Turun yliopisto
University of Turku

UNDERSTANDING THE CONCEPT OF LOGISTICS COST IN MANUFACTURING

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ABSTRACT

This thesis aims at providing a better understanding of the concept of logistics cost in manufacturing. One of the reasons for choosing this topic was the realization that very little research has been published on this subject. This is somewhat surprising given the significance of logistics and supply chain management (SCM) and its improvement for the profitability especially in manufacturing.

The thesis has its roots in a broader research effort within the Operations & Supply Chain Management subject at the Turku School of Economics (TSE) on the relationships between logistics costs and performance. During the past ten years, the O&SCM team, of which the author has been a member, has conducted five comprehensive logistics surveys in Finland, which have produced the largest national database on logistics – including logistics costs – in the World. This rich database has provided empirical evidence for three published PhD thesis at TSE (Rantasila 2013 and Solakivi 2014 at O&SM; and Heinonen 2013 at Dept. of Economics), and to well over 10 refereed journal articles.

Due to the holistic nature of logistics and supply chain management (SCM), data of its cost are typically fragmented across organizations. Improved information on the costs of logistics and SCM activities may assist the managers to make better decisions. For example, a realistic view on inventory holding cost may prevent over-optimistic offshoring decisions, not to mention better information of the costs involved in sourcing, or the "black box" of administrative costs of logistics.

Literature related to logistics/SCM costing and cost controlling has traditionally concentrated on the suitability and use of individual management accounting techniques such as activity-based costing, target costing, total cost of ownership or balanced scorecard, or discusses performance measurement in general, with strong emphasis on non-financial performance measurement. In addition, there are no commonly accepted international or national definitions on the concept of logistics cost(s). Thus, the meaning of the concepts used can vary significantly from one firm to another.

Management accounting literature, on the other hand, publishes research of the organization of costing in companies and the factors that affect the cost and control systems in organizations, but the context of logistics and supply chain management is seldom represented. The level of analysis in the

empirical research is often at the company or business unit level, but that may be too broad a level of aggregation to directly describe the cost controlling of logistics and supply chain management. Similar mechanisms may apply to organizing of costing in SCM as well, but the empirical evidence is virtually non-existent.

Based on the above, this thesis comprises two main research questions:

> RQ1: What are the specific features of the concept of logistics cost in a management accounting context in a manufacturing setting?; and
>
> RQ2: What factors contribute to how logistics cost management is organized in firms?

The thesis comprises an introductory part, and a collection of one published journal article and four conference papers that have been presented in academic conferences in the fields of supply chain management and management accounting. Paper I addresses the effect of a specific contingent factor, namely geographic dispersion of the supply chain, to the intra-firm supply chain performance. The conceptual paper II addresses the RQ1. Conceptual papers III and V deal with the both research questions. Paper IV that provides some empirical survey evidence on how logistics cost information is available in Finnish companies is related to the RQ2.

The thesis provides a model that answers the second research question. Based on the model, multiple hypotheses can be presented for testing in future research.

The published papers together with the introductory part provide a profound and novel discussion that links the extant research literature in SCM/logistics with that in the field of management accounting. This discussion is also supported by the empirical evidence provided in Papers I and IV.

The main theoretical contribution of the thesis lies in the treatment and deeper understanding of the cost-related terminology and concepts in SCM/logistics vis-à-vis management accounting literature. The findings have also a managerial relevance especially in the context of manufacturing firms.

TIIVISTELMÄ

Tämän tutkimuksen tarkoituksena on tuottaa uutta tietoa logistiikkakustannusten käsitteen parempaan ymmärtämiseen. Tarkastelun kohteena ovat erityisesti valmistavat yritykset. Aiheen valintaan ohjasi tutkimuksen alkuvaiheen huomio siitä, että aihetta on tutkimuskirjallisuudessa käsitelty varsin vähän. Tämä havainto oli yllättävä, sillä logistiikan ja laajemmin toimitusketjujen johtamisen merkitys yritysten kannattavuuteen on varsin iso.

Työ liittyy myös Turun kauppakorkeakoulun toimitusketjujen johtamisen oppiaineen laajempaan tutkimuskokonaisuuteen, jossa tarkastellaan logistiikkakustannusten ja yritysten suorituskyvyn välisiä yhteyksiä. Kuluneen kymmenen vuoden aikana kirjoittaja on ollut osa aineen tutkijaryhmää, joka on toteuttanut Suomessa viisi isoa logistiikkaselvitystä, joiden tietokanta muodostaa tällä hetkellä laajimman kansallisen kyselyaineiston maailmassa. Aineiston pohjalta on TuKKK:ssa julkaistu mm. kolme väitöskirjaa (Rantasila 2013 ja Solakivi 2014 sekä Heinonen 2013 TuKKK:n taloustieteessä) sekä yli kymmen referoitua journal-artikkelia.

Logistiikkaan ja toimitusketjun hallintaan ja niiden kustannuksiin liittyvä tieto on tyypillisesti hajautunut hyvin moniin paikkoihin yrityksissä, eikä kokonaiskuvan saaminen näistä ole usein kovin helppoa. Parempi informaatio ja tietämys näistä auttaisi kuitenkin tekemään parempia liikkeenjohdollisia päätöksiä mm. varaston hallinnan, sijoittumisen, hankintatoimen sekä näihin toimiin liittyvien yleishallinnon kulujen osalta.

Logistiikan ja toimitusketjujen johtamisen tutkimuskirjallisuus käsittelee kustannuksia ja kustannusten seurantaa useimmiten tiettyjen tuotantotalouden ja/tai liikkeenjohdon laskentatoimen menetelmien avulla. Näitä ovat esimerkiksi toimintolaskento (activity-based costing), elinkaarilaskennan sovellukset (esim. total cost of ownership ja target costing) ja tasapainotettu mittaristo (balanced scorecard). Niissä mittaaminen painottuu usein ei-taloudelliseen suorituskykyyn. Logistiikkakustannusten käsitteelle ei myöskään ole olemassa mitään yleisesti hyväksyttyä sisältöä. Tämän vuoksi käsitteen merkitys voi vaihdella merkittävästi yrityksestä toiseen.

Liikkeenjohdon laskentatoimen tutkimuskirjallisuus painottuu puolestaan usein kustannuslaskennan järjestelyihin ja toteutukseen organisaatioissa sekä niihin vaikuttavien tekijöiden tarkasteluun. Kytkennät logistiikan ja toimitusketjujen johtamisen kontekstiin ja käsitteistöön ovat vähäiset. Ongelmia tarkastellaan tyypillisesti yrityksen tai liiketoimintayksikön tasolla, mikä on

usein hieman liian karkea taso logistiikkakustannuksia ajatellen. Vaikka liikkeenjohdon laskentatoimen ja logistiikan kustannustarkastelussa olisi paljonkin yhteistä, niitä käsittelevää tutkimuskirjallisuutta ei juuri ole.

Tämä tutkimus pyrkii vastaamaan kahteen tutkimuskysymykseen:

> RQ1: Mitkä ovat logistiikkakustannusten käsitteen erityispiirteet liikkeenjohdon laskentatoimen kautta tarkasteltuna erityisesti valmistavassa yrityksessä?
>
> RQ2: Mitkä tekijät vaikuttavat logistiikkakustannusten hallinnan järjestelyihin (valmistavissa) yrityksissä?

Tutkimus koostuu yhdestä julkaistusta vertaisarvioidusta artikkelista, neljästä vertaisarvioidusta kansainvälisestä konferenssijulkaisusta sekä johdantoosasta. Paperi I tarkastelee toimitusketjujen maantieteellisen jakautumisen vaikutusta yritysten toimitusketjun suorituskykyyn. Paperi II on käsitteellinen tarkastelu, joka vastaa osaltaan ensimmäiseen tutkimuskysymykseen (RQ1). Paperien III ja V käsitteellinen tarkastelu kohdistuu molempiin tutkimuskysymyksiin. Paperin IV empiirinen tarkastelu suomalaisyritysten logistiikkakustannusten informaatiosta liittyy tutkimuskysymykseen 2. (RQ2); työssä kehitetty käsitteellinen malli liittyy myös tutkimuskysymykseen 2. Mallin pohjalta voidaan testata useita aiheeseen liittyviä hypoteeseja.

Tämä tutkimus on perusteellinen ja uudenlainen kokonaiskatsaus liikkeenjohdon laskentatoimen ja logistiikan kustannustarkasteluista, joka pohjautuu osin sekä empiiriseen että käsitteelliseen aineistoon. Tämä tarkastelu on myös työn keskeinen teoreettinen kontribuutio. Tulosten liikkeenjohdollinen relevanssi kohdistuu erityisesti valmistaviin yrityksiin.

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1 INTRODUCTION

1.1 The relevance of logistics costing and cost information

Due to the holistic nature of logistics and supply chain management (SCM) the data of its cost are typically fragmented to various places in the organization. This may lead to underestimating the significance of supply chain management and its improvement for the profitability of the organizations. In the mid-1980's there were concerns that in senior management distribution is considered solely as a necessary cost and service, and its profit enhancement potential is ignored. Distribution managers were seen generally unaware of the value of financial information for improving distribution performance, and also financial and accounting resources in companies were stated not to have kept pace with the developments in distribution. (Tyndall & Busher 1985.) Even in 2013 similar issues prevail: The Finnish Association of Purchasing and Logistics Professionals (LOGY) expressed concerns that SCM professionals are lacking in the ability to demonstrate how supply chain management affects the bottom line. Consequently perhaps, the top management tends to perceive supply chain management as operational activities with little relevance to organizational strategy. (Kekäläinen 2013.)

Improved information on the costs of logistics and supply chain management activities may assist the managers to make better decisions. For example, more realistic inventory holding cost than an industry average or other estimate may prevent over-optimistic offshoring decisions (Timme 2003, 37), not to mention information of all the costs involved in sourcing (Platts & Song, 2010; Weber et al. 2010). Opening up the "black box" of the administrative costs of logistics could contribute to the esteem of supply chain management within the organization: although the labor and wage costs of the logistics costs cover the largest part of administrative costs, a more detailed itemization of to which all activities those resources are spend might evoke interest in the re-design of activities in order to streamline the processes by removing redundancies and unnecessary tasks or replacing the tasks in the supply chain.

Furthermore, deficient information of the logistics and supply chain management costs hinders the negotiation and cooperation between supply chain partners. The members may have different understanding of the

definition or the content of some cost categories and may be unable to demonstrate the cost of performing certain activities or how the partner's behavior affects the whole supply chain's costs. (Norek & Pohlen 2001; Dekker & van Goor 2000).

Supply chain management literature related to logistics costing and cost controlling since 1980's has concentrated predominantly on suitability and use of individual management accounting techniques such as activity-based costing, target costing, total cost of ownership or balanced scorecard in a supply chain management context, or discusses performance measurement in general, with strong emphasis on non-financial performance measurement. Management accounting literature, on the other hand, publishes research of the organization of costing in companies and the factors that affect the cost and control systems in organizations, but the context of logistics and supply chain management is seldom represented. The level of analysis in the empirical research is often at the company or business unit level, but that may be too broad a level of aggregation to directly describe the cost controlling of logistics and supply chain management. One can logically deduce that similar mechanisms may apply to organizing of costing in supply chain management as well, but the empirical evidence is virtually inexistent.

1.2 Research questions and structure of the thesis

Costing systems may exist in organizations for several purposes: for external costing, to motivate and to evaluate employees, and to provide information for decision making. This thesis takes the viewpoint typically underlying the supply chain management literature on the topic of logistics costing: that the *main* purpose of a costing system is to provide information for daily management of the operations as well as strategic decision-making, although other uses are briefly presented. External reporting is addressed where its effect is relevant from the supply chain management perspective.

The discussion on logistics cost management and the problems related to it takes place from the perspective of a manufacturing firm unless otherwise stated in the text, as most of the literature reviewed takes that viewpoint.

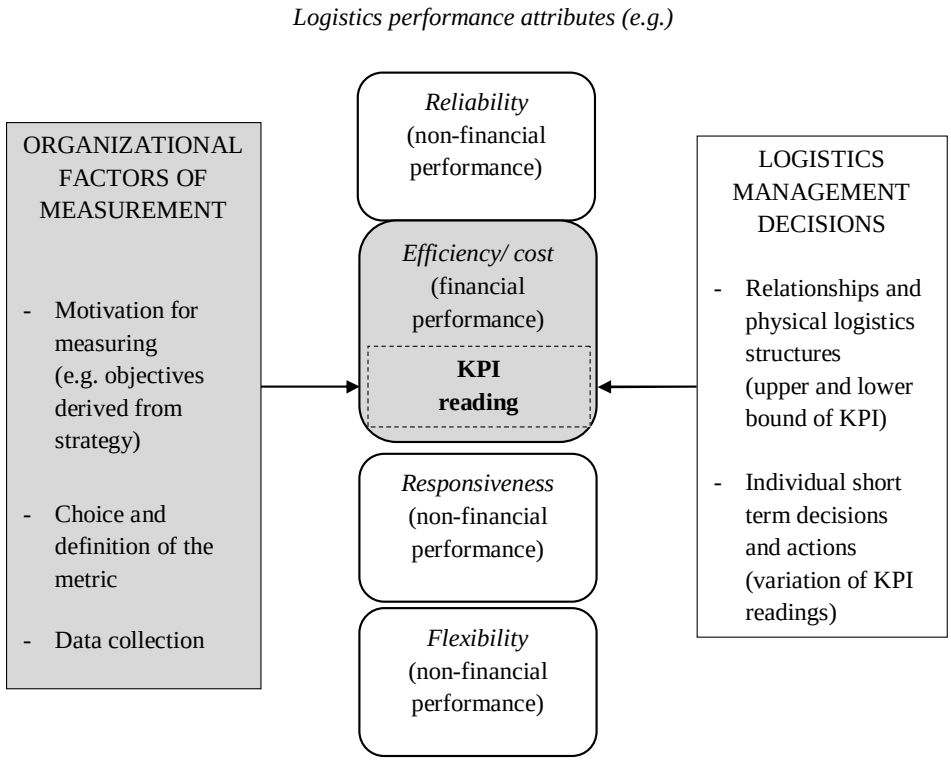


Figure 1 Focal areas of interest of the thesis indicated as shaded fields

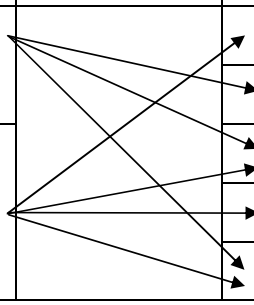
Based on supply chain management and management accounting literature, this thesis comprises two main research questions:

> RQ1: What are the specific features of the concept of logistics cost in a management accounting context in a manufacturing setting?; and
>
> RQ2: What factors contribute to how logistics cost management is organized in firms?

The thesis is organized as a collection of one published journal article and four conference papers that have been presented in academic conferences in the fields of supply chain management and management accounting. The paper I addresses the effect of a specific contingent factor, namely geographic dispersion of the supply chain, to the intra-firm supply chain performance. The conceptual paper II addresses the RQ1. Conceptual papers III and V deal with the both research questions. Paper IV that provides some empirical survey evidence on how logistics cost information is available in Finnish companies

is related to the RQ2. The connection between the RQ's and the appended articles is shown in Table 1.

Table 1 Research questions of the thesis and the papers addressing it

Research question		Paper nr
RQ1: What are the specific features of the concept of logistics cost in a management account context in a manufacturing setting?		Paper I Paper II Paper III Paper IV Paper V
RQ2: What factors contribute to how logistics cost management is organized in firms?		

1.3 Research process

The papers in this thesis have been written between 2010 and 2013, and they have been presented in academic conferences in the fields of supply chain management (NOFOMA 2013, paper IV) and management accounting (Manufacturing Accounting Research, MAR 2010 and 2012, papers II and III; and the 7th Conference on Performance Measurement and Management Control 2013, paper V).The NOFOMA conference paper has been double blind peer reviewed, and the both MAR papers have been presented in a Ph.D. track, with a discussant named of the conference participants for each paper. The conference admittance to the 7th Conference on Performance Measurement and Management Control was based on submitted full papers, but the paper V was not otherwise reviewed. The published article was begun in 2010, and published in 2012. Figure 2 presents the course of the research process and the papers in chronological order.

The literature used in this thesis is not systematically reviewed in the sense that it would be collected from article databases using specific search terms on a selected set of journals and analyzed using pre-defined criteria. Instead, literature has been collected between about 2008 and August 2014, with majority of the SCM oriented journal articles and literature on logistics costs found before 2011, with the exception of some articles dating from the 1980s and 1970s. Most articles are found as full texts in EBSCO, Emerald and ProQuest databases, but for some of the earlier, before 1990s, paper copies of

the journals had to be viewed. Some of the management accounting textbooks were used from the beginning of the process, but a body of management accounting articles addressing the specifics of the costing systems were found towards the end of the process, around 2012.

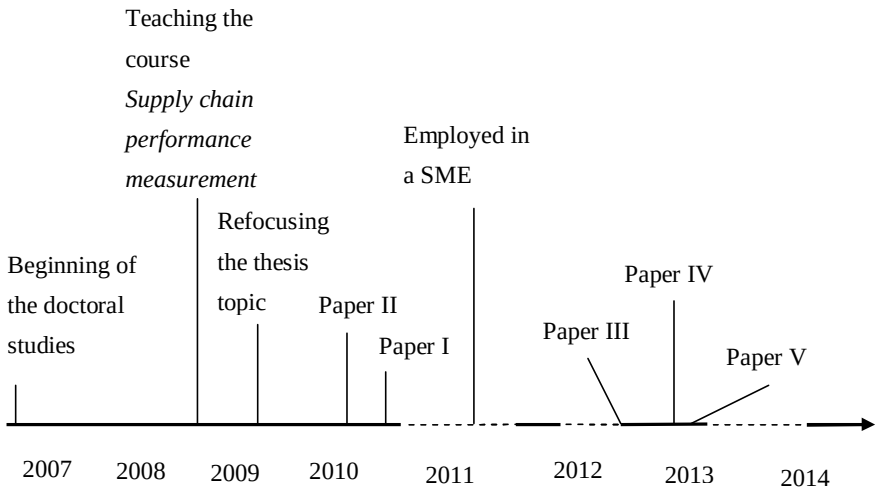


Figure 2 The research process and the papers in chronological order

A part of the articles were found by combining the search terms ‘logistics’, ‘supply chain’ or ‘distribution’ and ‘cost’, or specific cost analysis methods such as activity-based costing, total cost of ownership, direct product profitability or target costing. Others, especially the older articles, were found by snowballing, i.e. checking the references of articles and/or looking in the SCOPUS database whether the author(s) had published more articles on a similar topic.

The empirical data for both paper I (‘Geographic dispersion of the supply chain’) and paper IV (‘The availability of logistics cost’) are collected as a part of Finland State of Logistics survey, for paper I in late 2008 and for paper IV in April and May 2010. For both surveys, invitations to participate were sent to the non-student members of Finnish Association of purchasing and Logistics (LOGY), Finnish Transport and Logistics (SKAL), and the Federation of Finnish Enterprises and regional Chamber of Commerce that were involved in the industries studied (manufacturing and construction, trading, and logistics service provision). Language of the surveys in both years was Finnish. Regarding the paper I, the author of the thesis participated in brainstorming the hypotheses, wrote the initial draft of the supply chain

performance measurement section and commented on the paper at the review stage. (For more on data collection and the data analysis, see the paper I).

For paper IV (‘The availability of logistics cost’) 25 218 firms were targeted by email, and 1813 responses were received (a response rate of 7.1%). Of the respondents 31% (n=570) were from manufacturing companies (including construction) and 30% (n=545) from logistics companies. The remaining 39% of responses was from trading companies and logistics consultants and teachers, which were not target group of the research. After excluding missing responses and micro companies, 154 responses were qualified from manufacturing industry, 123 from trade and 150 from LSPs for the paper. Micro companies were excluded as they were considered to be too small to find formal logistics cost information useful.

The data analysis in paper IV was conducted with statistical analysis by SPSS. The Kruskal-Wallis test of independence was used to test the relationships between the applicable contingent variables and the items regarding the detail and availability of logistics cost information, as all items were not normally distributed. Additionally, the ordinal regression was used to test the contingent variables that could meaningfully be placed in order from smaller to larger.

During the process of writing this introductory part of the thesis, I complemented the framework of Paper III of the factors related to construction of company internal logistics cost (Figure 14) with additional factors, as the original framework begun to appear overly simplified. The initial model seemed to accentuate too much the internal capabilities of the firm, especially the management accounting and supply chain orientation. Some of the existing factors in the initial model have been disaggregated in more detail while writing the introductory part of the thesis, too, as it was possible to characterize certain factors such as industry dynamics in more detail. The model also seemed to provide too simplified an explanation for the way of organization of the logistics costing: Is professionalism in the fields of management accounting and supply chain management (or the lack of it) really a main contributing factor, particularly in the long run? If a firm is lacking capabilities in a specific professional field, why would it not seek to acquire them?

