Aalto University
School of Economics

Designing Management Accounting System to Support Lean Management in Multiple Supply Chain Strategy - Case Vaisala Oyj

Logistics

Master's thesis

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Aalto-yliopiston kauppakorkeakoulu, Liiketoiminnan teknologian laitos

Johdon laskentajärjestelmän suunnitteleminen lean ympäristöön usean toimitusketjun strategian tukemiseksi - Tapaustutkimus Vaisala Oyj

TIIVISTELMÄ

Esitetty tutkimusongelma on kannattavuustiedon puuttuminen usean toimitusketjun strategian tukemiseksi case-yrityksessä Vaisala Oyj:ssä. Vaisala on havainto- ja mittauspalveluiden ja -tuotteiden valmistaja, jonka asiakaat toimivat meteorologian, sääkriittisten toimintojen, sekä teollisuuden aloilla. Toivasen (2010) tekemä tutkimus osoittaa, että Vaisalan valikoidut asiakasryhmät ja segmentit voidaan jakaa kolmeen erilaiseen asiakkaiden ostokäyttäytymisen perusteella muodostettuun toimitusketjuun.

Tutkimuksen päätavoite on suunnitella johdon laskentajärjestelmä case-yritykseen usean toimitusketjun strategien tukemiseksi. Tutkimus keskittyy yrityksen sisäisiin toimitusketjuihin, jotka ovat osa yrityksen usean toimitusketjun strategiaa. Toinen tavoite on suunnitellun laskentajärjestelmän käyttöönotto lean-toimitusketjussa, mikä sisältää suuren osan case-yrityksen tuotevalikoimasta. Kolmas tutkimustavoite on verrata laskentajärjestelmän tuloksia perinteiseen tuloslaskelmaan, jossa tavoitteena on auttaa päätöksentekijöitä ymmärtämään suurimmat erot näiden kahden kannattavuuslaskelman välillä.

Teoreettinen osuus koostuu johdon laskentatoimeen ja toimitusketjuihin liittyvästä tutkimuksesta ja kirjallisuudesta. Huomiota on annettu erityisesti teorioille, jotka liittyvät lean-toimitusketjuihin, arvoketjulaskentaan sekä epäsuorien kustannusten kohdistamiseen. Empiriaosuudessa käytetyt tietolähteet koostuvat tietojärjestelmien analyyseistä, epämuodollisista tapaamisista, sekä keskusteluista johtajien ja henkilökunnan kanssa. Tutkimus on toteutettu yhden yrityksen tapaustutkimuksena. Tutkimuksessa luotu viitekehys kuvaa johdon laskentajärjestelmää, jota voidaan käyttää kohdeyrityksen usean toimitusketjun strategian tukemiseksi. Viitekehystä käytetään laskentajärjestelmän suunnittelemiseksi case-yritykseen. Laskentajärjestelmä otetaan käyttöön case-yrityksen lean-toimitusketjussa hyödyntäen sovellettua kaksivaiheista kustannustenkohdistamismallia, sekä lean-toimitusketjun suorituksen mittaamiseen liittyvää mallia.

Case-tutkimuksen tulokset osoittavat, että viitekehystä on mahdollista käyttää toimitusketjun kustannusten ja kannattavuuden ymmärtämiseksi. Laskentajärjestelmän käyttöönotto auttoi määrittämään case-yrityksessä kriittiset toimitusketjun kannattavuuteen vaikuttavat tekijät. Tutkimus ehdottaa, että viitekehyksen käyttäminen laskentajärjestelmän suunnittelemiseksi auttaa yritystä paremmin ymmärtämään tuotantokyvykkyyden ja asiakasodotusten välisen yhteyden toimitusketjussa.

Avainsanat

Toimitusketjun johtaminen, Standardilaskenta, Täyskatelaskenta, Johdon laskentatoimi, Kustannuslaskenta, Toimitusketjun kustannuslaskenta, Lean johtaminen, Toimintolaskenta, Vaisala, Usean toimitusketjun strategia

Aalto University of Economics, Department of Business Technology

Designing Management Accounting System to Support Lean Management in Multiple Supply Chain Strategy - Case Vaisala Oyj

ABSTRACT

Research problem presented is the lack of profitability information to support multiple supply chain strategy in the case company Vaisala Oyj. Vaisala is a producer of observation and measurement services and products for customers in meteorology, weather critical operations and controlled environments. A study made by Toivanen (2010) suggests that selected customer groups and segments of the case company can be divided into three different supply chain channels based on customer buying behavior.

Main objective of the study is to design management accounting system for the case company to support multiple supply chain framework suggested by Toivanen (2010). Study focuses on internal value chains that are part of company's multiple supply chain strategy. The designed management accounting system is further implemented for lean supply chain channel, which includes a large share of case company's product offering. A further objective is to link management accounting system with income statement to help decision makers understand differences between the two different presentations of profitability and performance.

Theoretical part consists of management accounting and supply chain management related literature. Additional focus is given to the theories related to lean supply chains, value stream costing, and the assignment of overhead costs. Data sources used in the empirical part consist of data analyses of information systems, informal meetings, and discussions with the managers and personnel. Study is a field study, in which a case study method is applied. Framework is developed to be used for building a management accounting system that supports multiple supply chain strategy of a company. Framework is called Value Stream Cost Assignment Model, and it is used to design management accounting system for the case company. Management accounting system is further implemented for lean supply chain by using adapted two-stage cost assignment model and performance measurement model for lean supply chain.

Findings from the case show that the framework can be used to understand the supply chain related costs and profits better within the company. A practical implementation of the management accounting system helped to identify critical factors within the company that affect to the profitability of lean supply chain. Study suggests that using the framework to design management accounting system around supply chains enables company to better understand the linkage of operational activities and customer expectations within the company's supply chain.

Key Words

Supply Chain Management, Standard Costing, Full Costing, Absorption Costing, Management Accounting, Cost Management, Lean Accounting, Supply Chain Costing, Lean Management, Activity-based Costing, Vaisala, Multiple Supply Chain Strategy, Value Chain Costing

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1. Introduction

1.1. Background of the study

Idea for this study came while the author was working in the case company, Vaisala Oyj. Initially there was a need to understand costs and profitability of the assembly cells, to be able to justify investments in the right place. Case company was using a full absorption costing system to value inventories for financial accounting. The same absorption costing system was used by managers in operations, sales, marketing, and other functions for decision making. Current management accounting system did not provide enough relevant information for decision making.

Later on, objective of the study was reformulated so that in addition to providing cost information from assembly cells, the management accounting system should capture profitability of the whole supply chain in the company. Another study made by Toivanen (2010) suggests that Vaisala should organize its operations into three supply chain channels. Supply chain channels are determined based on the customer buying behavior. The supply chains are lean, agile, and continuous replenishment. (Toivanen 2010) To limit the scope of this study, it was decided that the management accounting system will be implemented only for one supply chain. Lean supply chain was selected, because it includes most of the manufacturing activities.

Supply chain perspective towards cost management revealed to be interesting, while supply chains link customer buying behavior with operational competencies, like supplier collaboration and know-how in assembly cells. Cost management in supply chains also revealed to be interesting topic for the study, because not much previous research had been committed despite the increasing interest among practitioners.

Main purpose of management accounting is to help organization reach its key strategic objectives. Broad definition of management accounting includes also non-financial performance measurements. Performance measurement has become easier as massive amounts of data are available from the ERP -systems. The challenge is to keep focus on the right information. It is important to understand which information is relevant for measuring performance, and supports the business. Challenge to find right information applies also for cost and profitability, company has to select how to use performance measurements to continuously improve results.

Strategy provides employees direction and objectives of the organization. Many strategies fulfill the value promise to their shareholders by focusing to selected customers. Transfer from shareholder value to customer value may help employees to focus on more concrete objectives. Organization consists of individuals, and it is important to make sure that everyone understands the goals of the organization in the same way.

As we realize that organizations are living systems that consist of independent individuals, we cannot expect everyone to act automatically together as a single unit. It is easier for individuals to understand smaller parts of the systems, and try to act to optimize them. It is important to understand that complex relationships do exist in organizations, and that only the final outcome is the true measure of the system performance. Organizations should be careful in having objectives that optimize only single parts of the system. (Saarinen & Hämäläinen 2004, 10) As Saarinen and Hämäläinen say it in their article about Systems Intelligence; "The whole is more important than parts". Management accounting system with performance measurement should answer to the challenge, and keep in mind the objectives of the whole organization.

Biggest reasons for a system to lead into poor results are related to people's personal objectives. People might not see themselves as contributing agents of living systems, but more as individual contributors that are limited by the environment and behavior of other people. It is hard for people to see their possibilities to change the system they act in. People do not realize the potential of encouraging individual growth, but instead they keep promoting the system that focuses on the individual level and contribution. (Saarinen & Hämäläinen 2004, 27) Performance measures may help in revealing the system paradoxes, but they do not help in changing people's perceptions about each other. Managers have an active role in building the mental environment and rewarding the behavior that enables whole system to develop through individual contribution.

Many business theories and practices assume that all parts of operations have independent contributions to overall financial performance, and by developing independent parts, the overall performance will increase. Financial performance of business operations is not a sum of the individual contributions of independent parts, but it is the sum of collective contribution of the living system. The improvement should be seen in terms of system relationships. Operations of a business should be viewed as part of natural living system. Scientists view human social systems, such as business organizations, as examples of self-organizing and self-identifying living systems. (Johnson 2007, 5)

It has been suggested that organizations measure financial performance without understanding the causal factors that lead to the desired results. The criticism started already at mid-1980s, while it was claimed that management accounting information was distorted, aggregated, and too late to be relevant for managerial decision making and planning (Johnson & Kaplan 1987, 1). Much of the critique was directed towards the use of financial reporting based inventory valuation principles in management accounting (Johnson & Kaplan 1987, 13).

Absorption costing information is used commonly for management decisions. However, absorption costing should be used only for inventory valuation calculations, while it provides distorted and aggregated information for decision making. Activity-based costing has been suggested as one of the answers to improve cost tracking accuracy of overhead costs. Role of activity-based costing has remained as supporter of absorption costing. Activity-based costing has provided new methods, but fundamental ideas behind the management accounting system design have not changed. Not much has changed in the organizations' management accounting practices during the last few decades (Maskell & Katko 2007, 155-156).

Traditionally management accounting systems have been built under the assumption that there is single strategy that the company is aiming at. What if the company has customer requirements that need multiple supply chains to be fulfilled? Concept of supply chain has developed rapidly during the recent years, and is used to connect customer and suppliers with the company in a most valuable and profitable way.

Case company Vaisala Oyj is a global producer of observation and measurement services and products for meteorology, weather critical operations and controlled environments. The case company offered a perfect environment for designing management accounting system to support multiple supply chain channels. Management accounting system is designed based on literature survey from the fields of supply chain management and cost management. This paper presents a report of the case study in which management accounting system is designed to support multiple supply chain environments, and in which management accounting system is further implemented to support financial performance measurement of a lean supply chain.

1.2. Research problem and objectives

Research problem is the lack of profitability information to support business decision making in the case company's multiple supply chain environment. Business complexity emerges from the wide range of customer expectations in Vaisala. Challenges concerning business complexity and

different customer expectations are solved by dividing Vaisala's business into a three supply chain channels. The division of supply chain channels is based on a study performed at Vaisala about supply chain alignment to customer buying behavior (Toivanen 2010).

The first objective of the study is to design management accounting system to support multiple supply chain strategy in Vaisala. A framework is developed based on supply chain management and cost management literature. Another objective of the study is to test the framework by implementing it in more detail for lean supply chain. Third objective of the study is to allow comparison of management accounting system results with the income statement. Management accounting system should show how distorted the cost information presented in income statement actually is. Management accounting system design is tested by implementing framework into Vaisala's lean supply chain in chapter 5.5.

Case company produces mass-customized products on a job-basis, and the aspects of cost management in continuous flow production are not covered. Cost management literature includes wide variety of research about product costing, but because the perspective of the study is on supply chains, product costing is not the primary source of literature.

Research concerning supply chains has spread rapidly. The definition of supply chain management is generally accepted and agreed by most of the academics. Definition of supply chain is wide, and supply chains can be categorized into four groups based on supply chain scale. Analysis of supply chain related research has revealed that about 38% of the research is being made from internal supply chains. Also the research over dyadic or linear supply chains is about 40%. Research over supply chain networks is about 22%. (Hines et al 2002, 54) Simple internal supply chain scale is also chosen as an approach for this study.

Theoretical objective of the study is to introduce a framework of a management accounting system that may be used to support multiple supply chain strategy of a company. Theoretical framework is tested through a field study in Vaisala. Another theoretical objective is to investigate how financial performance of a lean supply chain can be measured with a management accounting system that is designed based on value stream costing and activity-based costing principles. Research objectives of the study in order of importance are:

1. *Supporting multiple supply chain strategy with a management accounting system*
2. *Financial performance measurement of lean supply chain with management accounting information*

3. *Comparison of management accounting results with the income statement information*

Study answers research objectives by presenting a framework of a management accounting system. First and third research questions are based on the supply chain and cost management related literature. The second research question is answered by building a more detailed cost assignment model based on lean and cost management related literature. Framework is implemented to the case company in empirical part of the study. See chapters that provide answers to the research objectives and present contribution of the study:

1. *Framework for designing management accounting system into a multiple supply chain environment is presented in chapter 4.2, and implemented to the case company in chapter 5.4.*
2. *Cost assignment and performance measurement model for lean supply chain is presented in chapter 4.3, and implemented to the case company in chapter 5.5.*
3. *Framework presented in chapter 4.2 considers the relationship between management accounting system and the income statement, and is tested with the case company in chapter 5.4.*

1.3. Approach and structure of the study

Study is performed as a field study in which case study method is applied. Data sources used in empirical part consist of data analyses of information systems, informal meetings, and discussions with the managers and personnel. These are further supported with personal observations, and case company's internal written material. Author worked at the case company on a full-time basis during the research period.

Objective of the study is focused on solving the specific challenge of the case company, but results may also be used for similar cases. The research question is answered in form of a case study, but more research has to be conducted in order to make general conclusions about the results. Study is divided into two main parts. Chapters two, three and four include the theoretical part, and chapter five forms the empirical part of the case study. Conclusion and propositions of the study are presented in chapter six. See figure 1-1 for illustrated structure of the study, and relationships between the chapters.

Literature survey is divided into chapters two, three, and four. Chapter two gives reader a basic understanding of supply chain management by presenting research related to multiple supply

chain strategy and performance measurement in lean supply chains. Chapter three introduces reader with the fundamentals of cost management, and reviews research related to both financial and managerial reporting from the point of cost management. Special topics are introduced, like standard costing, activity-based costing, and assignment of indirect and overhead costs. One of the most critical challenges discussed is the use of standard costing information as the basis for managerial decision making. See figure 1-2 for a categorized presentation of the literature survey made in the study.

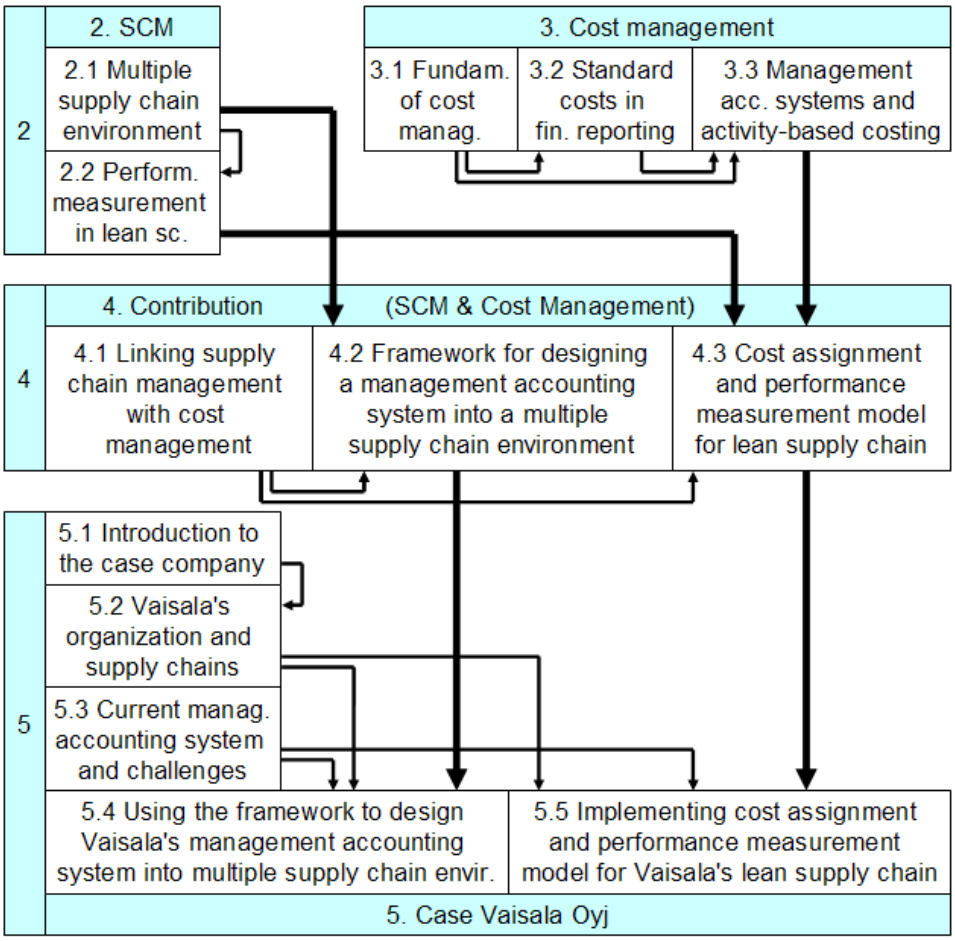


Figure 1-1 Structure of the Study and main relationships between chapters

Chapter four presents the theoretical contribution of the study. Chapter begins with a theoretical survey by reviewing previous research about cost management in supply chains in chapter 4.1. Contribution is presented in chapters 4.2 and 4.3 by building on top of the literature reviewed in chapters 2, 3, and 4.1. Chapter 4.2 answers to the first research objective by presenting a framework which can be used to design management accounting system into multiple supply chain environment. Chapter 4.3 answers to the second research objective by presenting a cost assignment and performance measurement model for lean supply chain. Chapter four also

includes a part that focuses on cost management in lean supply chain, a theoretical contribution that is called by the name lean accounting. Research about lean accounting is focused on finding ways to perform management accounting in lean environment.

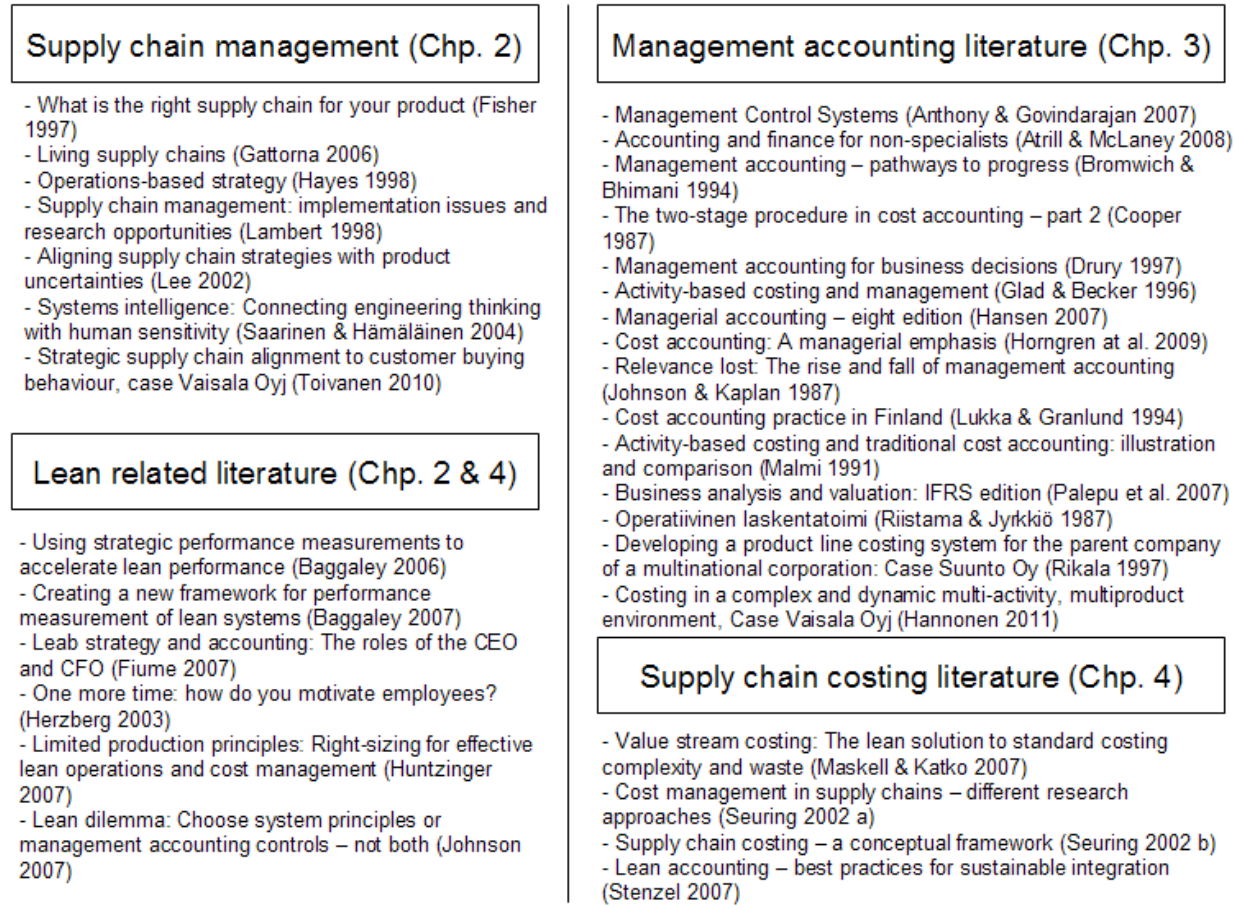


Figure 1-2 Categorization of literature survey into four main subject areas

Chapter five includes empirical part of the study, and introduces case company Vaisala Oyj. Organization structure and supply chains of the case company are introduced in chapter 5.2. Case company's supply chains are based on the proposal from the study of Toivanen (2010). Chapter 5.3 introduces case company's current management accounting system and its challenges. Most challenges are related to the distorted cost management information that is unusable for managerial decision making.

Chapter 5.4 develops a suggestion for Vaisala's management accounting system design that supports multiple supply chain strategy. Framework is tested by implementing it for the case company's supply chain environment. Management accounting system is built for lean supply chain to further test the framework. Other Vaisala supply chains, agile and continuous

replenishment are taken into consideration in implementing the framework. Implementation of the management accounting system with detailed cost model is done only for the lean supply chain. Purpose of the implementation is to test suitability of the designed framework, while analysis of profitability results is not in scope of the study.

Summary and conclusions of the study are presented in chapter six. Taking the study together, last chapter describes challenges faced and benefits achieved during the framework implementation. Chapter also presents managerial suggestions for next steps in implementing the management accounting system. Also the results of lean supply chain implementation are discussed. Theoretical propositions are given about how companies may design management accounting system into multiple supply chain environments. Also further research topics are introduced.

2. Supply chain management

2.1. Multiple supply chain environment

Supply chains are the core of business. Gattorna (2006, 2) defines supply chain as any combination of processes, functions, activities, relationships and pathways along which products, services, information, and financial transactions move in and between enterprises. Other definitions of supply chain are close to Gattorna's definition, and include at least the flows of material and information (Seuring 2002 b, 17). Kajüter (2002, 36) represents that supply chain management emerged as a research field in the 1990's and connected developments in logistics, procurement, marketing, and information technology.

Every company has at least one supply chain. It is crucial for a company to understand its supply chains, and use them to link suppliers and customers in a most profitable manner. Gattorna (2006, 5) argues that supply chains might seem uncontrollable, but are actually living systems driven by human behavior. Supply chain should not be seen only as a mix of infrastructure and information systems technology, but also as a mix of human behavior.

One of the most well known frameworks of supply chain processes is by Lambert, Cooper and Pagh (1998, 2). Lambert et al. (1998, 1) suggest that individual businesses no longer compete as solely autonomous entities, but as connected supply chains. This means that the key challenge single entities face is to select correct partners to their network, and link those partners, customers and suppliers, in a best possible way. Supply chains should be responsive towards customer demand, so customer is the perfect starting point for supply chain design (Gattorna 2006, 28). Gattorna (2006, 28-29) uses the term dynamic alignment of supply chains as the optimal situation of fulfilling customer demand with correct energy and opportunities.

Idea of having multiple supply chains in a single company was introduced by Fisher (1997, 109, and Gattorna 2006, 33). The concept multiple supply chain strategy can be used to describe managing several supply chains at the same time (Toivanen 2010, 8). According to Fisher (1997, 109) functional products should be matched with efficient supply chains and innovative products should be matched with market responsive supply chains, see figure 2-1. Gattorna (2006, 33-35) criticizes Fisher's model by arguing that a single product may belong to several supply chains, because market conditions might change and affect the demand patterns of the product. Lee

(2002, 105-119) presents a model of four supply chain strategies based on Fisher's distinction of functional and innovative products. Lee's framework of four supply chains matches supply uncertainty with demand uncertainty (Gattorna 2006, 34). Fisher and Lee present that supply chain alignment should be made against products, but Gattorna argues that instead of products, customers are the cornerstone on which supply chain strategy should be formed (Toivanen 2010, 8, and Gattorna 2006, 33).

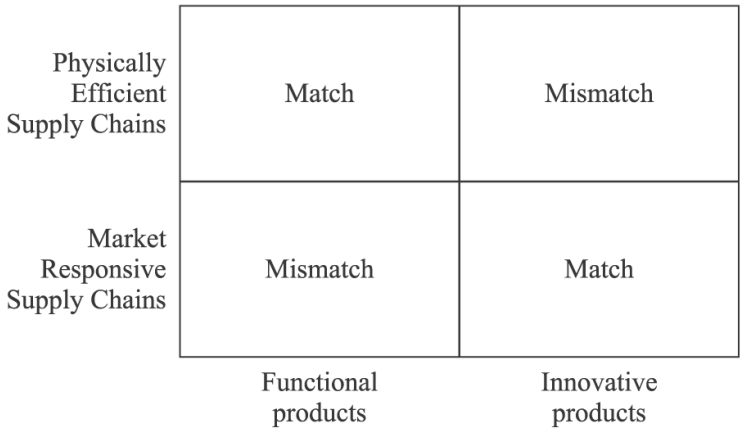


Figure 2-1 Matching supply chains with products (Fisher 1997)

Gattorna (2006, 42-44) introduces framework of four supply chains, see figure 2-2. The framework categorizes supply chains according to the predictability of demand and relationship with the customer:

1) Continuous replenishment supply chain includes high predictability of demand and tight relationship with the customer. Focus is on customer relationship.
2) Lean supply chain includes high predictability of demand and loose relationship with the customer. However, it does not mean poor service levels, but focus is on efficiency. Lean supply chain is presented in more detail in the next chapter 2.2.
3) Agile supply chain includes low predictability of demand, and tight relationship with the customer. Focus is on speed and capacity.
4) Fully flexible supply chain includes low predictability of demand and loose relationship with the customer. Focuses on providing creative solutions with premium price.

