	14	28.9 20:45	28.9. 22.20
127	14	28.9. 23.30	29.9. 00.20
70	52	29.9. 01.15	29.9. 05.45
76	34	29.9. 05.50	29.9 7:30
83	205	29.9 7:40	29.9 UNOHTU
89	52	29.9. 22.30	30.9. 02.40
70	47	30.9. 03.30	30.9 6:40
76	100	30.9 6:45	30.9 11:50
102	32	30.9 11:55	30.9 UNOHTU

AJO KESKEYTYI

APPENDIX 2. Example of template of surveying manufacturing employees of activity times.

Valmistettavat tuote A: kuinka kauan kestää yksi toiminto keskimäärin?

Vastaanotto:	vastaanotto	tarkistus	kovuusmittaus	
Poraus:	Asetus	Pakan vaihto	Poraus	
Nastoitus:	Asetus	Laatoitus	Liimaus	Nastoitus
Mustaus	Asetus	Läpimeno	Siirto kuivaukseen	Kuivaus
Pakkaus:	Pakkaus	Siirto ERPiin	Hyllyttäminen	Lähetysrutiinit

APPENDIX 3. TDABC –model for product A, continued in appendix 4.

Process	Activity	Quantity	est. Unit time (min)	Total time (min)	Time capacity usage %	Cost driver rate	Cost per bit	Total assigned cost	capacity usage of costs %	Cost capacity rate used	Cost capacity rate	Cost driver
		x	x	x	x	x	x	x	x	x	x	
Receiving	Receivement	x	x	x	x	x	x	x	x	x	x	Cost of incoming batches checked
	Checking	x	x	x	x	x	x	x	x	x	x	Cost of incoming batches checked
	Hardness test	x	x	x	x	x	x	x	x	x	x	Cost of incoming batches checked
		x	x	x	x	x	x	x	x	x	x	
Drill cell 1		x	x	x	x	x	x	x	x	x	x	
	Setup	x	x	x	x	x	x	x	x	x	x	cost of setup made
	Executing the program	x	x	x	x	x	x	x	x	x	x	cost of drilling a batch of products
		x	x	x	x	x	x	x	x	x	x	
Drill cell 2		x	x	x	x	x	x	x	x	x	x	
	Setup	x	x	x	x	x	x	x	x	x	x	cost of setup made
	Executing the program	x	x	x	x	x	x	x	x	x	x	cost of drilling a batch of products
Drill cell BB 3		x	x	x	x	x	x	x	x	x	x	
	Setup	x	x	x	x	x	x	x	x	x	x	cost of setup made
	Executing the program	x	x	x	x	x	x	x	x	x	x	cost of drilling a batch of products
		x	x	x	x	x	x	x	x	x	x	
Buttoning cell 1	Setup	x	x	x	x	x	x	x	x	x	x	cost of setup made
	Changing pallets	x	x	x	x	x	x	x	x	x	x	
	Executing the program	x	x	x	x	x	x	x	x	x	x	cost of products buttoned

APPENDIX 4. Continued TDABC –model for product A.

Buttoning cell 2	Setup	x	x	x	x	x	x	x	x	x	x	cost of setup made
	Changing pallets	x	x	x	x	x	x	x	x	x	x	
	Executing the program	x	x	x	x	x	x	x	x	x	x	cost of products buttoned
		x	x	x	x	x	x	x	x	x	x	
		x	x	x	x	x	x	x	x	x	x	
Hand buttoning 1	Setup	x	x	x	x	x	x	x	x	x	x	cost of setup made
	Conducting buttoning	x	x	x	x	x	x	x	x	x	x	cost of products buttoned
		x	x	x	x	x	x	x	x	x	x	
Hand buttoning 2	Setup	x	x	x	x	x	x	x	x	x	x	cost of setup made
	Conducting buttoning	x	x	x	x	x	x	x	x	x	x	cost of products buttoned
		x	x	x	x	x	x	x	x	x	x	
Painting	Installing products to trays	x	x	x	x	x	x	x	x	x	x	cost of products installed in a tray
	Setup painting program	x	x	x	x	x	x	x	x	x	x	Cost of setup made
	Executing the painting program	x	x	x	x	x	x	x	x	x	x	Cost of executing tthe program
	Drying	x	x	x	x	x	x	x	x	x	x	
	Receiving products from painting and packing	x	x	x	x	x	x	x	x	x	x	cost of the receiving actions made
	Loading products to the ERP	x	x	x	x	x	x	x	x	x	x	cost of loading the products to the ERP
		x	x	x	x	x	x	x	x	x	x	
Packing	Storing products to warehouse	x	x	x	x	x	x	x	x	x	x	cost of a storage made
	Collecting products from warehouse	x	x	x	x	x	x	x	x	x	x	cost of collecting the products
	Sending routines	x	x	x	x	x	x	x	x	x	x	cost of one sending routine
	Sending routines if 2 pallets	x	x	x	x	x	x	x	x	x	x	cost of sending routines with a second pallet
							All costs for product A	x				