Why did I consider it appropriate to borrow theories from management accounting research literature? Firstly, and most obviously, it is justifiable by the topic area: logistics cost management and controlling are a facet or an application of overall cost management in companies, and most likely the same basic principles, extensively studied in management accounting, apply also there. Most supply chain management articles on logistics performance measurement and logistics costing do not address in depth the underlying

theory or mechanisms but concentrate on presenting the application either conceptually or in an empirical setting. Secondly, the traditional management accounting stream of research shares similar rationalist epistemological perspective (Preston 1995, 273, 279) and ontological assumptions as logistics and supply chain management research. The management accounting research mainstream is dominated by the functionalist (Burrell & Morgan 1979) paradigm, though multiple paradigms are recognized (Lukka 2010). Similarly, the predominant paradigm in logistics research has been described as functionalistic (Mears-Yong & Jackson 1997; Arlbjørn & Halldorsson 2002) (see Figure 3).

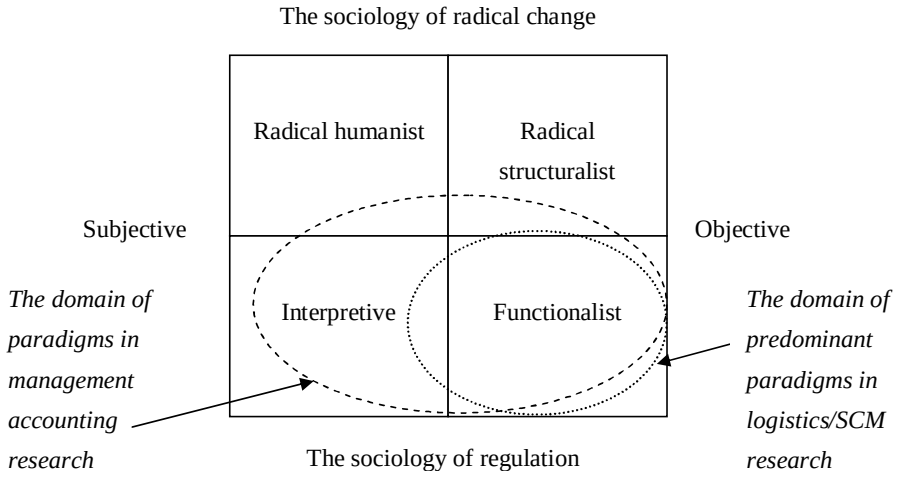


Figure 3 SCM and management accounting research in relation to Burrell & Morgan (1979) paradigms for analyzing social theory

Burrell & Morgan (1997) characterize the paradigms[1] in social science based on the assumptions on the nature of the social science (the dimension subjective – objective) and the perception of the nature of the society, building thus a frame of reference about 'the nature of the social world and the way it might be investigated' (Burrell & Morgan 1979; Mears-Yong & Jackson 1997)

[1] Paradigm refers to the world view of a scientific community: the set of ideas, assumptions and beliefs that guide its scientific activity (Jackson 1987 in Mears-Yong & Jackson 1997), providing the foundations of research practice, inclining the researcher to see and interpret the the world from one perspective rather than from another (Mears-Yong & Jackson 1997).

The continuum subjective – objective describes the assumptions regarding the view of the human nature, ontological and epistemological aspects underlying a paradigm, and the resulting type of methodology to be used in research. According to *objectivist* ontological assumptions, the world is considered a form an external, objective reality, independent of the researcher. Social sciences are correlated with the natural sciences, and the researchers would take a positivist approach regarding knowledge as something that can be objectively acquired; the aim is to understand what is true and false, and to identify regularities, causalities and laws. Human behavior is considered predictable through the understanding of the society, as certain situations will cause certain reactions. The research methods are nomothetic[2], follow the traditional scientific line of approach, with systematic protocol and technique, maintaining 'objectivity' and avoiding intervening with the research subject.

In the polar opposite, the *subjective* approach, the research stresses subjective experience of the individuals in the creation of a social world. Subjectivists are anti-positivistic, regarding knowledge as dependent on understanding the perspective of the people creating the 'reality'. Knowledge is regarded as situation specific, with no possibility of laws or regularities. People are believed to have free will and therefore not to be 'scientifically' predictable. Research methods tend to be qualitative, and acknowledge the belief that only way to understand the social world is through first-hand experience and knowledge is situation specific. (Burrel & Morgan 1979; Mears-Yong & Jackson 1997, 609–610.)

The nature of society, on the other hand, characterizes the approach to society itself: what types of research topics are perceived relevant. Regulative theories are to do with the explanation of status quo, and aim to explain why society is maintained as an entity and tends to hold together rather than break into oppositional factions. Characterizing the sociology of regulation are e.g. concepts social order, consensus and social integration and cohesion. (Burrell & Morgan 1979, 17; Mears-Yong & Jackson 1997). In the opposite perspective, the theories of radical change question the status quo and envisage emancipation for the humankind: the social 'system' is not seen as satisfying needs but as eroding the possibilities for human fulfillment. Characteristic concepts are structural conflict, modes of domination and contradiction. The theories seek to surmount the norms imposed by current society, and aim toward potentiality rather than actuality. (Burrell & Morgan 1979, 18; Mears-Yong & Jackson 1997)

[2] Nomothetic: 'of or relating to the search for general laws or traits' (MOT Collins English Dictionary, 2014)

Logistics research has been found to predominantly follow positivistic epistemology (e.g. Mears-Yong & Jackson 1997; Arlbjørn & Halldorsson 2002), and to be based on realist ontology and determinist view of human nature (Mears-Yong & Jackson 1997, 611–612); and to show adherence to regulative sociology (Mears-Yong & Jackson 1997) - i.e. can be categorized as functionalistic in the Burrel & Morgan framework. However, there are advocates in logistics and supply chain researchers for e.g. 1) *critical realism* (Aastrup & Halldorsson 2002): 'relaxing' the realist assumptions of external and objective reality, context-free knowledge, as well as the reliance on natural sciences methodology by acknowledging the reality experienced by individuals, and case research as a valid research method; and 2) *actors approach*, which sees researcher as an 'insider', an inseparable part of the research process, and emphasizes interpretations, contextualized knowledge and understanding (Arbnor & Bjerke (1997); Gammelgaard 2004). Therefore the range of logistics and supply chain management research can be considered to extend from the functionalist paradigm to the area of interpretive research paradigm. Nevertheless, the paradigms of radical change appear alien to the logistics research. Mears-Yong & Jackson (1997) contrast logistics research to the sociology of radical change, and argue that logistics research conforms to the sociology of regulation in the sense that the logistics professional is assumed to take the role of expert and guide the organization to the objectives set or agreed upon by the powerful members of the supply chain. Also 'non-logisticians' of the organization are argued to be 'coerced' into supposed social cohesion of the logistics managerial philosophy. For example, the functional attitudes and goals are seen to be hindering the integration of supply chain (Mears-Yong & Jackson 1997, 613–614.)

I identify three broader theoretical perspectives that underlie the discussion of the logistics and supply chain cost management presented in this thesis[3]. In Chapter 1.5 were presented various *development or evolutionary models* of the concept of logistics in the firms in connection with costing system related factors. Especially Weber (2002) adopted this perspective in his extensive study of logistics costing. However, the evolutionary models were criticized for path dependency and not providing explanations *why* a company would be at a specific phase of development or what impacts the transition to the next stage. Nevertheless, I support the idea that first an organization must reach an elementary level of cost system or logistics management upon which a more sophisticated system can be build.

Another theoretical background behind much of the discussion of cost management in SCM literature is the *resource based-view* (e.g. Barney 1991;

[3] These are by no means inclusive of all the perspectives identifiable in management accounting

Collis & Montgomery 1995). The resource-based view states that firm performance is driven by its resources or capabilities in a dynamic competitive environment (Collis & Montgomery 1995) This perspective is partly inherent in the concept of supply chain itself, which originates from the value chain concept (Porter 1980). The value chain is also the base of supply chain costing promoted by Pohlen et al. (2009) but also the activity-based costing and activity based management made popular by Kaplan & Cooper (1998) has adapted the idea of sequentially focusing on value adding activities bringing competitive advantage. Also Hergert & Morris (1989) implicitly take a resource-based view in focusing on the value chain metaphor in the discussion of accounting data deficiencies for costing of processes and value adding activities.

The principle in supply chain management and consequently also in supply chain cost management is to identify overlapping and redundant tasks and activities that do not bring value to the end customer and to perform them in a most efficient location of the supply chain, simplify or automate them, or to eliminate completely, if possible (Pohlen et al. 2009). This would create unique processes of indeterminate durance that are hard to imitate by the competitors, i.e. the supply chain management and cost management 'resources' of the organization would bring competitive advantage. However, an opposing view is that cost management systems would not be unique sources of competitive advantage, as the management accounting innovations and managerial trends are diffused by consultants, industry lobbying organizations, and professional education and professionals moving from one organization to another. Thus similar systems would appear in several companies, and be ubiquitous within an industry.

The main underlying theory base of this thesis, however, is contingency approach which is common in management accounting research (Otley 1980; Preston 1986; Chenhall 2003). Contingency theorists argue that performance is a function of the congruence between an organization and its environment, strategy and structure (Fredricks 2005) Management accounting literature presents contingency research of the connection of firm external factors on the broader management control systems and emphasizes the fit of the control system, the firm characteristics and the environment it operates in (a contingency perspective, in contrast to the resource-based approach explaining the organizational performance with the organization's capabilities). (Preston 1986). In this thesis the contingency approach is apparent in the RQ2: 'What factors contribute to how logistics cost management is organized in firms?', its handling and the model summarizing the discussion (Chapter 7).

1.4 Defining the scope of logistics

One of the general problems of costing is the scope, i.e. deciding which costs relate to specific cost object and should thus be included in the calculation (Kulmala et al. 2002; Kulmala 2003). In the context of supply chain management this means defining which activities are at the responsibility of logistics and which are the activities of purchasing, production or marketing, whether there are measurements at the supply chain level connecting these, and where to draw the boundaries of the supply chain to be measured.

The definition of logistics costs in a firm is based on how the logistics activities and outputs are defined. A factor complicating the definition of logistics output is the shared use of resources such as personnel or buildings with other company functions. (Weber 2002, 139.) Defining the logistics outputs is necessary for building cost standards for ongoing costing, and might require some simplification in order not to make costing system unnecessary complicated. For large scale decisions which are made only occasionally, more specific analyses are needed in addition. (Weber 2002, 131.) Setting standards for logistics activities has been considered more difficult than for manufacturing because – depending on the production process – more activities may exist than in production, and output measures vary more than in production (Lambert & Armitage 1979).

The extent of how far along the supply chain a firm aims to record and control the costs is also significant for the definition of logistics and supply chain costs. In this thesis the demarcation is made following Gudehus & Kotzab (2009) (see Figure 10) that logistics costs are those resulting from company internal processes and inbound and outbound transportation provided that it is paid for by the company. If costs incurred outside the company borders, e.g. expenses of logistics activities paid by customers in the distribution channel or first and second tier suppliers are followed, those costs are here considered supply chain costs. Weber (2002, 139) also discusses whether the logistics activities or outputs performed "for free" or at least without a separate charge by other members of the supply chain should be included in logistics cost calculation, but concludes that it is not practical: the information is not needed on daily basis, only in specific cases, and as there is no knowledge of the other firm's cost structure or the actual cost of performing the activities, the figures would be based on guesswork.

Management accounting literature addresses *inter-organizational cost and accounting controls* (Caglio & Ditillo 2008) that extend the scope of analyzing the costs outside the company's internal supply chain processes. The cost data may be mainly based on estimations, as in *value chain analysis* (Hergert & Morrias 1989; Shank & Govindarajan 1993) or based on shared information,

as in *open-book accounting* (Kulmala 2003; Agndal & Nilsson 2010) or *cost transparency* (Pohlen et al. 2009, 62), where a supply chain or network partner shares cost data of the internal processes. This sharing may be unilateral (e.g. a large client pressures the suppliers to reveal cost information) or bi- or multilateral sharing between partners or several members of a network (Kulmala 2003; Agndal & Nilsson 2010). Also *target costing*, a method where the allowable product cost is calculated starting from the desired market price and profit margin and product design as well as production process are improved to reach this cost target, may be rolled out also to the suppliers (Cooper & Slagmulder 2003; Pohlen et al. 2009, 61)

A supply chain or network partnership requires creating commonly accepted accounting practices between the partners (Kulmala et al. 2002). In a strategic partnership the process of negotiating and agreeing on costing or benefit sharing issues is more important than within a company, as there is no hierarchical authority to regulate the relationship (Seal et al. 1999). Common improvement efforts and profit share agreements thus create demand for reliable cost information, and accordingly, weaknesses in the firms internal cost systems cause difficulties in developing open-book agreements (Kulmala et al. 2002, 40; Seal et al. 1999). It is argued that in an established partnership, inter-company knowledge of costs forms the basis of continuous improvement programs that reduce costs of the whole supply chain rather than just supplier margins. And if the supplier asks for higher prices, the shared information ensures that price changes are based on actual changes in cost conditions. Correspondingly, a measurement system imposed on one of the partners conflicts with the principle of common goal and weakens the long-term prospects of the relationship (Seal et al. 1999, 310, 320).

The paper III of this thesis presents a supply chain cost framework, which gives an overview of the various activities and sub-processes that may be considered as the responsibility of logistics and supply chain management. As discussed in more detail in Chapter 1.5, the company's perception of logistics or supply chain management is likely to influence what activities are included as logistics, and consequently also to whether the cost of these activities is monitored or explicitly recognized as logistics cost. A company with more sophisticated logistics management practices and more supply chain minded perspective may be more likely to pursue the control and evaluation of the performance of broader range of logistics activities than one with basic perception of logistics as materials management and movement.

Another problem related to the scope of logistics is related to a broader perception of logistics as coordinating the internal operative processes. Although costs of activities previously considered as joint costs of several departments or indirect cost of another area (for example order processing: an

indirect cost of sales) can now be recorded as direct costs of logistics department or responsibility area (Weber 2002, 140), there still remains the question of which coordination or planning activities precisely are the responsibility of logistics. Which operative responsibility area manages for example production planning, materials requirement planning or sales and operations planning?

1.5 Perception of logistics and supply chain management

It has been suggested that the performance measurement and collection of performance information of logistics is related to how logistics or supply chain management is perceived in companies (Weber 2002; Cavinato 1992); ranging from a basic function conducted in lower organizational levels to a business strategy fulfilling orientation inherent in every-day business and strategic decision making at the senior management level. Also the firm's definition of the scope of logistics activities can be considered stemming from what is the general perception of logistics in a company (Weber 2002).

The idea that logistics and supply chain management develop in an evolutionary manner, in successive phases in firms has been persistent in supply chain literature, but has very rarely been empirically tested. In addition to the logistics of an individual company developing, the general perception of logistics has been developing in time. In the earlier articles the concept discussed was called distribution management (Heskett 1962), distribution logistics or integrated logistics (Halley & Guilhon 1997); later, it has been called purchasing and supply management (Cavinato 1999a), as well as logistics and supply chain management (Cavinato 1999b; Lockamy & McCormack 2004). The terms have different connotations especially regarding which functions (inbound or outbound) are in the focus and how far outside the firm borders the responsibilities extend – the scope of the supply chain. The tendency has been that broader range of activities and processes have been included in the supply chain management, and those logistics management practices that were earlier considered progressive or leading-edge have become commonplace and 'order-qualifiers' instead of 'order winners'.

Most of the articles on the development of logistics or the supply chain and the measurement of its performance reviewed here are conceptual, and those that are based on surveys or interviews reveal little detail on the data collection and analysis. Descriptions of the stages often are somewhat broad and by no means unified from one article to another. The models can also be considered to reflect the time of publication: over time the perceptions of supply chain management especially at the most advanced stage of the models

become more sophisticated and complex. The level of integration and the scope of operations required for the advanced stages tend to increase in the later models compared to the earlier ones[4]. Some of the models (Mentzer & Konrad 1991; Cavinato 1999a; 1999b) specifically address the performance measurement and controlling issues of logistics at the different stages of development, while others paint only a broad picture of the characteristics of the different stages (e.g. Hewitt 1994).

The models explicitly addressing supply chain cost measurement and controlling specific issues in different phases of development are summarized in Table 2.

Cavinato (1999a; 1999b; 1992) presents several models, two with over a dozen different attributes of the development phases of company orientation to purchasing and supply chain towards strategic management[5]. Here only the planning and performance measurement related attributes are presented. In different stages of development from a functional collection of activities to an area of strategic management there are different expectations for supply chain or purchasing management, and consequently also different performance information needs. At the first stage, *basic financial planning* focus is on functional operation of logistics, and formal planning concentrates in budgeting by cost centers. Overriding objective is to meet the budgeted goals and the concept of cost is the lowest price, rate or cost for a given item or service. The notion of supply chain is internal and unidirectional; from materials management to outbound transportation. In the second stage, *forecast-based planning*, logistics department is perceived as the distributor, and the main goal is system efficiency, where the role of logistics is to keep organizational costs in line. Forecasts are based in historical data, but may not be updated as situations change. Cost focus is on the lowest landed cost to the firm or to the next customer. (Cavinato 1999b, 167; 173.)

The third stage, *externally oriented planning*, seeks lowest total cost for the part of the whole of the supply chain that the firm controls by continuous improvement and cost minimization; the focus is on total product cost. There is a shift from orientation from being merely efficient to being competitive. Supply chain management provides all inbound and outbound flow functions, and is involved in procuring from third parties and creating inter-firm relationships. In the fourth stage, *strategic management*, supply chain management provides a tailored system for each line of business, and the perspective shifts from outsourced relationships to that of network

[4] E.g. Heskett (1962) names the phases shipping, traffic, movement and physical distribution, the latest including also demand-supply coordination; wheras in Cavinato (1999a; 1999b) this is included already in stage II at the latest.

[5] Based on Gluck et al. 1980 (in Cavinato 1999b)

orchestration. Synergies are sought across lines of businesses for logistics costs and services. The focus is on adding customer value with the lowest total cost to the entire supply chain. (Cavinato 1999b, 174–175.)

The final, fifth stage is *knowledge-based management*, and there supply chain strategy is coordinated with the firm as a whole as well as with each product line. Supply chain management is inherent in all types of business decisions. Speed of operations as well as time of new products to market is essential, cost is only one element of performance, and supply chain management is expected to anticipate the needs of the customers and to develop packages of services for them. (Cavinato 1999b, 176.)

Weber (2002) discusses extensively and in great detail the organizing of logistics cost measurement and controlling in connection with the level of development of logistics or supply chain management in a company. However, vast majority of the discussion is based on the first development phase, logistics as an isolated functional specialization, and focuses on the efficiency of logistics. On the other hand, that is understandable, when one assumes that the development stages build on top of each other. Similarly, the transaction based general accounting systems and databases are the foundation of logistics costing system, enabling more complicated cost and profitability analyses. For the other development stages broader guidelines are given. The second development phase, material flow oriented coordination function, emphasizes strategic perspective and the efficiency of the logistics operations: for logistics controlling selecting strategy related key performance indicators and building a balanced scorecard for different areas of logistics are recommended (Weber 2002, 294–307).

The main idea for the third development phase (flow oriented logistics) is that logistics should be organized as processes, and measured accordingly. Finally, in logistics as supply chain management the scope of measurement shifts outside the company boarders to measuring and controlling supply chain relationships. Also informal controls (e.g. cooperative practices and trust, shared values and understandings) gain in importance in this phase. (Weber 2002, 307–313.)

There are certain common elements in the models that distinguish one developmental stage from another. First is the integration of logistics function. The lowest stage is characterized by fragmentation into different logistics activities or isolation of the logistics function from the other activities of the company. This is also described with the metaphors flow (Weber 2002, Cavinato 1999a; 1999b) and process (Hewitt 1994). Second is the scope of the integration: whether extending to all operative activities within the firm, extending outside the firm to the imminent suppliers and/or customers, or to the whole supply chain. The element of performance in focus in each stage is

the third distinguishing element: whether efficiency or value added (to the customer), or a combination of both.

As deeply rooted in supply chain management literature as they may be, maturity or stage models in general have been criticized for oversimplifying reality and neglecting the existence of multiple maturation paths, as well as for merely describing the sequence of levels toward a predefined state, instead of clarifying factors that actually influence evolution and change (Röglinger et al. 2012). In purchasing and supply management literature the evolutionary and developmental metaphors have been criticized for taking certain assumptions for granted (Ramsay & Croom 2008), including:

- that (purchasing and supply) activities are classified either as 'strategic' or 'non-strategic';
- that strategic activities are associated with higher intra-organizational status than non-strategic activities; and
- that purchasing function is expected to undergo change following an evolutionary or developmental path from 'clerical', 'routine' or operational to a strategic focus.

Furthermore, the simplicity of the models undermines the complexities of the change from one stage to another, and does not acknowledge the fact that every company is different. Besides, different aspects of the same function may develop at a different pace. Doubts have also been raised about the suitability of the models for other than very large corporations: small companies may not afford to hire a specialized buyer, let alone a whole department. (Rozemeijer 2008, 206; Ramsay & Croom 2008, 198–199.)