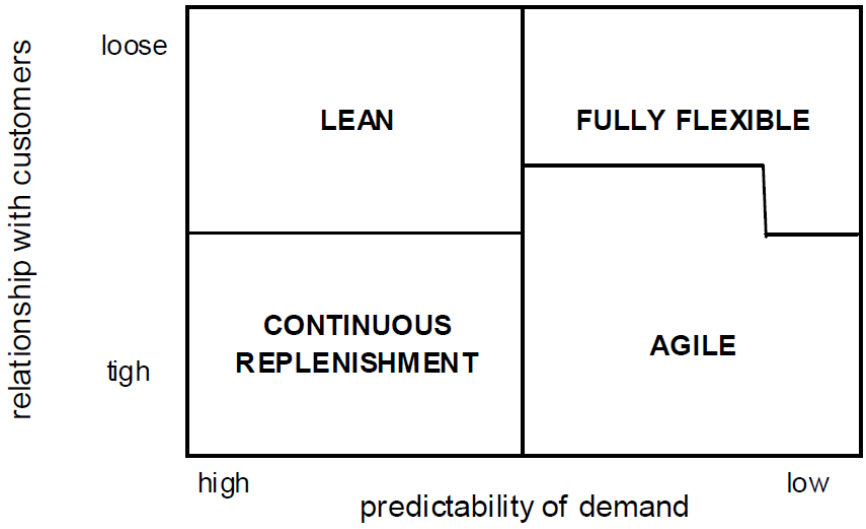


Figure 2-2 Four generic supply chain types (Gattorna 2006, 42-44, and Toivanen 2010, 33)

Gattorna (2006, 44) suggests that companies should recognize their customer demands through these four supply chains, and select the ones that suite them best. Aligning supply chains according to true customer needs and expectations improves operating and financial performance for several reasons. It is easier to focus on fulfilling customer requirements, and to charge value added based on the supply chain services offered for the customer. (Gattorna 2006, 47) Unlike some other authors (e. g. Fisher 1997, Lee 2002), Gattorna (2006, 47) suggests that products and services might belong to several supply chains as demand pattern changes. An interesting question is whether one product can belong to several supply chains at the same time. For simplicity it is assumed in this study that single product has a primary supply chain to which it belongs at a given time. Primary supply chain is selected mainly based on primary customers' buying behaviour instead of total demand faced by the product.

In multiple supply chain thinking, customer demand is the key driver for the supply chain instead of direct product demand. This means that products might require different supply chains depending on the phase of their life-cycle and demand behavior (Toivanen 2010, 8). Gattorna's model of four supply chains is used as a basic theory in this study for designing the management accounting system. Gattorna's model assumes that company may have multiple supply chains at the same time, and products and services are categorized into these supply chains mainly based on the customer buying behavior.

Supply chain design should start from the customer instead of operations (Gattorna 2006, 44, and Toivanen 2010, 11). Customers should be grouped based on their buying behavior instead of segmenting products (Toivanen 2010, 20, 26, and 54). Customer centric supply chain design

links customer segments to the supply chains (Toivanen 2010, 24). Porter's concept of value chain suggests that company's internal value chain interacts with the value chains of other actors in the supply chain (Kajüter 2002, 33). See figure 2-3 for industry value chain. As the terminology is used interchangeably, value chain may also be called supply chain (Seuring 2002 b, 17).

Figure 2-3 Industry value chain (Kajüter 2002, 33)

As mentioned in introduction, this study focuses on internal value chains that are part of wider supply chain networks. Reason for concentrating on internal supply chains is that before cooperating between supply chain partners, it is more important to understand cost structure of company's internal operations. Before trying to build common management accounting systems between supply chain partners, the company has to have management accounting system in place to understand profitability of its internal operations. Another reason for concentrating on internal supply chain is to limit the scope of the study. Building a model between supply chain partners would expand the study too much, while there is rarely integration between supply chain partners' management accounting systems (Kajüter 2002, 34).

Value stream is defined as collection of all activities that are required to create value for the end user or the customer (Gordon 2010, 12, and Huntzinger 2007, 24). According to Gordon (2010, 12) organization may have several value chains representing groups of products that have similar characteristics in their design and production. As mentioned earlier, the terms supply chain, value chain, and value stream are sometimes used interchangeably while referring to the same concept (Seuring 2002 b, 17). The concept value stream is used especially by lean management.

Value chain is defined in this study as a general concept that can be used to represent the concepts of value stream and supply chain. Figure 2-4 illustrates the use of definitions in this study. Product is the smallest unit for which activities or costs can be assigned. Value stream refers to a group of products that have common characteristics in their design and production. Value stream may represent product family, product line, assembly cell, manufacturing team, or manufacturing department. Suitable value stream is selected depending on how work is organized within the company. Internal supply chain includes multiple value streams, and is

designed based on customer buying behaviors. Supply chain gathers the customer segments whose buying behaviour is similar. According to Gattorna's framework, company might include four different supply chains. Figure 2-4 represents organization as the largest unit that includes all supply chains, and all the support activities and costs that do not belong to any specific supply chain.

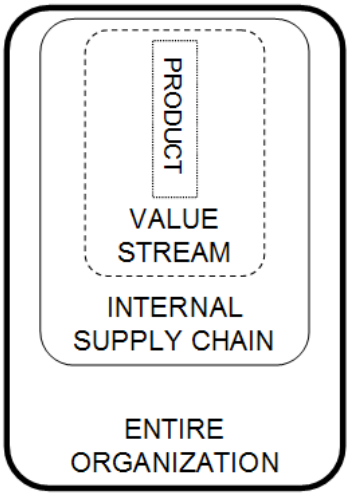


Figure 2-4 Value chains within a company

Concept of supply chain and multiple supply chain strategy has been introduces in this chapter. Next chapter 2.2 concentrates on ways to measure performance in lean supply chain. Emphasis is first on the non-financial performance measurement, and chapter 4.3 widens the perspective to the financial performance measurements.

2.2. Performance measurement in lean supply chain

Lean supply chain has high predictability of demand, and loose relationship with the customer. Loose relationship does not mean poor performance, but lean focuses on efficiency. (Gattorna 2006, 42-44) Basic idea of lean is that the organization exists for its customers, and fulfills customer demand with least amount of costs and resources. Lean targets to eliminate all waste, and focuses on value-adding activities of the organization. (Hansen 2007, 724) Many authors argue that lean requires the use of non-financial performance measurements instead of financial. One of the reasons is that traditional management accounting systems support mass production methods, and may disturb lean management. Johnson (2007, 12) argues that managers cannot manage business primarily by looking at financial information, but that managers need non-

financial performance measurements for decision making. The problem of financial quantities is that they cannot reveal whether improvement occurs or not (Johnson 2007, 12).

James Womack and Daniel Jones present five lean principles in their book Lean Thinking. The principles are illustrated in figure 2-5. Value to customers refers to the primary purpose of lean enterprise, and it differs from the concept of shareholder value. Difference is that even though both aim at same final goal, they communicate objective differently to the employees and other stakeholders. Value stream refers to process oriented view instead of traditional department oriented view. (Baggaley 2006, 37-38) Concept of supply chain management is often used interchangeably with terms value stream and value chain (Seuring 2002 b, 17). Third principle flow and pull aim at moving materials at constant rate without stopping. Rate of flow is determined by the rate at which customers demand or pull products (Baggaley 2006, 37-38).

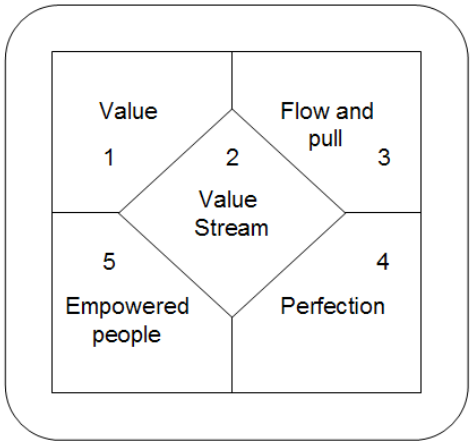


Figure 2-5 Principles of lean thinking (Baggaley 2006, 38)

Fourth principle, perfection means that performance measurements should capture the instances of non-value, non-flow, and non-pull, so that the causes can be removed rapidly. The purpose is to distinguish performance measurement from the use of budgets and standards which do not provide signals for exceptions. Lean performance requires empowered people to correct problems faced in daily work. Fifth principle, empowered people are required to support the continuous running of operations in situations where there is no time to wait for management permission to fix problems. (Baggaley 2006, 38) Hansen and Mouritsen (2007, 8) criticize that proponents of lean will only see positive sides of the concept, and that if lean does not work, it is too often seen as mistaken implementation. Correct performance measures should be selected to support strategy. Baggaley (2006, 37) presents four principles of effective lean performance measurement:

1. Reflect the principles of lean thinking
2. Drive improvement of value stream results
3. Control adherence to standards in the lean cells
4. Link cell and value stream to corporate strategies and goals

The first requirement is that lean principles should be reflected to the performance measurements. The second principle of effective lean performance measurement is the requirement to drive improvement of value stream results. The challenge with financial measures is that they are derived from operations data, and are difficult to interpret. Financial measures do not emphasize the reasons why problems occur, and what needs to be done to fix problems. Financial measures come too late, even it is critical to spot the problems soon to be able to fix them. (Baggaley 2006, 38) In order to achieve value stream performance goals like lead time and productivity improvements, company has to measure causal factors that affect to the goals instead of measuring goals themselves. Performance has to be measured with causal factors at the cell level in real time, hourly or daily, to make sure that the desired levels of value stream results are achieved.

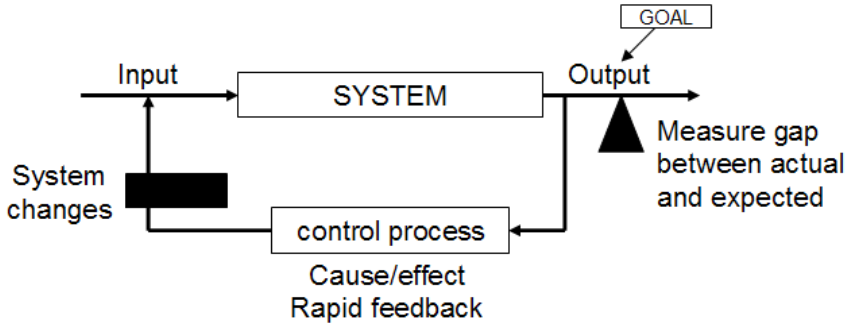


Figure 2-6 Performance measures achieving effective control in system (Baggaley 2006, 39)

Third principle of effective lean performance measurements suggests that measurements should trigger when performance differs from the standards, and set assembly cell back to control. Figure 2-6 presents a system in which continuous improvement of critical causal factors is monitored in real-time, in order to establish a system of effective control. Lean cell has to have performance measures in place that alert cell team about the problem. (Baggaley 2006, 38-39)

According to Baggaley's (2006, 37) fourth principle, performance measurements should link cell and value stream with the corporate strategies and goals. When company has multiple supply

chains, each supply chain has its own strategic objectives. Framework of supply chain performance measurement is presented in figure 2-7. Strategic objectives of the supply chain are turned down into measures that help in achieving the objectives. Next step is to define critical success factors for the cell by considering what has to be done at cell level in order to achieve supply chain objectives. After understanding the cell critical success factors, they need to be transferred into the cell objectives. Finally cell measures can be developed that guide daily operation of the assembly cell.

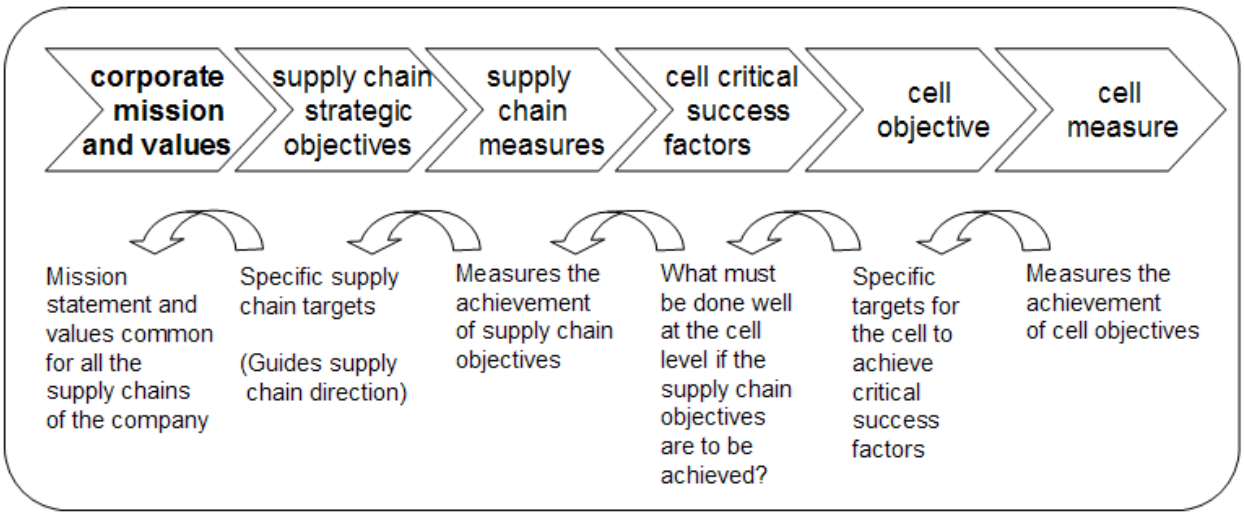


Figure 2-7 Supply chain performance measurement framework (Adapted from Baggaley 2006, 40)

Baggaley (2007, 72) argues that performance should be measured against improvement, not against results. Traditional way of measuring financial and operative performance is usually against results, where current period's results are compared to budgeted goals. Purpose is to try to understand why results achieved are better or worse than budgeted. Measuring against results brings us with two problems. Result measures are historical, measure indicates results achieved in the past. Most of the time result measures are only aggregations of operations data, while aggregated or averaged data hides the decision making information. (Baggaley 2007, 72)

Measuring improvement works better than measuring of results when something needs to be changed. The two most used ways to measure improvement are the concepts of efficiency and productivity. Efficiency is the relationship between two inputs, usually standard and actual. For example labor efficiency is the relationship between standard hours to produce something and the hours actually used to produce. Problem with the standard is that we have no way to make sure that they are correct (Fiume 2007, 59). To ensure continuous improvement, efficiency should not be used while it is based on standards.

Another way to measure improvement is to use productivity. Productivity is the relationship between quantities of output versus the quantity of resources consumed in creating that output. It is common to confuse productivity with dollars, but productivity is measured only against quantity. Productivity measures must focus on quantities being consumed versus the output being achieved. To ensure continuous improvement, relevant measurements should be based on productivity, not on efficiency. (Fiume 2007, 58-59) Table 2-1 represents different ways of measuring performance in a summary.

Table 2-1 Different ways of measuring performance (Adapted from Fiume 2007, 58-59)

1. Measuring performance against results	Results are measured against historical data, and are aggregations of operations data	
2. Measuring performance against improvement	2a. Efficiency	There is no way to make sure that standards used for efficiency are correct
	2b. Productivity	Productivity is best way to measure improvement and performance!

According to Huntzinger (2007, 17) companies practicing lean in their production design will more likely engage in true cost management instead of basic cost accounting. Important, but underestimated part of true cost management is the non-financial performance measurement. Non-financial measures are first indicator of changes in profitability, while weeks or months later the same changes can be seen through financial metrics. Despite the importance of non-financial measures, this study focuses more on financial measures. Focus is on financial measures while it is important to establish an overview of profiability to undestand which parts of the business need most emphasis. Also the importance of financial information at the shop floor has been emphasized by some authors in creating a stimulus for learning and improvement (Hansen & Mouritsen 2007, 14).

When organization wishes to use measures that are useful in guiding change, it should first understand factors lead to the results, causal and predictive factors. Only by measuring predictive factors, it is possible to obtain desired results. Also lean change programs should measure predictive factors, not just results. Lean relies on people leading the change to create

hypotheses about which predictive factors help to achieve desired results. Predictive factors provide concrete evidence for people participating to the change, not just results that should be achieved. (Baggaley 2007, 73)

Current business environments function by top-down authority, which means that objectives are set once a year in form of budgets and resources. Baggaley (2007, 75) argues that top management makes decisions too slowly compared to changes in the environment. Role of management is the creation of management systems, and performance measures that enable adaptive culture and continuous dialogue with environment. Management system should encourage organization towards changing itself in order to respond to changes in the environment. When organization can take advantage of the living system it is, it can better respond to changes. Top-down approach lacks continuous feedback loop and adaptation that are required in periods of rapid change. (Baggaley 2007, 75)

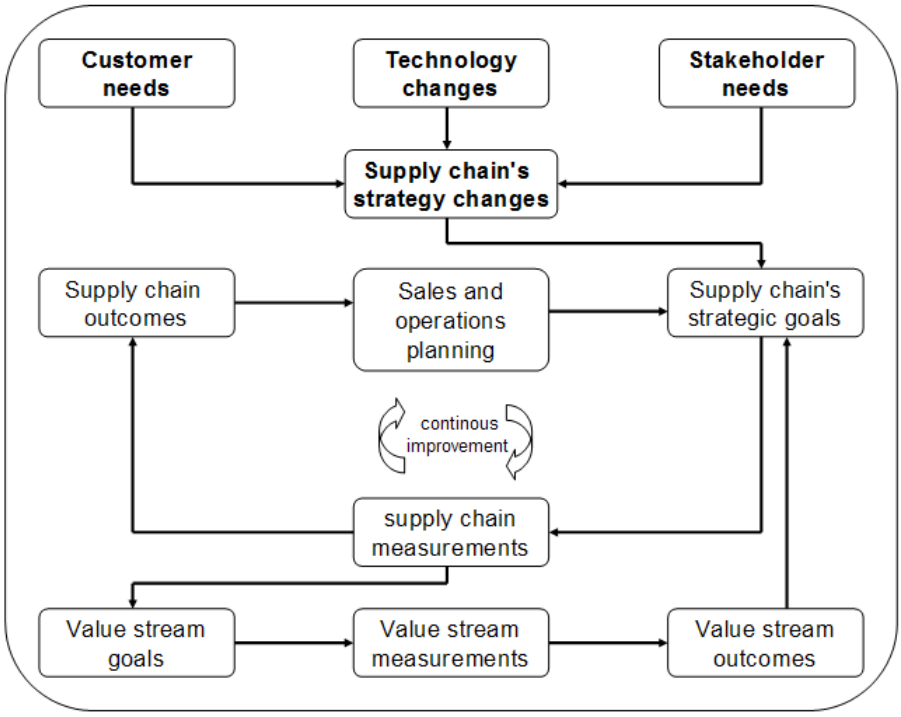


Figure 2-8 Performance measurement process for lean (Adapted from Baggaley 2007, 76)

Supply chain performance measurement framework described earlier in figure 2-7 presented that cell metrics should have causal linkage to the supply chain objectives. When environment is added to the framework, a feedback loop has to be included to keep up with the changes. Figure 2-8 presents a performance measurement process that is linked with environment. Development of strategy is fed by weekly operational value stream results, progress toward continuous

improvement goals, and projections of capacity expected to be freed up by lean. Supply chain strategy is developed in monthly sales and operations planning process. The 12-month rolling forecasts of sales, new product development and capacity plans are continuously updated and related to known opportunities to improve customer value and address the challenges in the business environment. (Baggaley 2007, 76)

Supply chain strategy is continuously affected both by conditions at the cell that limit or reinforce its achievement and by conditions of the environment, which shape the direction in which value stream must change. These forces change the cell conditions that reinforce or limit achievement of value stream goals. Thus, strategy development is done in the continuous learning and change processes built into the lean management system itself. (Baggaley 2007, 76) Whether strategy is coordinated through strategic business units or supply chains, it should be built on the operative capabilities. Operations of the company have a broader role than just implementer of strategy, while operations of the company are foundation for successful strategic attacks and defences (Hayes & Upton 1998, 8).

Employees should have possibility to use their creativeness and problem solving skills in their work instead of concentrating to control their work. Instead of pushing employees to reach some specific planned targets, employees should be encouraged to be creative and see their work as interesting. (Herzberg 2003, 87) Traditional performance measurements try to encourage employees to better results by offering them bonuses, but some argue that it is more motivating for an employee to have a job that she or he thinks is interesting and offers challenges. Employee satisfaction is reached with achievement, recognition, work itself, responsibility and growth. Dissatisfaction is avoided by emphasizing more on company policy and administration, supervision, relationship with the supervisor, and work conditions. (Herzberg 2003, 90) Challenge of lean implementation is to design measurement and management processes that channel creative energies of all employees and managers into solving problems that come up on daily basis. (Baggaley 2007, 77)

3. Cost management for financial accounting and management accounting

3.1. Fundamentals of cost management

Costs are in core of this study, so the concept of cost is introduced in this chapter from different perspectives. Financial accounting and standard costing are discussed more deeply in chapter 3.2. The two topics are discussed together because the main purpose of standard costing has traditionally been inventory valuation for financial accounting purposes. Problems of using standard costing methods in management accounting are also discussed. Chapter 3.3 concentrates on management accounting systems, and especially on both activity-based costing that can been seen as a method to calculate costs more accurately, and value stream costing that is used for cash-flow type costing.

Accounting can be divided into two main parts, financial accounting and management accounting. Table 3-1 describes some of the differences between financial accounting and management accounting. Financial accounting is based on rules and standards that are necessary to keep harmonization in preparation of financial statements. Basic rule of financial accounting is that costs have to be matched with revenues to calculate profit. This rule has a natural consequence that work in progress and unsold stocks of finished goods are not included in the cost of goods sold (Drury 1997, 17).

Table 3-1 Comparison of financial accounting and management accounting (Horngren et al., 2009, 31)

	Financial Accounting	Management Accounting
Purpose of information	Communicate organization's financial position to the external stakeholders	Help managers make decisions to fulfill an organizations's goals
Primary Users	External stakeholders	Managers of the organization
Focus and emphasis	Past-oriented	Future-oriented
Rules	Accounting standards (IFRS, IAS, GAAP)	No limitations
Time span	Annual and quarterly reports	From hourly information to 20 years
Type of reports	Company as a whole	Financial and non-financial reports on products, departments, processes

Cost management calculates cost of product or service, while the results can be used for inventory valuation in financial accounting, or for decision making purpose in management accounting. Cost management is seen as a method that supports both management accounting and financial accounting, but the terms cost management and management accounting are

sometimes used interchangeably. (Horngren et al., 2009, 25-26) In this study cost management is defined to describe a method to calculate costs for both financial accounting and management accounting. Management accounting normally deals with issues like setting budgets, analyzing cost centers, and enabling cost control in the company. Cost can be defined as a resource sacrificed or forgone to achieve a specific objective (Horngren et al 1994, 26).

There are different ways to classify costs, and this chapter presents the few most used categorizations. Cost can be classified for example based on costs variability, or based on nature of the cost. Nature of the cost is either direct or indirect based on causality of the cost and cost object. Variable costs are defined as costs that change in proportion to changes in volume of production or sales, while fixed costs represent all other costs (Riistama & Jyrkkiö 1987, 54-59). Total sum of variable costs depends on the operation ratio and total sum of fixed costs depends on size of capacity. (Riistama & Jyrkkiö 1987, 54-59, and Rikala 1997, 9) On longer-term, over several years, all costs are argued to be variable, and vice versa shorter the time period, greater the probability of costs being fixed (Drury 1997, 25).

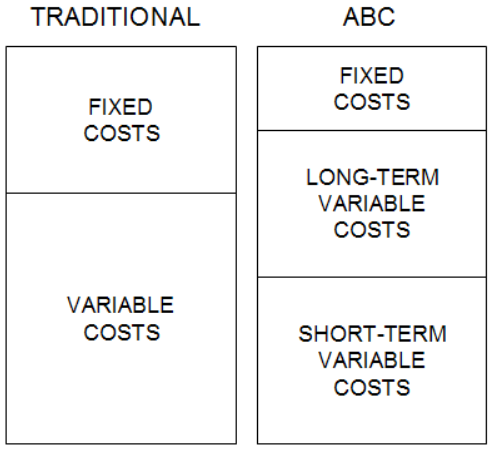


Figure 3-1 Traditional versus activity-based costing driven definition of cost variability (Malmi 1991, 7)

Definition of variable costs has changed after the emerging of activity-based costing (ABC) in the 1980's. According to the new definition, variable cost is a cost that changes in total in proportion to changes in a cost driver instead of volume of production (Horngren et al 1994, 29, and Rikala 1997, 9). See figure 3-1 for how the share of variable costs has increased due to the use of cost drivers. In ABC literature short-term variable cost is referred to the traditional definition of variable costs. Long-term variable costs are used with costs that have been traditionally defined as fixed costs, but which vary in relation to some non-volume related cost driver. (Malmi 1991, 7-8, and Rikala 1997, 9)

Cost driver is any factor that affects costs, and is used to classify costs between variable and fixed. Fixed costs do not change even if the cost driver would change. (Horngren et al 1994, 29, and Rikala 1997, 9) Cost driver has exactly the same meaning than allocation base, but term cost driver is used especially in activity-based costing to point that assignment of costs is done based on causal driver instead of general estimation (Malmi 1991, 11, and Hannonen 2011). Overhead rate is used to assign overhead costs to products in traditional management accounting systems. Traditional way to calculate overhead rate is to divide total overhead value with total direct labor hours. (Malmi 1991, 14)

Another common categorization is to separate costs based on their nature into direct and indirect costs. For example manufacturing costs are commonly classified into three groups (Horngren et al., 2009, 62-63):

1. Direct material costs represent material cost of goods sold (COGS)
2. Direct manufacturing labor costs represent labor COGS
3. Indirect manufacturing costs, or manufacturing overhead costs include all manufacturing costs that are claimed to be related to relevant cost object, but cannot be traced to it in economically feasible way. Examples include indirect material, indirect manufacturing labor, and general manufacturing related overhead costs.

As described in previous definition, indirect costs are also called overhead costs. Usually manufacturing companies assign direct costs to products easily, but face challenges in assignment of indirect costs. There is no correct way to assign indirect costs to products, because by definition indirect costs are not related with a specific product (Atrill & McLaney 2008, 277). Some authors have questioned whether indirect costs should be assigned at all to products, while costs do not have causal link with individual products.