Also, the strategic importance of purchasing is noted to be contingent on at least the overall strategic objectives of the organization, the type of organization and the purchase. What is operative to one organization may be a source of competitive advantage to another. It is also possible that unless the industry and market environment demands it, there may be no benefit for the firm from a greater strategic role of purchasing (Ramsay & Croom 2008, 198). Therefore, development models should be regarded as conceptual, possible helpful for classifying companies in terms of their current position, but other company and industry specific factors should be examined when considering possible directions for strategic change (Rozemeijer 2008, 206). The similar approach may be applied to the development models of logistics and supply chain management and their controlling: they may be helpful for broad description of the characteristics of the firm, but depending on the context also a less sophisticated system may be a satisfactory and functioning solution.

Table 2 Models of evolutionary development of supply chain management and performance measurement

Author	A.T. Kearney (1985) in Mentzer & Konrad (1991)	A.T. Kearney (1986) in Hewitt (1994)	Hewitt (1994)	Cavinato (1992)	Cavinato (1999a; 1999b)	Weber (2002)
Description of the model	*Performance measurement in stages of logistics management sophistication*	*Levels of integration and related objectives of optimization initiatives*	*Levels of integration and related objectives of optimization initiatives*	*Management control and measurement approaches of procurement and logistics*	*Attributes of stages of strategic management in purchasing and SCM*[6]	*Development phases of logistics*
Stage I	Simple financial measures[7]; information from financial department; measures not given much consideration	Fragmented, technical disciplines; local quick fixes	*Fragmented, technical disciplines:* local quick fixes	Lowest price or cost	*Basic financial planning*: financial key measures; budgeting by cost centers; price information	*Isolated functional specialization*: transportation and warehousing; effectiveness and efficiency
Stage II	Measures of productivity; 'reactive' measures	Functional focus; cost reduction	*Logistics functional integration:* logistics network cost minimization	Lowest landed cost	*Forecast-based planning:* firm focused planning by past performance and cost centers; deviation from plans analyzed; landed costs	*Material flow related coordination function*: support function implementing company strategy

[6] An extract of the model, focusing on the attributes performance measures, (budgetary) planning, and information needs

[7] e.g. cost as percentage of sales

Author	A.T. Kearney (1985) in Mentzer & Konrad (1991)	A.T. Kearney (1986) in Hewitt (1994)	Hewitt (1994)	Cavinato (1992)	Cavinato (1999a; 1999b)	Weber (2002)
Stage III	Sophisticated, 'proactive' performance measurement, goals for operations	Broad scope logistics; network productivity improvement	*Cross functional logistics integration*: logistics and asset rationalization	Lowest total cost to the firm	*Externally oriented planning*: inbound and outbound flows; continuous improvement and cost minimization; lowest total cost to the chain controlled; total product cost	*Flow oriented logistics:* integrated management and planning of material and information within company
Stage IV	As previous, but measurement system integrated across departments and with financial data; balancing departmental goals	Links with customers and suppliers	*Inter-company logistics coordination:* Joint enterprise network rationalization	Lowest total cost to the final firm in the supply chain	*Strategic management*: System tailored for each line of business; highest total value to end user; lowest total cost to the entire SC; synergies in resource use	*Supply chain management:* Management of material and information flows extended outside company borders
Stage V	-	-	*Integrated intra- and inter-company SC process management*: total business process efficiency and effectiveness maximization	Highest total value to the end customer of the final firm	*Knowledge-based business:* SCM intertwined with business; anticipatory; packages of services; networks in innovation; time and value of essence	-

2 THE MANAGERIAL AND ORGANIZATIONAL CONTEXT OF LOGISTICS COST

2.1 Role of management accounting

The management accountants of the organization influence greatly if not almost completely how logistics costing is organized in the firm. The development of supply chain management places additional criteria to cost and performance information than what has been traditional. Along with the universally increased importance of supply chain management also the role of management accountant in companies has changed. The management accountant nowadays is expected to have a more active, even pro-active role in the provision of cost and performance information.

A general development similar to the development of supply chain management has taken place in management accounting since mid-twentieth century. The emerging new management accounting techniques are argued to have affected the whole process of management accounting (planning, controlling, decision-making and communication) and shifted the focus from 'simple' role of cost determination and financial control to a 'sophisticated' role of creating value through improved deployment of resources. The International Federation of Accountants (IFAC) has presented a four-stage conceptual framework of the general development. (Abdel-Kader & Luther 2006.)

The first stage, *cost determination and financial control*, is described to have taken place mainly before 1950, when production technology was relatively simple, labor and material costs were easily identifiable, and competition on the basis of either price or quality was relatively low. The focus of management accounting was mainly on the determination of product cost, and the use of budgeting and cost accounting techniques were prevalent. However, cost information was not disseminated much, and its use for management decision-making was poorly exploited. The shift to the second stage, *information for management planning and control*, is seen to have taken place by mid-1960s. The focus shifted to the provision of information for planning and control purposes, and management accounting was recognized a management activity, but in a staff role, providing staff support to line management. Management accounting tended to be reactive, identifying problems and actions only from the deviations from the business plan. Management controls were oriented toward manufacturing and internal

administration rather than strategic and business environmental concerns. (Ashton et al. 1995, 1–2; Abdel-Kader & Luther 2006.)

The transition to the third stage, *reduction of resource waste in business processes*, took place by the mid-1980s, motivated by the increased global competition, shortened product life-cycles and rapid technological development both in production and information processing. This was met with introduction of new management and production techniques, at the same time controlling costs, often through reduction of waste in business processes. This was in many instances supported by employee empowerment, and lead to distribution of decision-making and the need for management information throughout the organization. The fourth stage, *creation of value through effective resources use*, is argued to have taken place by the mid-1990s. With the development of Internet, appearance of the e-commerce and ever increasing global competition the focus of management accounting shifted to the generation of value through the effective use of resources. The critical difference compared to earlier stages is the change in focus away from information provision and toward resource management, first in reducing waste and then creating value. However, the attention in information provision is not lost, but information becomes a resource along with the other organizational resources. (Abdel-Kader & Luther 2006; Ashton et al. 1995, 3–4.)

This development model appears very similar to the general maturity models the logistics and SCM (as discussed in Chapter 1.5). Also similar critique may be presented: the stages may not apply to all industries and all company-sizes, or to all countries. In some industries and competitive environments more elementary role of management accounting may be sufficient, and the firm has had no need to adopt the more sophisticated approach of management accounting. However, one may argue that in the most competitive environments at least, the aims of management accounting and supply chain management have converged. Nowadays, management accountants are increasingly expected to act as business partners and part of the team, and are increasingly involved in functional areas such as production and marketing. The audit and control mentality traditionally associated with management accounting is seen unhelpful for that. Flexibility is hoped for in the design of reporting systems and in the budgets in response to changes in business environment, and instead of standard information, more relevant information tailored for the needs of managers is hoped for. (Pierce & O'Dea 2003.)

Pierce & O'Dea (2003) noted that managers reported the use of specific management accounting techniques such as target costing, distribution channel profitability analysis and benchmarking higher than the management accounting in the same organizations. This implies that it is not necessarily management accounting function conducting the cost analyses but the

managers themselves – i.e. the data analysis and information provision role has shifted to some extent to the information users themselves. Crude analyses of customer profitability were used in some companies, avoiding the difficulties of indirect cost allocation. This was raised as an example of 'good-enough accounting', where the managers appreciate the timeliness of specific data more than technical accuracy (Pierce & O'Dea 2003, 282–283.)

As the strategic level of perception of both management accounting and supply chain management increase, there is not so great difference for the practice in the logistics context which term is used. Both aim for the creation of value through effective resources use, and this is likely to be pursued in inter-functional teams. At a lower level of supply chain orientation (logistics management) the difference between the roles of the two functions are more likely to be higher. The perceptions of the information requirements and availability as well as the purposes of the use of cost and performance measurement systems may be then less likely to converge.

2.2 The firm size

The company size has been recognized in management accounting literature an important factor affecting the organization of management control. Larger organizations have resources available to adopt more sophisticated and advanced management accounting practices (MAP) than smaller ones. (Abdel-Kader & Luther 2008, 7). Increasing firm size also adds to the complexity of operations, increasing the need for formal controls and specialized functions (Chenhall 2003) The connection between the development level of management accounting practices and the organizational size has been found statistically significant e.g. by Al-Omiri & Drury (2007), Abdel-Kader & Luther (2008) and Askarany et al. (2010).

The firm size is also been used as a contingent variable in two of the papers in this thesis. Paper I uses firm size as a control variable in examining the effect of geographical dispersion of supply chain to the intra-firm supply chain performance, and paper IV finds the size of a firm to be related to the availability of administrative logistics cost information in trading companies and to the detail of logistics cost information available in trading and manufacturing companies.

Halley & Guilhon (1997) set boundaries to the evolutionary metaphor of general development of logistics by including contextual factors, and present a framework for examining the logistics strategy of small companies. They state that an external pressure from the market (e.g. in the form of customer demands or increased competition) motivates the shift to a next phase.

Additionally, the distinctive competencies of the firm as well as the owner-manager's preferences of strategy are seen influence the logistics strategy practiced in a small firm. Consequently, logistics strategy is described as

- *reactive*: logistics activities are unintegrated, focus is on their efficiency and cost reduction, and logistics is developed sporadically, often in response to another organization's initiative;
- *emergent:* logistics performance is developed gradually, with the purpose of jointly pursuing with other firms long-term competitive goals; or
- *pro-active*: logistics is highly integrated within the organization, and the objectives include effectiveness, value creation and broadening the control of the firm (and the owner-manager) over the environment. (Halley & Guilhon 1997, 481–482.)

2.3 Products and production process

Product and production process related factors also contribute to the logistics costing. The *size and weight of the product* affect the relative importance of logistics costs in the total product cost. For a manufacturer of heavy machinery, for example, who uses great amounts of plate steel as well as castings and forgings, which are costly to transport, receive and handle, logistics costs are a major expense (Jones 1991). Oversimplification of a costing system in this area would greatly distort logistics costs. Company thus has used a variation of an activity-based cost system, with specific cost pools for logistics. There are two cost pools for the cost of activities on shipping docks, in the receiving areas and in the storage areas for the heavy material groups, and, similarly, two costs pools for the intra-plant handling of materials as it moves through the production process. Based on these, variable and period costs rates are calculated, and allocated either by product weight poundage (as planned to be used in the next period), or the poundage multiplied by the number of material moves in the production process. For lighter purchased finished material the costs of buying, receiving, storing and moving are grouped together, and allocated based on material prices (Jones 1991)

Product diversity has been identified as a factor contributing to the sophistication of product costing system (Abernethy et al. 2001): higher level of product diversity indicated low satisfaction in traditional (low sophistication level) costing system, but high satisfaction in high sophistication level costing system. In firms with low product diversity, on the other hand, the managers experienced high level of satisfaction with less sophisticated costing system.

The phase of the *product life cycle* also contributes to how high priority is placed on efficiency and cost reduction. As the product moves from the phases launch of the product and market growth to maturity and decline of the market, the performance priority of logistics shifts from fast delivery to market to availability of the product cost efficiently and finally to cost efficient deliveries of small orders. (Fisher 1997)

Also the *storability* of end products and raw material, and the point of inventory may influence the relevant importance of cost (efficiency) in contrast to other elements of performance in different parts of the intra-company supply chain. McKinnon and Bruns (1993) noticed that the nature of production process and the raw material used for the product affected the main consideration in purchasing: the cost of running out of material versus the cost of maintaining the material inventory. A relatively stable production process, where production is planned and plans rarely change also allows for predictable material requirements. Prices and inventory levels were then monitored over longer time periods. Also long term contracts with suppliers lengthened the time frame of monitoring the purchase price. (McKinnon and Bruns 1993, 31–32)

Less stable production environment was found to shorten the time horizon in purchasing for monitoring inventory levels and process. Volatility in the raw material market (e.g. when raw material were commodities), on the other hand, lead to the aim of minimizing the inventories while continuously monitoring the market price for price advantages. And if the supply of the raw material was volatile (e.g. seasonal agriculture products), so was the price, which was carefully monitored. (McKinnon and Bruns 1993, 32–33.)

The *order penetrating point (OPP)* has been stated to be the point within intra-company supply chain where the strategic focus moves to price competition through cost efficiency with respect to capital tied up in capacity and inventories (Olhager 2003, 323). Schary (1985) recognized the conflict between product flow and the order fulfillment mission: aggregated material flows become components and then products, which are shipped in various combinations to customers. Even with a single product flow, customer groups require different levels and types of services, with corresponding differences in costs. At some point in the supply chain there is a change in management focus, from a common integrated process to the service requirements of individual customers (see Figure 4). (Schary 1985, 38).

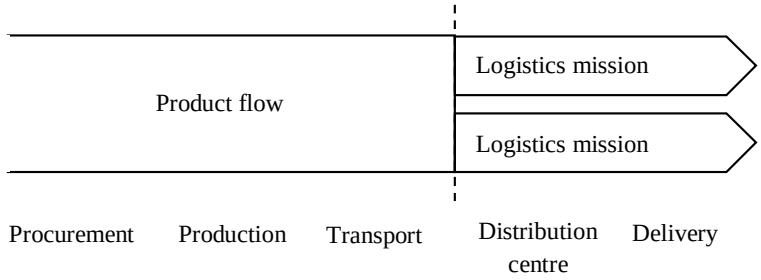


Figure 4 Change of management focus from efficient product flow to different customer group service requirements (Schary 1985)

The OPP[8] is the point in manufacturing value chain where the product is linked to a specific customer order (Olhager 2003, 320) or where order-driven and the forecast-driven activities meet. Typically it coincides with an important stock point from which the customer has to be supplied. (Hoekstra, Sjoerd & Romme 1992 in Mason-Jones & Towill 1999.) The order penetration point thus acts as a buffer between upstream and downstream players against the fluctuation and uncertainty of customer market demand (Mason-Jones & Towill 1999, 16). Mason-Jones et al. (2000) distinguish between lean and agile supply chains, where a lean supply chain strategy is applied upstream the OPP, and agile supply chain would be more suitable for downstream operations (Mason-Jones et al. 2000). The order penetration point would thus determine the relevant importance of efficiency in comparison to flexibility and service quality in the different phases or functions of intra-firm supply chain. The chosen product delivery strategy (or manufacturing strategy) of a firm, MTS, ATO, MTO or ETO naturally affect the placement of OPP. (see Figure 5).

Delivery-lead time requirements in combination with production lead-time restrict how far upstream the OPP (and inventory) can be placed. Characteristics of the end-product, i.e. how perishable it is and the customer market-related requirements for product range and customization also guide the placement of OPP. A broad product range and a wide set of customization options would be impossible to provide on MTS basis, as the end product inventory investment would be immense. (Olhager 2003; McKinnon and Bruns 1993.)

Reduced product-variety would decrease the variety-driven complexity costs (see also Chapter 4.4). The end-product (or semi-finished product)

[8] a.k.a. customer order decoupling point (CODP) (Olhager 2003) or demand penetration point

inventory acts as a buffer against the customer market uncertainty, making demand forecasting possible and enables other type of planning as well, e.g. production planning, materials requirement planning, sales & operations planning (S&OP) as well as related budgeting.

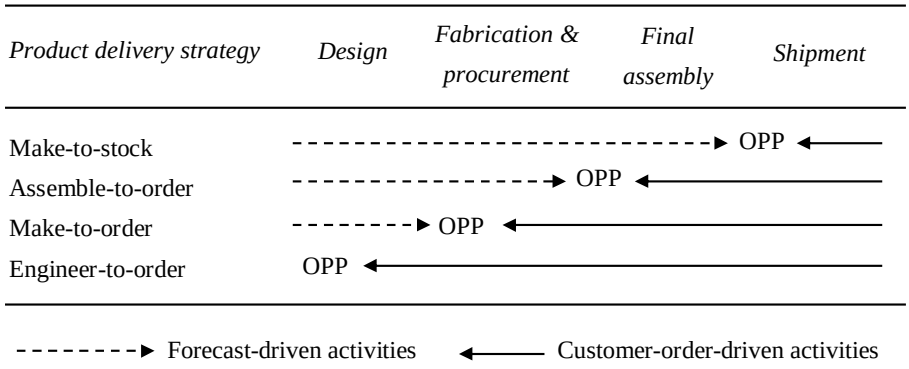


Figure 5 Different order penetration points related to production delivery strategies (modified from Olhager 2003)

Macintosh and Daft (1987) demonstrated that increasing interdependency of departments reduces the reliance on formal management accounting tools and increased face-to-face communication. In sequential interdependence the departments are linked in serial fashion, and the output of one department becomes a direct input to the next department (Macintosh and Daft 1987, 50). This could be the compared to typical relationship of purchasing and production: purchasing acquires and stores the raw material and components that is the input of production process. The reciprocal interdependence, on the other hand, is characterized by the movement of work back and forth among departments in reciprocal fashion (Macintosh and Daft 1987, 50). This could be likened to the interface between the sales and the order penetration point: e.g. in make-to-order and engineer-to-order the customer requirements may change and be communicated to production in several occasions, and the production send samples or prototypes to sales for showing to the customer.

Support was found that under sequential interdependence there is need for data for scheduling and planning the flow for materials and activities between the departments, and budgeting and non-financial reports on short intervals are needed for coordination. Under reciprocal interdependence between the departments formal control systems are likely not sufficient for information requirements. The systems may be used for planning and scheduling, but face-to-face coordination and mutual adjustment are emphasized. As

interdependence increases, data are needed that are current, timely and concern unforeseen events. Multiple types of data are used, from budgets and statistical reports to face-to-face coordination. (Macintosh and Daft 1987, 58.)

The *nature of the production process* has long been recognized to determine the amount of direct cost that can be traced to the products, as opposite to allocating them on some criteria: the level of accuracy that can be attained in a job-shop environment with somewhat simple system is not possible in process production, where a larger part of production costs are incurred jointly by a range of final products and need to be allocated with some criteria if full costing is used. (Otley 1995, 53.) Brignall (1997) suggests that the traceability of costs of different types of service processes is analogous to production processes. Professional services, such as services of an architect, a lawyer or a consultant are highly customized, labor intensive, solve discrete problems, the contact time with the customer is high, and the process is at least equally important than the product (outcome). A large part of costs are labor costs identifiable to a particular client, and a simple job costing system would be sufficient. Mass services, such as e.g. airline check-in, in the other extreme, provide a complex mix of equipment, facilities and back-office staff to provide standardized services for millions of people. Service shop type of services, e.g. an upmarket hotel or a restaurant chain, is situated between the two extremes. Professional services would include the largest part of direct costs, whereas mass services would need a complex system to fairly allocate the joint costs to an individual unit (service) produced. (Brignall 1997, 327–328.)

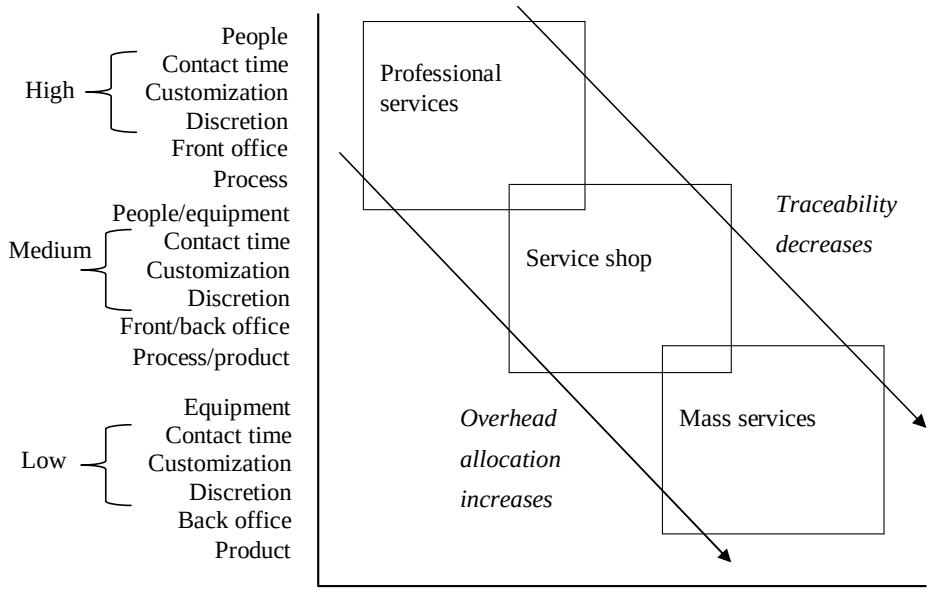


Figure 6 Service classification and the traceability of cost (Brignall 1997)

Logistics processes may be likened to these service process types, especially in the case of logistics service providers. For example, the standard services of large international logistics service providers resemble mass services, whereas, depending on the extent of customization and the expertise required, customized solutions or project logistics may be analogous to either service shop or professional services. In a similar line of thought, Kallio et al. (2000) divide delivery processes from the order-penetration point onward into routine, normal, and custom processes. Routine process is a streamlined process for standard orders, which can be automated to a high degree. The pre-designed and products incorporating low costs and one way communication with the customer are delivered from stock (make-to-stock production). Normal process is based on standardized components and parts, and non-standard combinations of those can be assembled after customer order (assembly to order). Process involves communication with the customer about the preferred combinations, and is assisted by information systems but cannot be completely automated without very high costs. Custom process meets specific customer requirements for the product concerning quality specification, delivery time etc. (engineer-to –order), which requires interactive communication, and the work is often conducted by project teams. (Kallio et al. 2000, 78.) The authors suggest how to prioritize the performance aspects of time, cost, quality and efficiency for each type of delivery process. Regarding cost and efficiency, routine processes should minimize the cost and maximize

efficiency. Normal processes should standardize the costs and maximize the efficiency, whereas in custom processes the aim would be to standardize both the cost and efficiency. (Kallio et al. 2000, 83–84.) Consequently, the suggestion provides guideline also for choosing relevant individual performance measures of divergent logistics processes.

2.4 ERP and other information systems

On one hand, the changes in information technology taking place in the 1980s and 1990s (e.g. personal computers and spreadsheets) have allowed the data modelling and analysis be dispersed across the organization, but on the other hand, the enterprise resource planning systems (ERP) have integrated the production and management control, making bill of materials a central lever for the control of the firm. (Granlund & Mouritsen 2003). Information systems available in a firm also influence the reliability and usefulness of the costing system. The likelihood of errors is decreased as the data is situated in one database that can be accessed by multiple users, and integrated information systems with several analysis and reporting options may remove the management accountant as the middle man and increase the speed to obtain necessary cost and information. However, the usefulness of the IT-system depends on the accuracy of the underlying data, as well as the technical properties and configuration of the system. Furthermore, standard solutions may not provide the needed information for everybody, especially for rarely occurring decision-making situations, and additional information collection and analysis may still be necessary.

Most cost accounting, management accounting and cost management approaches generally are supported by higher-end ERP (enterprise resource planning) systems such as SAP or Oracle (Deshmuk 2005, 255). ERP software supports traditional cost accounting tools such as various methods for product costing and allocating overheads, and most ERP systems also support or have add-on modules for advanced cost accounting techniques like activity-based costing. ERP systems allow for the calculation of unit costs, definition of costs for each batch, and automatic allocation of overhead expenses using different allocation bases or cost drivers. Analytical tools of the system also enable comparison of budgets and standard costs with actual costs, simulating different cost scenarios and what-if analysis. Also cost estimation across the supply chain is supported. (Deshmuk 2005, 251; 253.)

For example, the properties of Oracle ERP software include (Deshmuk 2005, 254):

- *product costing*, e.g. cost roll up for bill of material and various routings; assigning overheads to items; updating of costs to revalue inventory and work in process;
- *allocating overheads*, e.g. by multiple bases, fixed or relative to value; and
- *inventory, manufacturing and maintenance costing*, e.g. using rule-based accounting for revenue and cost of goods sold, automatically re-valuing inventory after standard or average cost changes.

As activity-based cost accounting support features in Oracle software are presented (Deshmuk 2005, 255):

- *cost assignment and mapping:* assigning costs multiple ways, to departments or activities; assigning costs using multi-stage mapping;
- *hierarchies:* e.g. defining activity hierarchies (such as batch or channel); assigning activities, materials and cost objects to bill hierarchies;
- *cost drivers:* e.g. assigning multiple drivers to the same activity;
- *calculations*: e.g. activity rates; material unit cost; cost object unit cost; activity cost roll up; and
- *visual tracing*: e.g tracing cost components back to their source department accounts.

Additionally, the analytical tools of ERP systems allow the generation of multiple reports by item, time, cost elements, activities, departments etc.: conducting of what-if analyses by estimating the changes to various costs due to changes in supply chain management actions, engineering changes, make-or-buy decisions and so on; and target costing by allowing the simulation of the effect of changes in sourcing, design and manufacturing on the costs. (Deshmuk 2005) Some ERP systems (e.g. SAP and Oracle), also support certain standard performance metrics, such as those specified in the SCOR framework, which facilitates intra-organizational performance management in the supply chain with common definitions (Forslund 2010).

With access to an integrated and up-to date ERP or other (accounting) information system managers may be less likely to create their own cost calculations. Timeliness of information is a key factor, and the current ERP systems have improved this so that most information can be accessed on demand. (Bruns & McKinnon 1993.) However, the master data (bills of materials of the products, machine routings and other production process data, as well as the distribution etc. process configuration) as well as inventory information needs to be kept up to date in order the cost information to be reliable (Ptak & Schragenheim 2000, 265–283).

Another benefit of an ERP system is that installing it often forces the firm to define its processes and related activities, and thus define the scope of

logistics or supply chain functions. By adding cost standards or rates to activities or transactions, also cost models of logistics processes are created that are easy to update with most recent cost information. However, production processes are likely to be the first to be configured, whereas in a non-logistics company the other supply chain processes are probably of a lower priority. And if the ERP system is designed around broader responsibility (i.e. cost) centres than logistics, level of data aggregation of reports may be too broad and other solutions have to be implemented or created. The configuration options of standard systems may not correspond with the processes of the company, and creative solutions or quick fixes need to be implemented to get the system to work. Also, once the system is in use, the basic structures may not be modifiable anymore, and for example the organizational structure cannot be changed (e.g. Mouritsen & Dechow 2005). In some cases, even with SAP implemented, managers that wanted some particular information were found to build their own Excel spreadsheets or have add-on solutions installed (Pierce & O'Dea 2003, 277). Lack of adequate skills or training may also limit the use of ERP systems potential (Forslund 2010).

3 PERFORMANCE MEASUREMENT

A vast variety of definitions and measures exists for logistics and performance, which can be considered a sub-set of organizational performance (Chow et al. 1994, 23). Also in different parts of the company internal supply chain there are divergent aspects of performance which are prioritized, and thus affect the performance measures or metrics utilized (as discussed in Chapter 2.3). Logistics performance of a company is based on a combination of abstract attributes such as timeliness, efficiency, quality or flexibility, which are operationalized in performance metrics into a measurable form. Elements of logistics performance typically presented include customer service or quality, flexibility (Beamon 1999; Gunasekaran, Patel & Tirtiroglu 2001; Shepherd & Günter, 2005) and time to perform various activities or processes (Shepherd & Günter, 2005; Gunasekaran et al. 2001) Efficiency in the sense of efficient use of resources is perhaps the most commonly discussed element of logistics performance, but operationalized in different ways: (Beamon 1999; Griffis, Goldsby, Cooper & Closs 2007.)

For the sake of measurement these attributes have to be quantified into more specific performance measures or performance metrics. Performance can and needs to be defined by combination of different metrics by each firm to match its strategy, subject to external constraints of the markets the firm operates in. (Lebas 1995, 27) Melnyk, Stewart and Swink (2004) classify performance metrics into three levels: 1) the individual metrics, 2) the metrics set and 3) performance measurement systems.

An apt definition of a *performance metric* or *performance measure* is (Melnyk et al. 2004):

> *[…]a verifiable measure, stated either in quantitative or qualitative terms and defined with respect to reference point.*

A carefully selected set of measures; 'the relevant few', that are seen to implement the organizational strategy are called *key performance indicators* (KPI). A *performance measurement system* may be defined as a (Neely, Gregory & Platts 1995)

> *strategic control system […] part of a wider system which includes goal setting, feedback and reward or sanction.*

Another definition is by Ljungberg (1994):

> *set of related measures – described by rules and procedures for caption, compilation, presentation and communication of data –*

> *that […]reflect key performances […] of a selected process […] to allow intelligent analysis leading to action if needed.*

The task of a performance measurement system is to ensure alignment and coordination: aim is to align the metrics of every managerial level or level of aggregation with strategic goals of the organization. The measures also need to be coordinated so that they are consistent and supportive to each other in different areas to reduce the conflicts between different areas or departments prioritizing different elements of performance (Melnyk et al. 2004, 213), such as efficient use of manufacturing capacity, fast inventory (i.e. capital) turnover and speed and flexibility in answering to customer demand.

Existing between the individual metrics and a performance measurement system and linking was also proposed a *set of metrics* (Melnyk et al. 2004, 213), defined as the metrics assigned by a higher level of management to direct, motivate and evaluate a single person in charge of a specific activity, process or area. One may criticize the notion that the metrics are assigned to an individual, and specifically for such decision-influencing (van Veen-Dirks 2010) purposes; equally, a set of metrics might be for a team or the personnel connected with a process. The purposes of the metrics, on the other hand, could include e.g. providing feedback of the results of actions or verifying that plans progress as anticipated. However, a category between independent metrics and a full performance measurement system appears to be called for. The metrics of a firm may be developed for one department at a time and more metrics added in the course of time but never systematically revised, so set(s) of metrics could also describe such a situation.

Both terms *performance measurement* and *performance management* are used in literature, sometimes even together[9]. It is argued (Folan & Browne 2005, 674; Lebas 1995, 34) that the performance measurement and management are an iterative process; that management both precedes and follows measurement, and thus creates the context for the measurement. A definition is provided for performance management (Amaratunga & Baldry 2002 in Folan & Browne 2005) :

> *[…]the use of performance measurement information to effect positive change in organizational culture, systems and processes, by helping to set agreed-upon performance goals, allocating and prioritising resources, informing managers to either confirm or change current policy […] to meet these goals, and sharing results of performance in pursuing these goals.*

Performance measurement and literature has developed from providing recommendations for selecting performance measures through

[9] see e.g. Melnyk et al. (2013): 'Is performance measurement and management fit for the future?'

recommendations for and issues in performance measurement frameworks and systems design to the broader and more strategy and context related areas of intra- and inter-organizational performance management. (Folan & Browne 2005; Lebas 1995, 34.) Earlier on the performance measurement literature, especially in management accounting, emphasized the use of performance measures for evaluating managerial and divisional performance or the use of standard costing and variance analysis to control production activities. Profit-based, financial measures dominated, as well as labor based metrics and metrics of (production) productivity. (Chenhall & Langfield-Smith 2007; Ghalayini & Noble 1996) In the late 1980s the changes in production technologies and management such as computer aided manufacture/design (CAD/CAM), total quality management (TQM) and JIT manufacturing undermined the importance of short-term financial and labor based measures, and so called non-traditional, primarily non-financial performance measures were adopted. Focus moved from recording and reporting the costs and cost variances against budget to understanding and controlling the causes of cost. (Chenhall & Langfield-Smith 2007; Kaplan & Cooper 1998)

A widely discussed and fairly standardized performance measurement framework is the balanced scorecard (Kaplan & Norton 1992) that aims at balancing several aspects of performance both in short- and long term, at different organizational levels and incorporating both internal and external (customer) focus. Measures are derived from the organization strategy for financial, customer, internal business, as well as innovation and learning perspectives on performance (Brewer & Speh 2000; Akyuz & Erkan 2010) A version of a balanced scorecard has also been proposed to support and advance the supply chain management orientation in organizations (Brewer & Speh 2000). Another standardized performance measurement system developed specifically for the supply chain management is included in SCOR (Supply Chain Operations Reference) model (Supply Chain Council 2006). The model contains metrics at three levels for the processes plan, source, make, deliver and return with variations for different production strategies, as well as the support processes for these. The customer-facing attributes of reliability, responsiveness and flexibility are measured, as well as internal costs and assets. The metrics are concisely defined to allow benchmarking, and instructions are given for necessary data collection (Supply Chain Council 2006, Akyuz & Erkan 2010).

The advantages of standardized performance measurement systems such as SCOR metrics are that it provides a holistic view of the supply chain processes, enables benchmarking and may facilitate understanding and collaboration in inter-organizational performance measurement. On the downside, the amount of individual metrics is abundant, and it is not realistic

to expect every metric be monitored with equal intensity. However, standardized measurement systems assume that 'one size fits all': for example in SCOR the elements of performance are given and each element is assumed to have equal emphasis. At least for implementing differentiation strategy such performance metric system does not appear very useful in guiding the managerial attention to critical success factors, if most firms in the industry measure and focus on the same elements of performance. So even with standardized performance systems organizations still need to decide what are the critical few metrics that implement their chosen strategy and to possibly modify them to suit their organization and operating environment.

Forslund & Jonsson (2007) present the performance management as a process, and highlight the issues in it that are critical for the integration of performance management in a supply chain. Although they discuss dyadic relationships between a customer and a supplier, the same principles may well be applicable to internal integration of performance management, as well. Ideally, the performance management process starts with the identification of strategic priorities and continues with

- selecting performance variables i.e. selecting the logistics specific elements of performance that are considered to operationalize the strategic priorities of the firm;
- defining metrics in detail, including the dimensions such as object of measurement (items, order lines etc.), measurement point along the supply chain (e.g. at the supplier ready for delivery or at the customer's premises), and for the time-based measures the time units and comparison date for measurement (e.g. per day, week or month, and date as promised or date as requested),
- setting targets; either individual targets for each supply chain member (e.g. supplier or customer) or same target level for everybody; if possible quantified and connected to a specific time frame or unit;
- measurement; including reporting issues such as frequency of measurement and report generation, whether data is exerted directly from an IT system or modified e.g. in an Excel sheet, level of aggregation of the performance outcome (e.g. by certain customers or suppliers or as an average, and the way of feedback (negotiated and adjusted or simply handed over); and
- analysis, whether regularly and jointly or as needed, and the extent of use for continuous improvement and pro-active decision making. (Forslund & Jonsson 2007, 549–552).

Performance measurement systems are a form of a *cybernetic control system* (Simons 1995; Malmi & Brown 2008, Schary 1985) with a feedback and feed-forward loops. When a change is detected in a performance measure (cost

or other element of performance), its significance is evaluated, which leads to a decision of a corrective action in the logistics activities or processes, whose performance is then again reviewed. A cybernetic control system requires five characteristics (Welsh & Green 1988 in Malmi & Brown 2008, 292):

- measures that enable the quantification of underlying phenomenon, activity or system;
- standards of performance or targets to be met;
- a feedback process that enables comparison with the standard;
- variance analysis arising from the feedback; and
- the ability to modify the system's behavior or the underlying activities.

Figure 7 illustrates logistics performance measurement as a cybernetic control process with feedback loop from analyzing the performance and feed-forward loop for planned action and outcome.

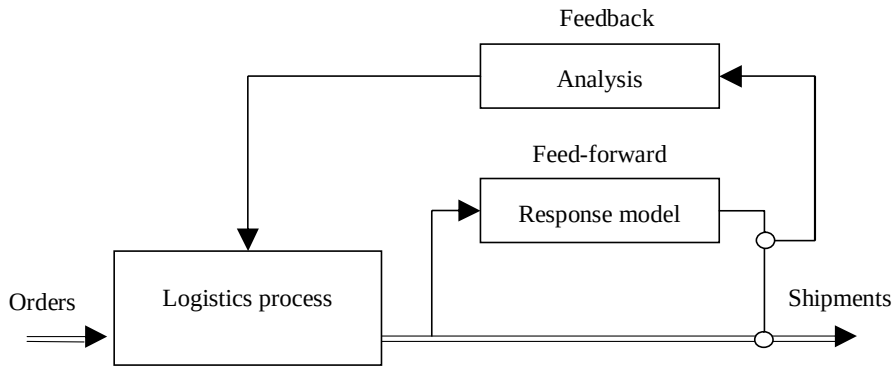


Figure 7 Logistics control as a cybernetic control system (Schary 1985)

The performance measurement processes in logistics and supply chain literature often implicitly regard performance measurement as cybernetic control. For example Rodrigues et al. (2004) describe performance measurement in supply chains[10]:

> *Integrated measurement systems extend across the borders of internal functional areas and external supply chain partners to provide timely feedback that enables management to take corrective action and drive superior results.*

[10] Compare also the performance management process discussed above (Forslund & Johnsson 2007)

Schary (1985, 43–45) explicitly presents logistics control systems as cybernetic control. In addition to performance measurement, other example of cybernetic systems in the context of logistics controlling is e.g. budgeting process

Performance measures and measurement systems can be designed and used for multiple purposes. A cybernetic system can be either used as a control system or an information system for decision-making[11] (Malmi& Brown 2008). Van Veen-Dirks (2010) divides the purposes of performance measurement into decision-facilitating and decision-influencing roles. The *decision-facilitating* role refers to the provision of information to reduce pre-decision uncertainty, to provide insight into cause-effect relationships and to guide decisions and managerial action. *Decision-influencing* role, on the other hand, is related to use of performance information for motivating and controlling the personnel to prevent opportunistic behavior and to promote organizationally desirable behavior, perhaps in connection with rewards. (van Veen-Dirks 2010, 142–144.)

A similar categorization into enabling and coercive formalization[12] (Adler & Borys 1996) or enabling/coercive control (Jordan & Messner 2012) has been used to analyze the introduction and development of performance measurement in lean management (Jordan & Messner 2012) and logistics management contexts (Wouters & Wilderom 2008). Characteristics of *enabling control* are (Adler & Borys 1996; Jordan & Messner 2010, 546, Wouters & Wilderom 2008, 492):

- repair: users are able to repair or modify the system or the processes themselves without having to rely on an expert for the maintenance and modification – routine tasks are not separated from non-routine repair and improvement tasks;
- internal transparency: personnel understands the function logic of the system and receive information on its status on demand, users are provided with feedback of their actions;
- global transparency: personnel understands the broader system context and how their tasks contribute to it, and additional information beyond their own domain is available ; and

[11] Malmi & Brown (2008, 290) consider management *controls* to be the systems, rules, practices, values and other activities put in place by management in order to *direct employee behavior*; whereas accounting systems that are designed to support decision-making but where the use of the system and the following results are not monitored should be called management *accounting systems* instead. Linking the behavior to targets and establishing accountability for the performance targets distinguishes an information system (a decision-support system) and a management control system (MCS).

[12] The extent of written rules, procedures and instructions (Adler & Borys 1996, 62)

- flexibility: users are able to modify the system interface and to add functionality to suit their specific requirements.

In contrast, *coercive control* is designed to inform superiors whether subordinates actions are in compliance. Procedures are not designed to help employees judge how the process is operating, to cope with inevitable disturbances of the work, nor to help them identify improvement opportunities. When enabling characteristics are lacking, covert and inefficient 'work-arounds' may appear. (Adler & Borys 1996, 71) The central proposition of the framework is that formal systems will be received positively if they are perceived to enable the personnel better to manage their tasks, but tend to be regarded negatively if the formalization is perceived as an attempt of top management to coerce employees' effort and compliance (Jordan & Messner 2012, 546).

A more specific categorization of the different uses or roles of performance measurement systems has been presented by Franco-Santos et al. (2007):

- 'measure performance', monitoring progress and measuring and evaluating performance;
- 'strategy management', planning, strategy formulation and execution, focusing attention and providing alignment;
- 'communication', internal and external communication , benchmarking and compliance with regulations;
- 'influence behavior', rewarding behaviour, managing relationships and control; and
- 'learning and improvement', providing feedback information for double-loop learning and performance improvement.

From the performance measurement systems perspective, logistics cost can be considered a quantification in monetary units of one attribute or element of logistics performance, namely efficiency; along with other attributes of logistics performance, such as reliability, responsiveness or flexibility (Figure 8).

Management accounting literature uses the term *incompleteness* of a performance measurement system to recognize the fact that a PMS does not completely reflect the functioning of the organizational reality and all its cause-effect relationships. According to Lillis (2002), incompleteness arises when strategic performance measures are disaggregated into performance dimensions, separate periods and organizational sub-units, but the dependencies between disaggregated measures are inadequately reflected in the PMS.

Incompleteness is suggested to take place in a broad form, i.e. the relevance of the measurement is questioned: the measure does not measure the element of performance that is considered essential or does not measure all the relevant performance attributes; or in the narrow form, where the definition of an indicator is considered faulty. (Jordan & Messner 2012) The greater the

incompleteness, the more the PMS may be perceived as unfair, negative or coercive instrument of management control (Wouters and Wilderom 2008, 491).