Absorption costing means that both direct and indirect manufacturing costs are assigned to products (Malmi 1991, 4). Absorption costing is also called full costing, or full absorption costing (Atrill & McLaney 2008, 272-273, and Baxendale et al 2006, 30). In absorption costing products absorb all manufacturing costs. When calculating financial results, all period's manufacturing costs are not deducted directly from period's income, but they are included into company's balance sheet as inventory value.

As was mentioned at the beginning of chapter, in financial accounting all costs have to be matched with revenue (Drury 1997, 17). This has the consequence that when product is sold to customer and income is earned, inventory value of the product is subtracted from the income through cost of goods sold. See from figure 3-2 how all manufacturing costs are eventually transferred to COGS through the balance sheet. Direct material inventory consists of unused direct material costs, like components that are waiting in the stocks. Work-in-process and finished goods inventories consist of used, but yet not sold direct material costs, direct labor costs and related indirect manufacturing costs. Finally COGS consists of all direct and indirect manufacturing costs for products that are sold to customers.

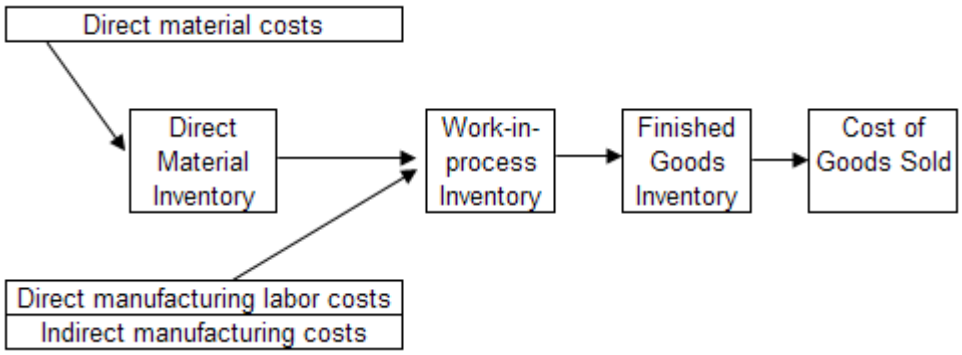


Figure 3-2 Treatment of manufacturing costs in a full absorption costing system (Horngren et al., 2009, 65)

International accounting standards, IAS 2 Inventories, require the use of full absorption costs in inventory valuation (Atrill & McLaney 2008, 297). The principles require that manufacturing overhead has been included into the inventory value in addition to the cost of direct materials and direct labor (Baxendale et al 2006, 30). Regulation is important, because it is necessary that financial statements of different companies are comparable. Absorption costing has its supporters also for other reasons, like pricing and output decisions, controlling purposes like budgets, and assessing performance (Atrill & McLaney 2008, 268). Atrill and McLaney (2008, 281) argue that absorption costing provides working solution for pricing decisions.

Absorption costing has received lot of critique, mainly due to the assignment of indirect manufacturing costs to products. Most companies have distorted full costs, because assignment of indirect costs is done according to broadly defined allocation rules. Improved accuracy of costs could be achieved by assigning indirect costs to a broader cost objects, like groups of products instead of single products. Another factor affecting to information distortion is that most managers do not know principles and allocation rules used to calculate full product costs.

In absorption costing some products might have too high or too low costs because of the indirect costs that do not have a causal link to the product.

Accountants and practitioners have different opinions about how product costs should be calculated for managerial decision making purposes. Accountants in practice tend to report full costs. Academics argue that product costs should include only variable costs, because only those are relevant in decision making. (Malmi 1991, 4) Variable costing means that only costs defined as variable are included into the products. According to the accounting standards, variable costing is not accepted method in valuing inventory for manufacturing companies. Some authors argue that if variable costing is used instead of absorption costing, there is a risk that business might charge too low prices to cover the costs (Atrill & McLaney 2008, 281).

Table 3-2 Options for improving cost data accuracy

	FULL COST SYSTEM FOR MANAGEMENT ACCOUNTING	SEPARATE COST SYSTEM FOR MANAGEMENT ACCOUNTING
HOW TO GET THERE?	Use of activity-based costing to assign indirect manufacturing costs to the products	Use of activity-based costing to assign indirect costs partially to products or other cost objects
POSITIVE	Only one system needed for product costing	Management accounting analyses are not limited by full cost system
NEGATIVE	Product costing is limited by full costing and product costing perspective	Separate system has to be maintained for management accounting

Some argue that management accounting should not use full costs that are used for financial reporting, but choose another method to calculate product costs for decision making purposes. Table 3-2 presents two possible options for solving the challenge of distorted products costs. The first option is to use single product costs for both financial reporting inventory valuation and management decision making purposes. Another option is to build a separate management accounting system in which costs can be calculated to support the decision making needs. The challenge of using full cost system is to have product costs that are accurate enough, but still fulfill the requirements set by the accounting standards. In most cases it is necessary to build separate management accounting system to get relevant cost and profitability information. A

separate management accounting system is seen necessary for true cost management, and that is also the approach chosen in this study for designing the management accounting system.

Previous development of inventory valuation principles into accounting standards is made during the 1950's and 1960's (Baxendale et al 2006, 31). At that time there was considerable debate about proper treatment of fixed factory overhead costs, and especially about how they should be treated against income. Supporters of direct costing argued that fixed manufacturing overhead costs should not be included to the products, but instead should be treated as period costs when they occurred and products were manufactured. Supporters of absorption costing argued that fixed manufacturing overhead cost should be included to the product as inventoriable cost based on the matching principle. (Baxendale et al 2006, 31) Debate ended in favor of absorption costing, which requires that indirect product costs are recognized in the period goods are sold, instead of the period in which costs were incurred. (Baxendale et al 2006, 32)

Absorption costing has been argued to provide managers a tool that can be used to affect earnings management. While cost profile of companies has changed from labor-intensive toward more capital-intensive, also inventory's impact to earnings management has increased. (Baxendale et al 2006, 34-35) According to a research conducted by Baxendale et al (2006, 36), the effect of managerial judgement to the ending finished goods inventories is much greater in capital intensive environments compared to the labor intensive environments.

In absorption costing, when ending inventory of finished goods and work-in-process is bigger than the starting inventory, part of the overhead costs incurred during that period have been included in the inventory rather than expensing them through the cost of sales. Also, when the ending inventory of finished goods or work-in-process is smaller than beginning inventory, more overhead costs are released to cost of goods sold than the amount of costs incurred during that period. (Anthony 2007, 435-436)

This far the chapter has defined concepts of financial accounting and management accounting, and presented different ways used to classify costs. Also the concept absorption costing was introduced in the chapter. Cost object may represent product, service, manufacturing department, or what ever object to which costs are assigned to. Costs can be assigned to cost objects by using three main methods. Cost assignment method is usually selected based on nature of the cost. Direct costs are assigned with different method than indirect costs. Three main cost assignment methods are presented in figure 3-3.

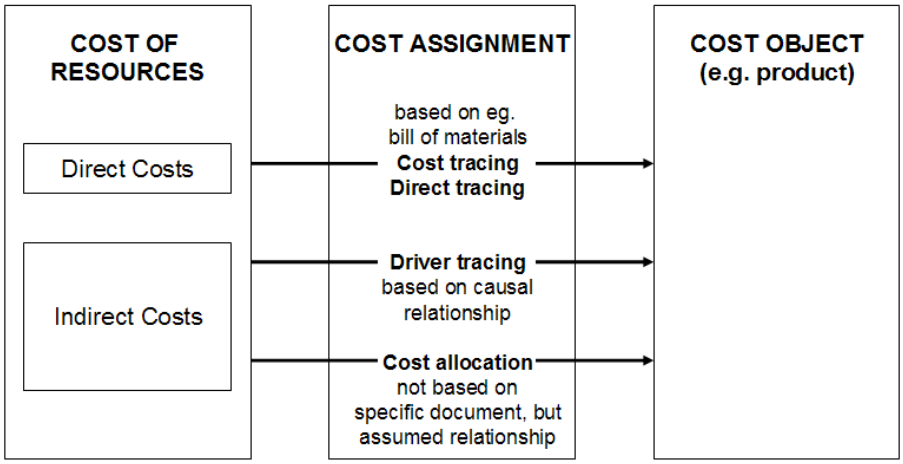


Figure 3-3 Cost assignment methods (Adapted from Horngren et al., 2009, 55, and Hansen 2007, 39)

Direct costs can be assigned to cost object by using direct tracing (Horngren et al., 2009, 55). Direct tracing means that costs are assigned to cost objects as such without using any estimates or criteria. Direct tracing is used to assign direct material costs and direct labor costs to the cost objects. Direct tracing is used when costs can be assigned with a causal relationship (Rikala 1997, 18-19) or when costs can be assigned with a physical observation (Hansen 2007, 39). Unfortunately terminology used with cost assignment is not well defined, and some of the terms are used interchangeably. For example cost tracing is equal to direct tracing.

Second method to assign costs is driver tracing. In driver tracing costs are assigned by using a cost driver (Hansen 2007, 39). When cost driver is used, the assignment can never be exactly correct, but usually this is a good way to assign costs if the causality of the cost driver is in line with the cost itself. Driver tracing provides reliable results only if the cost driver has been selected correctly. Driver tracing is used with activity-based costing, and it provides a way to treat some fixed costs as long-term variable costs.

Cost allocation is the third method to assign costs to cost objects (Hansen 2007, 39). Cost allocation is a normal procedure used in assigning indirect costs to the cost objects (Horngren et al., 2009, 55). Rikala (1997, 18-19) divides allocation further to estimation and arbitrary allocation. Estimation and arbitrary allocation are used when there is no direct causal relationship with the cost object (Rikala 1997, 18-19). In cost allocation, relationship between costs and the cost object is estimated or assumed, and there is no causal connection. Cost allocation is the biggest reason for having distorted product costs.

As presented in figure 3-3, there are three different ways to assign costs to the cost objects. Terms and definition vary, but methods used in practice are the same. Another unfortunate confusion arises from the use of term allocation. Sometimes allocation is used to describe all different cost assignment methods, instead of using the term assignment. Cost assignment is used in this study to describe all different ways to bring costs to the cost objects, and cost allocation is treated as one of the three main methods.

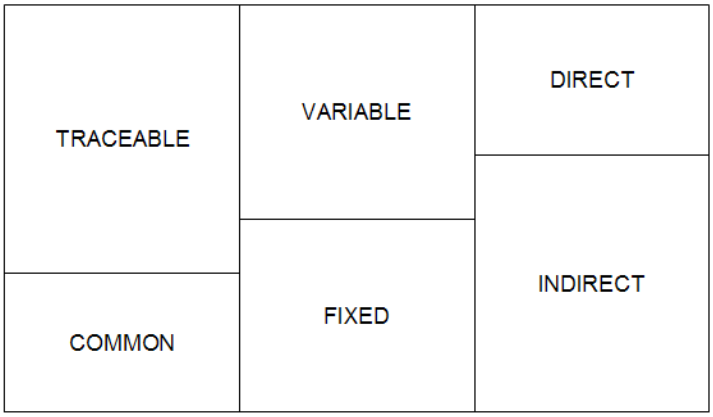


Figure 3-4 Comparison of different cost concepts (Malmi 1991, 29)

Costs can be grouped also based on their traceability (Malmi 1991, 29). Figure 3-4 presents a comparison between different cost categorization methods. Traceability determines whether costs can be traced to primary or secondary activities (Glad & Becker 1996, 35).

Figure 3-5 represent different definitions of product costs (Hansen 2007, 42). Discussion around product costing is usually focused on traditional products costs presented on right-hand side of the figure. The traditional product costs include only the costs of manufacturing and production (Hansen 2007, 42). The common practice has been that products costs include only the manufacturing related costs, but it is good to understand the different perspectives for calculating product costs.

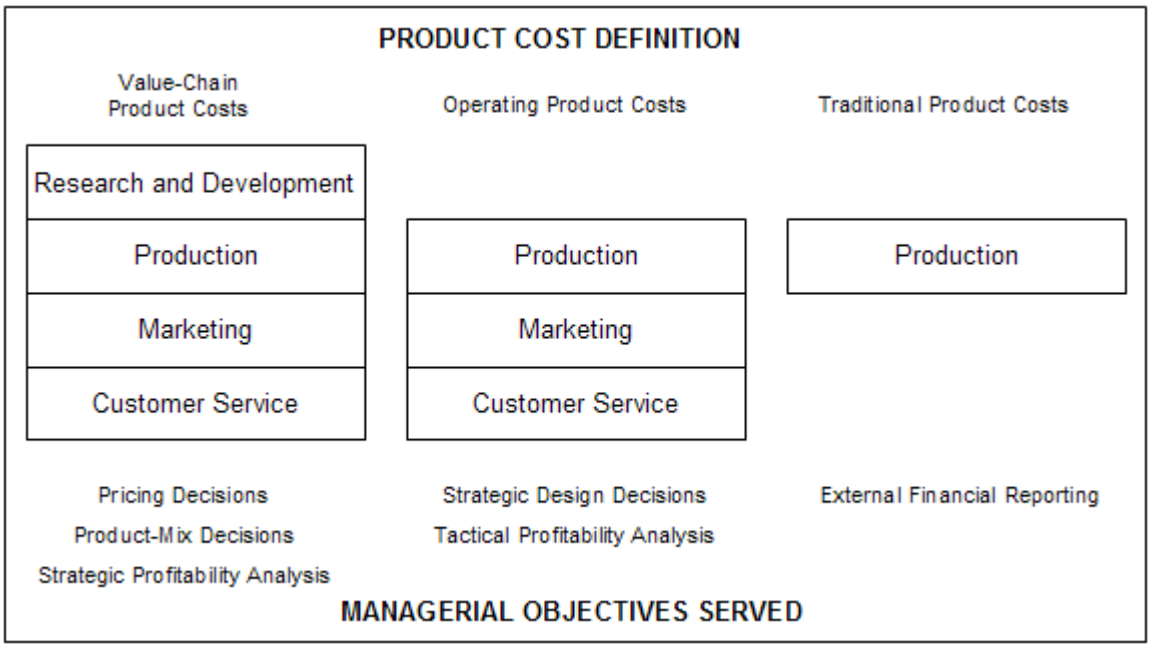


Figure 3-5 Different definitions of product costs (Hansen 2007, 42)

Management accounting systems are often limited to calculate costs for products, and more often even the product costs are limited to full costs. Limitations can be seen as consequence of accounting standards, when inventory valuation methods used for financial accounting also form the basis for management accounting system. Building a separate management accounting system for decision making purposes is recommended for several reasons that are also mentioned earlier. First, costing should not be based purely on products. There is no compulsory need to allocate all manufacturing overhead costs to the products, while also for example groups of products can be used as cost objects. Separate management accounting system may support performance measurement of the organization also through value stream costs or process costs. Another argument for separate system is that the requirement of absorption costing can be avoided.

Most management accounting systems focus on calculating product cost. It is suggested that other perspectives, like value stream costs might provide better results (Maskell 2006, 33). Advantage of calculating costs for group of products is that cost assignments are more accurate, while driver tracing can be used instead of cost allocation. Pricing is traditionally seen as one important reason to calculate products costs, but lean related literature argues that pricing should be based on the value that customer receives from the product, not on cost of the product (Maskell 2006, 33). Generally product costs are considered poor driver for pricing, while market competition and customer value provide better results. It is more important to understand

profitability of entire value chains for selected product mixes than profitability of single products. It is common that groups of products share common resources, and it can be dangerous to treat profitabilities belonging to single products.

Responsibility centers are used to coordinate their level of decentralization and empowerment of decisions to the managers. The major types of responsibility centers are cost centers, revenue centers, profit centers, and investment centers. (Hansen 2007, 420) In practice many companies call their responsibility centers cost centers, regardless of what type of responsibility center it actually is. Responsibility centers provide a crucial tool in management accounting to indicate which departments or units are responsible over which costs, revenues, or investments. The number of cost centers varies a lot between different companies. A study made in the UK for larger businesses showed that 36% of businesses had less than 10 cost centers, and the same share 36% of businesses had more than 20 cost centers (Atrill & McLaney 2008, 286).

3.2. Standard costs in financial reporting

Essentials of modern management accounting were already established by 1925, and no significant changes have occurred since. (Johnson & Kaplan 1987, 12-13, and Fiume 2007, 55) Since that time typical manufacturer's cost structure has changed significantly as the share of overhead has increased and share of labor has decreased. See figure 3-6 for the cost structures of typical American and Finnish manufacturing units. Full absorption costing was introduced in chapter 3.1 as method that requires all manufacturing costs to be included into the products' inventory value. Full absorption costing is the main reason for distorted product costs, while it requires that the ever larger share of indirect manufacturing costs is assigned to single products.

During 1990's the relevance of management accounting systems was questioned by several authors (e.g. Johnson & Kaplan 1987). Full absorption costing methods were developed to support decision making needs of mass production companies in the mid-20th century (Maskell 2006, 27). Authors argue that business environment has changed dramatically during the past decades, but management accounting has remained the same. Costing principles and system assumptions has not changed to reflect the new environment. Management accounting systems of the 1990's were not responding to the challenges they were facing. Management accounting systems used today have been created to support the historical business environment (Fiume 2007, 55). In the past, a small amount of overhead was allocated to products on basis of their

labor usage. Using same principles today will lead to bad allocations and misleading interpretations. (Fiume 2007, 55)

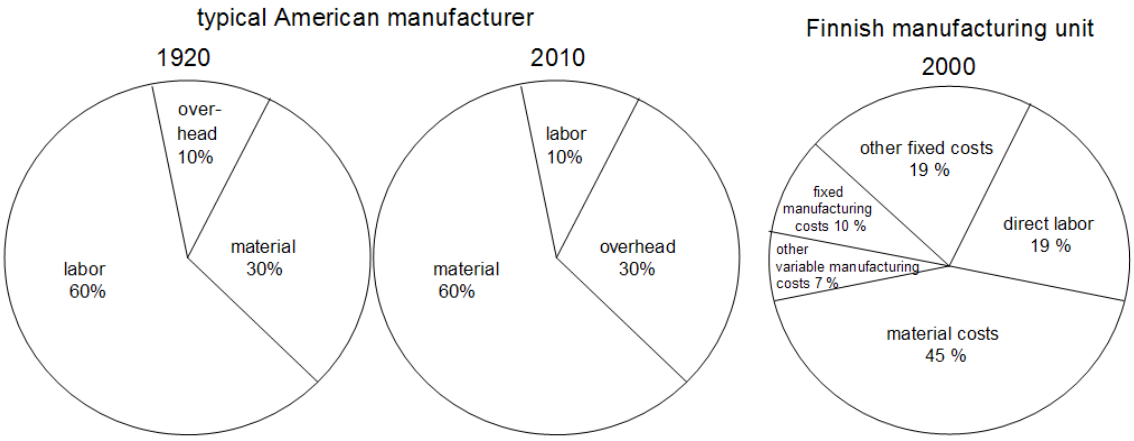


Figure 3-6 Typical cost structure of American (Fiume 2007, 55) and Finnish (Lukka & Granlund 1994, 13, and Rikala 1997, 19) manufacturing unit

Full absorption costing may still provide reasonable results for companies in which indirect manufacturing costs represent only a small share of total manufacturing costs. However, as suggested in figure 3-6, the share of indirect costs has increased dramatically since the establishment of modern management accounting systems. Hansen and Mouritsen (2007, 3) argue that management accounting plays a critical role in operations management, even though tensions between accounting and operations managers have led some to argue that accounting should be disconnected from the operational control. It has been argued that accounting system should be a subservient system to production system (Huntzinger 2007, 34).

Measuring lean performance with full absorption costing system gives conflicting results in the income statement. For example, when work-in-process and finished goods inventories are decreased in current period, it is shown negatively in the operating results. Full costing has absorbed part of previous period's labor and manufacturing overhead costs into assets, instead of expensing them from income during the previous period. When inventories are decreased during the current period, share of labor and overhead costs for sold products is expensed as part of cost of goods sold. While no new inventory is being built, it means that the labor and overhead costs occurred in this period will also be expensed from income statement. The result is that while inventory decreases, share of indirect manufacturing costs in the income statement increases. Share of indirect costs increases for two reasons. First, it includes indirect costs that were previously absorbed to the assests, but are now expenses as the inventories are used. Second, it

also includes indirect costs that were used during the period, but were not absorbed to assets for future periods, but instead were expensed through the variance accounts. (Baggaley 2007, 78)

Another wave of criticism has been directed toward standard costing. Standard cost is the cost that represents usual cost of a cost object. Standard costs are calculated based on historical data, budgets, and financial plans of the company, while updates are often made annually. Since emerge of financial reporting, standard costs were designed to support inventory valuation. (Johnson & Kaplan, 129-130) Standard costs are commonly used in full absorption costing system with the consequence that the costing system is called standard costing system. However, it is important to separate the problem of standard costing from the problem of full absorption costing. A common misunderstanding is that accounting standards like IFRS, IAS and GAAP allow organization to use only standard costing, but actually they only limit companies to use full absorption costing (Maskell & Katko 2007, 165). Standard costs are the most common costing system, but company may also choose to use actual costs or normal costs and still fulfill the mandatory requirements of full absorption costing.

Standard costing system has become the most dominant management accounting system that companies use to measure and calculate their results. About 80% of American companies use standard costing systems (Hansen 2007, 369-370). Differences of actual and standard costs are handled with variance accounts, but unfortunately only few users of information know how to interpret variances. Standard costing systems have been criticized for providing financial reports and variance accounts that are unusable to managers in operations. It is almost impossible for managers to see potential problems from income statement when manufacturing costs are calculated with standards costing system.

Standard costs are suitable tool for financial reporting, but challenge is that many companies use standard costing information in their management accounting systems. Standard costing system has provided a good answer for the needs of batch production and resource-based operations in past decades. Modern businesses with larger overhead and increased interest in single-batch production find it challenging to use standard cost information in their decision making and performance measurement. Most often standards are used to refer product costs, but standards can also be used for other purposes. See figure 3-7 for all the different variances that result from standard costing system. Standard costs have been claimed to mislead managers and cause them to make wrong decisions related to pricing, profitability, and make or buy decisions (Maskell 2006, 27).

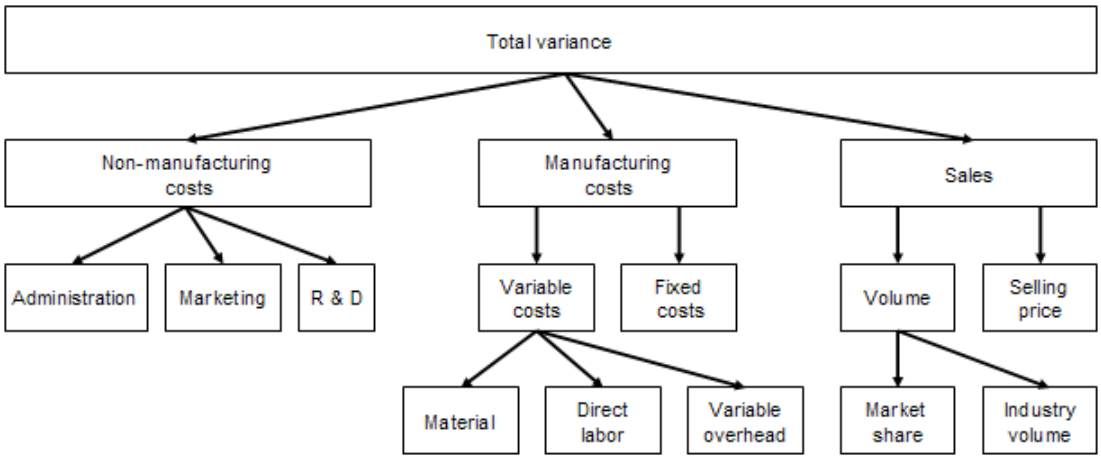


Figure 3-7 Division of variances in the organization (Adapted from Anthony 2007, 426)

Some companies have responded to the increasing overheads with their traditional management accounting systems by calculating overhead rate with direct material value instead of direct labor hours (Malmi 1991, 15). This might have changed the cost allocations between the products, but has not solved the problem of distorted costs. A further problem of providing standard cost information is that sales and marketing might assume that standard costs of the products are correct (Maskell & Katko 2007, 156). If standard costs are perceived too high, they might be simply assumed wrong. If standard costs are perceived too low, margins are seen as high, and effort is made to sell more of these high-margin products. (Maskell & Katko 2007, 156)

Productivity achieved with lean methods increases available capacity for future orders, but it shows conflicting results in income statement as the unit cost increases. Increase in unit costs is a characteristic of standard costing. Costing system sees more available machine and labor resources, which in turn shows less efficient use of resources. The result is increased unit cost for that period, even though all achievements were positive for the organization. According to Baggaley, organization that will continue to use traditional performance measurements cannot sustain lean development, because measurements will "push it back" to traditional way of working. (Baggaley 2007, 78)

As a solution to support lean management, some authors have argued that management accounting should be made lean (Maskell 2000, 47, and Hansen & Mouritsen 2007, 11). Value stream costing has been suggested as a simplified version of activity cost analysis, while target of lean companies is to perfect value stream instead of department effectiveness (Maskell 2000, 47). It is suggested that lean does not need complex costing systems, but rather a simple system like back-flush accounting in which it is assumed that operations have been carried out correctly.

Lean accounting would eliminate need for detailed evaluation processes, and heavy support processes (Hansen & Mouritsen 2007, 11).

Costs can be divided into two distinct categories, inventoriable and periodic costs (Horngren et al., 2009, 63):

1) **Inventoriable costs** include all costs that are treated as assets in the balance sheet. Inventoriable costs become COGS in the income statement when products are sold and there is revenue that costs are matched against. When revenue is not earned, products remain as assets in the balance sheet. Costs of goods sold include direct material, direct labor, and indirect manufacturing overhead costs. (Horngren et al., 2009, 63) Inventoriable costs can be further categorized into two separate parts (Fiume 2007, 61):
    a. The first part is "true" assets, like raw materials and the material content of work-in-process and finished goods.
    b. The other part is not a "real" asset, even though it is considered as asset in the balance sheet. It is actually deferred costs which represent all the labor and manufacturing overhead costs that are "capitalized" as the products have been manufactured to the inventory, but not yet sold or used.