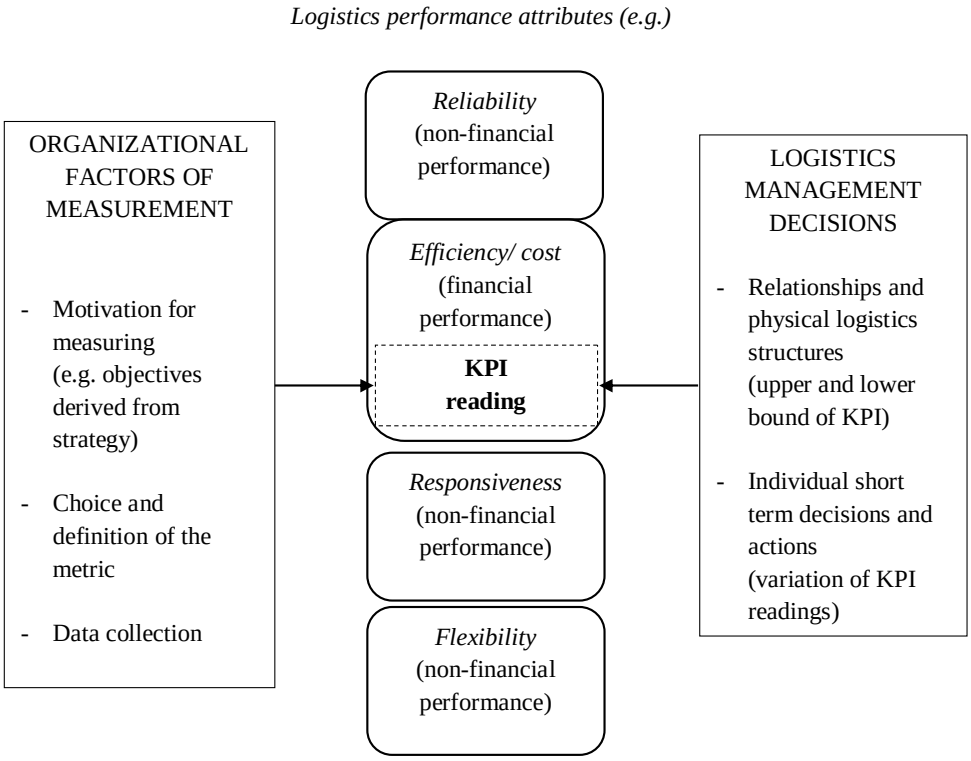


Figure 8 Logistics cost as a part of logistics performance

However, a perfectly complete PMS is hard, if not impossible to obtain, as this would require involving all relevant aspects of performance in quantitative terms, consideration of interdependencies between different organizational units and estimations of trade-offs between the divergent targets of different performance aspects. (Wouters and Wilderom 2008, 491). Nevertheless, although managers recognize that accounting information does not fully represent the performance dimensions that are considered important, the incompleteness is not always considered problematic Jordan & Messner (2012, 559). Jordan & Messner (2012) noted that managers took a pragmatic approach to incomplete productivity measures in the early stage of their development process, as these were seen as means guiding towards targeted improvements (i.e. an enabling control). Also, the performance targets were understood as visions to strive for but were not realistically attainable in the

near future. However, as the targets were lowered and a time horizon for their attainment was set, the incompleteness – definition of a performance measure, which did not accurately reflect all improvements made in productivity – became a problem. Also the fact that the measure was compared between factories heightened the concern for its inaccurate representation of the actual performance. Thus, as the measure was perceived mainly as a tool for evaluation (coercive control), the incompleteness of the measure became problematic. (Jordan & Messner 2012)

4 LOGISTICS AND SUPPLY CHAIN RELATED COST TERMS

4.1 Logistics controlling, logistics costing, and logistics cost control or management

The concept of control that has dominated management accounting thought is ‘control over something’, and is typically portrayed in the textbooks as being located at the top of the organization. For example, setting standards, evaluation of performance and budgetary-process are top-down. Control is exercised through the establishment of rules and regulations to guide the behavior. The underlying assumption of this type of control has been called ‘Theory X’, which suggests that individuals are inherently lazy, rational economic beings, and require constant supervision and motivation by economic gains. Motivation is based on an incentive system providing economic reward for good performance. (Preston 1995, 277.)

Another concept of control, consensual control, which emphasizes participation, is based on ‘Theory Y’. It regards individuals as responding to a wider range of incentives such as greater autonomy and control over their tasks, and group participation. It is assumed that if individuals are involved in setting the standards and in the evaluation of their own performance, they will internalize the goals and strive to achieve them. Under consensual control, budgeting process, for example, is bottom-up, with top management basically approving the standards proposed by lower level managers. (Preston 1995, 278.)

A third approach to the individual is ‘Theory Z’, which proposes even less formal controls. The organization is compared to a clan, which functions by socializing the individual completely, so that the goals of the individual merge with the goals of the organization. The clan is culturally homogenous, members share a common set of values and beliefs, and there is a mutual interdependence between the individual and the organization. Relatively few rules, regulations and control systems exist, which enables the members to adapt their behavior to changing conditions. This has been thus considered an appropriate model of control in rapidly changing environments. (Preston 1995, 278.) Linked to this are the concepts boundary systems and belief systems (Simons 2000). A belief system is ‘the explicit set of organizational definitions that senior managers communicate formally and reinforce systematically to provide basic values, purpose and direction for the organization’ (Simons

2000, 34), or the core values linked to the business strategy of the firm. Their aim is to guide the organization members to find the way to solve problems or search for new ways of creating value in line with the organizational goals and values. Boundary system, on the other hand, establishes the limits for the opportunities that the individuals should seek, i.e. what they should not do. These can take form as e.g. codes of conduct or definitions in the strategy what is not part of the firm's business. (Simons 2000, 39, 42.)

Figure 9 clarifies the relationship of logistics cost and logistics cost management in the broader organizational context. Apart from the presumably information technology based ERP and accounting information systems, of which there is probably not many in a firm, the costing systems and performance measurement systems may be formally organized or be managers' own informal solutions (Preston 1986; McKinnon & Bruns 1992; Bruns & McKinnon 1993) Thus they may overlap the management control systems, which are to some extent assumed to be formal, but not fully. Management control systems can be considered to include so called interactive controls such as regular meetings, personnel development discussions, strategy and mission workshops etc. as well as belief and boundary systems (Simons 2000). Also, logistics cost management may take place either formally, and thus be part of accounting information systems, or informally, e.g. in the form of managers' own excel sheet calculations.

Based on a survey by Weber and Blum (in Weber 2002, 99–100), several tasks of *logistics controlling* are listed. The given alternatives included both 'intuitively' cost management related tasks, such as calculation of logistics costs and generating a logistics costing system, but also tasks that could be considered as the responsibility of logistics management (e.g. generating logistics strategy, organizing the logistics, or logistics benchmarking, and indeed it was indicated which department the respondents saw the task belonging to. The five most commonly named tasks of logistics controlling were:

- the control[13] of logistics costs, (performed amount of) logistics activities, and logistics budgets;
- compiling of logistics costs;
- planning of logistics costs, logistics activities, and logistics budgets;
- management of logistics performance metrics; and
- financial reporting of logistics.

[13] Malmi & Brown (2008) give examples of conflicting interpretations of 'cost control'. It may mean e.g. that an entrepreneur controls his own expenses, that a large organization creates a costing system to support decision-making, or that sub-ordinates are required to report their expenses relative to budget, and this accountability may cause the subordinates to control costs by themselves. Here it is presumably utilized in the sense of measuring and monitoring.

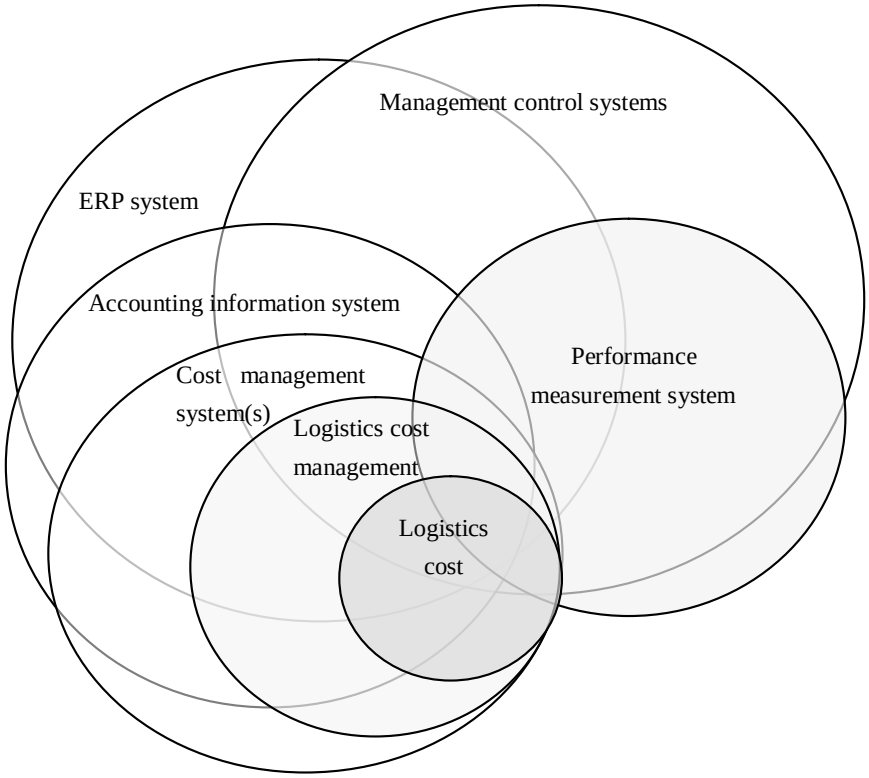


Figure 9 The concept of Logistics cost in the broader organizational context within a firm

Interestingly, generating a logistics costing system and especially calculating the logistics costs were among the most rarely mentioned tasks of logistics controlling.

Strictly speaking, *logistics costing* (Schary 1985; Fernie et al. 2001) (or *logistics cost accounting* (Gudehus & Kotzab 2009) is a narrower concept than *logistics cost management* (*or logistics cost control*). That in turn is an element of *logistics controlling* which includes not only the calculation, budgeting and recording of costs (i.e. costing), but also the monitoring of performance and quality (Gudehus & Kotzab, 2009) – in other words the overall logistics performance measurement and the related processes and their design. This thesis concentrates on the calculation and recording of the costs, and regards quality one element of overall logistics performance (Chow et al. 1994), efficiency being another performance element, of which cost is an indicator. I mainly use the term logistics cost management in the thesis instead of logistics costing, as it more clearly includes the managerial use of cost information for some purpose, but I consider logistics costing to a large extent

a synonym for logistics cost management. In some instances in this thesis 'costing' may be used for synonymously to 'cost management' for brevity.

Logistics costing has been defined as:

- identifying different costs that result from servicing customer with particular product mixes (Fernie et al. 2001); and
- registering, calculating and reporting all logistics costs, which are caused by the business between the dispatch ramps of the suppliers and the receiving ramps of the customers (Gudehus & Kotzab 2009).

Pohlen et al. (2009) also use the term *supply chain costing*, and define that as

> *"…the collection, expense assignment and analysis of cost information across all of the work activities comprising a supply chain for the purpose of identifying opportunities to obtain a competitive advantage through a combination of reduced costs or improved performance."*

This definition is also suitable for logistics cost management, when 'supply chain' is replaced with 'intra-company supply chain': the author of this thesis considers that a supply chain extends outside the firm boundaries and includes at least one external partner, either a customer or a supplier.

The aim of a *logistics costing system* (or *logistics control system* (Schary 1985)) is considered to be to 'determine the total cost of specific logistics objectives (outputs) by quantifying the various logistics inputs', i.e. to quantify the resources used in logistics activities (in a given period).

Drawing on this and the other definitions presented here, *logistics costing (/cost management) system* can therefore be defined as

> *"…a system comprising the rules, routines and responsibilities for registering, calculating and reporting all logistics costs, which are caused by the business between the dispatch ramps of the suppliers and the receiving ramps of the customers."*

If a cost analysis extends the legal company borders and includes suppliers or customers, it may be considered supply chain costing.

4.2 Total cost of logistics and supply chain cost

Logistics costs here are understood as expenses incurred from performing logistics activities, and from having the infrastructure, capacity or the readiness to perform logistic activities during a certain period of time. Unlike in external reporting for financial purposes (e.g. for stock owners), there are no set rules regulating precisely which expenses should be included as logistics

costs. It largely depends on what activities the firm defines as logistics[14] (Weber 2002) or supply chain.

Gudehus & Kotzab (2009, 131) provide an all-encompassing definition of logistics costs:

> *"The logistics costs K_{Log} [€/planning period] are the total operating costs of a single logistic performance station, a logistics profit center, the logistics network of a company or a of a logistics service provider."*

This definition aptly describes the broad range of possibilities for organizing logistics costing. On the one hand, 'a single logistics performance station' is probably the smallest unit in a company where costs are measured and recorded; but on the other hand the logistics network of a company or a LSP is likely to extend outside the legal borders of the company and may include dozens of independent organizations. Also, implicit in the part 'a logistics profit center' is the assumption that also the revenues of logistics activities are monitored, whereas an individual logistic performance station may as well be organized as a cost center (i.e. only costs are attributed to it, but no revenues).

There is also a more practical definition of company logistics cost that is suggested for market surveys and comparisons between companies (Gudehus & Kotzab 2009, 131):

> *"…the total company logistic costs comprise all logistics costs between the receiving ramps of the company and the receiving ramps of their customers."*

In addition to these, also the expenses for external logistics services should be included as the logistics cost of the company (Gudehus & Kotzab 2009, 131). This way double counting of logistics costs is avoided, and although in reality the supplier may deliver the goods Ex Works or with some other INCOTERM[15] with limited liability and the focal company pays for the freight, insurance, customs charges and unloading, those costs are at least approximately allocated to whom they incur.

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[14] Or as in the case of earlier discussion of physical distribution cost: what activities are included in physical distribution function (van Amstel 1985).

[15] INCOTERMS: a set of international rules for the interpretation of the most commonly used trade terms:

Ex Works (EXW): the goods are delivered by the seller when he places the goods at the disposal of the buyer at the seller's premises or at another named place (e.g. factory or warehouse). The seller does not need to load the goods, nor to clear the goods for export.

Delivered Duty Paid (DDP): the goods are delivered by the seller when they are placed at the disposal of the buyer, cleared for import ready for unloading at the place of destination. The seller bears all the costs and risks involved in bringing the goods to the place of destination, and has an obligation to clear the goods not only for export but also for import. (International Chamber of Commerce 2010)

Additionally, Gudehus and Kotzab (2009) also exclude the costs of buying and procuring merchandise, material, parts and equipment that are not directly caused by the execution of logistics tasks and services. So, according to their definition, logistics costs do not include procurement costs. The costs for packing sales units are attributed as production costs, whereas the costs for other packing material, pallets, bins etc. are classified as material costs of logistics. (Gudehus & Kotzab 2009, 134.)

However, according the Gudehus & Kotzab (2009) definition of logistics costing in Chapter 4.1, a company should monitor 'all logistics costs which are incurred between the *dispatch ramp of the suppliers* and the receiving ramps of the customer'. This definition assumes that the focal company aims to control or takes interest also in the logistics costs incurred upstream beyond the company borders, though it is noted that in some cases this monitoring is impossible, e.g. if the purchasing freight is included in the material sales price. (Gudehus & Kotzab 2009, 131). Figure 10 further illustrates the differences of these definitions.

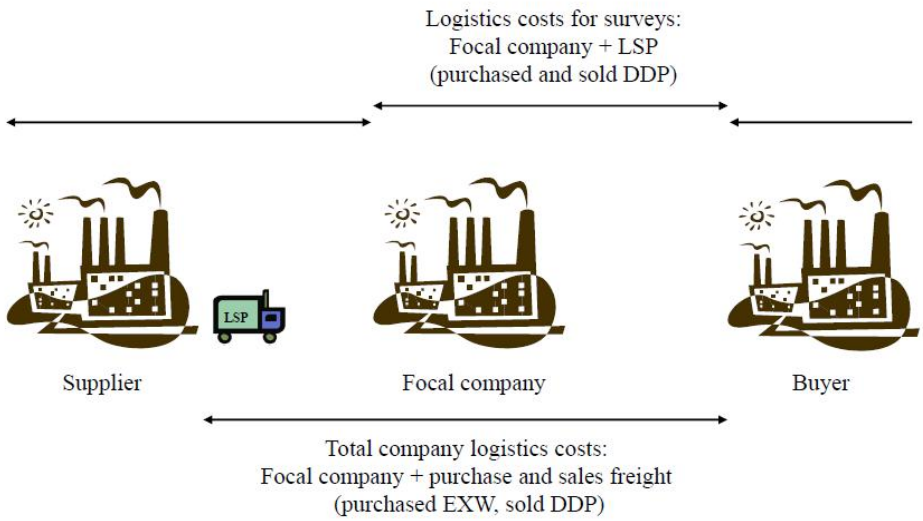

Figure 10 Gudehus & Kotzab (2009) definitions of logistics costs for survey and internal costing purposes

Figure 10 also demonstrates how the firm's perception of the extent of supply chain that they control influences the scope of costs that are included as intra-company logistics costs.

However, firms are free to define logistics and supply chain cost as they best see fit. For example, Pettersson (2013), interviewed 30 Swedish

companies in various industries and found that only one of the 30 companies used the term supply chain cost. In the following, I will therefore use the term logistics/SCM cost to acknowledge that it there may be differences in the scope and the definition. The term intra-firm supply chain cost (Lorentz et al. 2012), on the other hand, is used to cover the same extent of the material flow as the Gudehus & Kotzab (2009) total company logistics costs in Figure 10.

4.3 Typical components of logistics/SCM costs by activities and cost types

A typical perspective in supply chain management literature is to classify the logistics costs by activities or supply chain functions (e.g. procurement or warehousing). From accounting perspective this way is less common, and management accounting text books more often present costs by cost types. Various cost logistics components have been suggested in supply chain management literature, varying from one publication to another: Rantasila (2013, 49, 57) identified well over twenty different cost elements from publications, but closer examination reveals that some of them are overlapping. However, transportation and inventory carrying cost are found in all of the reviewed publications, and all but one also include warehousing costs. Pettersson (2013) included as the supply chain cost manufacturing cost, administration cost warehouse cost, distribution cost, capital cost and installation cost. However, only one of the 30 companies interviewed measured these cost components; others measured part of them (Pettersson 2013).

4.3.1 Transportation cost

The most common cost that is understood as logistics cost is probably transportation, along with the inventory and inventory-keeping related costs: these are mentioned already 1930 (Ostlund 1930) as part of operation costs. In a survey from the end of 1970's (Lambert & Armitage 1979), 87% of the 300 North American respondents reported having transportation cost information readily available, and in mid-1980's it was estimated that together transportation and warehousing represent about 80% of overall distribution cost in most companies (Tyndall & Bushner 1985).

More specifically, in the reviewed literature in transportation cost are included inbound and outbound transportation[16] (Lancioni 1991), and pilferage or damage during transportation (Zeng & Rossetti, 2003). Gunasekaran et al. (2001, 78) recommend trucking cost plus local delivery cost [incurred by the focal company] to be treated as total transportation cost.

Weber (2002) discusses the recording of transportation costs in a great detail, and differentiates between company internal (e.g. transport from one warehouse to another) and external transportation; transportation with own fleet and third party transport services; and regular and as-needed transport. It depends by the company, what kind of transport cost classification is required; also a closer examination by transport mode may be needed. (Weber 2002, 180; 196; 208.)

4.3.2 Inventory-related costs

Although costs related to inventory are one of the best known components of logistics costs along with transportation costs, slightly differing classifications of inventory-related costs exist. Typically the definitions include costs of warehousing activities: handling (receiving, moving, order picking, packing, shipping, and inventory counting) of the goods; as well the costs of keeping inventory.

As a general rule, Lambert (1994, 271) instructs that *inventory carrying costs* should include only the costs that change as the level of inventory changes, i.e. are variable with the inventory volume *in storage*[17]. *Warehousing costs*, on the other hand, should include those costs that vary with the number of (the firm's own) stocking locations or warehousing facilities – i.e. those incurred from running the warehouse, regardless of the level of inventory – and those occurring from the throughput or *moving* the goods into and out of the warehouse. In contrast, the cost of storage space provided by third party logistics service providers are assigned to inventory carrying cost, as they typically are charged based on the volume of the goods. (Lambert 1994, 271).

Packing cost and the costs of reconditioning (i.e. altering the packaging for consumer needs, e.g. repackaging into smaller units, adding address stickers or inserting operating instructions (van Amstel 1985) have sometimes been treated as a separate categories, but here they are included in warehousing

[16] Cavinato (1992) includes also supplier's and buyers private fleet and supplier/buyer selected carrier, not only those of the focal company, but this is broader than intra-company perspective

[17] Or in the possession of the company: also work-in-process and in-transit inventory are included here. Consignment stock located in clients' premises would also be included based on this principle (see also CSCMP 2013).

costs. However, if reconditioning is extensive (e.g. installing software or pressing of clothes) and adds value to the extent that customer is willing to pay extra for it, the reconditioning costs may be best treated as a separate category, to better match the costs to revenues of the value added service.

Council of Supply Chain Management Professionals (CSCMP, 2013) includes as *inventory carrying cost* 1) the opportunity cost of holding inventory (i.e. the capital cost); 2) shrinkage; 3) obsolescence of raw material, work-in-process and finished goods inventory; 4) channel obsolescence (material that goes obsolete while in distribution channel and under buy-back agreements); and 5) field service parts obsolescence.

According to another classification, the *total cost of holding inventory* (Timme 2003) consists of 1) the inventory non-capital carrying cost (including warehousing, obsolescence, pilferage, damage, insurance, taxes, administration and other), and 2) the inventory capital charge (i.e. the capital tied in inventory): the inventory value and the cost of capital (Timme 2003, 31).

Lambert (1994) classifies inventory carrying costs as 1) inventory service costs (taxes and insurance paid as a result of holding inventory; 2) storage space costs of the firm's own or leased warehouse; 3) inventory risk costs, including obsolescence, damage, pilferage, shrinkage and relocation (shipping from one warehouse to another to avoid obsolescence) and 4) capital costs. All these costs are expected to correlate with the amount of units in inventory. Note that the definition of inventory carrying costs by Lambert (1994) is narrower than the total cost of holding inventory by Timme (2003): the other cost components are included, but the warehousing is treated as a separate cost category because of its variability according the movement of the goods, not just having them. Also the value of inventory is a separate category.

For simplicity and to facilitate comparison over time and across companies the inventory-carrying cost may be expressed as an estimated percentage of the inventory value. The percentage varies by the industry, with the risk of obsolescence being the key driver for the non-capital cost of inventory. The average rate used in U.S. companies around 2003 was 10 percent (Timme 2003) A factor influencing the cost of capital tied in inventory could be the availability of financing for the company.