2) **Period costs** include all other costs in the income statement, but the COGS. Period costs are treated as expense in the period they have incurred, because they are expected to benefit revenues in that period. Period costs include for example general administrative costs, design costs, and salaries of sales personnel. (Horngren et al., 2009, 63)

Separation of inventoriable and periodic costs is important for financial accounting. Requirement of absorption costing means that all manufacturing costs will be treated as inventoriable costs. From figure 3-8 it is possible to see division of inventoriable costs and period costs. Figure shows how inventoriable costs are formed into income statement through the balance sheet. (Horngren et al., 2009, 65)

In standard cost systems, planning is done through budgets and analysis of variance accounts. Standard costing systems are widely used, while about 80% of American companies use standard costing. Significant amount of firms calculate variances at operational level, for example 40% report variances for small working teams or individual workers. (Hansen 2007, 369-370)

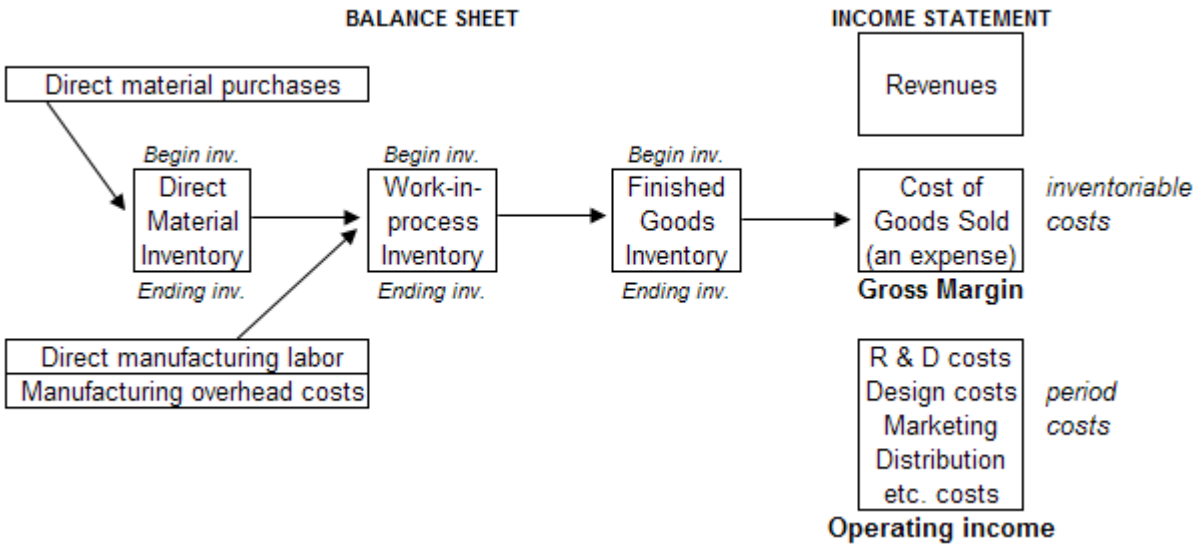


Figure 3-8 Transferring cost of goods sold to income statement (Horngren et al., 2009, 65)

Product costing in standard costing system is done by calculating quantity and price standards for all three manufacturing costs; direct material, direct labor, and indirect overhead. In addition to standard costing system there are also other product costing systems. Hansen presents three different cost assignment approaches that treat costs differently, see table 3-3 for differences between actual costing, normal costing, and standard costing systems. Normal costing system assigns overhead costs by using a budgeted rate and actual activity, while direct materials and direct labor are assigned to products by using actual costs. Actual costing system assigns all manufacturing costs to products according to actual costs. (Hansen 2007, 370)

Table 3-3 Different cost assignment approaches (Hansen 2007, 371)

	Manufacturing costs		
	Direct material	**Direct labor**	**Overhead**
Actual costing system	Actual	Actual	Actual
Normal costing system	Actual	Actual	Budgeted
Standard costing system	Standard	Standard	Standard

Some companies use average costs to value their inventories instead of standard costs. The difference is that instead of using fixed inventory value for single product, the product's value is calculated again every time a new product is received into the inventory with new purchase price. The result of the approach is that material price variance is zero, but other variance prices remain the same as before. Standard costing system with average costing for material prices can be argued to belong somewhere between normal and standard costing systems.

Hansen (2007, 422) presents two different methods used to calculate income, variable costing and absorption costing. Difference between variable and absorption costing is the treatment of fixed overhead cost. Variable costing treats fixed overhead costs as period costs, while absorption costing treats all overheads as inventoriable. See table 3-4 for the comparison of absorption and variable costing.

Table 3-4 Comparison of variable and absorption costing (Hansen 2007, 423)

	Absorption costing	Variable costing
Product costs	Direct materials Direct labor Variable overhead Fixed overhead	Direct materials Direct labor Variable overhead
Period costs	Selling expenses Administrative expenses	Fixed overhead Selling expenses Administrative expenses

Variable costing assigns only variable manufacturing costs to product, arguing that fixed overhead cost is a cost of capacity, or cost of staying in business. Absorption costing assigns all manufacturing costs to the products, including fixed overhead costs. Absorption costing treats fixed overhead cost as a product cost instead of period costs. Fixed overhead cost is assigned to products through a predetermined fixed overhead rate, and it is not expensed from income statement until the product is sold. According to the accounting standards, absorption costing is required for external reporting. (Hansen 2007, 422) According to a survey made by Lukka and Granlund in 1994, in Finland variable costing is being used by 42%, absorption costing by 31%, and both in parallel by 27% of the large and medium-sized industrial units (Rikala 1997, 15).

While absorption costing is mandatory requirement in accounting standards, variable costing is propably used by companies that do not operate in manufacturing and are missing manufacturing overhead costs. Third of companies use variable costing in addition to absorption costing, which suggests that variable costing provides is widely used practice in Finnish management accounting. Most management accounting systems are built based on the same product costing information that is used for external reporting. Variable costing gives managers better understanding of the true cost structure.

3.3. Management accounting systems and activity-based costing

Hansen and Mouritsen present four views on the relationship between strategy and management accounting. The views are, information about competitors, strategic positioning of the firm with the management accounting system, value chain perspective, and product focus on market information. (Hansen & Mouritsen 2007, 138) Value chain perspective on strategic management accounting is the most interesting view for this study. Value chain perspective consists of value chain analysis, cost driver analysis, and competitive advantage analysis (Hansen & Mouritsen 2007, 142). Value chain analysis refers to analyzing the company's value chains that connect supplier's raw material with the customers' or consumers' requirement fulfillment. Cost driver analysis is the determination of causes or drivers that generate costs for each value activity. (Hansen & Mouritsen 2007, 142-146)

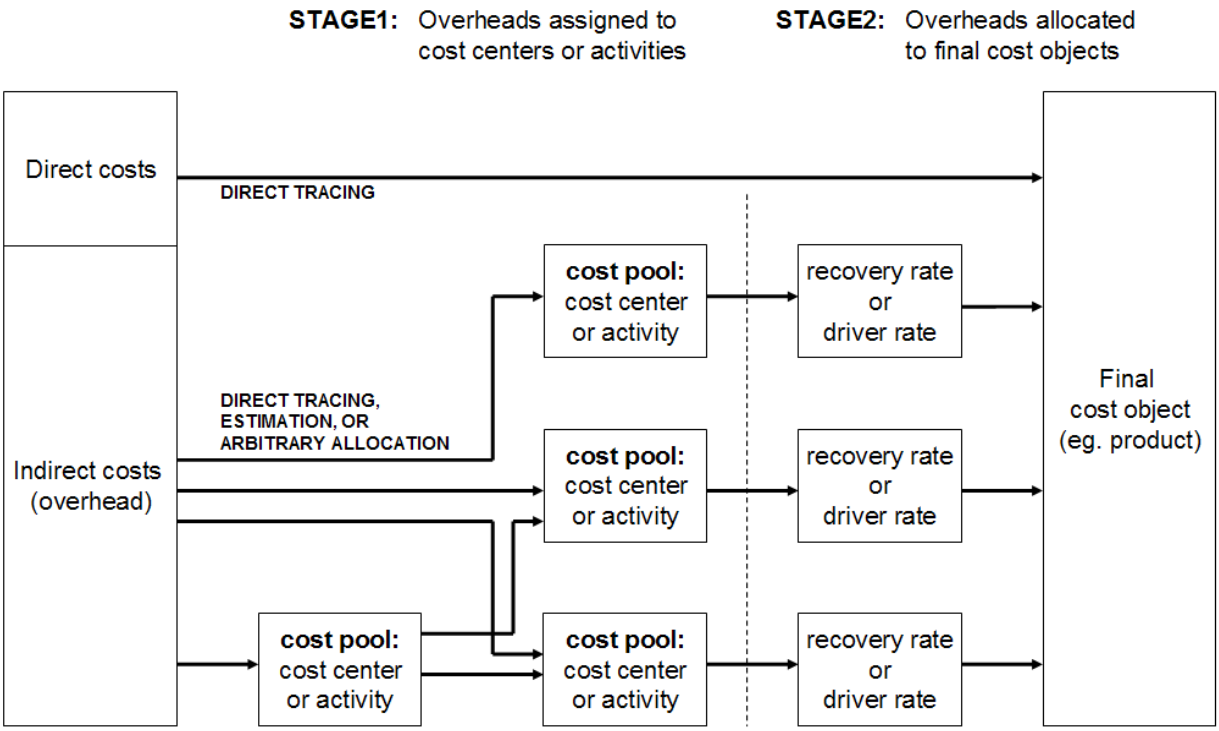


Figure 3-9 Two-stage cost assignment model (Adapted from Drury 1997, 89, and Rikala 1997, 18, and Atrill & McLaney 2008, 294, and Glab & Becker 1996, 38)

Previous chapter 3.2 discussed the problem of using financial accounting information in managerial decision making. Standard costing based product costs are distorted and aggregated, and unsuitable for managerial decision making. Two options were presented to solve the problem. Either the inventory-valuation based product information should be made more

accurate or a separate management accounting system should be maintained simultaneously to calculate cost and profitability information for decision making purposes.

Figure 3-9 presents a general two-stage model for assigning costs. During the first stage all manufacturing costs are assigned to the department cost centers, also called cost pools. Cost centers are traditionally used for cost control and performance evaluation together with budgeting. In the second stage a suitable cost driver rate is selected. Usually the selected measure is direct labor hours, machine hours or direct material costs. (Drury 1997, 88-89) Direct labor hours are the most popular allocation base used in the UK (Atrill & McLaney 2008, 282).

Overhead rate, also called burden rate is a percentage that is calculated by dividing the total cost of the cost center with total quantity of the allocation base. Finally overhead expenses are allocated to the products by multiplying the overhead rate with the amount of allocation base consumed by the product. (Drury 1997, 88-89) Many times overhead rates are calculated based on the cost center budgets, result being that when budget does not mach with the reality, the difference of costs is directed to variance accounts. Differences between actual and budget provide management important indication about costs.

Terminology concerning assignment of costs was presented in chapter 3.1. Assignment of costs has a key position in management accounting system. Two-stage cost assignment model is presented by several authors with slightly different perspectives (Drury 1997, 89, and Rikala 1997, 18, and Atrill & McLaney 2008, 294, and Glad & Becker 1996, 38). Most manufacturing firms allocate their indirect manufacturing cost through two-stage cost assignment procedure (Bromwich & Bhimani 1994, 62). According to the two-stage model, direct costs are traced directly to products, while indirect costs are assigned first to cost pools, and then to final cost objects or other cost pools.

Two-stage cost assignment model may consist of different types of cost pools, like cost centers or activities. Rikala (1997, 18) argues that there are three types of cost pools; main cost pools, auxiliary cost pools, and facility sustaining cost pools. Main cost pools have direct causal relationship with the cost objects. Auxiliary cost pools are lacking direct causal relationship, but they have direct causal relationship to the other cost pools. Facility-sustaining cost pools do not have causal relationship to final cost objects or other cost pools. Rikala argues that from the causality point of view, it is questionable to assign costs from facility sustaining cost pool any further. (Rikala 1997, 18-19)

Three types of cost assignment methods were introduced in the chapter 3.1. The three cost assignment methods are direct tracing, driver tracing, and cost allocation. During the first stage the costs elements are assigned to cost pools. In Finland this practice is called cost center calculation, and it assigns costs from general ledger accounts to the cost centers (Malmi 1991, 31-32). Cost center is the smallest activity unit or responsibility area for which costs are assigned separately (Malmi 1991, 31-32). Direct costs are assigned directly to cost objects by using direct tracing, also called cost tracing. In the second stage indirect costs are assigned from the cost pools to the final cost objects by using a suitable recovery base. In practice recovery base can be any suitable rate, traditionally it has being labor or machine hours.

Many of today's management accounting topics and innovations became popular during the 1990's after the published critique towards management accounting practices. Activity-based costing (ABC) was one of the answers provided to solve the challenges. Idea of activity-based costing is to understand activities that cause costs, and assign costs to the final cost objects with the help of activity driver rates. Activity-based costing can be though as a method to assign all indirect costs (Seuring 2002 b, 16). Figure 3-10 represents how ABC has replaced arbitrary allocation, and allowed improved assignment accuracy for indirect costs.

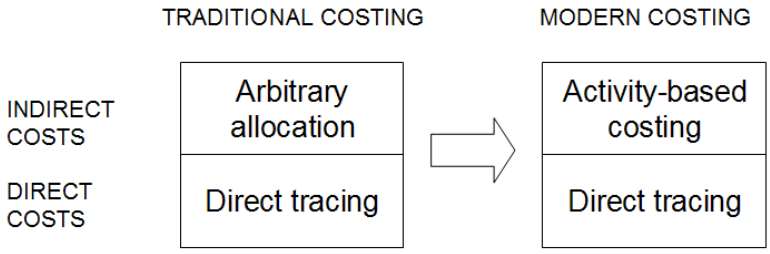


Figure 3-10 Emerge of activity-based costing

Malmi (1991, 7) argues that activity-based costing helps to decrease the amount of fixed costs by treating part of the fixed costs as variable. Activity-based costing categorizes most overhead costs as either short-term or long-term variable costs. Figure 3-1 in chapter 3.1 shows how activity-based costing has increased share of variable costs by introducing long-term variable costs. Malmi argues that the use of ABC reduces the problem of allocating fixed costs, but does not eliminate it. (Malmi 1991, 7-8) Activity-based costing has been criticized for taking management attention away from the real problems (Johnson 2007, 10). Johnson argues that instead of proposing better ways to allocate overhead cost, management should eliminate causes of overhead cost.

Horngren et al. (2009, 529) presents four different criteria for making cost assignment decisions, the most important being cause and effect criteria. For decision making purposes it is critical to understand the causality of the costs. It should be understood which costs are a consequence of which decisions. (Malmi 1991, 21) Other criteria for making cost assignment decision are based on benefits received, fairness or equity, and ability to bear. (Horngren et al. 2009, 529) In practice causality is the most important and most used criteria to argument cost assignments.

Cooper has classified activities into four groups; unit-level, batch-related, product-sustaining, and facility-sustaining activities. Unit-level activities are performed each time product or service is produced. Batch-related activities occur when ever a single batch is used to produce products, and batch has a fixed cost. Product-sustaining activities have connection to the products or product lines, but cost is independent from the amount of products produced. Facility-sustaining activities support the facility and have no direct linkage to products. Examples of facility-sustaining activities include administration, plant management, and other activities that cannot be linked to products or product lines. (Drury 1997, 113-114)

Drury (1997, 114) argues that ABC systems are resource consumption models, which attempt to measure the cost of using resources, not the cost of supplying resources. In practice this means that ABC attempts to separate the unused capacity, and to allocate only resources used for products. Traditional periodic financial accounting measures assume that capacity is fully used and cost of unused capacity should be allocated to products. (Drury 1997, 114)

Technically ABC can be seen as two-stage cost assignment model, in which cost centers are replaced with the activity centers (Rikala 1997, 18-19, and Glad & Becker 1996, 38). In ABC activity centers are assigned to products with cost drivers instead of recovery bases (Malmi 1991, 12). ABC is two-stage absorption costing method for calculating product costs (Malmi 1991, 19). Malmi (1991, 19) argues that activity-based costing follows a multi-stage cost assignment, in which costs can be assigned from cost pool to another cost pool before assigning costs to products. This increases the complexity of costing, but provides more opportunities for the cost assignment decisions. (Malmi 1991, 19)

Assignment of direct costs is straightforward and does not usually produce distorted cost information. The biggest reason for distorted costs is the assignment of overhead costs. Traditionally overhead costs are assigned to products through two-stage process. The first stage assigns costs from general ledger to cost pools, varying methods exist for this first assignment.

Second stage assigns costs from cost pools to products by using direct labor hours, direct wage costs, or material dollars as assignment method. (Malmi 1991, 6-7) Theoretically activity-based costing does not differ from the traditional cost assignment model (Rikala 1997, 20), but in practice it provides better results (Malmi 1991, 27). However, fully decision-relevant approach provides even better results, as it focuses on calculating costs to support a single decision (Malmi 1991, 27).

Job-order costing is one of the most used methods to calculate full costs to products in multi-product business. By using this practice, each product or batch of products is given a job that includes material usage and labor time needed to manufacture that job. Assignment of direct material and direct labor costs for a job is straightforward, because all information is included in the job. Assignment of indirect manufacturing costs is based on arbitrary allocation, and a job is said to be given a fair share of overhead costs. (Atrill & McLaney 2008, 272-273) Job-order costing is a commonly used method in Finland for calculating product costs. Job-order costing is suggested for complex environments in which modern technologies are used to manufacture various types of products in different lot sizes. Also job-order costing can be presented through two-stage cost assignment model that was presented in figure 3-10.

Malmi (1991, 46) argues that the theoretical fundamentals between job-order costing and activity-based costing are very close to each other. The main difference between the two cost assignment methods is the use of cost pools. Job-order costing calls cost pools cost centers, while activity-based costing calls them activities. In practice the number of activities is much bigger than the number of cost centers. (Malmi 1991, 46)

Emerge of activity-based costing has helped organizations to find more drivers than just labor usage, but it has not provided alternative for full absorption costing system. Activity-based costing is just a new method that most companies use in their absorption costing systems. Management accounting system should be separated from full absorption costing system to avoid unnatural assinment of indirect manufacturing costs. Strategic cost management provides the concepts of value chain, strategic positioning, and cost drivers (Kajüter 2002, 37). Major weakness of strategic cost management is that the three concepts remain separate from each other, and they lack empirical studies. (Kajüter 2002, 37) Strategic cost management differs from the traditional cost management and activity-based costing by providing a process focus (Hines et al 2002, 58). Even though the concept of strategic cost management remains too

theoretical and open to be used in this study, the idea behind process costs will be used in chapter 4.1.

Inter-organizational cost management is presented as the cost management approach for supply chains. Main purpose is to identify cost reduction possibilities by using dimensions of relationship and product. (Kajüter 2002, 37) Due to the focus on internal supply chains, the concept of inter-organizational cost management is not used in this study, and for that reason not presented any further. Lean accounting is term used from several cost concepts that are used with lean management. Value stream costing provides most potential for designing a new management accounting system, so the concept will be examined further in chapter 4.1.

4. Cost management in supply chains

4.1. Linking supply chain management with cost management

In the two previous chapters the concepts of supply chain management and cost management have been introduced. Both concepts are platforms for a wide variety of methods, concepts, and instruments, and therefore it is not possible to find a single framework that combines both (Seuring 2002 a, 3). Consistent theory that would extent cost management efforts into the supply chain management has not been developed so far (Kajüter 2002, 48). Development of supply chain management and cost management has been rapid during the past decade (Seuring 2002 a, 3). Despite of the rapid development, there exist only a few cost management concepts that are capable of considering the supply chain perspective for total costs (Seuring 2002 a, 5, and Seuring 2002 b, 15).

There exists a considerable gap in theoretical foundations of cost management in supply chains, even though the topic has huge practical relevance (Kajüter 2002, 38). Most studies define the problem narrowly, and cost management in supply chains is often analyzed from the perspective of a particular management discipline. Empirical studies of the topic are limited to case studies, and no conceptual framework exists that would not focus on certain individual contributions of cost management in supply chains. (Kajüter 2002, 39)

Role of cost management in supply chains is important, because it is crucial to meet customer expectations and create more value while reducing costs through supply chain management (Seuring 2002 a, 10). This chapter 4.1 presents existing concepts of cost management in supply chains. In chapter 4.2 a new framework is developed to be used for designing management accounting system to support multiple supply chain strategy. As mentioned earlier, the framework is targeted for internal supply chains. Concept of supply chain includes material and information flows, and relationships with supplier and customer. Cost management concept applied to supply chain should take these interrelated processes and relationships into account.

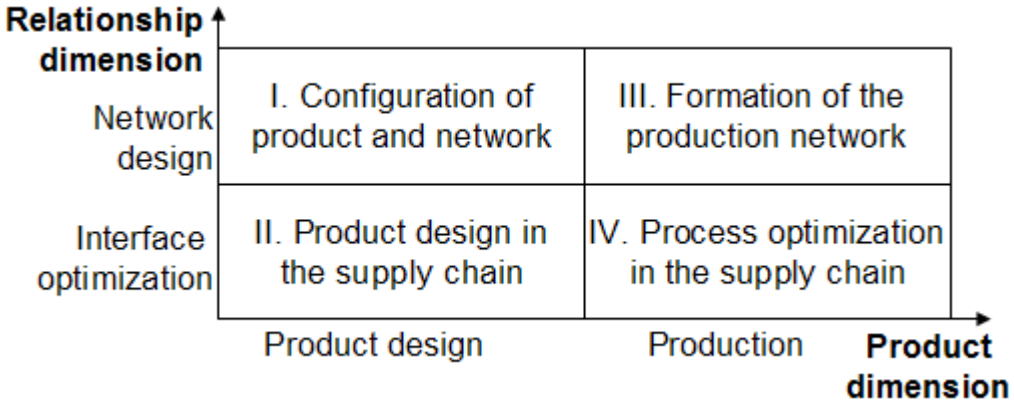
Seuring (2002 a, 3) defines cost management in supply chains as methods or concepts that allow analysis and control of all costs within supply chain. Some existing cost management concepts like life-cycle costing and target costing have been suggested to be used for cost management in supply chain environment (Seuring 2002 a, 6). Life-cycle costing is not considered in more

detail by this study, as it concentrates on cost management of a product or a service based on its life-cycle (Rebitzer 2002, 129). Despite the importance of life-cycle costing, this study concentrates on understanding current cost structure of the supply chain. Another suggested concept, target costing in supply chains also provides an interesting theoretical framework. Objective of target costing is to bring market pressure into product design process inside the company (Seuring 2002 c, 112). Target costing is not considered in this study. This study concentrates on understanding the current cost structure of supply chain, which is a prerequisite for entering into target costing. Guiding objectives of supply chain management are the reduction of cycle time and inventory along the supply chain (Seuring 2002 b, 20).

Value chain was originally introduced by Porter. Porter's value chain represents organization according to activities from which value is derived. Activities are categorized into primary activities and support activities. (Glad & Becker 1996, 66) Value chain is generally used to describe chain of different activities which create total value for the customer (Hansen 2007, 41, and Horngren et al., 2009, 33). Value chain perspective argues that different value activities should not be viewed in isolation. Cost benefits can be only achieved, when company value chain is synchronized with the customer value chain.

Supply chain costing refers into a conceptual framework that connects concept of product-relationship-matrix with three cost levels (Seuring 2002 b, 24). Product-relationship-matrix in table 4-1 presents a decision framework for supply chain management. Matrix proposes that all four fields in the table should be considered whenever supply chain management decisions are made. (Seuring 2002 b, 17-18)

Table 4-1 Product-relationship matrix of supply chain management (Seuring 2002 b, 18)



Traditionally costs have been categorized based on their nature into direct and indirect costs. Seuring (2002 b, 22-23) argues that supply chain costing includes transaction costs that represent costs that arise from interactions with other companies in the supply chain. Transaction costs arise from design, agreement, and control of contractual relationships, and they are not under control of a single company, but influenced by all supply chain partners. (Kajüter 2002, 34) Seuring (2002 b, 23) suggests that indirect costs may be replaced with activity-based costs. See figure 4-1 for different cost levels in supply chain costing.

Supply chain costing combines product-relationship-matrix with three cost levels (Seuring 2002 b, 24). Each of four fields in the matrix must be analyzed and controlled through the three cost levels. Seuring (2002 b, 24) presents supply chain costing as three dimensional matrix containing product dimension, relationship dimension, and cost dimension. Integrative framework for supply chain costing is still missing, and cost management techniques are presented separately from the product-relationship-matrix (Seuring 2002 b, 22).

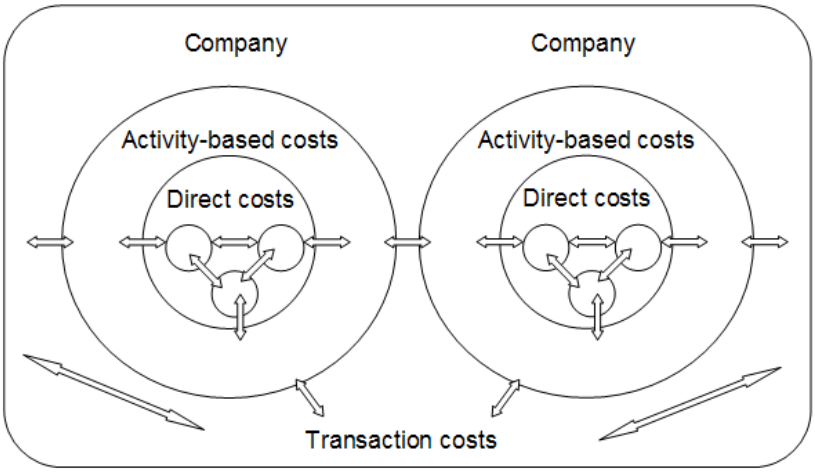


Figure 4-1 Cost levels in supply chain costing (Seuring 2002 b, 23)

Concept of supply chain costing is one of the rare concepts that concentrate on cost management in supply chain management. Objective of this study is to build practical framework that can be used to design management accounting system into multiple supply chain environment. Concept of supply chain costing is not used in this study for few main reasons. First, the concept of supply chain costing is presented by Seuring (2002 b, 24-27) as high-level concept, and it is viewed too theoretical for the study. Secondly, the concept of transaction cost is interesting, but as internal supply chains are focus of the study, transaction costs do not benefit the study.

Too many times cost management efforts are temporary reaction to declining profits. Proactive cost management is presented by Kajüter (2002, 32, 40-41) as another linkage of cost management and supply chain management. Kajüter introduces a conceptual framework for proactive cost management in supply chains. Framework offers a structured approach into proactive cost management. Though, framework will not be considered by the study as the objective of the study is to design a cost management that supports the understanding of the current cost structure of the supply chain, and the proactive perspective is not considered separately.