The *cost of capital* tied in inventory is actually an opportunity cost[18], not an out-of-pocket expense, but it is discussed here, as it is an established part of the inventory carrying cost. Very few supply chain management texts actually provide guidelines for assigning the cost of capital tied in inventory – probably it is assumed to belong to the responsibility of management accounting. In

[18] The benefit that is forgone as a result of choosing one course of action rather than another (Zimmermann 1995, 24).

many companies information systems may not capture these costs, and if the information is available at an enterprise-wide level it often is not available for a product line, geographical area, customer group and channel (Timme 2003).

CSCMP (2013) suggest that the capital charge should be 'based on your company's own cost of capital standards'. Timme (2003) recommends using weighted average cost of capital (WACC)[19], as it represents the opportunity cost for a company's average risk investment. Another option is using the short-term borrowing rate like the bank prime loan rate: a rationale for this is that inventory is a short-term (current) asset, and loans have been granted against inventory. Also other short-term investment rate of a finance instrument may be used as the cost of capital. For WACC, however, speaks the fact that inventory is less liquid than financial market instrument, probably yields less than the purchasing price when sold, and needs to be renewed (i.e. re-investments made) if sales and deliveries are to be continued. Therefore using a finance market instrument as a proxy of cost of capital tied in inventory may understate the capital charge and the risk of investing in inventory. WACC also takes into consideration the targeted (or actual) capital structure (depending on the formula used). (Timme 2003, 34–35.)

4.3.3 Administrative cost

In the literature reviewed, administrative cost is a somewhat vague cost category, and is seldom itemized in detail. Discussing distribution costs, Lancioni (1991) divides them into two areas: line/operational costs and staff/administrative costs. *Operational costs* are defined as those cost centers dealing with the functional areas of logistics, whereas *administrative costs* are the cost centers associated with supporting the line or operational functions. Examples given of the distribution staff's administrative functions include customer service, forecasting, scheduling of production and transport, planning of inventory and distribution, and vendor, systems, transport and analysis. Order processing and purchasing, however, are classified as operative costs, along with transportation and the inventory related costs discussed above. (Lancioni 1991, 12.) According to this classification, then, planning, scheduling and analysis as well as problem solving (customer

[19] WACC = %Equity x Cost of equity + %Debt x Cost of debt (x 100% - Marginal tax rate) , where %Equity = targeted percentage of capital financed by equity, %Debt is targeted percentage of capital financed by debt and (x100% - Marginal tax rate) is tax benefit reduction of the interest expense (Timme 2003) Also other formulae exist, where the percentages are actual, not targeted percentages financed by equity/debt.

service[20]) are administrative functions, and the daily material flow related activities are operational functions. Correspondingly, the related costs can be considered either administrative or operative.

Although order processing is a daily activity, and overlaps transportation and inventory control in addition to logistics administration, Mentzer & Konrad (1991) recommend measuring it separately. Tasks included in (customer) order processing are order entry and editing, scheduling, shipping and billing (Mentzer & Konrad 1991, 43)

With enterprise resource planning (ERP), electronic data interchange (EDI) and other IT systems becoming more common, the costs of order processing have probably fallen generally and lost in significance. However, a routine order may take much less time and have a more simple ordering process than a custom order, so in order to evaluate customer profitability it is good to have at least a rough estimate of the cost of ordering.

4.3.4 Purchasing cost

Purchasing cost in academic literature is often treated as a different concept from logistics cost; on the other hand cost items such as purchasing freight and costs from receiving and inspection may be regarded as typical logistics cost as well. In these cost categories there is overlap between the purchasing and the logistics management, in some cases also between purchasing and manufacturing. The common points in approaches to purchasing cost appear to be that it includes the material price, the purchasing freight, and that the cost of distributing the product to customer is excluded.

An accounting textbook (Drury 1990) recommends that freight charges made by suppliers would be charged as direct costs of the purchased material, allocated by weight or value between the different SKUs, if there are various materials in the shipments. As a more simple alternative, though, the book suggests charging transportation costs to factory overhead account, and allocating these "as part of the factory overhead procedure", especially if the costs are small in proportion. (Drury 1990, 58–59). Biggs et al. (1990) discuss the costs of placing a purchase order as a relevant cost of purchasing activities: the tasks include amongst other things supplier selection, inquiring quotations for price, as well as follow-up and expediting of the order. However, the relevance of the ordering cost may depend on the complexity of the ordered

[20] Also Mentzer & Konrad (1991, 43) classify customer communications, which includes provision of product information, answering inquiries, order modifications and expediting, under logistics administration.

product, as well as the type of purchase (repeat or first-time purchase) and the relationship with the supplier (e.g. long-term contract or spot market). Additionally, with supply chain management advancements such as EDI (electronic data interchange) and Kanban gaining popularity, the purchase ordering cost may in many cases be marginal only.

Certain cost analysis frameworks, such as (total) landed cost (e.g. Young et al. 2009) and total cost of ownership (TCO) (e.g. Ellram & Siferd 1993; Weber et al. 2010) take a broader view on the costs of purchasing, both in the scope of activities and in temporal dimension. TCO includes at the minimum (in addition to purchase price) also other costs of the transaction with a specific supplier: transportation and receiving costs, purchasing administrative expenses, and quality costs of inspection, rework and reject (Ellram 1993). In a broader form TCO identifies costs stemming from not only transaction but also pre-transaction and post-transaction phases. Pre-transaction phase includes activities such as investigating sources, preparing specifications qualifying suppliers and sending requests for quotations, whereas post-transaction phase includes costs from maintenance and spare parts, failures, line fallouts and warranty costs caused by the purchased item. (Ellram 1993). By including post-transaction phase TCO provides a broader temporal scope than most other cost analysis frameworks, in trying to estimate future expenses as well, not just a cross-section of the current situation possibly at the rates based on historical data, although those are also present in the TCO model. A similar concept is the life cycle costing, which, however, focuses primarily on capital or fixed assets, and does not emphasize pre-transaction costs to the extent TCO does (Ellram & Siferd 1993, 57).

Although maybe the most common application of the frameworks is for evaluating different sources of supply or outsourcing decisions (Platts & Song 2010; Weber et al. 2010), especially for capital goods or other durable items of large value (Ellram 1993), TCO has been used in supplier selection, ongoing supplier management, to drive improvement, to communicate both within company and with suppliers, and to create shared understanding within the company (Ellram & Siferd 1993), but may also provide information of the company internal costs of purchasing, if these were not previously known.

McKinnon & Bruns (1992) noticed that raw materials price was one of the key financial indicators followed by purchasing managers, and also (presumably inbound) transportation cost was dealt with on daily bases. Also cost of raw material inventory was evaluated against the cost of running short of

material.[21] Relative importance of each cost was found to be affected by the nature of production process (e.g. continuous process or batch manufacturing,) and the cost and nature (perishability and availability) of the raw material. The timeframe at which the material price was monitored was shortened by the increased volatility of the material price. The prices of commodities with fluctuating market prices were monitored continuously, whereas items with long-term contacts were monitored less frequently. (McKinnon & Bruns 1992, 31–32.)

4.3.5 Logistics costs by cost types

Another way to classify the logistics costs is by cost type. This corresponds with accounting perspective ('natural accounts' or typical expense accounts), and cost information is likely to be found in many companies classified this way in the accounts: however, to sort out the logistics part in the account from e.g. manufacturing or marketing functions may be tricky, depending on the organization.

Personnel or labor cost probably forms a large part of the logistics, whether in the purely operative logistics task in warehouse or in logistics administration. Warehouse staff may be outsourced in many organizations, in order to make this cost group more variable with the volume handled. *Facilities* cost include the buildings used for logistics activities, either leased or owned. Land cost may be included in this or be a separate item. (Mentzer & Konrad 1991; Kivinen & Lukka 2003)

Equipment includes the shelving, forklifts, pallets, and other equipment used for logistics operations. *IT-systems* and computers may be a part of this, or nowadays a separate category. *Running cost* include items such as fuel, electricity, water, maintenance, insurance, telephone expenses, printing and photocopying etc. (Kivinen & Lukka 2003.)

Depreciation of logistics assets (buildings, machinery and transportation fleet) is also an expense influencing the profit-loss statement. Different companies may use different depreciation methods, which affects the comparability of logistics costs between companies (Weber 2002, 137).

[21] Although based on the report, inventory levels appear to be used as a proxy of inventory cost, and the authors do not describe *how* the cost of running out was estimated: in monetary units or e.g. downtime and amount of units not produced during that time.

4.4 Costs of complexity

The inter-connected nature of supply chain processes even within a single company and the various trade-offs inherent in logistics and supply chain management result in the need to examine the costs from a holistic, system-wide perspective. A category of costs not explicitly identified by management accounting but appealing from a supply chain management perspective may be called complexity-driven costs or costs of complexity (e.g. LeKashman & Stolle 1965; Callioni et al. 2005; Olavson & Fry (2006). In this thesis to this category are included the efforts to express in monetary terms the impact of certain decision in one part of the logistics system to another part of the system or to the total costs of the system. These may be also called with the more common term of opportunity costs, but cost of complexity emphasizes the systemic nature of the costs. Transportation versus warehousing cost trade-off or order lot size versus inventory carrying cost trade-off can be considered as some of the best known examples of such analyses that require knowledge of the systemic effects of a decision to the supply chain. Weber (2002, 141) recommends case-specific analyses to find out the cost effects of trade-offs, but excludes these from on-going cost collection.

Ojala (1995) emphasizes the understanding of the 'intangible' costs of logistics as well as the 'tangible' costs, i.e. the potential costs (opportunity cost) resulting from a decision, in addition to the actually incurring costs of the current state. This is generally considered important in re-engineering the supply chain, for example in make-or-buy decisions, such as off-shoring production or outsourcing of logistics activities; or shifting logistics activities in a relationship to the supply chain partner who is able to perform them more efficiently (Norek & Pohlen 2001 .

Cooper and Kaplan (1988, 27) note that some costs vary with the diversity and complexity of the product line, and that their variability is largely due to transactions that they cause in logistics or distribution stage. Olavson & Fry (2006) present the term complexity driven costs, or cost of complexity: the excess costs caused by the variety and volume of products to various functions of the firm. The impact of complexity may be small in one area, but the compound effect of a large number of impacts across a wide range of costs in different parts of the organization. These appear as cost of goods sold, operating expenses, or are opportunity costs (missed incomes). Analyzing the costs of complexity requires understanding what causes variation in which costs and at what level (eg. batch, channel, supplier or product level), similar to establishing activities hierarchies in activity-based costing. Although the decisions themselves may be somewhat commonplace, such as including an

item in product range, they require firm-wide examination of relevant costs affected by the decision, not merely the imminent direct costs.

Variety-driven complexity costs are the per stock-keeping unit (SKU) costs required to bring new products to market, and to support the products over their life cycles. These may result for example from supplier selection and qualification, product data entry, tooling, testing, rework, marketing, warranty costs, returns, and are mainly classified as fixed cost, as they do not vary with the units produced. *Volume-driven* complexity costs, on the other hand, are increases in the variable unit cost of a SKU or an item resulting from 1) insufficient (production) volume to reach an operationally efficient scale (e.g. higher material prices, production switching costs), or from 2) the demand variability (e.g. increased inventory, obsolescence of slow moving inventory, expediting costs, missed income of lost sales) (Olavson & Fry (2006)

Cost of quality (COQ) may be considered largely as belonging to complexity costs, although part of the costs is actually incurred costs from a use of resources (e.g. scrap and rework). Cost of quality framework attempts to put in monetary terms all the costs that are attributable to nonconforming operations, i.e. failures in production or other order fulfillment processes, and their prevention. COQ includes four categories (Thorne 1990; Shank & Govindarajan 1993, 218–219):

- Prevention costs: actions in the process to ensure that defects do not occur, e.g. preventive maintenance, stable product design, supplier audits and development;
- Appraisal cost: costs associated with measuring the level of quality attained by the system, such as incoming inspection, statistical process control, cost accounting for production variances, quality data gathering, analysis and reporting;
- Internal failure costs: costs incurred to rectify output before it reaches the customer, including scrap, rework, failure analysis and downtime caused by defects, as well as opportunity cost of lost sales due to having fewer units on hand; and
- External failure costs: costs associated with delivering defective output to the customer, such as investigation of defects, warranty repairs, returns or discounts, and loss of sales due to the loss of customer goodwill.

Prevention and appraisal costs may be also considered as the cost of conformance, and internal and external failure costs as the cost of non-conformance (Thorne 1990.)

COQ framework is partly similar to or overlapping with the total cost of ownership (TCO) framework (see Chapter 4.3.4.), as COQ also takes into examination cost incurred before the transaction as well as the costs incurred

after the sales. The main difference is perhaps the level of aggregation: TCO analysis typically takes place at an item, an item group or a supplier level, whereas COQ is conducted at the level of individual location, business unit or for the entire firm (Shank & Govindarajan 1993, 218).

5 DIVERGENT LOGISTICS COST INFORMATION NEEDS AND USES WITHIN THE FIRM

5.1 Accounting choices affecting logistics costing

5.1.1 Proportion of direct costs to indirect costs

Costing systems have traditionally been mainly manufacturing oriented, for monitoring the efficiency of manufacturing, and assigning the unit produced a cost for inventory valuation and financial reporting purposes. (Cooper & Kaplan 1988) Traditionally manufacturing has been considered the department adding value to the customer, and logistics (distribution) either a part of manufacturing or a support department for manufacturing among others like accounting or HR. Either way, the costs of logistics have often been allocated to manufacturing department as overheads. In effect, management accounting textbook recommends that if transportation costs are negligible, then it is preferable to charge them to a factory overhead for simplicity, and the same advice is given regarding the materials handling cost. (Drury 1990, 58–59.)

Whether the fixed part of the overheads should be further allocated to products or not has been a longstanding debate[22]. This stems from a basic accounting problem of assignment: how the total costs are divided to cost objects (Kulmala et al. 2002, 37). In *direct costing* (variable costing; marginal costing) only the direct material, direct labor and variable manufacturing overhead costs are included in the finished product cost, but when *absorption costing* (full costing) is used, products are valued based on the direct materials, direct labor, variable factory overhead *and* the fixed factory overhead that are used in manufacturing those finished goods. (Baxendale et al. 2006, 30.) Direct costing therefore includes only the costs that vary with the amount of units produced, whereas absorption costing includes costs that vary with other factors and possibly only in the long term (e.g.acquiring a new machine). For

[22] Opponents of absorption costing state that variable costs are the relevant ones for product decisions, especially when there is manufacturing capacity available. Proponents argue that variable cost is inadequate and gives only short-term perspective to the decision whether to offer a product although a new product is a long-term commitment, and that fixed overhead nowadays represent a larger share of the manufacturing costs than before (Cooper & Kaplan 1988).

internal decision-making purposes a firm may have different costing system(s) or that include a broader part of fixed overhead costs and allocates the cost to another cost object than the product, e.g. department, customer or distribution channel. For example, Jones (1991) describes a case where a simple standard costing system exists for valuing inventory for financial reporting, and whose costs are seldom updated, but for production and logistics costing more elaborate system is used and regularly updated.

The proportion of direct cost[23] to indirect cost[24] affects both the reliability of the cost information and the usefulness of the information for analyses. The more direct costs can be traced to a cost object, the more accurate the cost assignment is (Drury 2004, 30). A large part of indirect costs makes a closer analysis or a more sophisticated costing system with multiple allocation bases worthwhile, whereas if the proportion of direct costs is high, a more simple system might suffice. However, as the level of aggregation of costing increases, more costs are likely to become direct with regard to another cost object. For example, the costs of a warehouse rental would be indirect for a product or a SKU, but direct for a specific distribution channel. (Drury 2004, 30–31).

The proportion of direct costs e.g. in the logistics department of a company is therefore dependent on the perspective of examination, not something permanent or to be taken as given. However, it is dependent on the capital intensity of the department (see e.g. Baxendale et al. 2006, 35). Costs of facilities and machinery are more difficult to allocate to specific items, and are usually dealt as fixed (period) costs. Outsourcing logistics activities can increase the amount of direct costs in the firm structure of logistics costs, and at a lower level of aggregation: logistics service providers often charge per unit of output bases, whether in pallets, m^2 or hours (Norek & Pohlen 2001, 46)

5.1.2 Allocation of indirect/common costs

Though direct costing may be considered more reliable, an absorption cost system can also be more or less sophisticated, i.e. follow the cause-and-effect relationships of the cost and its cause with a greater or lesser accuracy. There are also variations in how large a part of overheads are allocated. The number of cost pools, how homogeneous they are (i.e. do they contain expenses from similar or very different activities) and the use of one or multiple cost drivers

[23] i.e. cost directly attributable to a cost object

[24] cost which cannot be specifically and exclusively identified with a given cost object; also referred to as fixed overheads

(allocation bases) all affect the sophistication of the system (Al-Omiri & Drury 2007, 401). Abernethy et al. (2001) similarly characterize the sophistication of cost system by number of pools (single versus multiple), type of cost driver (unit-level or hierarchical) and nature of cost pools (responsibility center versus activity) Low sophistication is characterized by a single-plant wide cost pool, unit-level cost driver, and responsibility-based cost pool, whereas a high sophistication cost system features elements of activity based costing with many cost pools, hierarchical cost drivers and activity cost pools (Abernethy et al. 2001, 264). However, hand in hand with the increase in cost system sophistication (increasing detail) goes the trade-off between the complexity of the costing system and the costs of generating and keeping up the system. Also the accounting system for recording transactions of the company sets limitations how detailed the costing system can be; for example whether data can be grouped easily by different criteria in required levels of detail. (Eldenburg & Wolcott 2005, 302; Al-Omiri & Drury 2007, 401.)

Activity-based costing, which has been recommended for logistics and supply chain management (Lin et al. 2001; Gupta & Baxendale 2008; Pohlen et al. 2009) is actually an absorption costing system[25], but a highly sophisticated one. It contains a larger number and variety of (hierarchical) cost drivers that better reflect the cause-effect relationships of the cost object's consumption of activities and resources. Larger amount of costs are allocated to homogenous cost pools, not arbitrarily to the unit produced, if that is not the reason why the cost pool's costs vary, but by hierarchical drivers (Al-Omiri & Drury 2007). Multiple cost object and allocation bases (cost drivers) based on the understanding of how costs vary at different hierarchical levels (by batch, shipment, order etc.) help to recognize the complexity inherent of supply chain (Pohlen et al. 2009, 51), and to look at the individual activities and to make them more manageable.

Logistics may be organized as a support department serving the operating departments (usually manufacturing) that produce goods or services for the external customer[26]. The costs of the logistics department are in that case allocated to the operating department, i.e. production, which may be a cost center accountable for its costs only, or a profit center with a profit target, having to balance the costs with revenue. This allocation of the logistics costs to other departments has been criticized (Schiff 1972) on the basis that arbitrary allocation of logistics costs with average rates to the profit centers

[25] In some firms activity-based costing may be also used as a 'one-off' cost analysis method in specific part of the firm, instead of updating the driver rates continuously.

[26] Although according to the value chain logic of supply chain management, logistics also serves and adds value to the external customer, e.g. transporting the goods to a desired location on time or providing value-added services such as re-packaging or customizing or finishing the product.

would provide little motivation for logistics management to improve performance since all costs are allocated further to other responsibility centers. Furthermore, inefficiencies in one profit center (user of the service) are reflected as increased cost in logistics (demand for extra service, order modifications required due to poor planning and expedited shipments etc.). The increased total costs are then allocated to all profit centers in the form of increased rates, which may be considered unjust. (Schiff 1972, 50). This criticism, however, took place before activity-based costing had gained popularity and concerns more traditional (i.e. less sophisticated) costing systems with perhaps a single factory-wide allocation base. Using several cost drivers e.g. based on use of the activities would better reflect the actual causation of costs.

However, activity-based costing with its complexity may not be as broadly diffused and commonplace as academics literature may imply. Also smaller firms with fewer resources available may try to keep their costing systems as simple as possible (Halley & Guilhon 1997). In retail and wholesale companies a costing or cost analysis method called direct product possibility (DPP) gained popularity in the late 1980s (Bookbinder & Zarour 2001). DPP describes more accurately product profitability than variable costing or traditional absorption costing methods, where fixed overheads are allocated rather arbitrarily based on one or few cost drivers. In DPP distribution costs directly attributable to the product or SKU are subtracted from the gross margin of the product, thus giving a better approximation of the profit by product. However, the part of fixed costs that is not directly attributable to a product is not allocated. (LaLonde & Pohlen 1996) The information has been used to make decisions about the shelf-space given to products in the retail stores and warehouses, customer and product profitability (Fernie et al. 2001), and to estimate the costs of a supply chain in order to re-allocate logistics activities among the chain members (Dekker & Van Goor 2000).

5.1.3 Variable or absorption costing method in inventory valuation

The company's choice of variable (direct; marginal) or absorption (full) costing method affects the inventory value and consequently also the calculated capital cost as a percentage of the inventory. Using direct costing inventory is valued based only on the costs that increase with the units produced: the direct material, direct labor and variable (factory) overhead costs are included in the finished product cost, based on which the inventory is valued. The costs therefore vary in direct proportion to the quantity produced during an accounting period. Fixed factory overhead costs are treated as period

costs, i.e. not recorded by unit produced, but by accounting period. (Baxendale et al. 2006, 31; Zimmermann 1995) But when absorption costing is used, finished goods inventories are valued based on the direct materials, direct labor, variable factory overhead and the fixed factory overhead that are used in manufacturing those finished goods. (Baxendale et al. 2006, 30.) The cost of produced unit is therefore higher, and the finished goods inventory value is higher than by using variable costing.

The Finnish Accountancy Board has also given instructions on the possibility to include fixed costs of production and procurement in the product cost. The expenses need to be either relevant in proportion to variable costs, or large in absolute value. The firm also has to have a costing system that is able to separate the costs of procurement and production from other costs and to divide them into variable and fixed components. With a more sophisticated costing system a smaller proportional amount of fixed costs is considered relevant. (Leppiniemi 2013, 178–180.)

Although it gives a closer estimate of the resource use for manufacturing a product, absorption cost may give incentive to use the inventory to manage profits. While the goods are in inventory, part of the fixed costs is tied in inventory and carried on to financial statement of next accounting period(s), whereas when the goods are sold, the fixed costs are realized as an expense, and profit is diminished. So in order to increase profit in the current period managers may be prone to overproduce to inventory. (Baxendale et al. 2006; Zimmermann 1995, 443–444.) In contrast, managers may be in the short term reluctant to reduce excess inventory (e.g. write off obsolete goods), although in the long run decrease in inventory would reduce warehousing costs and simplify production and inventory management. This distorting effect of absorption costing is higher in more capital intensive production than labor intensive, as the portion of the fixed overhead (e.g. machinery) of the total productions costs is larger (Baxendale 35–36). It could, however, be possible to reduce the incentive for such inventory gaming by paying attention to how the managers are evaluated (Zimmermann 1995, 443–444). Less emphasis should be put on the short-term profit and for example a measure of inventory turn could be included as a performance evaluation base. However, with JIT production (and deliveries) the reduction of inventory levels is likely to further reduce possibilities for inventory gaming. Also, JIT purchasing has rendered the issue whether inventory should be priced with FIFO; LIFO[27] or average price method virtually irrelevant (Drury 1990, 59).

[27] First In, First Out; Last In, First Out: how the purchased material is assumed to be used in production

5.2 Cost information needs at different managerial levels and positions

The requirements for logistics cost information are bound to differ by the different organizational levels, functional positions, timeframe of the decision to be made and the purposes of use (e.g. analysis of past performance, planning and forecasting, setting performance targets or managerial evaluation). From the supply chain perspective a costing system should help answer the questions such as what causes costs to vary, which costs are under the firms control , which costs are driven by suppliers' and customers' actions, and what the costs are of using a particular distribution approach. (Pohlen et al. 1999, 56)

Schary (1985) presents that the logistics control system operates at three levels:

- Level I, the functional activity center;
- Level II, logistics system management; and
- Level III general management,

where first level deals with operations and levels II and III with strategy. The focus of level I managers is on controlling specific operations and completion of routine schedules, whereas level II management is concerned with planning, directing and controlling the logistics system as an integrated unit, but with the given resources. Control includes also the use of selected aggregate indicators to indicate whether the conditions for which the plans have been made still hold, and whether the activities and resources are in balance as intended. Finally, level III, general management, is in connection with the markets of the company, and evaluates their contribution to the company's profit. Consequently, the requirements of cost and control information are divergent at the different managerial levels of the system. (Schary 1985.)

McKinnon & Bruns (1992), on the other hand, (1992) group the information needs based on the operative function and time-frame: for daily control, longer term analysis and planning, and forecasting the future. In the short term, cost was not found very relevant information for production and distribution managers, but other performance measures expressed in physical units are used instead as a proxy of cost. When the operations take place at the normal volume or range of demand and other things remain constant, the income or expense report mainly confirms what the managers already know. Also, managers perceived the physical inputs and outputs as something that they are able to control, whereas measured costs may originate from standard systems and arbitrary allocations beyond their influence. A month was found a long enough timeframe for accumulations of daily data to achieve meaning

that can be expressed in monetary terms, as the costs are not stable in short periods: e.g. seasonality contributes to cost fluctuation. (McKinnon & Bruns 1992; Bruns & McKinnon 1993.) In purchasing, material prices were central for control; also cost of inventory was balanced against the cost of running short at a critical time. In less stable production environments, i.e. production plans change often, or the raw material price or availability are volatile, the horizon for monitoring price and inventory was found to be shorter than in a more stable environment. Long-term commitments with the suppliers, on the other hand, reduced the daily monitoring of purchase price (McKinnon & Bruns 1992, 32).

As time horizon expanded, financial data about the effectiveness of purchasing was found to be used increasingly, and non-routine efforts were found to be largely concerned with how total cost variances above budget could be minimized over long term (McKinnon & Bruns 1992, 34). In sales, profitability by product and customer were of interest, and these were estimated by deducing costs of production and distribution from the sales. Especially in the production the use of financial measures for managerial evaluation purposes, as well as pressure to meet cost or profit targets were considered to increase the importance of cost measures. Also, concerns about costs were noted to lead to search for opportunities to improve operations efficiency. The longer term strategic planning often determined also the acceptable range of costs for the short term (e.g. decisions to increase capacity affected labor costs and introduction of new products determined the necessary raw materials to purchase) (McKinnon & Bruns 1992, 79–82, 84).

Griffis et al. (2007) asked SCM professionals to position a selection of performance measures on three dimensions: competitive basis of the firm (responsiveness or efficiency), focus of the measurement (operational or strategic) and measurement frequency (monitoring or diagnostic). As expected, both logistics cost as a percentage of sales and logistics costs per unit were found to represent efficiency. They were also found to be perceived as strategic measures, logistics costs as a percentage of sales even more so than cost per unit, and diagnostic, i.e. consulted infrequently to diagnose problems, which the authors did not anticipate for logistics cost per unit. (Griffis et al. 47). This would, however, be in line with the findings of Bruns & McKinnon (1993) that logistics managers place more emphasis on physical measures in their daily work than cost, but cost is important in comparison to budgeted or normal level.

5.3 Need for multiple aggregation levels of cost data

The main objective of the supply chain management can be considered to be integrating different functions or organizational sub-systems into horizontal business processes 'the flow orientation' (Mentzer et al. 2001; Chen et al. 2009; Kotzab et al. 2011), in order to fulfill the customer requirements as efficiently as possible. Despite the process metaphor, a functional specialization typically prevails at the operational level of the organization. This poses a challenge of balancing the inherently or occasionally conflicting objectives of different functions to best respond to the 'higher level' or broader goal of supply chain management. Simultaneously, the supply chain as well as the distinctive functions or departments are expected to conform to the highest level goals, the strategy of the firm. Therefore, the logistics and supply chain control system as a whole needs to be aligned both vertically with the firm objectives, as well as horizontally with the operative processes. Accounting tools such as performance measurement systems and use of integrated budgets in various organizational levels, as well as sales and operations planning (S&OP) to balance different targets, assist in this task.

Too rigid an accounting data collection system is a serious problem for logistics costing – instead, multiple ways to group the costs are needed (Weber 2000). As the firms attempt to better understand costs of supply chain management, the need for multiple cost classifications increases: for example by process, by product group, by customer or by distribution channel (Pohlen et al. 2009). For evaluating the performance of an organizational unit, cost data at a higher level of aggregation (e.g monthly data of personnel, material and facilities expenses of the cost center) is sufficient, whereas for analyzing customer profitability, information is needed on the number and sizes of the orders made by an individual customer.

Hergert & Morris (1989) identify obstacles for using accounting data for value chain analysis, i.e. decomposing the firm into strategically important activities and understanding their impact on cost behavior and differentiation at the customer markets. One is that critical activities as defined in the value chain do not necessarily correspond with responsibility centers[28] as defined in accounting systems. Consequently, the cost center budgets are likely to be a poor reflection of the actual costs of performing an activity. Another is that traditional accounting systems do not trace non-manufacturing costs to products. Also, critical value adding part of the product offering may be a

[28] Responsibility center is an organization unit for whose performance a manager is held accountable. Responsibility accounting accumulates costs and revenues for each responsibility center so that deviations from target can be attributed to the individual accountable of the center. (Drury 2004, 41.)

service, but traditional cost accounting data does not assist accumulating costs, revenues and assets around different constituents of buyer value (Hergert & Morris 1989).

An example of data required at various levels of detail is cost-to-serve analysis (Braithwaite & Samakh 1998). To define cost drivers for activities for example order and sales data are required at a transaction level for number of shipments, orders, lot sizes, sales terms and delivery locations, and product master file data needed for standard manufacturing costs and physical characteristics of the products. For analysis the data are aggregated first by activities, then by product groups and distribution channels. (Braithwaite & Samakh 1998).

Weber (2002) distinguishes different 'layers' of cost collection that increase in complexity along with the perception of the responsibilities of logistics in the company. According to him, when logistics is fragmented in the firm in activities of material moving, warehousing and transportation, also the costs are fragmented in the accounting and costing system. Already collecting these together takes logistics costing to the next level and gives a better view of the total effect of logistics and its largest cost groups. From there improvement takes place by re-organizing the cost centres in accounting systems to better correspond to actual logistics work centres. Next improvement would be including information of the costs and cost effects of coordinating and integrative activities, such as production planning, to give better view of the whole order-fulfilment process and its relationships to other processes. All this information is recommended to be collected in an on-going basis. A further advance would be to include costs of other areas of the company in an analysis to demonstrate the effects of logistics related decisions. This would be done only as needed, however, as well as collecting cost information from other supply chain members. (Weber 2002, 42).

5.4 On-going cost controlling versus special cost analyses

The same cost management techniques that are used in other areas of business are useful for logistics as well, namely planning and budgeting, standard costing and variance analysis, responsibility accounting and reporting, and the use of performance measures. The costing systems and tools may be used for example for the purposes of continuous cost monitoring and the evaluation of the employees or responsibility centres. On the other hand, for strategic, seldom recurring and large-scale decisions a costing tool is likely not readily available but needs to be developed or adapted, and data is likely be needed from different sources. Some of it may be future estimates instead of historical

performance data, and qualitative data such as estimates of market development and supplier information is likely to be required to contextualize the numerical information and to account for possible trade-offs.

The information requirements for on-going control differ from those of decision making. The purpose of control is to monitor (the performance), to sense the need for a change, and signal the need for decisions. (Schary 1985) This takes place by creating a model of intended future operations (e.g. performance measure targets) based on past data, continually updated for comparison. Decision making for e.g. budgeting or resource allocation may utilize some of the same data but are oriented towards future targets. Adaptive control is emphasized: comparing the current outcome with a *planned* future, not (only) with the historical data. Control therefore should not simply assume the continuation of the past, but also conduct contingency planning both for emergencies and reasonable expectations of change. (Schary 1985.) Cost data for decision making requires future costs, i.e. costs adjusted for anticipated price changes, and only the costs relevant for the specific decision, i.e. those that will change as the result of the decision, should be included in the calculation. (Drury 2004, 41.)

In addition to monitoring the performance of a responsibility centre, the logistics *budget* can also be an integrating tool, as it integrates logistics activities with the company-wide profit plan. (Tyndall & Bushner 1985, 5; 7). Depending how it is used, budgets and budgeting may also aid in balancing the needs for efficiency and flexibility inherent in supply chains. Frow, Marginson and Ogden (2010) present a case of reconciling budgetary control and budget flexibility. Managers had personal budgetary targets, which they were expected to adhere, but if the strategic priorities demanded it, were able to compensate exceeding some part of the budget by finding savings in another part. Often this required collaboration with and help from managers from other areas of accountability. If the target nevertheless was not attained, it was acceptable, as long as the manager was able to demonstrate s/he had done everything that was reasonably possible to fix the problem. For this way of budget use to work, however required good understanding of the cause-effect relationships of the costs, common understanding and agreement of the strategic priorities of the company and good relationships within the company. (Frow et al. 2010.)

Variance analysis, i.e. comparing actual performance (financial or output) to the budgeted is valuable to the extent that the causes of variances are resolved, that is, the analysis helps in problem solving and is not merely used for evaluating the performance of employees against a pre-set target (Emsley 2001). Variance analysis may also aid in identifying causes and cost impacts over the cost centre borders or outside the company, i.e. extend the variance

analysis beyond the traditional responsibility accounting perspective to problem solving (Ansari 1979).

The special cost analyses are situation specific and even existing guidelines for such need to be adapted for the particular context. For the purposes of supply chain management may include well documented methods such as target costing in product development, landed cost, total cost of ownership or life-cycle costing in purchasing, activity-based costing in e.g. warehousing or distribution. Activity-based costing may also be conducted with various levels of detail and complexity, and also in 'stripped-down' analysis forms, namely activity analysis and activity cost analysis (Askarany et al. 2010) in different organizational contexts. Activity analysis is the first stage of activity-based costing, which identifies the necessary activities; activity cost analysis identifies the costs of activities, but does not assign them to individual products and services. (Askarany et al. 2010). Also typical text-book cases such as make-or-buy analysis, off-shoring decisions and deciding warehouse locations can be included in special analyses. Although the structure of the problem may be familiar, context specific cost data is needed, often estimated at an (average) unit level, but simultaneously other performance as well as qualitative considerations need to be accounted for.

5.5 Characteristics of intra-company logistics/SCM control systems

Figure 11 presents a conceptual model for unbundling (i.e. describing in detail) management innovations (Bjørnenak & Olson 1999, 328). With some modifications it is used here to sum up the earlier discussion of logistics cost management related aspects in organizations. It is also suggested as a framework for empiric research to describe and structure the characteristics of logistics control systems such as logistics cost management system in firms[29].

[29] To the author's knowledge, the model has not been empirically tested to date. However, Kulmala (2003) has used the framework in his doctoral thesis for conceptual analysis of activity-based costing, target costing and open-book accounting cost analysis frameworks or methods.

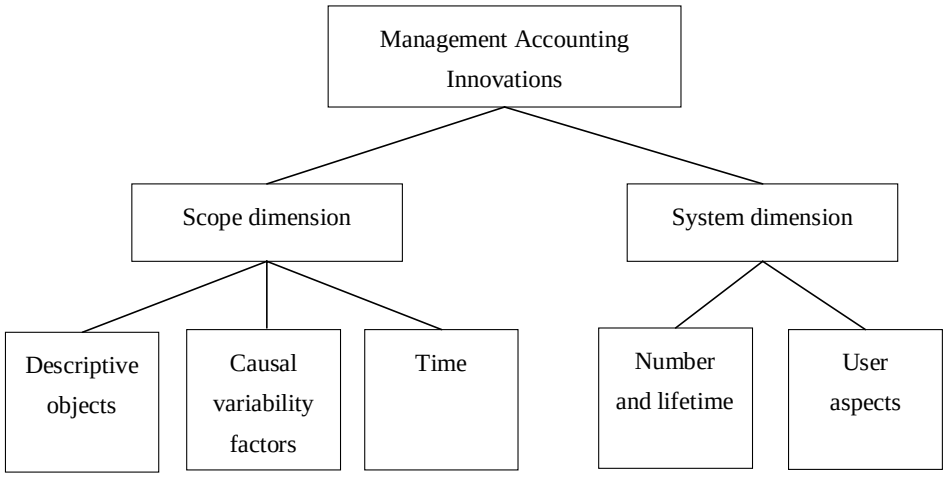

Figure 11 A generic model for unbundling management accounting innovations (Bjørnenak & Olson 1999)

Bjørnenak & Olson (1999) include in their model two main dimensions: scope and system dimension. *Scope dimension* covers the basic management accounting problems: what should be accounted for, for what period of time and how the costs should be allocated. Scope dimension thus includes the following sub-dimensions (Bjørnenak & Olson 1999):

- *Descriptive objects*: the number and scope of the objects whose performance or cost varies. These can be cost objects such as products, activities or departments, but in addition to cost also other data such as revenue or non-financial performance may be related to the descriptive object.
- *Causal variability factors:* factors that describe the causes such as production volume, number of orders, shipments etc. These are also called cost drivers in activity-based costing. Cost drivers or causal variability factors can also be understood in the broader sense of the strategic management literature, e.g. learning curve, interrelationships between SBUs, linkages in the value chain, vertical integration, location and institutional factors (Bjørnenak & Olson 1999, Hergert & Morris 1989, 184).
- *Time:* the timeframe for accounting, traditionally a reporting period, but with IT-systems a shorter time frame is possible if needed; and for example in total cost of ownership time frame is the life-time of a product. The dimension also includes the aspect whether the data is historical, e.g. cost standards based on past periods (ex post) or future-oriented (ex ante), e.g. budgeted costs or target costing.

The second dimension is the *system dimension*, which focuses on the link between the users and the design of the system. It includes the system attributes (Bjørnenak & Olson 1999):

- *number and lifetime of the systems*: instead of conventional perspective of an accounting system with very long lifetime, there may be systems designed for specific situational problem-solving purposes (e.g. excel sheet solutions), or an accounting system may combine data from many different systems (e.g. balanced scorecard with data from production systems); and
- *user aspects*: how the system corresponds to local information needs and enables learning, as opposite to traditional perspective of top-down design of accounting system for decision-making purpose.

The framework in Figure 12 is adapted from the model of for unbundling management accounting innovations, and is modified to analyze the characteristics of logistics control systems. The model excludes the so called soft controls, such as organizational norms and culture, and belief and boundary systems (Simons 2000), and concentrates on controls that are observable, e.g. reports, excel sheets or software. However, interactive controls are included in so far as many systems can be *used* in an interactive way (Simons 2000, 96–97): for example information from and assumptions underlying performance measurement system or budgets may be regularly discussed and debated in meetings at various organizational levels.

In the applied and revised model a fourth sub-dimension is added in the scope dimension, namely the *type of data* used in the control system. This includes the aspects of types of costs that are included in the cost calculation, direct or indirect (or variable cost only or overheads, too), whether non-financial performance data is utilized and are there opportunity costs included (and if so, to what extent). The aspect internal / external data refers whether the data is from internal or external sources: for example the company's own transactional data or invoices received, or is it obtained from another company (e.g. open-book costing).

Descriptive objects refers in this case to the scope of supply chain measurement and the level(s) of data aggregation: at what extent is the performance measured and what are the specific objects whose performance is examined in the context of logistics controlling. These may be for example an activity such as transportation, a cost center (e.g. a warehouse or distribution function), a process (e.g. order processing), a distribution channel or a component or component group purchased from a specific supplier. This dimension examines the data aggregation levels in place issues at different levels of precision needed. Causal variability factors refer to the explicitly identified (most relevant) cause-effect relationships of factors by which the performance varies

in the time frame of measurement. There may be one, such as units produced in traditional costing, or multiple like in activity-based costing or more sophisticated costing systems. The purpose that the control instrument is used for and the level of management are reflected in the time dimension of the model: at operational level the time frame is more likely a day or a week, whereas in use for strategic planning at a higher managerial level the timeframe may be a quarter year, a year or longer.

The modified version of the Bjørnenak & Olson (1999) model is completed with additional features in the number and lifetime and user aspects dimensions. In the number and lifetime of the system, in addition to categories 1) stand-alone or integrated application, 2) temporary or permanent solution and 3) continuous monitoring and reporting or as-needed analysis, the aspect 4) formal or informal application or tool has been included. Several authors have noted (Preston 1986; Bruns & McKinnon 1993; Mouritsen & Dechow 2005) managers using informal information sources and analyses to complement the formal information provided within the firm. The formal/informal aspect may be intertwined with the attribute temporary/permanent since formal systems, especially IT-systems, tend to be meant as a long-term investment to be used well into the unforeseeable future. On the other hand, an informal information or analysis tool may be used permanently by the managers if no formal solution is provided.

Bjørnenak & Olson (1999) discussed in the user aspects in the design of the system: whether top-down design (management accounting decides what information is provided) or involving the users, and for the purpose of relatively simple-minded decision-making or organizational learning. In the modified model multiple also other purposes of use are considered. Also, the user perception of the system is included, consisting of whether the users are satisfied with the system – i.e. find useful information for their purposes – or not. The characteristics of coercive and enabling control (Adler & Borys 1996, discussed earlier in Chapter 3) are included in the model for a more detailed picture of (design) aspects of the control system the users may not be satisfied with, helping to target the subsequent question ‘for what reason’?