Cost management of value chains can be thought as process of managers and accountants tracking costs within each activity of the value chain. Objective is reducing costs and improving efficiency. (Horngren et al., 2009, 33) Value chain perspective provides interesting view to the organization compared to traditional functional perspective. Functional perspective is the most common way of presenting summarized accounting information. Usually functional perspective includes separate manufacturing and trading accounts, and all other expenses are summarized under general, selling, and administrative account. (Glad & Becker 1996, 66)

Opposite to the functional presentation, value chain presentation focuses on flow of business, and instead of functions it present activities that are performed in the organization. Support activities in Porter's value chain are connected to cost objects through primary activities. There exists strong relationship between primary activities and secondary activities described in figure 4-2. Support activities include business infrastructure, human resource management, technology development, and procurement (Glad & Becker 1996, 68).

All primary activities have external focus, such as market, customer, distribution channel, or product that is being delivered. It is easy from costing perspective to connect each activity into specific cost object. Primary activities in Porter's value chain include inbound logistics, operations, outbound logistics, marketing, sales, and service (Glad & Becker 1996, 66-67). Glad & Becker (1996, 66-68) suggest that support activities should be traced to primary activities, and primary activities should be further traced to cost objects as illustrated in figure 4-2.

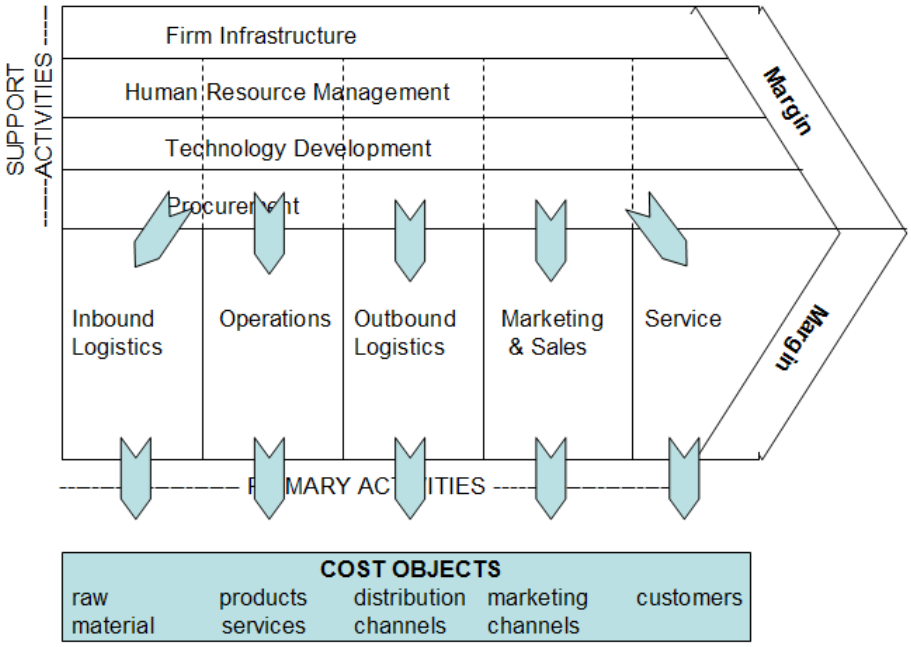


Figure 4-2 Assignment of Porter's value chain activities into cost objects (Glad & Becker 1996, 67-68)

Traditionally cost accounting has distinguished costs into two parts, production and non-production, as presented in chapter 3.1. By using Porter's value chain we can distinguish several different phases in accounting cycle which equal to primary activities of the value chain. (Glad & Becker 1996, 69)

Glad and Becker (1996, 69) introduce an integrated performance model, which is used to determine profitability. Authors have combined value chain thinking with activity-based costing to understand cost of processes, and to understand strategic perspective of organization. (Glad & Becker 1996, 69) See figure 4-3 for the model. Value chain model by Glad and Becker has integrated management accounting information with the income statement by presenting net profit at the end of accounting phases.

As described in chapter 3.1, there are three methods to assign costs to cost objects. Methods are direct tracing, driver tracing, and allocation. Direct tracing is the most accurate of the three, and should be used when possible. If value chain is defined as the cost object instead of product, more costs can be assigned by using direct tracing. Costing of value chains becomes more transparent with less cost assignment with driver tracing or allocations. (Hansen 2007, 733)

The model presented by Glad and Becker (1996, 69) includes five different phases which are based on Porter's value chain's five primary activities. The model assumes that costs from support activities are assigned to primary activities. It is relevant question whether support

activities have causal relationship with primary activities. If causal relationship exists between support and primary activity, then cost assignment is natural, but common administrative costs that are missing causal relationship should be shown separately from the value chains (Hansen 2007, 736).

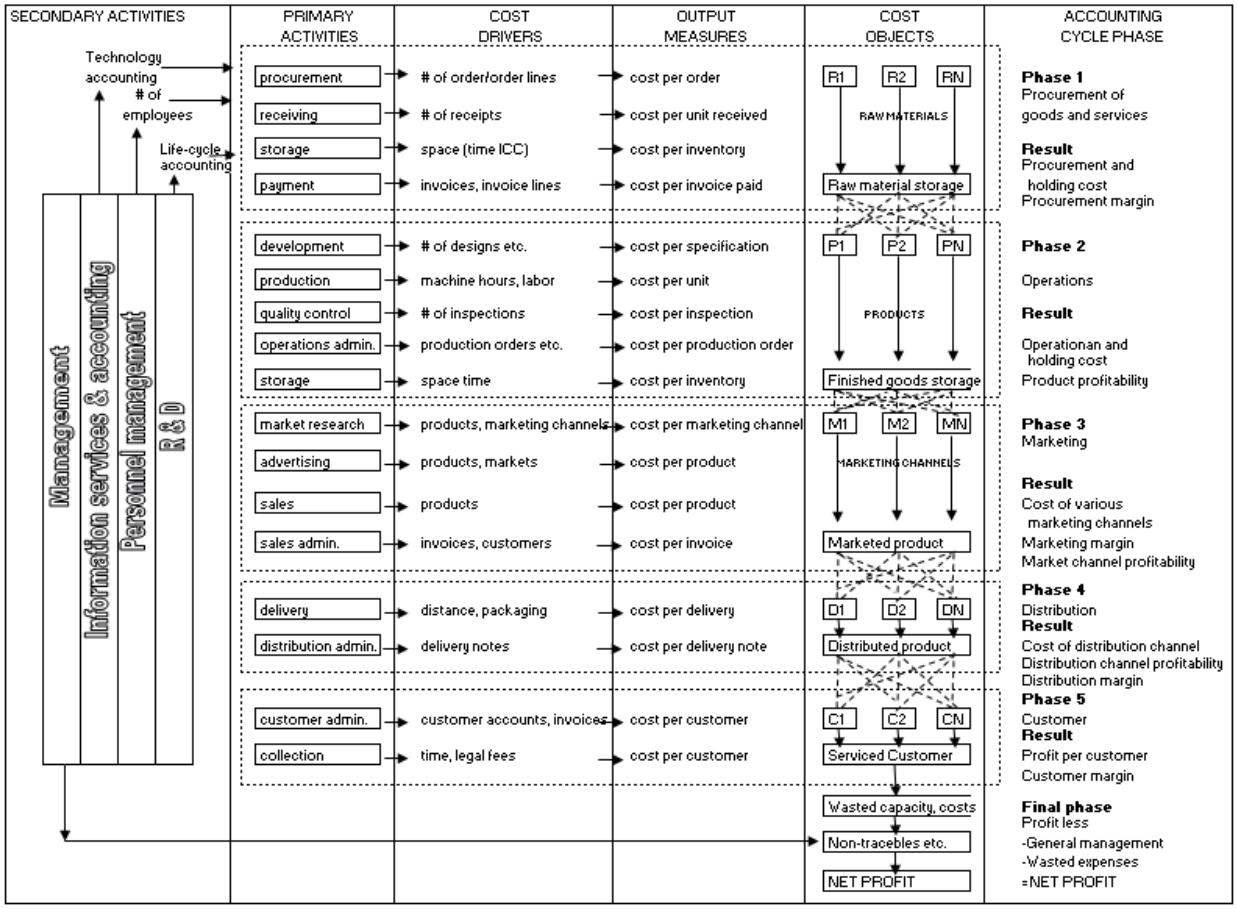


Figure 4-3 Model for assigning costs through a value chain (Glad & Becker 1996, 69, Figure 5.2 attachment)

The concept value stream was introduced in chapters 2.1 and 2.2. Value stream costing is a costing approach in which all associated activities and their costs are assigned into a value stream (Gordon 2010, 12). Value stream costing aims for simplicity and integrates accounting and production information with lean management concepts (Gordon 2010, 11). Value stream costing does not follow traditional definition of direct and indirect costs, but considers all costs as direct that belong into a value stream (Maskell 2006, 28). Costs that do not belong to any value stream are simply not included by value stream costing, but instead are considered as general support costs (Maskell 2006, 28). These so called monuments should not be allocated to the value streams, because they make value stream cost information distorted (Maskell, 30-31). There is no need to absorb overhead costs (Maskell 2006, 30)

Value stream costing seems simple way to assign costs, and is focused more on causality of costs than accuracy of costs. Purpose of value stream costing is to provide relevant, accurate, and understandable cost information to people managing value streams (Maskell 2006, 31). Value stream costing has been suggested as a solution to standard absorption costing (Maskell & Katko 2007, 155).

Value stream costing does not have limitations of financial accounting, and each weeks total value stream costs are purchases made during that week (Maskell 2006, 30). With the same logic, labor costs are not collected through tracking, but they are the sum of wages paid to people working in that value stream (Maskell 2006, 30). Objective of this study is not to implemented value stream costing as such, but use the existing concept in designing of the management accounting system.

Revenue is calculated in value stream costing as the amount if invoices processed for products manufactured in the selected value stream (Maskell 2006, 30). Value stream costing takes a cash-flow perspective on management accounting. Activity-based costing is seen as a model of resource consumption model instead of spending (Malmi 1991, 23). Value stream costing presents fundamentally different results as cash-flow based cost assignment model. Unlike activity-based costing, value stream costing provides a concept for designing a new management accounting system. Value stream costing will be used in the following chapters 4.2 and 4.3 in which the framework for designing a management accounting system is presented.

Value stream mapping is the core of value stream costing. Mapping determines people and resources involved in the value stream (Maskell & Katko 2007, 158-159). Machine cost for value stream is calculated based on the depreciation expense of machines from the fixed assets and depreciation system (Maskell & Katko 2007, 160). Maskell and Katko (2007, 162) present the three methods to charge support costs from value streams as direct charge, monument allocation, or no charge to value stream. Maskell and Katko (2007, 162) suggest that assignment of monument costs should be avoided, and people should be assigned directly to value streams.

One challenge of value stream costing is that no consideration is given to costs that do not belong to any value stream. Perspective of this study is to build an overall picture on profitability which requires the , and also support costs have to be included somehow. Approach taken by this study is that some support costs have to be allocated to the value streams. At least it is not making the situation worse from the current, as allocations play critical role in most companies

currently. Ideally there would be no need for allocations, but in practice there always is. In traditional costing products cause costs (Malmi 1991, 20), in activity-based costing activities cause costs (Malmi 1991, 20), and in value stream costing value streams cause costs (Gordon 2010, 12).

4.2. Framework for designing management accounting system into multiple supply chain environment

Value chains of a company were presented in chapter 2.1 as product, value stream, and internal supply chain. Entire organization was described as the cost object for costs that do not belong to any value stream or supply chain, but belong for the organization. Two-stage cost assignment model was introduced in chapter 3.3. Activity-based cost assignment model used to assign costs into a value chain was presented in chapter 4.1. All contribution from the mentioned frameworks will be brought together in order to build framework for management accounting system into multiple supply chain strategy. In chapter 4.3 the framework will be designed to support financial performance measurement of lean supply chain.

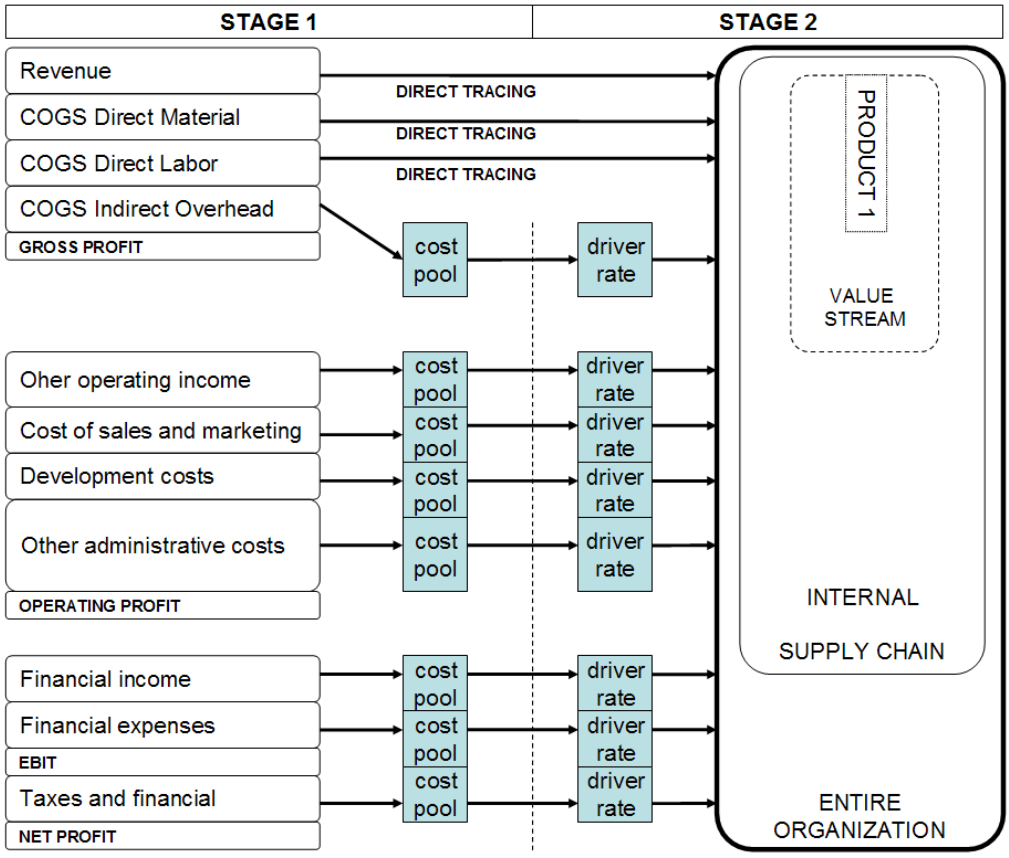


Figure 4-4 Value Chain Cost Assignment Model

Framework is presented in figure 4-4, and it integrates two-stage cost assignment model with the company's value chains. Two-stage cost assignment model has been traditionally used to assign manufacturing costs, but the new framework presented widens the scope by including all costs within the company. Framework will be called Value Chain Cost Assignment Model.

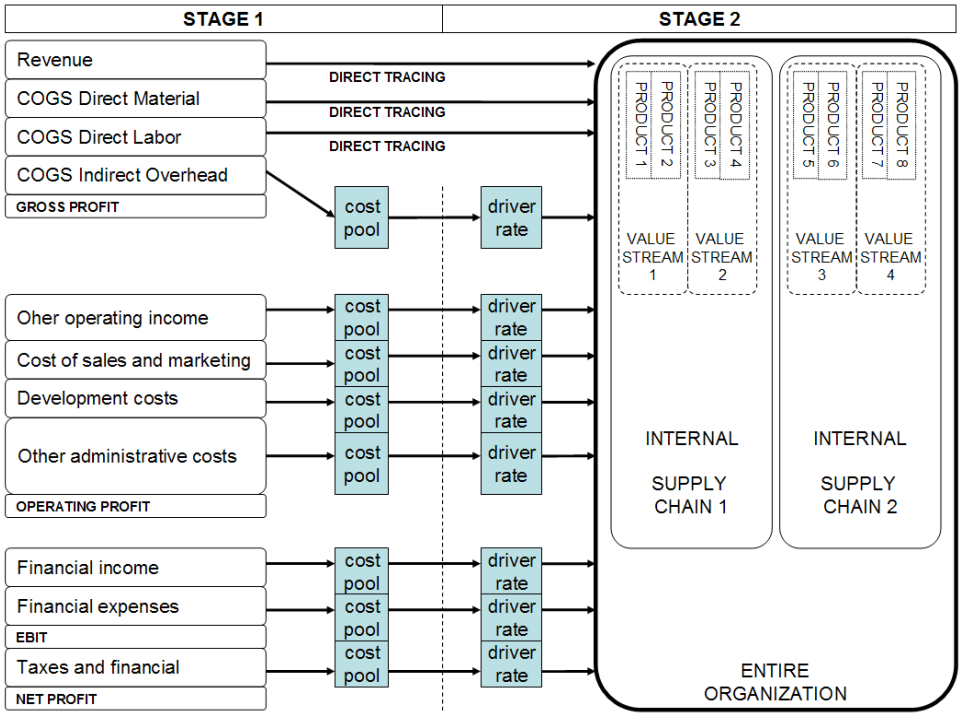


Figure 4-5 Value chain cost assignment framework for multiple supply chain environment

Framework allows comparison between management accounting system results and the income statement. Comparison between the two presentation of profitability and performance is tested with the case company in chapter 5.5, while the model is implemented into lean supply chain. It would be possible to build value stream for every product, but it is reasonable only in simple manufacturing environments. Assignment of costs becomes easier the bigger the chosen value streams are. Manufacturing teams, assembly cells, product lines, product families, and supply chains are different options for value streams, but the decision is mainly dependent on how work is organized in the company.

When company is pursuing lean strategy, the whole way of how resources are used changes. Traditional cost management practices like standard costing encourage using resources as efficiently as possible, because the unit cost decreases as more is produced. However in lean company overproduction is one form of waste, while lean companies focus on eliminating non-value-adding activities and using least amount of resources needed to satisfy customer demand.

Standard costing variances work against lean, as they encourage overproduction (Hansen 2007, 732). Hansen argues that distorted products costs result in failure of lean improvement activities (Hansen 2007, 732).

Cost systems become easily too complex and hard to understand for the decision maker. Another problem of traditional management accounting systems is that costs are calculated according to too general rules. It is more important for decision maker to understand the big picture, than to get cost information that is exactly correct. Figure 4-5 present the value chain cost assignment model applied into multiple supply chain environment.

4.3. Measuring financial performance of lean supply chain

Lean management has faced lot of interest lately. This chapter will concentrate on management accounting system design and performance measurement for the lean supply chain. Chapter 2.2 gave an introduction to lean supply chains, and presented some of special characteristics for measuring performance in lean environment. The previous chapters have raised a need for management accounting system that can support performance measurement in lean environment (Hines et al 2002, 53). The chapter aims answering the need by presenting how value chain cost assignment framework can be used to measure lean performance.

Cost and performance management has increased attention in supply chain context, and it is argued that entire supply chain should be included in the measurements (Slagmulder 2002, 76). Hines et al (2002, 57) argue that lean management lacks currently a global picture of process performance, while there are no concepts that provide cost information. Financial performance measurement is needed to measure business priorities and support continuous improvement. Cost information should support management in decisions concerning resources and related benefits. (Hines et al 2002, 57) Hines et al (2002, 55, 58) suggest that an integrated process based approach including lean management, cost management, marketing, and policy deployment, is the most effective to achieve competitive advantage.

Traditional cost systems consider mainly product as the cost object, and threat other potential cost objects like suppliers, customer, or groups of products either as general overhead that is arbitrary allocated to products or as period cost that is expensed directly through the income statement (Slagmulder 2002, 76). Activity-based costing offers an improved way to assign overhead costs to products in a more causal manner, but it has not affected to the idea of having different cost objects (Slagmulder 2002, 57). Treating suppliers and customers as cost objects

broaden the cost management's scope into inter-organizational without the joint action of suppliers and customers (Slagmulder 2002, 57). Even though product is the most common single cost object used by companies, some companies use groups of products as cost object, like product lines (Rikala 1997, 18)

Some authors argue that lean performance cannot be measured with the help of management accounting system. It has been claimed that the use of traditional absorption costing based accounting systems is one of the biggest obstacles for lean management (Johnson 2007, 7-8). Non-financial performance measurements provide the most important support for lean management and improvement. It is suggested in this study that lean performance can be measured also with financial performance measurements. It is also suggested as important to provide financial measurements to support lean, and help management to see points of improvement with greatest financial potential. Lean performance measurement model is presented in chapter 2.2, and is supplemented with financial aspect in this chapter.

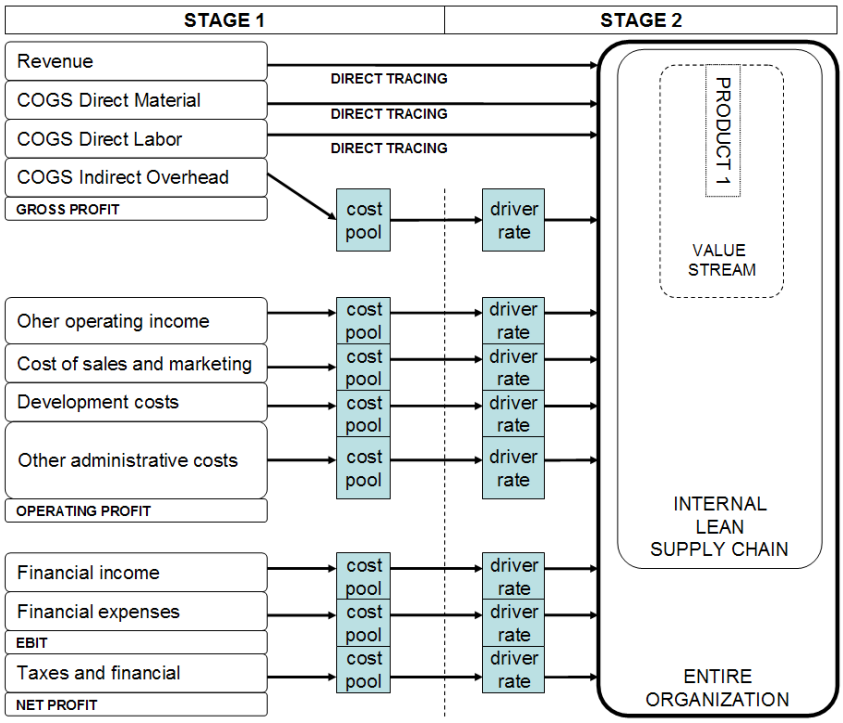


Figure 4-6 Two-stage cost assignment model for supply chain environment

The first objective of the study about developing a framework that can be used to design a management accounting into multiple supply chain strategy is answered in chapter 4.2. The second objective of the study is to implement management accounting system to support lean

supply chain. The model for lean supply chain implementation considers the special requirements of performance measurement in lean environment presented in chapter 2.2.

Figure 4-6 presents the framework applied into the lean supply chain. Framework represents two-stage model including the value chain perspective. Main purpose of this study is not on calculating exact product costs, but on understanding profitability of value chains. While supply chain provides aggregated presentation of profitability, value streams offer more exact picture, but lack some of the cost information that could not be reliably assigned to the value stream due to lacking causal linkages.

Non-financial performance measurement process for lean supply chain was presented in chapter 2.2. Figure 4-7 represents a modified lean performance measurement process from the financial perspective. Profitability information from management accounting system can be used in leading the lean supply chain improvement. Financial measurements are important while they allow supply chain performance to be linked with the income statement. Showing real profitability numbers allows comparison of supply chain and profitability with income statement results.

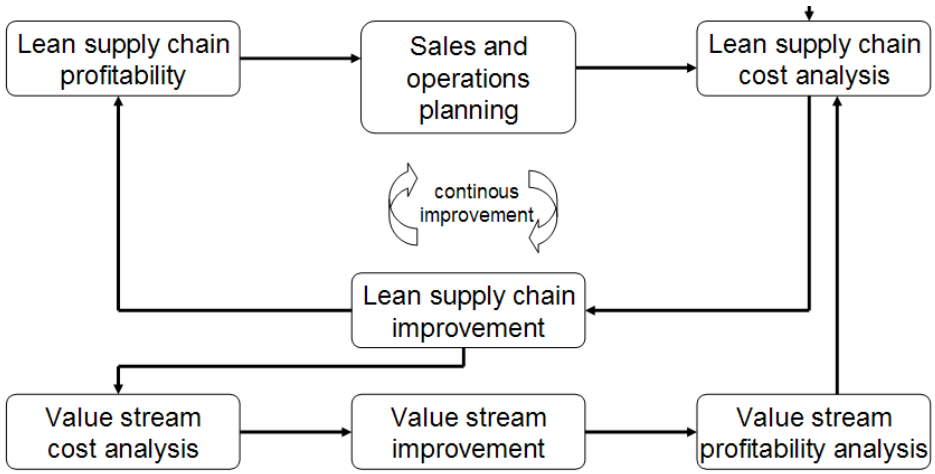


Figure 4-7 Using management accounting system results for measuring performance in lean supply chain

In activity-based costing each activity center includes cost pool for each resource category consumed by that center (Malmi 1991, 10). Cost pools are the results of the first stage-stage cost assignment, and represent the smallest groups of costs that can be further assigned to the final cost objects. The Value Stream Cost Assignment Model presented originally in chapter 4.2 defines cost pools as groups of accounts in specific cost center. Cost pools are grouped from

accounts and cost centers that can be assigned or allocated with a single cost assignment or allocation method to the final cost objects.

Example of value stream costing information is provided in table 4-2. Two-dimensional presentation of cost structure allows easier way for management to make resource decisions. In addition to financial information, managers need to follow also non-financial measures that show the causal factors affecting to the costs.

Table 4-2 Example of value stream cost information (Maskell 2006, 29)

Value Stream Process Steps	Material Costs	Outside Process Costs	Employee Costs	Machine Costs	Facilities Costs	Tooling Costs	Other Costs	Total Costs
Sales and Marketing			10,150	0			1,012	11,162
Customer Service			1,848	0				1,848
Purchasing			616	0				616
Materials handling			1,576	0				1,576
Parts Fabrication	63,544		3,322	1,529		2,011		70,406
Machining			4,728	0		2,466		7,194
Anodizing		32,433	0	0				32,433
Assembly	47,887		15,297	6,584		366		70,134
Shipping			630	0			101	731
Maintenance			1,576	0				1,576
Product Engineering			2,448	0				2,448
Quality Assurance			2,448	0				2,448
Cost Accounting			816	0				816
Managers and Supervisors			4,060	0	12,750		2,177	18,987
TOTAL	111,431	32,433	49,515	8,113	12,750	4,843	3,290	222,375

By combining several value streams together it is possible to calculate profitability of the whole supply chain. Table 4-3 presents an example in which total supply chain profitability is calculated by summing up all information from the value streams.

Table 4-3 Value stream based income statement (Maskell 2006, 31)

	Motors	Systems	Spare Parts	New Product Design	Support Costs	TOTAL
Sales	326,240	748,894	453,215			1,528,349
Additional revenue	0	0	12,422			12,422
Material costs	111,431	232,774	149,561	87,909	12,764	594,439
conversion costs	57,628	70,406	81,579	203,769	37,645	451,027
Outside process costs	32,433	22,991	22,661		7,531	85,616
Other costs	16,040	57,816	29,459	72,721		176,036
Tooling costs	4,843	12,544	6,588			23,975
Value stream profit	103,865	352,363	175,789	-364,399	-57,940	209,678

Profit centers and cost centers are normally evaluated based on income statements. In a typical situation company has a segmented income statement for each responsibility center. (Hansen 2007, 422) Income statements by responsibility centers are normally build exactly from the same information than the financial statement. The challenge is that these financial statements do not provide the necessary information for managerial decision making for two main reasons. The first reason is that responsibility centers offer only a small snapshot of the business processes, and they lack the big picture profitability information, which is necessary for true cost management decisions. Is it possible to assume that manufacturing and sales can optimize customer value delivery if both are observing only their parts of the costs or sales? Most companies use standard costing with full absorption costing system, which allocates manufacturing overhead costs to the products. This approach hides the cost of quality and costs of unused capacity.

When comparing the Value Chain Cost Assignment Model with the traditional job-order costing system, some major differences may be identified. In job-order costing, the first stage cost assignment is done from the general ledger to the main cost centers. Value Chain Cost Assignment Model assigns costs to the cost pools, which resemble more activities than cost centers. In the second stage traditional job-costing system assigns costs from the cost centers to the products, while in the presented framework costs are assigned from the cost pool to the value chains that represent the final cost objects. Traditional job-order costing system uses general allocation bases to assign indirect costs to the products, while the Value Chain Cost Assignment Model uses suitable driver rates for each cost pool. Value Chain Cost Assignment Model allows greater accuracy in cost assignments due to using wider cost objects than the job-order costing system.

5. Management accounting system design - Case Vaisala Oyj

5.1. Introduction to the case company

Vaisala Oyj is a global leader in environmental and industrial measurement. Vaisala was founded in 1936 by Professor Vilho Väisälä, and started as a producer of radiosondes. Today Vaisala employs about 1,400 people worldwide and provides a wide range of observation and measurement products and services. Customers are served in three business areas; meteorology, weather critical operations, and controlled environments. Vaisala achieved net sales of 253.2 million euros in 2010, and operating profit of 11.8 million euros. Vaisala is listed in Helsinki stock exchange. (Vaisala Stock Exchange Release 18.2.2011)

Vaisala's mission is to be the leading supplier of observations and measurement products and services to the selected customer segments. Leadership mission is achieved "by providing a comprehensive range of innovative products and services for each chosen segment with the right mix of performance, reliability and convenience to best fulfill the needs of the customers". According to CEO Kjell Forsén, Vaisala's organization "is structured to capitalize on global expertise with local implementation". (Vaisala corporate websites, 2010) Vaisala renewed its organization structure during the year 2008, rearranged its customer segments and strategic priorities, and made a transition from product leadership view towards more customer-oriented strategy.

Vaisala uses absorption costing to value inventories, and the same costs are used to calculate financial results for each business area. Vaisala has core competence in many levels of production from single sensors to instruments, and to whole systems. What makes this competence interesting is that Vaisala sensors are the core of the Vaisala instruments, and Vaisala instruments are the core of Vaisala systems. Vaisala has recently implemented a new ERP system in place in Finland, and the global implementation is ongoing. Vaisala is building new business infrastructure and competencies based on the new organization structure and information systems.

5.2. Vaisala's organization and supply chains

Vaisala has organized into three business areas; Meteorology, Weather Critical Operations, and Controlled Environment. Business areas consist of ten customer segments, and the sales

organizations. Customer segments consist of customers with similar needs, and each segment represents an attractive market in terms of size, sustainable growth and profitability (Vaisala corporate websites 2010). See figure 5-1 for Vaisala's matrix organization. On the other axis of the matrix, Vaisala can be divided into three main functions; Services, Products and Technology, and Operations. In addition to main functions, there are support functions like finance, human resources, and business development.

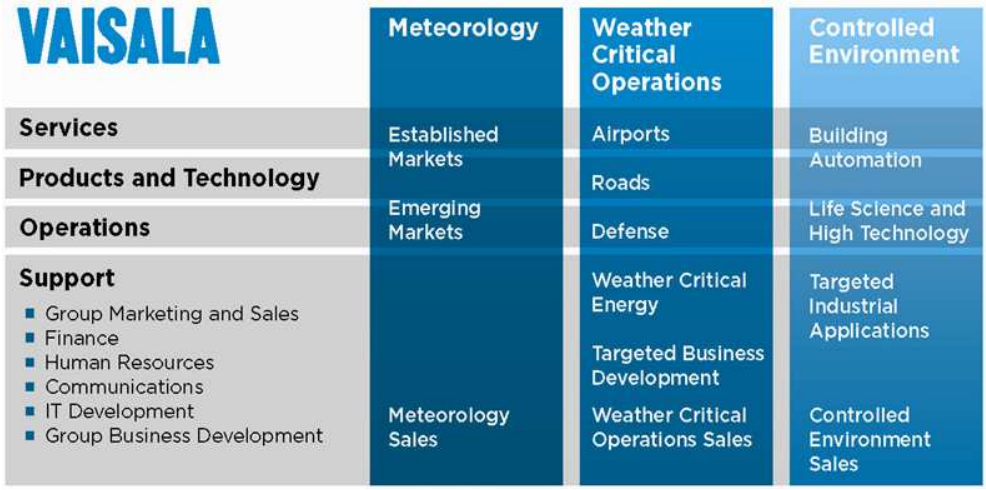


Figure 5-1 Vaisala's matrix organization (Vaisala Corporate presentation 2010)

Vaisala's ten customer segments provide wide range of different customer expectations, and several differing demand patterns. As mentioned in chapter 2.3, most of the segmenting efforts by companies are made for the purposes of sales and marketing. The challenge of segmenting is to identify operational requirements of customers, and use those as segmenting criteria. Behavioral segmenting includes the operational aspect, and some authors have suggested that the dominant buying behavior should be used as the single tool for segmenting (Gattorna 2006, 31)

Toivanen (2010, 54) suggests that there is need for multiple supply chain strategy, because Vaisala faces diversified customer needs with several business models. In addition to the research committed by Toivanen, some previous customer satisfaction surveys had also indicated similar needs, while same product faced a need for urgent deliveries in addition to normal deliveries. (Toivanen 2010, 54) This study does not consider the scenario of having the same product in several supply chains at the same time. For simplicity it is assumed that one product may belong only into one supply chain at once. Of course there is the possibility that a product may belong into several supply chains during its entire life-cycle (Toivanen 2010, 11).

Study made from Vaisala's customer preferences reveals that the current customer segmentation does not consider the operational requirements of customers (Toivanen 2010, 89). Toivanen (2010, 78, 89) suggests that Vaisala should serve its customers through three supply chain channels; agile, lean, and continuous replenishment. See figure 5-2 for Toivanen's framework. Management accounting system is built for Vaisala to support the proposed supply chains. Toivanen's proposition is used in this study.

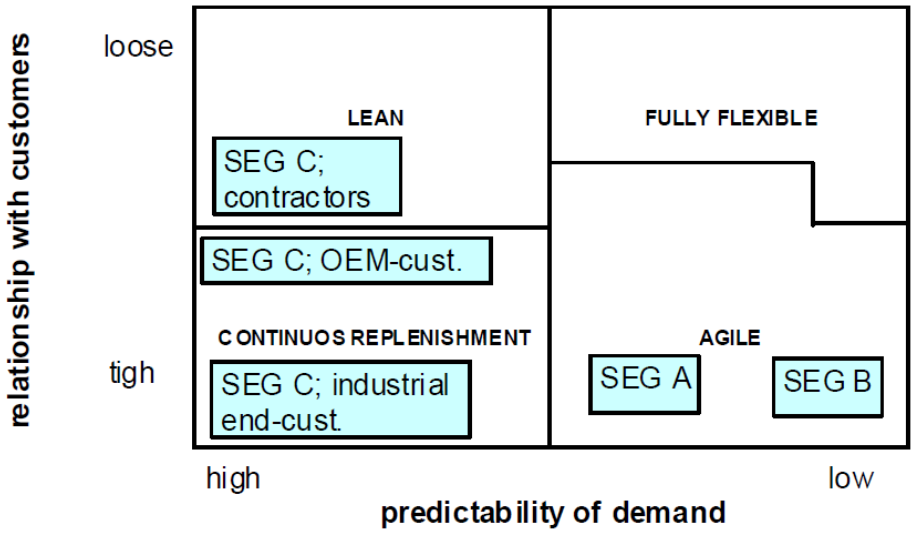


Figure 5-2 Proposal of a multiple supply chain strategy for Vaisala (Toivanen 2010, 78)

The presented framework of three supply chains provides an ideal basis for designing a management accounting system. Purpose of management accounting is not to track costs, but to help organization to reach its key strategic objectives. As it is assumed in this study, these three supply chains are the connecting factors of Vaisala capabilities, suppliers, and customers. Toivanen (2010, 65) divided part of Vaisala's existing customer segments into two groups, because customers within those segments could be separated into different supply chains based on their buying behavior. Table 5-1 presents the final outcome of Toivanen's study, and shows the linkages between Vaisala customer groups and the supply chains. Decision on the supply chain is made based on the largest importance percentage of the customer value attributes, but also on other criteria. (Toivanen 2010, 80)

Table 5-1 Linking Vaisala customer segments into the supply chains (Toivanen 2010, 80)

	segment	SEGMENT A	SEGMENT B	SEGMENT C
Demand profile	nature of demand	Sporadic demand; increase at the end of the year	Stable demand except few demand increases; increase at the end of the year	very stable and continuos demand
	volume of demand	low volume (less than 50 system deliveries in year)	40 % high volume (product deliveries), 60 % low volume (project deliveries)	very high volume
	predictability of demand	content easy to forecast, timing difficult to forecast	content easy to forecast, timing difficult to forecast	easy to forecast
Product profile	level of customization	customers wish customization (software)	customers wish customization (software)	customer do not wish customization
	product variety	product variety very important	product variety very important	product variety not critical
Service profile	lead-time	1-6 months for project deliveries	1-6 months for project deliveries, 1-4 weeks for product deliveries	1-4 weeks
	delivery mode	project deliveries	project deliveries, product deliveries (radiosondes)	product deliveries (instruments)
Relationship profile	tightness of the relationship	tight relationship	tight relationship	tight relationship wished by OEM- and industrial end-customers, loose relationship wished by contractors
	QFD matrix ranking 1 supply chain mode	agile	lean	lean, continuos replenisment

Vaisala customer groups are linked to the supply chains by Toivanen (2010, 78). Results from Toivanen's study are used to further link products to their primary supply chains. Vaisala has a wide offering of different meteorological and industrial measurement devices. Toivanen (2010, 74-75) presents a categorization of products into 26 groups, excluding services. The grouping of products revealed that some customer segments used a wide range of products from more than half of the product groups, while other segments were clearly focused on specific product groups containing about 25% of the product groups. (Toivanen 2010, 74-75) Vaisala's products are sold for a wide group of customers in different supply chains. By combining the customer data with the product sales it is possible to find out

Vaisala has a wide variety of products and services, which are used in multiple customer segments. Some of these products can be easily assigned into particular supply chains, but some others might be important for a several supply chain. For simplicity however, each product is

assigned into a single supply chain, the one that has been sold the most. It should also be kept in mind that the customer demand patterns are under constant changes, and product belonging into lean supply chain today might need agile supply chain tomorrow.

Toivanen (2010, 84) suggests that Vaisala should identify the needed changes in the current supply chain, and create new multiple supply chain network. Network should include channels called lean, agile, and continuous replenishment. Service levels and pricing decisions should be established for each supply chain channels separately. Toivanen also emphasizes the importance of understanding the cost structure of each supply chain channel. One product might belong into several supply chains at the same time, and therefore company should develop appropriate ways to respond into these requirements. However Toivanen suggests that it might be more appropriate to start supply chain implementation by defining dominant supply chains for the products. (Toivanen 2010, 84)

5.3. Current management accounting system and challenges

Vaisala uses standard costing system for its financial reporting. The same information that is used for external stakeholders is also used in internal decision making. In addition to general ledger accounts, costs are assigned to responsibility centers. Only part of Vaisala's responsibility centers are pure cost centers, while other are revenue centers, profit centers, or investment centers. However, the same terminology is used than in the case company, and all responsibility centers are called cost centers. For simplicity, Vaisala's cost centers can be presented in categories based on type of costs, see table 5-2.

Table 5-2 Categorization of Vaisala's responsibility centers

	Responsibility center category	Count	Type of costs included	Responsibility center type
1	Operations / Production	9 %	Variable costs	Cost center
2	Operations / Logistics	1 %	Variable and fixed costs	Cost center
3	Market segments	2 %	Fixed costs, sales revenue	Profit center
4	Research and development	10 %	Fixed costs	Investment center
5	Market segments / Service	9 %	Sales revenue	Revenue center
6	Service	7 %	Fixed costs	Cost center
7	Sales region costs	16 %	Sales cost	Cost center
8	Products and technology	7 %	Fixed costs	Cost center
9	Sales region costs	3 %	Fixed costs	Cost center
10	Administrative	9 %	Fixed costs	Cost center
11	Other	26 %	Other	Other
	Total responsibility centers	**100 %**		

Chapter 5.3 is partly based on an ongoing study by Hannonen (2011). In the case study Hannonen focuses on product costing in Vaisala's full absorption costing system. Hannonen presents detailed analysis of Vaisala's current traditional management accounting system, and provides suggestions for improving the system. In Hannonen's study the suggested management accounting system is build on full absorption costing, and it fulfills the mandatory regulations of inventory valuation set by the accounting standards. The focus is on assigning manufacturing overhead costs to support product costing. (Hannonen 2011)

As mentioned in chapter 3.2, use of standard costing assumes that cost rates are already calculated at start of the year. Everything that differs from the standard costs will be transferred to the variance accounts. Analyses of variance accounts would potentially indicate decision maker about how estimated standard costs differ from the actual costs. However, variance accounts do not provide much of useful information, because many times reasons behind the differences are too difficult to find. Usually only few people are able to analyze variance accounts in the company. For this reason, managers can rarely use standard costing information to support their decisions.

Vaisala uses job-order costing method to assign indirect manufacturing costs to products. Direct material and labor costs are assigned to products with direct tracing. As described in chapter 3.3, job-order costing is normally used in multi-product business to assign direct costs to jobs, after which products absorb a fair share of overhead costs. In Vaisala, absorption of overhead costs is based on annually calculated recovery rates (Hannonen 2011). Recovery rate is calculated by dividing the value of overhead costs of the manufacturing department with the corresponding direct costs of the manufacturing department.

Recovery rate is a percentage that is used to assign overhead costs to each job-order, every time direct costs are assigned to product. For example, if recovery rate would be 10% and direct labor cost would be 30 € for a product, then overhead cost of 3 € would be assigned to a job at the same time while the direct labor cost 30 € is assigned to the product. Vaisala uses two different types of recovery rates, one for labor, and one for material (Hannonen 2011).

Two-stage cost assignment model can be used to present Vaisala's process of valuing inventory with standard costing system. Two-stage cost assignment model represents how indirect manufacturing costs can be assigned from each manufacturing department to products belonging into that department. Each manufacturing department has its own cost center. Some indirect

manufacturing costs are assigned to the support cost centers. To assign all costs to products, costs from support cost centers are assigned to manufacturing departments and further to products with predefined departmental recovery rates. (Hannonen 2011)

Indirect material costs are assigned to the products through manufacturing departments as in figure 5-3. All indirect manufacturing costs are assigned to products either through manufacturing or labor related cost assignment rules. Some cost centers are considered indirect manufacturing costs, but do not represent any specific manufacturing department. Costs from support cost centers are assigned to department cost centers as indirect material or labor costs, depending on whether cost is seen closer to the material or labor related costs (Hannonen 2011). In figure 5-3, recovery rate for indirect material is calculated annually by dividing the value of indirect material costs with direct material costs. Each manufacturing department has specific departmental recovery rate that is used to assign overhead costs for the products that belong into that manufacturing department.

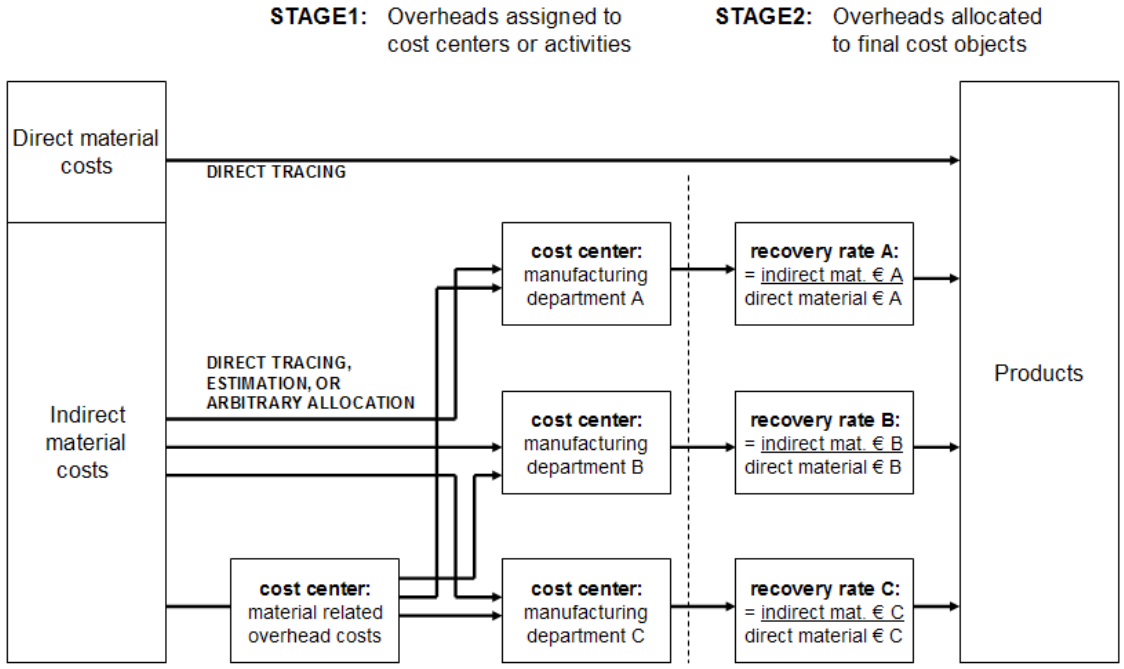


Figure 5-3 Assignment of material costs to the products in Vaisala's standard costing system

Direct material costs are assigned to products by using direct tracing. In Vaisala's job-order costing system direct tracing means that each job has a predetermined material usage, and when job is manufactured, the corresponding material cost is assigned for the job. Figure 5-4 describes the assignment of labor costs to the products. Direct labor costs are assigned to products also through the use of job-order costing system, in which every job is given a labor time it takes to

manufacture the job. When direct labor cost is assigned to the product, the share of indirect labor cost is included to the costs by using predetermined recovery rate. Indirect labor cost is assigned to products through manufacturing departments, by using the same principles than in the assignment of indirect material costs. Recovery rate is calculated for each manufacturing department by dividing the departmental indirect labor costs with the direct labor costs of that department.

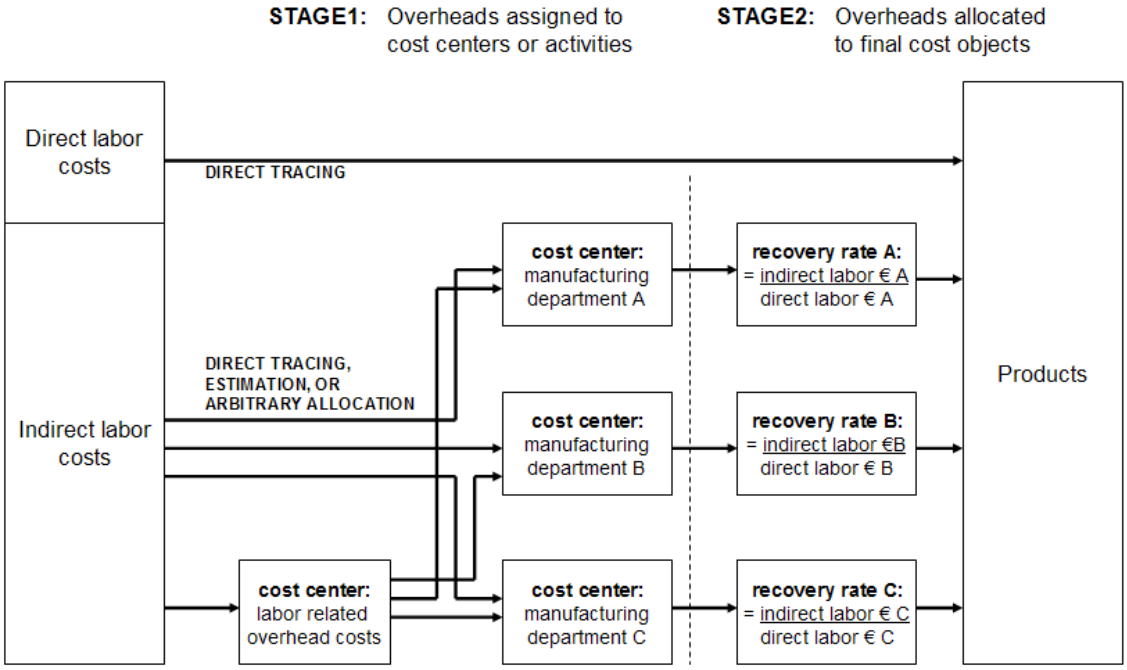


Figure 5-4 Assignment of labor costs to the products in Vaisala's standard costing system

As described, Vaisala's standard costing system assigns costs through two cost types, material costs and labor costs (Hannonen 2011). Some companies use only single cost type in assigning their indirect manufacturing costs. Despite the division of material and labor costs, Vaisala's cost management system principles may be seen simple. Simplicity of cost assignment principles leads to product costs that do not present true cost structure of individual products.

Vaisala's product cost information is used for inventory valuation and decision making purposes by different internal stakeholders. The risk of using distorted absorption costing information is that managers might get wrong picture about profitability, and assume wrong margins based on standard costs. Another defect of current cost information is that due to standard costing it has become challenging for managers to interpret even the cash-flow based period costs, while the cost reports are presented with the standard costing based information.

Vaisala uses average costing to value material in the inventories. Average costing means that the cost of a purchased item is updated every time a new material receipt is made to the stock. Vaisala's standard costing system calculates predefined recovery rates to assign indirect overhead costs to the products. In an ideal situation standard costs equal to the actual costs, and variance accounts will result in zero. In practice, it is impossible to know future cost beforehand, meaning that part of the costs will go to the variance accounts. Managers who follow their product costs do not see whether product related costs are increasing or decreasing. Cash-flow based management accounting system provides the only possibility to understand real costs that were spent during the period. Standard costing system is not interested about real costs, but it is interested on valuing inventory according to the accounting standards.

Chapter 3.2 introduced the problem of full absorption costing, in which indirect manufacturing costs are treated as inventoriable costs instead of period costs. Accounting standard require companies to assign all indirect manufacturing costs to the products for inventory valuation. For companies that build large inventories, profit in the income statement changes depending on how much products are manufactured to the inventory instead of selling them during the same period. Vaisala produces most of its products through mass customization, which has the implication that there are only a small amount of finished goods in the inventory. Due to the small amount of finished goods inventories, not that much indirect manufacturing cost is probably assigned to the products. Bigger challenge of Vaisala's cost information is that the current cost information is distorted, and do not serve management in their decisions or understanding. Current management accounting system is based on full absorption costing, and is used to calculate product costs. Clearly there is a need for new management accounting system.

5.4. Using framework to design management accounting system for Vaisala

This chapter uses the framework from chapter 4.2, and implements it into the case company Vaisala's business environment. As described in the previous chapter 5.3, Vaisala operates in a multiple supply chain environment. Framework is used to design a management accounting system to support the multiple supply chain strategy. Framework is designed by assuming that Vaisala has three supply chains, which consist of customer segments or groups based on their buying behavior (Toivanen 2010). Implementation is taken into practice in chapter 5.5, while management accounting system is implemented to the lean supply chain.

Concept of supply chain for Vaisala is defined by Toivanen (2010). Toivanen introduces three supply chains that consist of customer groups with similar buying behavior. Product is defined as any item that is sold to customer, whether it is originally manufactured or purchased by Vaisala. Definition of value stream for Vaisala is the most interesting, while the role of value stream in cost assignment is critical. Value stream was already defined in the chapter 2.1 as a group of products that have common characteristics in their design and production. Table 5-3 presents the potential value streams for Vaisala to group the products.

Table 5-3 Potential value streams for Vaisala

Product Group Name	Grouping Criteria
Product Family	Products are suitable for similar purposes
Product Line	Products have common characteristics by their design
Assembly Cell	Products are manufactured in the same cell
Manufacturing Team	Products are manufactured by the same team
Production Department	Products are manufactured in the same department

Selection of value stream has to be made by considering two major criteria. The first criterion is that does the selected value stream belong to a specific supply chain. Supply chains are build based on customer buying behavior, and single products can be assigned to supply chains by analyzing which customer groups sell product the most. When the group of products is smaller, it is probably easier to find primary supply chain for the value stream. Value stream has to be existing grouping of products whose performance can be measured and in which products share the same resources.

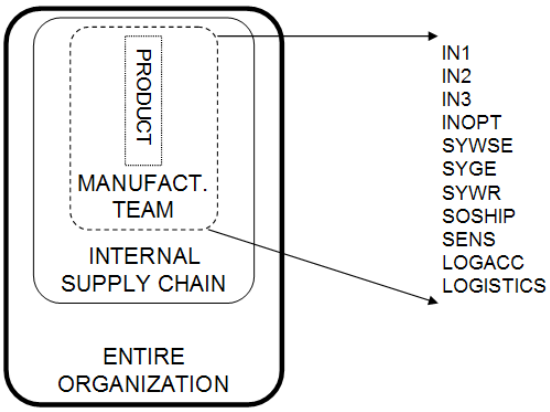


Figure 5-5 Choosing manufacturing team as value stream in Vaisala

Based on the mentioned criteria and discussions with managers, manufacturing team was selected to present Vaisala's value streams. Manufacturing team is selected to present value

stream, because it is an existing representation of products that share the same resources. Manufacturing teams can be treated as cost objects in the management accounting system. According to initial analysis in most cases products within a team belonged into a single supply chain. Not all products in a team belong into the same supply chain, but in order to keep the cost assignment process simple, all products within a team are treated as belonging into same supply chain. As a result of the analysis it has been recommended that the products with differing supply chain should be transferred into a team which supply chain suites them is properly selected. Some products might belong into a different supply chain than other products within that team. When that happens, those products should be moved into another team that is part of correct supply chain. Figure 5-7 describes the selected value chain setup for Vaisala.

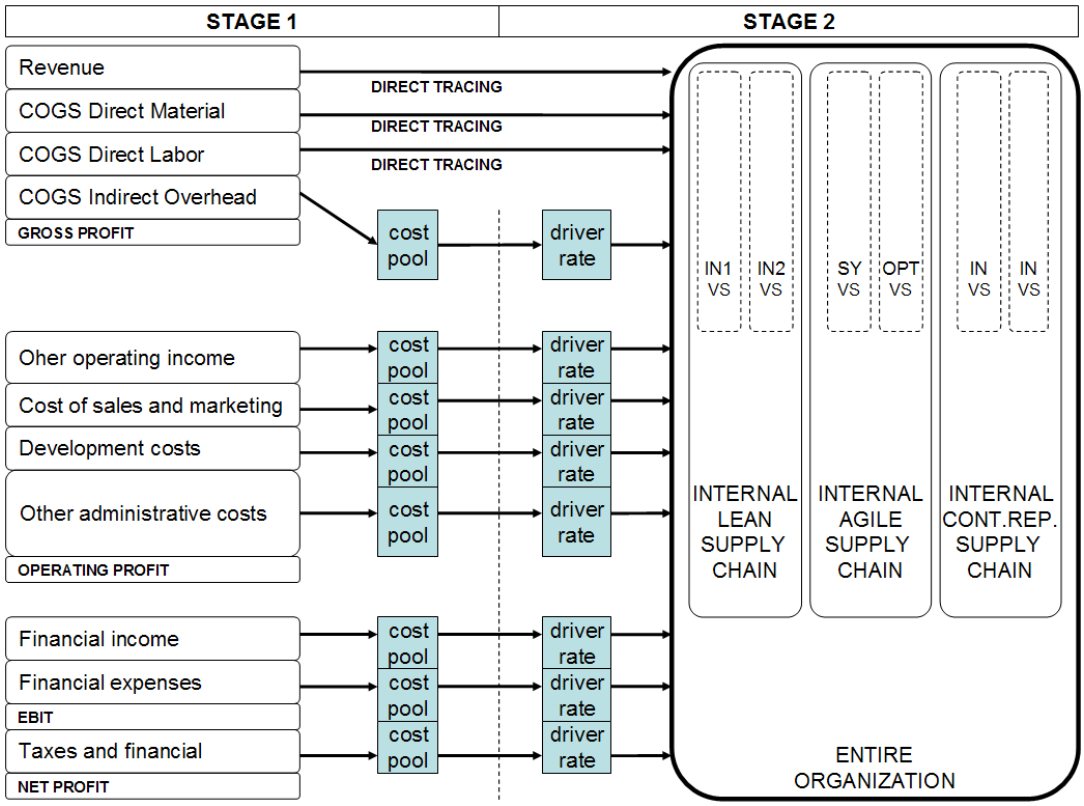


Figure 5-6 Presentation of Vaisala supply chains through the Value Chain Cost Assignment Model

Vaisala's manufacturing operations consist approximately of ten teams, which are partly presented in figure 5-5. Vaisala's products' demand was analyzed in different customer groups or segments. Each product's primary supply chain was chosen based on the customer segment in which product was sold the most. Analyses showed that single manufacturing team included products from multiple supply chains, but it was possible to decide primary supply chain for each team. Even though each team included products from multiple supply chains, primary

supply chain could be assigned for most of the manufacturing teams. Objective of this study is to design management accounting system to support Vaisala's business.

The framework suites well into Vaisala's multiple supply chain strategy, while providing opportunities for new perspectives on profitability. Framework provides possibilities to compare income statement results with the management accounting system results. Figure 5-6 presents the framework applied for all three supply chains. All three supply chains have different needs from the management accounting system, but the same concept should be used to compare the supply chain results, and to analyze at least overall profitability of the entire organization. Chapter 5.5 implements management accounting system to the lean supply chain in practice and analyses how framework can be used as a practical tool. To limit the study, the implementation is done for the framework, but analysis of financial results is not in scope of the study.

5.5. Implementing value chain cost assignment model into lean supply chain

Lean supply chain has been argued to be driven purely with non-financial information. Framework presented in this study is suggested to provide cost and profitability information that can be used also for lean supply chain financial performance measurement. As a result of analyzing primary supply chains for products, three Vaisala's manufacturing teams were argued to belong into lean supply chain. The manufacturing teams are IN1, IN2, and IN3. Implementation of the management accounting system is done for lean supply chain consisting of these three manufacturing teams, and all products that belong into the teams despite the primary supply chain of the product itself. Figure 5-7 presents overall picture of the cost assignment model implemented into Vaisala's lean supply chain.

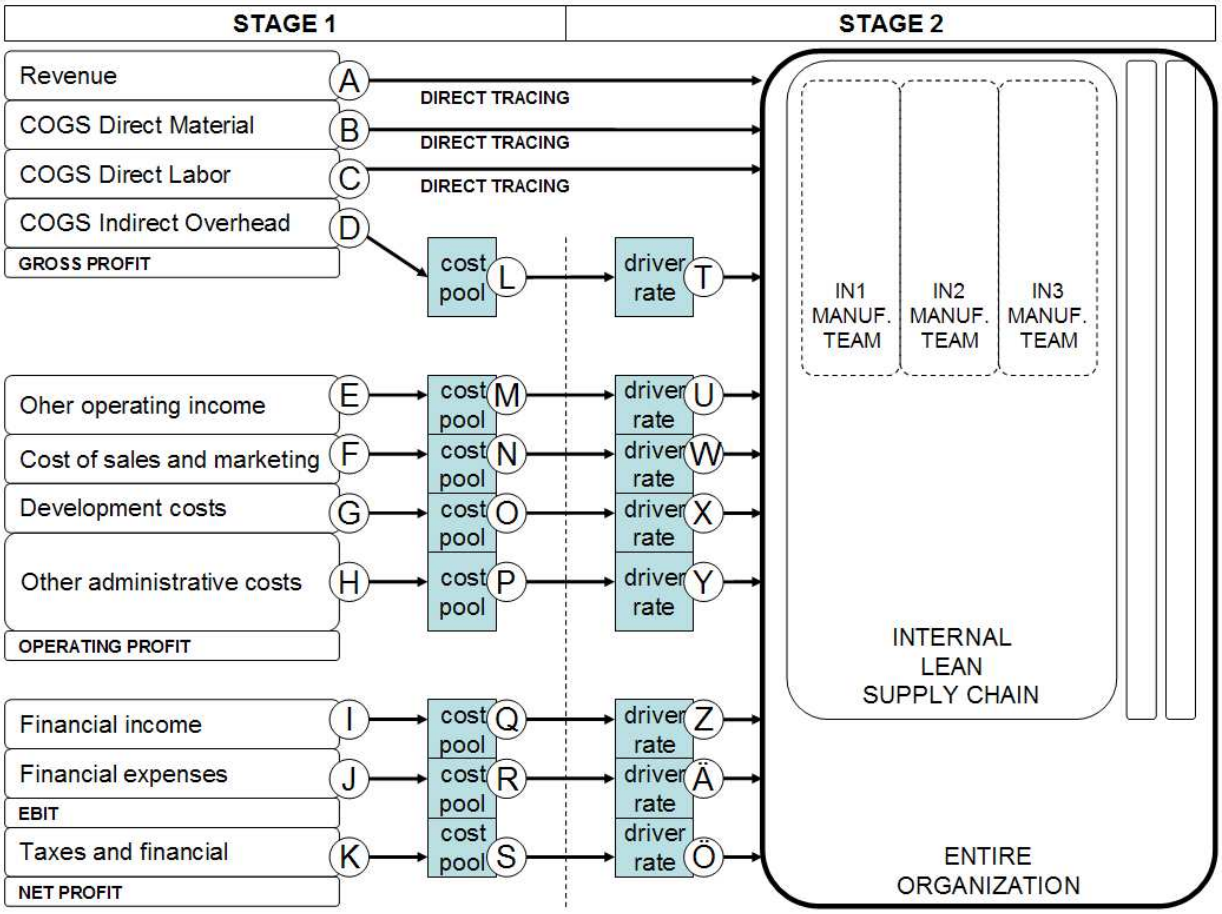


Figure 5-7 Cost assignment model implementation for Vaisala's lean supply chain

Value Stream Cost Assignment Model assigns revenue to the products with direct tracing. Figure 5-8 represents how revenue is treated by the cost assignment model. Revenue is assigned to products straight from the order lines. Each order line has item, and each item belongs into a specific manufacturing team which represents value stream. The implementation is done for lean supply chain, while other supply chains are treated as single cost objects in this study. Items that belong to other than lean value stream included to the other cost objects representing agile and continuous replenishment. While revenue is calculated by using values from the sales order lines, it might differ from the revenue shown in the general ledger account. Revenue from general ledger accounts is included to the management accounting system for comparison. We can easily calculate revenue for value stream by summing up values for all items that belong into that value stream and are sold during specified period.

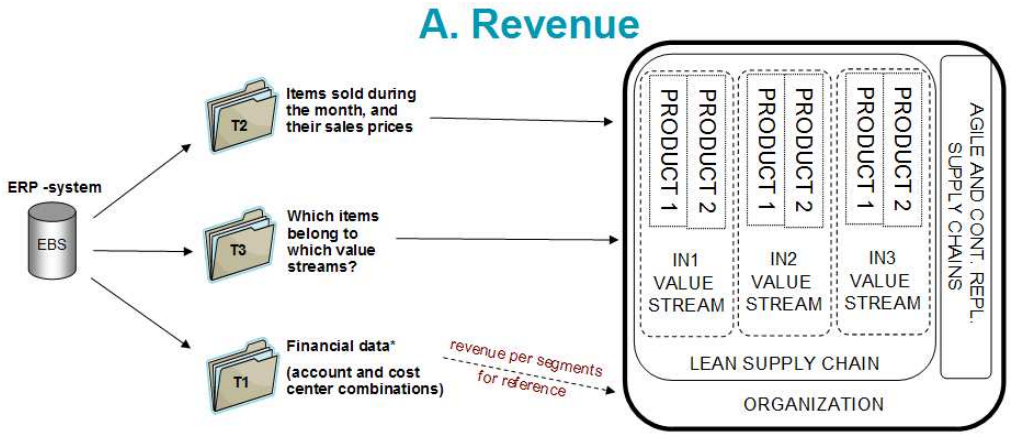


Figure 5-8 Assignment of revenue into products

Direct material costs are also assigned to products by using direct tracing, as described in the Value Chain Cost Model in figure 5-7. Detailed description of assigning direct material costs to products is presented in figure 5-9. Vaisala's current full absorption costing system uses direct tracing of material costs to the products. The assignment information for direct material costs is taken from the absorption costing system, and used as such in the new management accounting system.

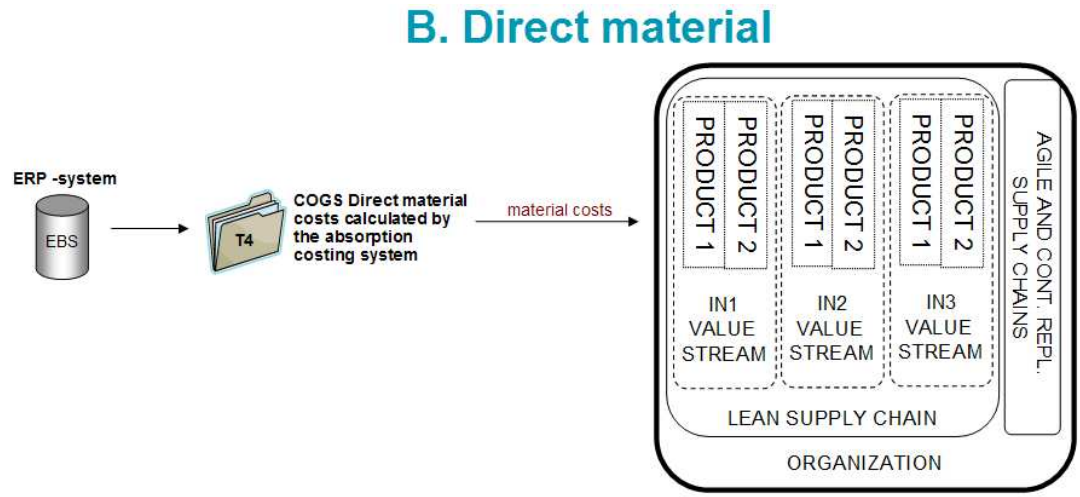


Figure 5-9 Assignment of direct material costs into products

Direct labor costs are also assigned to the products by using direct labor costs from the absorption costing system. Cost assignment is described in detail in figure 5-10. As a caution however, direct wage costs are compared with the direct labor costs of absorption costing system. Possible difference between the direct labor costs is assigned to the correct value stream instead of the products.

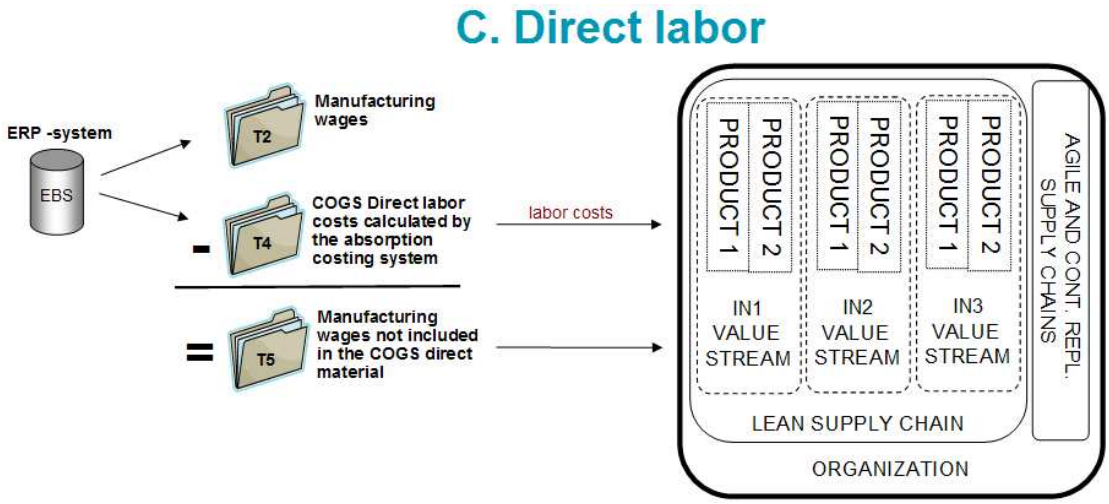


Figure 5-10 Assignment of direct labor costs into products and value streams

Assignment of indirect overhead costs is done through two stages. Indirect costs presented by the Value Stream Costing Model include all manufacturing related costs that are also included in product inventory values by full absorption costing system. The biggest difference in the treatment of indirect costs is that while absorption costing system assigns all indirect costs to the products, the Value Chain Cost Assignment Model assigns indirect costs to the value streams. There might be conditions in which indirect manufacturing costs do not causally belong to any value stream, and costs have to be assigned to the supply chain. The desire is to assign all indirect costs to the value stream in order to keep the logic clear, enable comparisons with the absorption costing system.

As presented in chapter 5.3, Vaisala's absorption costing system divides overhead costs in two main groups, material and labor overheads. Vaisala's standard costing system calculates difference between standard and actual costs, and assigns any differences to variance accounts. Variance accounts are also included to the income statement while calculating the net income. Absorption costing does not provide operations manager ways to notice any variation in costs. Variation and changes in costs will be noticed by people analyzing variance accounts, so direct feedback loop is missing from the process. Variance accounts are criticized for being difficult to interpret.

Value Chain Cost Assignment Model divides indirect manufacturing costs into multiple cost pools based on causality of costs. Purpose is to assign costs further to value streams by using causal driver rates to assign suitable amount of costs between value streams. The mentioned second stage cost assignment method resembles very much with activity-based costing, in which

cost pools would be called activities. In the first stage, costs are assigned to the cost pools. Figure 5-11 presents the first stage cost assignment for the example cost pools that are derived from the indirect costs.

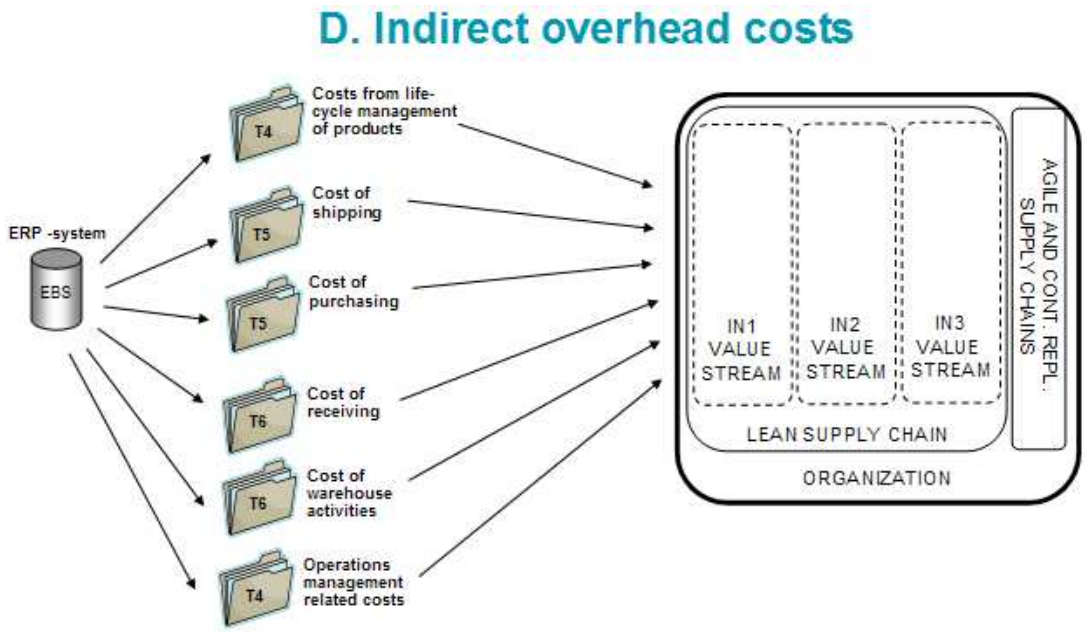


Figure 5-11 Assignment of indirect manufacturing costs

Table 5-4 presents examples cost pools that are used to assign indirect manufacturing costs. Cost drivers are used to costs in the stage two from cost pools to the value streams. An additional purpose of the selected cost drivers is to provide financial ratios that can be used to follow the future development of costs.

Table 5-4 Cost pools for indirect costs, and cost drivers for assigning cost to value streams

Cost pool / activity name	Cost driver description
Life-cycle management	Number of products
Shipping	Number of shipments
Purchasing	Number of PO's
Receiving	Number of receipts
Warehouse activities	Number of warehouse locations
Operations management	Revenue earned

Fixed and administrative costs are presented with the letters E-F, and they are usually expensed from the income statement during the period they occur. Inventory valuation does not consider those expenses into the products, or neither are they traced into any other cost objects in absorption costing. Value Chain Cost Assignment Model provides a possibility to assign costs to

the products, value chains, or simply to the supply chains. Costs are assigned to internal supply chains, in order to keep the comparison of financial statement and new management accounting system simple. Figure 5-12 presents the assignment of fixed and administrative costs to the supply chains.

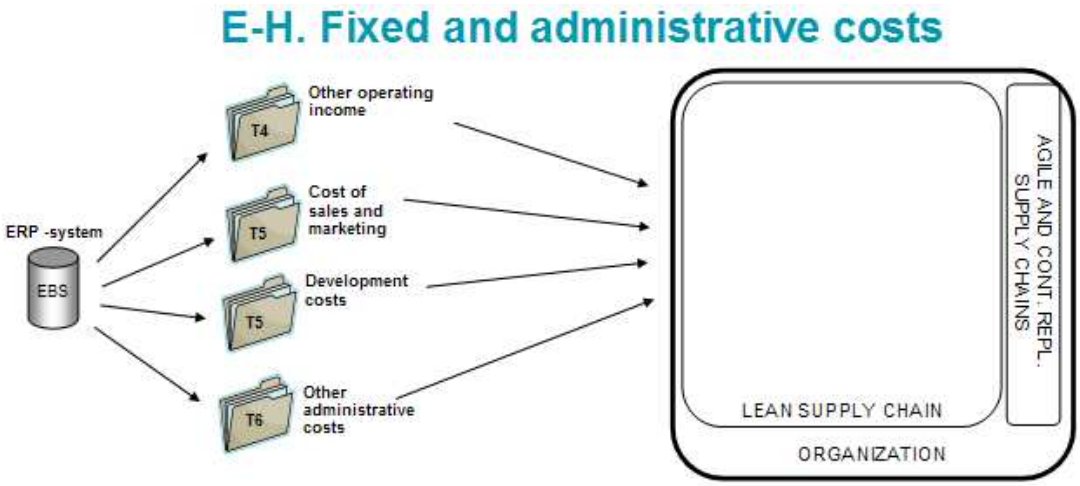


Figure 5-12 Assignment of fixed costs to the internal supply chains

The last group of costs consists of financials and taxes. These costs have to be assigned to the organization, while they support all supply chains within the company. Figure 5-13 illustrates the assignment of organizations related costs.

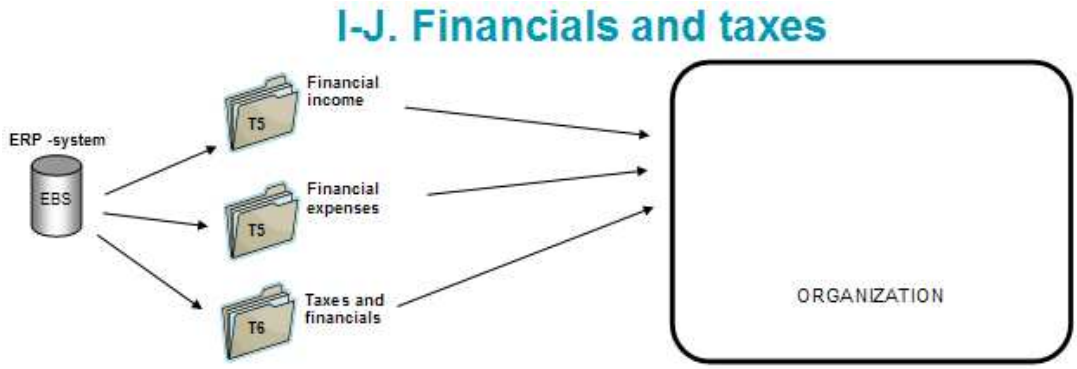


Figure 5-13 Assignment of financial expenses to the organizational value chain

Chapter 3.1 discussed the role of absorption costing as the inventory valuation method for the financial statement. The absorption costing system of the case company is not being affected due to its important role in valuing inventory for financial reporting. However, a separate management system is needed to implement the Value Chain Cost Assignment Model for Vaisala's lean supply chain.

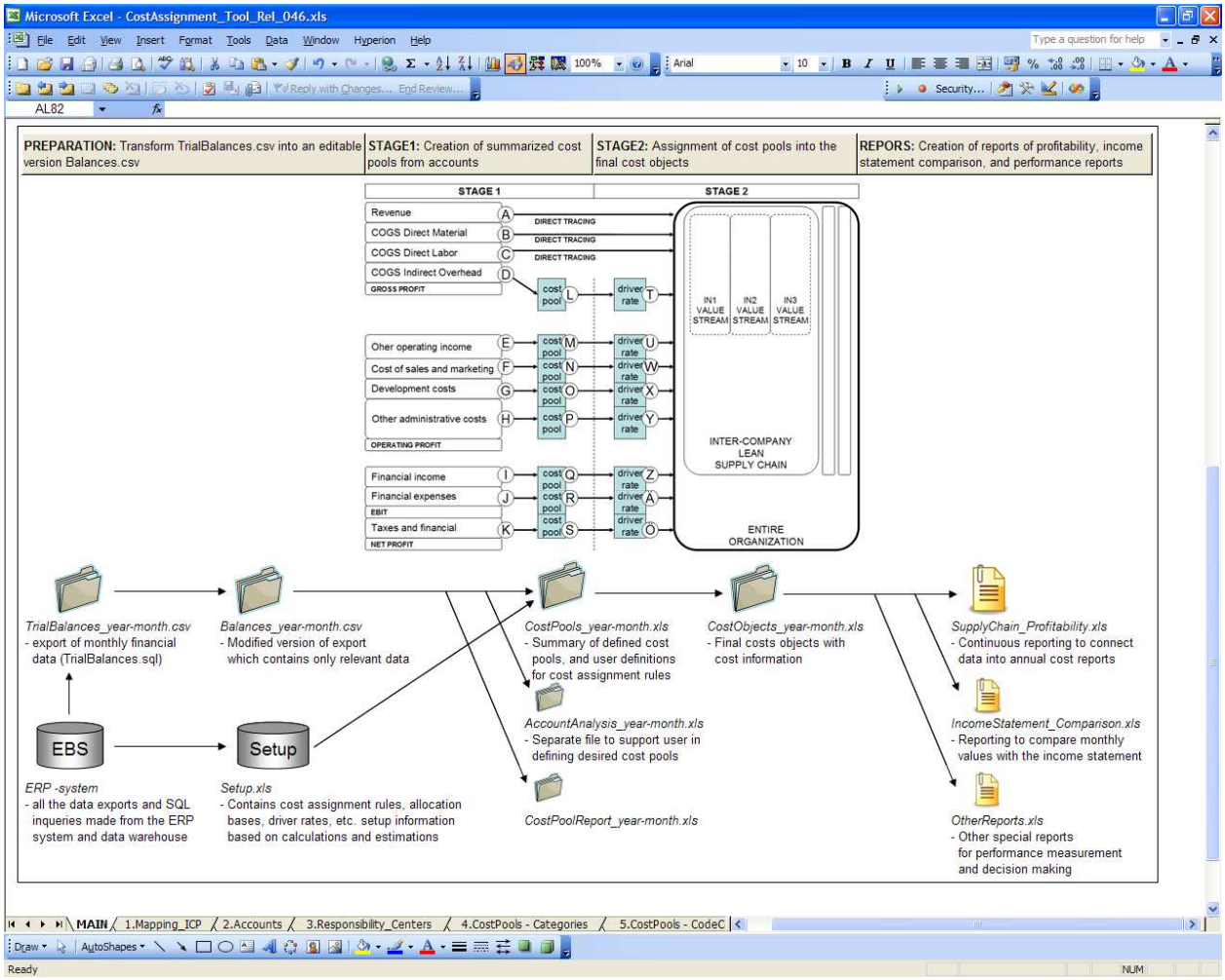


Figure 5-14 Screenshot from Vaisala's excel-based Cost Assignment Tool

Next step for building management accounting system is to prepare a tool that assigns costs first from general ledger to the cost pools, and then from cost pools to the value chains. Excel-based pilot-version of the tool is presented in figure 5-14. Tool consists of four main functionalities called Preparation, Stage1, Stage2, and Reports. Each functionality contains is a separate macro that has been programmed into excel by using Visual Basic for Applications. All the functionalities are needed to assign Vaisala's costs from the accounts to the selected cost objects, mainly to supply chains and manufacturing teams.

The first functionality is called Preparation, which is simply an extra step that prepares data for further processing. The next step is called Stage1, which transforms the account and cost center information into summarized cost pool information that is easier to interpret and process further. The third step, Stage2, is the most complex. It assigns costs from cost pools to the final cost objects by using user defined driver rates. Direct manufacturing costs have been assigned by cost tracing with data received from the ERP -system. Driver rates have been calculated by analyzing

transactional data from the ERP -system, and cost allocation rules are based on management estimates.

The fourth and last functionality of the cost assignment tool is Reports. Main objective of the functionality is to link monthly data with the previously received cost data. Another objective is to compare the cost information with the income statement based information. Also other reports are generated based on the data to support performance measurement, and managerial decision making.

Chapter 2.2 and value stream costing literature have suggested that weekly reporting of value stream results would provide managers the necessary frequency for cost information. However, it is seen more realistic to implement monthly frequency for the pilot tool. Period of one month is partly selected due to the limitations faced in gathering the trial balance data from the general ledger accounts. A strong argument for monthly reporting is that for example depreciations are included into the general ledger accounts monthly. Tool is run separately for each month. In case major changes are made to the cost pools or cost assignment rules, it might be necessary to re-run also the previous months costs to keep the information comparable between different months. Annual and quarter cost information is calculated with a separate reporting tool that combines the cost information calculated separately for each month.

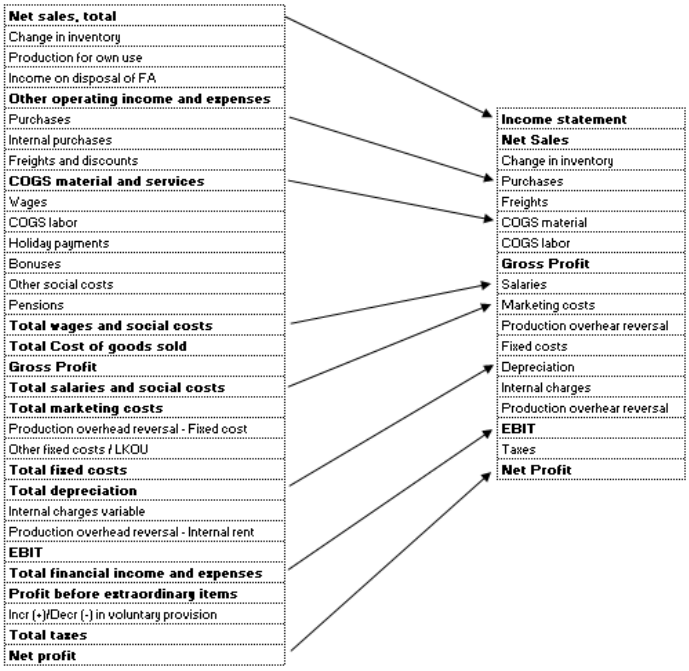


Figure 5-15 Summarizing accounts into account categories

In order to find the best possible set of cost pools, the cost information needs to be analyzed each time after running the tool. After running tool for some periods, costs pools start to settle, and less changes are needed in the cost assignment rules. Smallest cost unit of the management accounting system consists of an account in a specific cost center. In the first stage the user basically creates the cost pools and chooses which account and cost center combinations will be linked with specific cost pools. Challenge of the first stage is the existence of hundreds of different accounts and tens of cost centers. Going all through would mean assigning all together thousands of account and cost center combinations. Going through so many small cost units does not make sense, and relevance would easily be lost.

To make determination of cost pools easier, user starts by categorizing the accounts and cost centers into bigger groups that include costs that can be handled in the same way. Categorization process of accounts is presented in the figure 5-15. After running the tool for some periods, the categorization of the accounts and cost centers will probably settle, and not so many changes will needed. Table 5-5 represents examples of both account categories, and cost center categories set up by the user.

Table 5-5 Categorization of Vaisala's account and cost centers

Account name	Account Category
Sales	Net Sales
Sales, ext EU and Export	Net Sales
Production for own use	Net Sales
Wages	Wages
Remunerations, fees	Wages
Overtime claims	Wages
Wages for illness, accidents	Wages
Absence payment	Wages
Holiday pay/compensation	Wages
Salaries	Salaries
Salaries -Training	Salaries
Remunerations, fees	Salaries
Overtime claims	Salaries
Brochures	Marketing costs
Representation/Entertainment costs	Marketing costs
Business gifts	Marketing costs
Other marketing costs	Marketing costs
Rent/office space/facilities	Fixed costs
Rent/leases office equipments	Fixed costs
Other rent/leases	Fixed costs
Training	Fixed costs

Responsibility center name	Responsibility center Category
Responsibility Center Description	Responsibility Center Category
HEL OPS Management	OPS Management
Product life cycle	OPS LCM
Global logistics	OPS Logistics
HEL APS	Segment revenue + fixed costs
HEL DEF	Segment revenue + fixed costs
HEL EMM	Segment revenue + fixed costs
HEL RDS	Segment revenue + fixed costs
Upper Air	R&D
Data collection syst and disp	PTE
HEL PSE Common	Service fixed costs
HEL SER Cust commitment	Service fixed costs
WCO Management	Segment fixed costs
CEN Management	Segment fixed costs
HEL Field services	Service fixed costs
Sensors and Transmitters	PTE
Prod management common	R&D
Surface sensing	PTE
HEL APS Applications	Segment fixed costs
APS Offering	Segment fixed costs
DEF Applications	Segment fixed costs

Running the program Stage1 results in a report that presents total values of the general ledger account through the account and cost center categories set up by the user. See table 5-6 for the report, and note that values on the table are just examples, and they do not represent real values.

Table 5-6 Reporting costs through account and cost center categories with random numbers

Responsibility Center Category / Account Category	OPS LCM	OPS Logistics	Segment revenue + fixed costs	R&D	PTE	Service fixed costs	Segment fixed costs	Service revenue
Net Sales	0	0	-32,432	0	-233	0	0	-565,234
Wages	0	0	0	0	0	0	0	0
Salaries	4,789	4,553	3,546	84,522	417,269	390,362	23,443	0
Marketing costs	0	0	6,743	3,219	0	122	4,334	800
Fixed costs	744	96	89,097	8,564	234,342	24,338	342,342	4,500
R&D	-345	9	74,633	1,568	34,212	0	0	0
Facility costs	0	3,478	0	2,341	75,677	34	324	0
Depreciation	0	353	345	342	87,542	342	34	0
Financials and taxes	0	34	0	34	0	0	0	0

As mentioned, instead of assigning costs to cost pools from thousands of account and cost center combinations, the user assigns costs to the cost pools with the help of categorizations. If the user would categorize all hundreds of account in into 60 groups, and tents of cost centers into 20 groups, user would have to assign all together 1.200 cost units into the cost pools. While most of the cost units are zero, user has to assign about few hundred cost units into different cost pools. After finding the suitable cost pools, fewer changes will be needed in the assignment of cost units into the cost pools.

Table 5-7 includes all combinations of account categories and cost center categories. User connects each combination of account category and responsibility center into a cost pool. Table 5-7 describes the spreadsheet in which the user defines which cost pool is used for each combination of account category and responsibility center category.

Table 5-7 Assignment of account and cost center categorizations into the cost pools

Responsibility Center Category	Account Category	Cost Pool Name
OPS Management	Salaries	P-OPS, Salaries
OPS Logistics	Salaries	P-Logistics, Salaries
OPS LCM	Salaries	P-LCM, Salaries
Service fixed costs	Salaries	P-Salaries
Admin	Salaries	P-Administration
Sales cost	Salaries	P-Salaries
Service fixed costs	Fixed costs	P-Fixed costs
PTE	Fixed costs	P-Fixed costs
Segment revenue + fixed costs	Fixed costs	P-Fixed costs
OPS LCM	Fixed costs	P-LCM, Fixed costs
OPS Management	Fixed costs	P-OPS, Fixed costs
Sales cost	Marketing costs	P-Marketing costs

User has already defined the desirable cost pools for each account and cost center combinations before running the Stage1. After running the Stage1 functionality, all costs are collected into the user defined cost pools, and the resulting amounts are presented in the table 5-8. Period activity per cost pool may be used to analyze results of the first-stage cost assignment. When user has made desired number of trials, and is confident that the cost pools represent the optimal

situation, next step is to start the setup for second-stage cost assignment, Stage2 functionality of the program.

The second-stage cost assignment begins by choosing a suitable driver rate. Table 5-8 presents all the cost pools and their related driver rates. All the cost objects are presented at the right-hand side of the table. User makes the setup manually by selecting which driver rate is used to assign costs from cost pools to the cost objects. After typing down the correct driver rate name, user may type manually the correct resource usage for each cost object. The total resource usage is summed, and will be used to calculate the driver rate for each cost objective when the costs from cost pool are assigned to the cost objects.

Table 5-8 Vaisala cost pools, their period activity, and definition of driver rates

Cost Pool		Driver Rate		Final Cost Object				
				T Revenue IN1	T Revenue IN2	T Revenue IN3	T Revenue A&C	T Purchasing IN1
Cost Pool Name	Period Activity	Cost Driver Rate	Total transactions	T-Revenue_IN1	T-Revenue_IN2	T-Revenue_IN3	T-Revenue_A&C	T-Purchasing_IN1
P-Logistics, Fixed costs	-335,783	Number of shipments	3000	232	762	125		
P-Facility costs	-63,678	Direct tracing	1					1
P-Systems, Facility costs	-323,281	Direct tracing	1					
P-SWS, Facility costs	-49,133	Direct tracing	1					
P-Quality, Facility costs	-256,418	Number or products	1034	47	37	42		
P-Sonde, Depreciations	-241,867	Direct tracing	1					
P-OPS, Depreciation	-311,410	Revenue earned	1	0.01	0.03	0.007		
P-Financials and taxes	-118,514	Direct tracing	1					
P-Sensors, Depreciation	-114,513	Direct tracing	1					
P-Instruments, Depreciation	-222,056	Direct tracing	1	0.2	0.2	0.2		

Table 5-9 Profitability map and final cost objects of the management accounting system

	Final Cost Objects						
Value stream process steps	IN1	IN2	IN3	Lean supply chain total	Agile and continuous replenishment sc's	Organization	
Revenue	T-Revenue_IN1	T-Revenue_IN2	T-Revenue_IN3	0	T-Revenue_A&C		
Purchasing	T-Purchasing_IN1	T-Purchasing_IN2	T-Purchasing_IN3	0	T-Purchasing_A&C		
Material Handling*	T-Handling_IN1	T-Handling_IN2	T-Handling_IN3	0	T-Handling_A&C		
Machines	T-Machines_IN1	T-Machines_IN2	T-Machines_IN3	0	T-Machines_A&C		
Wages	T-Wages_IN1	T-Wages_IN2	T-Wages_IN3	0	T-Wages_A&C		
Shipping	T-Shipping_IN1	T-Shipping_IN2	T-Shipping_IN3	0	T-Shipping_A&C		
Life-cycle Management	T-LCM_IN1	T-LCM_IN2	T-LCM_IN3	0	T-LCM_A&C		
Salaries	T-Salaries_IN1	T-Salaries_IN2	T-Salaries_IN3	0	T-Salaries_A&C		
Quality Assurance	T-Quality_IN1	T-Quality_IN2	T-Quality_IN3	0	T-Quality_A&C		
Managers and Supervisors	T-Management_IN1	T-Management_IN2	T-Management_IN3	0	T-Management_A&C		
TOTAL VALUE STREAM	0	0	0	0	0		*GROSS PROFIT*
Sales and Marketing				S-Sales_L	S-Sales_A&C		
Customer Service				S-Service_L	S-Service_A&C		
Development				S-Development_L	S-Development_A&C		
Other chain costs				S-Other_L	S-Other_A&C		
TOTAL SUPPLY CHAIN				0	0	0	*OPERATING PROFIT*
Other org costs						O-Other	
Cost Accounting						O-Accounting	
Financial costs						O-Financials	
Organization costs						O-Organization	
TOTAL VAISALA						0	*NET PROFIT*

* Picking, Putaway, and Warehouses

Table 5-9 presents all Vaisala's 52 final cost objects. Cost objects are mapped into a table from which profitability of the value chains can be calculated. The cost assignment model for Vaisala

is build with a small number of cost objects as the main purpose is to test the framework. Vaisala's cost structure is presented through value streams and supply chains. Also the comparison with the income statement is possible, while the management accounting system calculates the corresponding profitability values at the right hand-side of the table.

Results of management accounting system implementation for the lean supply chain are presented in table 5-10. The final outcome of the management accounting system in table 5-10 is presented with random numbers. The results are easy to interpret while all the information is based on cash-flow cost information, and neglects the standard costing based cost information. Results of the management accounting system are based on how well the cost pools, driver rates, and cost objects are defined. As the purpose of this chapter is mainly on testing the framework, instead of analyzing cost information, the number of cost objects and driver rates has been minimized.

Table 5-10 Results from Vaisala's Cost Assignment Model presented with random numbers

	Final Cost Objects						
Value stream process steps	IN1	IN2	IN3	Lean supply chain total	Agile and continuous replenishment sc's	Organization	
Revenue	31,554,940	8,700,184	12,849,434	53,104,557	171,682		
Purchasing	-258,095	-696,450	-141,495	-1,096,039	-493,567		
Material Handling*	-371,115	-838,337	-1,053,076	-2,262,528	-725,065		
Machines	-311,460	-290,734	-308,148	-910,342	-739,014		
Wages	-287,508	-215,161	-859,346	-1,362,015	-1,208,481		
Shipping	-55,051	-546,901	-875,013	-1,476,965	-1,322,819		
Life-cycle Management	-322,509	-1,156,312	-70,000	-1,548,821	-181,960		
Salaries	-203,393	-38,495	-870,440	-1,112,327	-1,320,487		
Quality Assurance	-72,170	-877,497	-7,388	-957,055	-1,066,139		
Managers and Supervisors	-508,491	-158,581	-913,844	-1,580,916	-430,299		
TOTAL VALUE STREAM	**29,165,149**	**3,881,716**	**7,750,683**	**40,797,548**	**-7,316,149**		*GROSS PROFIT*
Sales and Marketing				-43,823	-48,301		
Customer Service				-2,555	-85,063		
Development				-30,704	-127,138		
Other chain costs				-33,153	-80,868		
TOTAL SUPPLY CHAIN				**40,687,313**	**-7,657,520**	**33,029,794**	*OPERATING PROFIT*
Other org costs						-210,975	
Cost Accounting						-128,833	
Financial costs						-188,592	
Organization costs						-230,065	
TOTAL VAISALA						**32,271,329**	*NET PROFIT*

* Picking, Putaway, and Warehouses

After having value chain profitability information for the lean supply chain, the next step is to connect periodical cost information with all other period cost information. This is done with the help of reporting macros. Lean supply chain profitability information should be used for financial performance measurement of the lean supply chain in addition to the non-financial performance measurements. Figure 5-16 presents a continuous loop through which profitability information should be continuously followed to support the continuous improvement of lean supply chain performance.

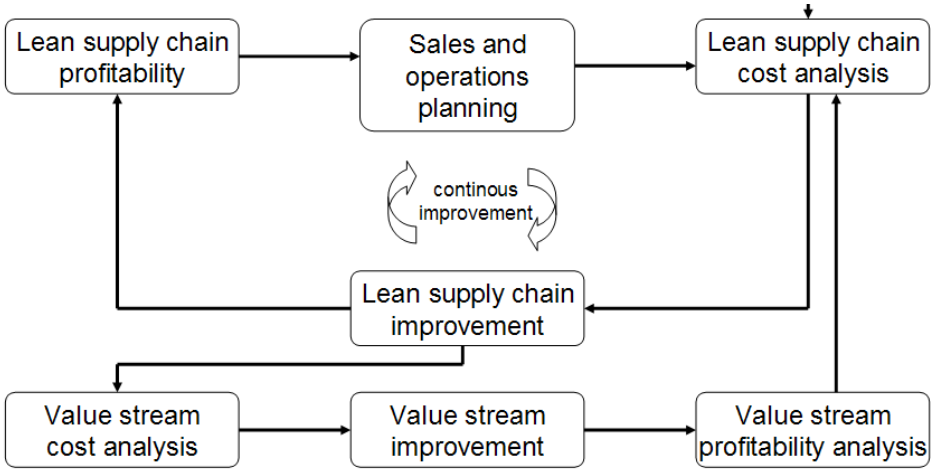


Figure 5-16 Financial performance measurement loop for lean supply chain

Implementation of the framework proved that a separate management accounting system can represent cost and profitability information in a way that is understandable for the decision makers, and can be used investment decisions, and other decision making.

6. Summary, conclusions and propositions

6.1. Theoretical findings and empirical results

Profitability is one of the most important concepts that company has to understand in order to succeed. By understanding the current cost structure and profitability, managers can make decisions that help company to achieve its long-term profitability objectives. Performance measurement has the role of continuously assess and indicate beforehand whether profitability is increasing or decreasing on long-term.

Debate between managers in operations and finance has concerned whether financial information can be used to measure performance of operations and manufacturing. The importance of non-financial performance is unquestionable for operations indeed. As a result of this study, it is argued that also financial performance measurement in operations is needed, and can support managers in their decision making.

The importance of supply chains has increased while the whole supply chains compete with each others. It is important for companies as supply chain partners to understand their internal cost structure and profitability. Internal cost structure has to be understood in order to select supply chain partners and customers that provide most value to the shareholders. In order to support the use of supply chains, costing model has to be capable of analyzing supply chain cost structures and profitability separately. The concept and tool were implemented in the study, but next step for the case company is to analyze the data and modify allocation rules according to the cost.

Literature concerning cost management in supply chains consists mainly on understanding transaction costs between supply chain partners. Objective of this study is on internal supply chains, and literature containing supply chain management and cost management did not provide much of help. However, value stream costing is more of a cash-flow -based costing model, and it provides interesting possibilities for cost management in supply chain context. Theoretical contribution of the study is presented in chapter 4.2. The Value Chain Cost Assignment Model is introduced for making cost assignment decisions in multiple supply chain contexts.

Research problem and objectives of the study were presented in chapter 1.2. Research problem was described widely as the lacking profitability information to support multiple supply chain strategy of a company. The main objective of the study was to measure financial information

with a management accounting system to support multiple supply chain strategy. Study objective could be further divided into three separate objectives:

1. *Supporting multiple supply chain strategy with a management accounting system*
2. *Financial performance measurement of lean supply chain with management accounting information*
3. *Analyze the results standard costing system by comparing income statement with the management accounting system results*

Study objectives were answered by creating a framework that can be used to design a management accounting system. Chapters providing answers to research objectives are the following:

1. *Framework for designing management accounting system into a multiple supply chain environment is presented in chapter 4.2, and implemented to the case company in chapter 5.4.*
2. *Cost assignment and performance measurement model for lean supply chain is presented in the chapter 4.3, and implemented to the case company in chapter 5.5.*
3. *Framework presented in chapter 4.2 considers the relationship between management accounting system and the income statement, and is tested with the case company in chapter 5.4*

The first research objective is achieved by creating a framework that may be used to design a management accounting system. The framework is build based on three existing concepts that were presented in the literature part of the study. The first and most important concept is the traditional two-stage cost assignment model that is used by multiple authors to assign indirect manufacturing costs to traditional cost objects, mainly products. The framework created in the study widens the two-stage cost assignment model in two main ways. First, instead of indirect manufacturing costs, it includes all costs of a company, and uses the existing account and cost center division in the first stage assignment. Secondly the framework defines cost objects as value chains in different levels, instead of products. The concept and terminology of value chain is presented in chapter 2.1, and it includes three levels, product, value stream, and supply chain.

The third concept used in building the framework is by Glad and Becker (1996). The concept is introduced in chapter 4.1, and it described how activity-based costing may be used to assign

primary and support activities to cost objects that are then used to calculate net profit of the company. The framework that is built based on the three existing concepts is named as Value Chain Cost Assignment Model. The framework answers the first research objective, while it can be used to design a management accounting system into multiple supply chain environment of a company.

The second research objective was to measure financial performance of a lean supply chain. Research objective was answered by using the framework to design management accounting system for lean supply chain. Lean supply chain was selected, because it offered the best scenario for implementation in the case company. Special characteristics of traditional lean performance measurement were reviewed to make sure that designed management accounting system may be used to measure financial performance of lean supply chain. The implementation of the Value Chain Cost Assignment Model revealed to be rewarding, while the results could be used to understand the whole profitability of whole lean supply chain, and value streams in it. The most critical phase of the implementation revealed to be the design of cost assignment rules.

The presented Value Chain Cost Assignment Model provides a basis for management accounting design, but selection of cost assignment rules has at least as important role in the implementation. This in mind, the management accounting system can be developed further by choosing best possible right driver rates that are used to assign costs to the value chains. However, even the use of simple cost assignment rules in the lean supply chain implementation revealed that information from the management accounting system may be used for decision making.

Third objective of the study was to analyze the results of standard costing system by comparing the current income statement with the profitability results from the management accounting system. The most valuable information from the management accounting system is the cash-flow based profitability information which differs from the results given by the standard costing system. The framework allows comparison between standard costing system and the cash-flow based management accounting system, while the same account and cost center information is used in both presentations of cost and profitability.

Results of the implementation show that profitability in the standard costing system shows better results for the selected month than the cash-flow based management accounting system. Reason for differing results seems to be that while the inventory value has increased, the standard

costing system has absorbed part of indirect manufacturing costs to the balance sheet while the cash-flow based management accounting system treats all indirect manufacturing costs as period costs instead of inventoriable costs.

The results of the study indicate that standard costing systems and full absorption costing systems should not be used for decision making. Another indication is that cost assignment rules normally used in standard costing systems may not provide efficient assignment of costs to analyze the profitability of value chains in the company. As a suggestion companies should consider designing a separate management accounting system that is purely designed for understanding the total profitability of the value chains, and the which cost information is understandable, and may be used to support decision making. A framework called Value Chain Cost Assignment Model is introduced in the study, and can be used to design management accounting system into a multiple supply chain environment.

6.2. Managerial suggestions

A study has proved that profitability of value chains cannot be measured with traditional standard costing systems. In most companies the share of indirect manufacturing costs is high, and the use of absorption costing results in distorted cost information that is unsuitable for decision making. It is suggested that companies should design a separate management accounting system to support management decision making and performance measurement. A framework of cost assignment model is introduced, and suggested to be used in the design of a management accounting system.

Also the role of supply chains has become more important, and the concept has proven lot of potential for connecting the customer requirements with the supplier capabilities. Companies might compete in total of four different supply chains at the same time, as is suggested by Gattorna (2006). It is critical for companies to understand cost structure and profitability of their internal supply chains in order to make right investment decision, and charge necessary value-added services from different supply chain partners. The framework that is introduced in chapter 4.3 considers a multiple supply chain approach by offering cost objects that refer into different value chains of the company.

The framework was implemented into the case company Vaisala with high potential for improving understanding of the cost structure of internal supply chains and manufacturing teams. As the pilot implementation was done with excel and VBA, it is suggested that the

designed management accounting system is further improved by defining suitable cost assignment rules. By improving the model, profitability of all Vaisala supply chains and value streams may be calculated and analyzed. After using and improving the pilot model for some time, it is suggested that the information is used in decision making by sharing it through company's internal decision support systems. Another suggestion is that the financial information is used in continuous performance measurement to provide an important aspect to the traditional performance measurement.

The study proved that designed framework provides new insights into the case company's profitability and cost structure, but analysis of the cost information was not in scope of the study. As a natural step, it is recommended that cost information provided by the management accounting system is analyzed further and used for decision making. As mentioned, the costing model implemented is a pilot version, and it can be improved further by analysing the prevailing cost structures.

Vaisala should not use standard costing system to support managerial decision making purposes. Also income statement should be compared with a relevant costing model to understand both. However, Vaisala should not either let go from the standard costing system, because it is currently used for financial reporting. Vaisala should consider seriously building new management accounting system without standard costing and use them to ultimately build comparative financial statements to build trust to the numbers. Quality related costs and unused capacity can also be recorded by adding them a new cost objects to which all additional capacity may be assigned to.

6.3. Future research

During the study several limitations had to be made in order to keep the study focused. These limitations affect to the applicability of the model, but also provide interesting research topics for further studies. One of the limitations of this study has been focus on internal supply chains, while the management accounting systems between supply chain partners might provide interesting aspects. Measuring costs from multiple management accounting systems might provide supply chain partners new insight about how they could organize their collaboration. However, the challenges include the lack of integration between management accounting systems, and the level of cooperation needed to share management accounting system results with supply chain partners.

While the focus of this study has been on designing a management accounting system, another study might be needed to focus on long-term results and benefits of suggested management accounting system. There is no empirical evidence that the framework provides management accounting system that helps company to improve its profitability on long-term. Also the comparison of standard costing system and cash-flow based management accounting system results has limited more into theoretical comparison between the systems. Empirical comparative research about how the standard costing system and cash-flow based management accounting system results is missing.

Appendix A:

DICTIONARY:

Activity (Horngren et al., 2009, 170) = "an event, task, or unit of work with s specified purpose." An example could be designing products, setting up machines, or distributing products.

Allocate costs (Horngren et al., 2009, 124) = refers to assigning indirect costs to a cost object. Assigning indirect costs is usually more difficult than direct costs, because there is usually no clear causality towards some specific cost object, and some consideration has to be taken.

Assign (Hansen, Mowen 2007) = one if the principal objectives of a management accounting information system is to assign costs to products, services, customers, and other objects of managerial interest

Assign costs (Horngren et al., 2009, 124) = "a general term for assigning costs, whether direct or indirect, to a cost object". This term included the terms cost tracing, and cost allocation.

Cost Driver (Horngren et al., 2009, 58) = "a variable, such as the level of activity or volume, that causally affects to costs over a given time span". So the cost driver of a variable cost can be the level of the activity, but there exists no cost driver for fixed costs on the short run.

Cost Object (Horngren et al., 2009, 123) = "anything for which a measurement of costs is desired", an example could be a specific car model, or a chair for example.

Cost Pool (Horngren et al., 2009, 124) = "grouping of individual indirect cost items". Cost pool can refer to a large factory or to small equipment in the factory floor. Cost pools are normally organized to suite the allocation purposes.

Trace costs (Horngren et al., 2009, 124) = refers to assigning direct costs, when there normally exists a clear causality towards the cost object.

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