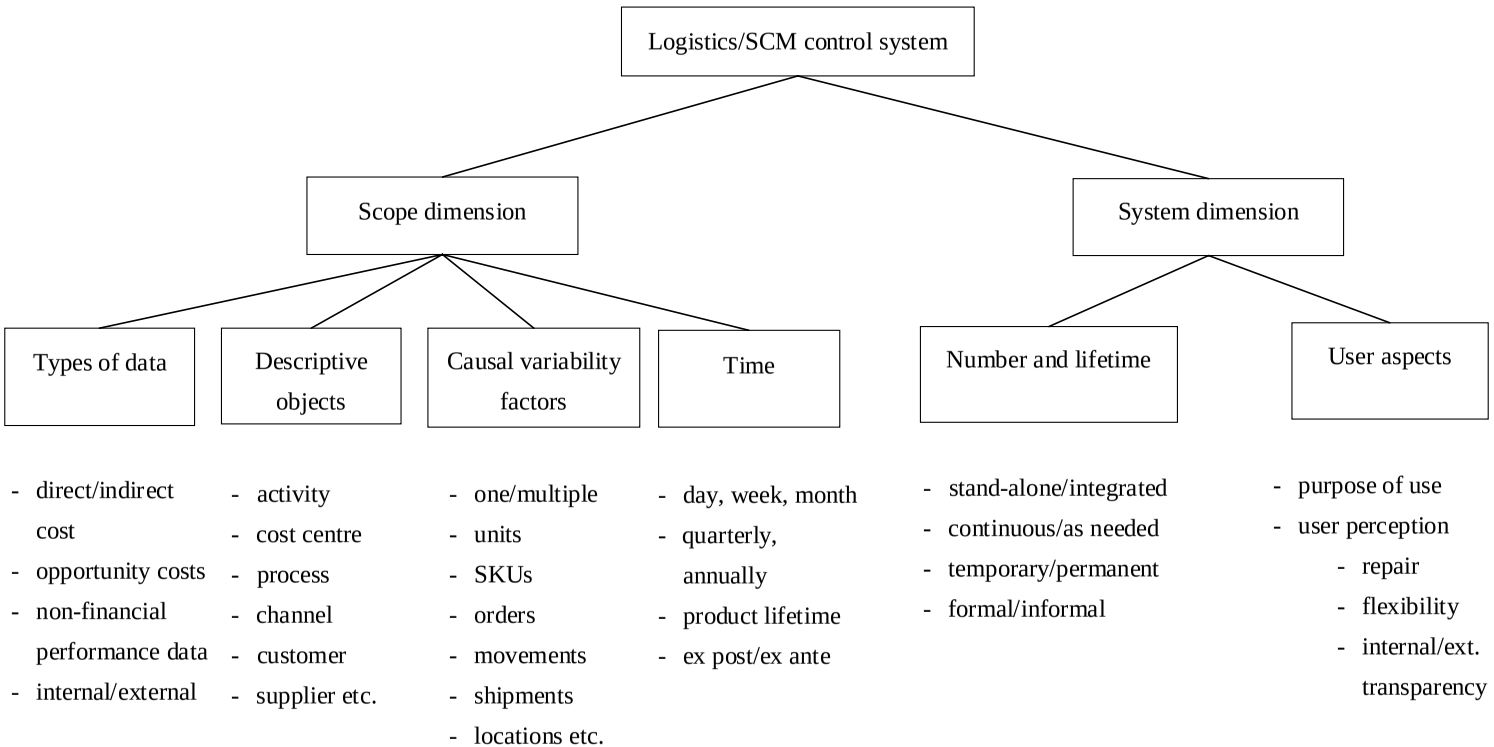

Figure 12 A model for analyzing logistics/supply chain management control systems (modified from Bjørnenak & Olson 1999)

The logistics control system may be used e.g. for the purposes listed by Franco-Santos et al. (2007):

- measuring performance, i.e. progress and status information,
- strategy management, that is, planning, focusing attention and providing alignment,
- communication, both internal and external, as well as benchmarking;
- influencing behavior, i.e. rewarding behavior and managing relationships, and
- learning and development, providing feedback information for performance improvement.

The model addresses the question how the logistics control system currently is, but not so much how or why it turned out that way[30]. It thus is suitable for a cross-sectional examination only. The model may be used for an analysis of one specific control instrument or the set of control instruments of a specific part of a firm.[31] Here the context is intra-company supply chain, but the model might be used for example in the context of sales or production. Also it may could be used for examining intra-organizational control systems if the scope of measurement extends beyond company borders and external data such as delivery performance records or cost structures are obtained e.g. from suppliers. The model enables a nuanced description of a control system of an organization: for example regarding a costing system the model is not limited to ideal-type costing methods, such as activity-based costing, but can also be utilized to applied implementations of 'text-book' costing systems, as it breaks the system down into individual aspects.

Model does not explicitly address the relationships or interconnectedness of the various sub-dimensions: for example, if a control system is used for planning purposes, the time horizon is likely to be medium- to long-term.

[30] Although user involvement in implementation and on-going development of the system may contribute to the user satisfaction of the system and whether it is perceived enabling or coercive (Wouters & Wilderom 2008)

[31] In principle it might be used for analyzing all the control instruments of a firm – except boundary and belief systems – but this hardly would be practical for other than quite small firms.

6 SUMMARY OF RESULTS IN APPENDED PAPERS

6.1 Paper I: Effects of geographic dispersion on intra-firm supply chain performance

The article addresses the question *how does the geographic dispersion of a firm's supply chain impact on intra-firm supply chain performance?* Geographic dispersion of supply chain operations may take place in the upstream supply chain in the form of low cost country sourcing or using several geographically dispersed suppliers as a sourcing risk hedging strategy (Platts & Song 2010). The motivation for investing in production facilities in foreign countries may be for example access to market, the desire to manage risk, competition and government policies, to reduce production and logistics costs and to serve global customers better. Downstream the supply chain the geographic dispersion of sales is largely motivated by the desire to achieve growth in export or international sales and thus to increase the volume of the business.

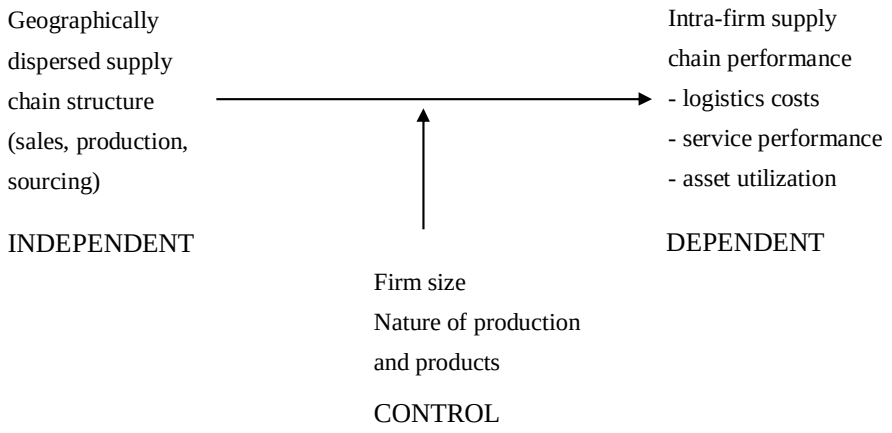

Figure 13 The investigative model of the article (excerpt from Lorentz et al. 2012)

Geographic dispersion of supply chain is defined along the lines of Stock et al. (2000) as the extent to which the elements in a firm's supply chain are located in a wide range of geographic regions, especially the facilities and activities. It is operationalized for each, sales, production capacity and direct purchasing, as the percentage taking place in home country, other EU (including Norway, Iceland and Switzerland), Russia, North and South America, Asia, and other countries.

The concept intra-firm supply chain performance is operationalized as logistics cost, service performance and asset utilization in the focal firm (measurement conducted within the boundaries of the firm). Logistics costs consist of transportation cost, warehousing cost, costs of capital tied in the inventory and logistics administration costs (all expresses as percent of turnover). Customer service performance is defined as perfect order fulfillment and order fulfillment cycle time, and asset utilization includes cash-to-cash cycle time and inventory days of supply.

Evidence was found to support the general hypothesis (e.g. Bozarth et al. 2009) that increased complexity resulting from the geographic dispersion in up and downstream has negative performance effects on supply chains. Increased geographic dispersion of the purchasing was found to result in higher costs of warehousing and logistics performance due to additional inventory locations and increased in-transit and safety inventories. The decline in service performance discovered is in line with increased challenges of coordination and quality management reported in the context of low cost country sourcing. With geographically dispersed sales network the inventory costs, inventory days of supply and cash-to-cash cycle tend to increase. Similarly to upstream supply chain, the inventory related asset investments and costs increase as the amount of in-transit and local inventories increase. Also, the varying payment practices in global sales affect the cash-to-cash cycle. The only positive performance effect from geographic dispersion was found in the production tier: the dispersion of production network was found to improve order fulfillment cycle time.

The results also indicated that the larger the firm, the better it can alleviate the negative performance implications of geographic dispersion on perfect order fulfillment. Make-to-stock companies were found to suffer less from the supply chain dispersion related effects on order fulfilment cycle time in comparison to companies with more pull-type production and inventory strategies. These findings confirm in their part the firm size and the nature of manufacturing strategy as a significant differentiating factor of supply chain properties and performance (Daugherty et al. 1996; Olhager 2003).

6.2 Paper II: An approach for estimating total logistics costs at a company level

The paper problematizes the concept of logistics cost their comparability between different firms. Indirect costs of logistics are often classified in other cost centers such as manufacturing and marketing, and may be assigned various ways which affect the comparability between firms. Typical logistic cost categories are presented, and examples provided of differing definitions of inventory-related costs. With divergent category definitions and the different cost categorization of three distinct survey researches the paper illustrates how the comparability of logistics cost is complicated by differences in cost categories and category definitions.

The paper presents common cost analysis frameworks used for analyzing different parts of the company internal supply chain, divided in methods for analyzing inbound logistics costs on one hand (total landed costs and total cost of ownership), and outbound logistics (cost-to-serve and direct product profitability) on the other. The output of the paper is condensed in a model of factors that obscure the concept of total intra-company logistics costs and complicate the comparability of total logistics costs between firms. These include the purchasing and sales terms determining the payer of freight and transportation insurance as well as the ownership of the in-transit inventory in the supplier/customer interface, the valuation method of the inventory, the allocation method used for assigning indirect costs, and the scope of the cost analysis conducted.

6.3 Paper III: A framework for evaluating the sophistication of internal supply chain cost measurement in manufacturing companies

Paper III presents 1) a tentative model of factors related to how intra-company logistics costs are constructed in manufacturing companies (Figure 14) and 2) a framework classifying logistics costs at different levels of complexity and by functions or activities along the intra-company supply chain processes (see Paper III).

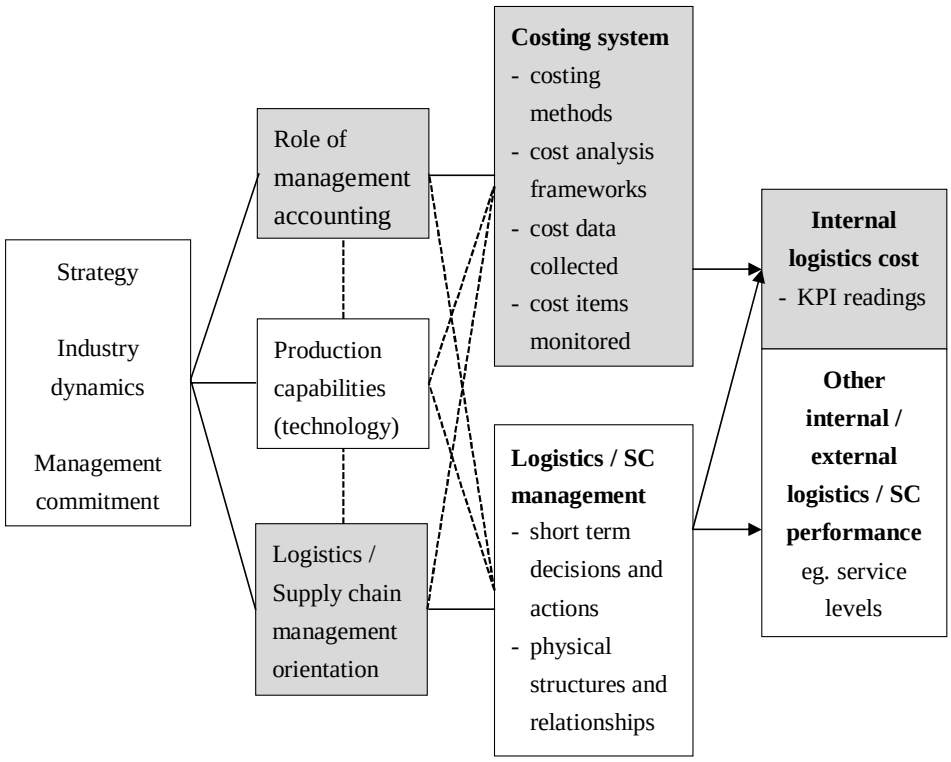

Figure 14 Factors related to the construction of firm or business unit internal logistics cost in manufacturing companies

Figure 14 illustrates factors on which the intra-firm logistics cost figure is based on in a manufacturing company. The actual logistics cost figure is seen to vary based on the measurement technic aspects of costing system on the one hand, and on the logistics management actions, infrastructure and existing relationships on the other hand. These in turn are guided by the role of management accounting in the organization, the production processes in place and the extent of supply chain orientation within the organization. Factors underlying these are suggested to be the dynamics of the industry which the firm operates in, the chosen strategy of the organization and the management commitment for supply chain management and management accounting on a strategic level.

The actual logistics cost figure(s) (key performance indicator, KPI) are seen to vary on the short term based on the aspects of the costing system: which logistics costs items (i.e. which logistics activities) are monitored, the scope of costs analysis frameworks utilized for cost analysis, and what kind of cost data is collected. The short term logistics management decisions and actions based on those are regarded to influence the performance indicator, but existing

physical structures and supply chain relationships provide the range for normal or acceptable fluctuation of the cost indicator.

The role of management accounting (perception of its purpose as a controller or a business partner providing broad range strategic information), and supply chain orientation, i.e. perception of the strategic importance of logistics and supply chain management are seen to together influence the costing system implemented. An integration and co-operation of both functions would be necessary for a sophisticated measurement of supply chain costs within the organization to take place. However, the dynamics of the industry the firm operates in, the organizational strategy, and the support of the top management combined with the production technology of the firm are considered to contribute to the perception of both management accounting and supply chain management in the organization.

The role of management accounting in logistics costing may be characterized as minimal, implementing logistics costing for financial reporting mainly; moderate, where specific logistics cost centers are defined, but emphasis is on maintaining the budget or cost cutting, or advanced (strategic cost management): collaboration or frequent exchange of information takes place between management accounting and SCM, and holistic value-added perspective extending to suppliers and customers prevails.

Supply chain orientation is suggested to be categorized in low, medium or high level. Low level of supply chain orientation, 'logistics management' is expected to be characterized by focus in transport and warehousing. Logistics cost measurement is likely to concentrate on easily available operative costs. At medium level, 'integrated logistics management', the internal processes are integrated to some extent. At a high level of supply chain orientation, 'supply chain management' extensive measurement of costs at both the process scope of activities and the levels of cost categories is expected to take place. Complementing the on-going monitoring of costs specific analyses such as customer profitability or total cost of ownership would be conducted as needed.

The supply chain cost framework (see Paper III) is based on the processes of the supply chain management processes crossing the firm by Lambert & Douglas (2000), and on the activity-based costing logic of a hierarchy of activities which results in several causes of variation in cost (eg. unit level, channel, customer or product-sustaining, or order-related activities) (Kaplan & Cooper 1998). Similar logic has been applied earlier e.g. in total cost of ownership cost analysis framework used in supply management (e.g. Ellram & Siferd 1993; Weber et al. 2010). The framework may be used to assess the scope of activities that are included in supply chain cost measurement of intra-company supply chains either for constant monitoring or in special analyses.

The costs are categorized at five levels: 1) Minimum requirements for financial reporting, 2) Costs of operative activities, 3) Structural costs; i.e. the costs of planning the supply chain structures and relationships; 4) Supply chain assets; i.e. the capital tied in the supply chain, including accounts payable and accounts receivable[32]; and 5) the opportunity costs, which are a loss of potential income or increase in costs as a result from making a specific trade-off between alternatives, rather than actual cost. The levels indicate an increasing order of difficulty to measure them: the costs of financial reporting such as purchasing price, freight and inventory value are usually available in their own accounts, whereas in the other extreme the opportunity costs such as end-product failure costs or cost of loss sales are educated guesses at the best.

6.4 Paper IV: The availability of logistics cost: A comparison between Finnish manufacturing, trade and logistics service providers

The paper IV of this thesis (Hälinen, Solakivi & Ojala 2013) examines factors possibly related to the detail and availability of logistics cost information. Availability of operative and administrative costs of logistics were operationalized by asking whether the IT-systems of the respondents company provide sufficient and up-to-date information on the costs of operative logistics activities and on the costs of managing and planning logistics activities.

Monitoring logistics costs by product, customer and distribution channel is already considered in the paper a rather detailed cost information and an indication of somewhat sophisticated costing system or analysis, as it is likely to include collecting cost data from multiple sources or from various expense accounts, and possibly allocating them at different levels of cost objects (assuming that the respondents did not agree to some of the three aggregation levels, but monitoring all of them).

The *operative costs* of logistics appeared to be better available than the administrative costs in all the three industry groups examined (manufacturing, trade and logistics service providers; these were, however, not statistically tested). In trade there was a significant difference between small and other company sizes in the availability of administrative cost of logistics.

Contrary to expectations, industry (manufacturing or trade) was not associated with the detail of monitoring logistics costs – in trade the monitoring of logistics costs by product, customer and distribution channel

[32] The supply chain assets might be better classified as supply chain resources: depreciation of these (not accounts payable and receivable, though) should also be in costs required for financial reporting.

might be more relevant for the contribution margin than in manufacturing. Company size, however, appeared to be related to the detail of logistics costs. It would seem that the detail of assigning logistics costs to different cost objects increases as the company size increases both in manufacturing and trading industries. Based on the sample, large manufacturers monitor their logistics costs at a greater level of detail than medium-sized manufacturing companies, so one may conclude that the detail of assigning and monitoring logistics cost appears to increase as the company grows sufficiently large. In trade there was a difference especially between the detail of cost assignment of small and large companies. (Hälinen et al. 2013, 15–16.)

This may be explained by two things: larger companies may have better resources at their disposal (Al-Omiri & Drury 2007) and are thus able to employ cost management specialists and develop more sophisticated cost systems. On the other hand, small companies probably have fewer or a smaller variety of customers, products and distribution channels, and therefore formal and consistent cost information on a detailed level is not perceived necessary, as more aggregated information on the profitability may be sufficient (Hälinen et al. 2013, 16).

6.5 Paper V: Multiple perspectives on logistics costs: factors related to information provision

The paper (Hälinen 2013) discusses measurement of logistics cost and provision of logistics cost information from multiple perspectives in the context of manufacturing industry. Different levels of aggregation and accuracy of logistics cost information are required depending on the use of cost information: national or competitor benchmarking, strategy implementation, product and service costing, organizational control: responsibility accounting and monitoring the efficiency of operations. Scope and strategic level of logistics cost information needed in an organization are proposed to be dependent on how strategic company perceives supply chain management; ranging from logistics as a support function performing routine tasks to supply chain management as a strategic orientation.

It is suggested that analysis from an alternative strategic perspective, i.e. supply chain strategy that integrates procurement, manufacturing and distribution within the organization, as well as external supply chain partners and service providers could be beneficial in examining the fit of management control system. Emphasis is on managing the efficiency of operations, i.e. financial performance metrics and their construction; non-financial

performance elements such as time, technical quality and customer service are outside the focus of the paper.

The use of logistics cost performance measurement and information is discussed from the enabling versus coercive formalization perspectives with the example of budgeting and variance analysis.

The contribution of Paper V as part of the thesis comprises the conclusion – based on extant research – that for simple operations simple systems may be sufficient, but as the complexity of operations and the resulting decisions increases, both the need and use of performance information increase in complexity (Cavinato 1999). When supply chain management is perceived as a strategic initiative, logistics performance measurement and logistics costing system need to be aligned both vertically with company strategic objectives, as well as horizontally along the actual processes taking place. Therefore, in an organization with or aiming for a highly integrated intra-firm supply chain the use of logistics cost information and performance indicator may be viewed as a ‘package’ of management controls (Malmi & Brown, 2008). The research aim is then to understand how the systems operate as an inter-related whole.

7 CONCLUSION ON FACTORS CONTRIBUTING TO INTRA-COMPANY SUPPLY CHAIN COST

Figure 15 presents a model that summarizes the factors discussed above and thus answers the second research question: *What factors may contribute to how logistics costing is organized in companies*? The two-way arrows indicate a connection, whereas a one-directional arrow indicates an inferred causality: e.g. existence of IT-systems in the firm hardly affects the firm size, but the firm size may well affect the adoption of IT systems. Based on the model, multiple hypotheses can be presented for testing in future research.

At the far right hand side of the model is the organizational *logistics performance*, both financial and non-financial, represented here by intra-firm supply chain cost and non-financial performance indicators, such as customer service level, inventory turns or percentage of on-time deliveries. The actual values of the indicators are the outcome of both the 1) costing system design and 2) logistics or SCM structures and actions taking place: the normal variability of the short term (daily or weekly) material volume and related actions, the medium term decisions and actions, and the long-term structures and relationships and the decisions related to those.

The form of the *logistics costing system* may be affected by 1) role of management accounting (MA) directly; or 2) the combination of the MA role and the perception of the SCM in the firm, mediated by the existing IT-systems. IT-systems, on the other hand, may be developed based on the requirements of the logistics costing system and the logistics management. It might be possible, if the role of management accounting is not participative but rather traditional (‘bean-counter’) and the SCM perception elementary, considering logistics as transportation, that the IT system’s standard solutions and performance metrics are what defines the form of logistics costing system.

Logistics and supply chain management is seen in the model to be directly affected by the perception of the SCM in the organization, whereas the supply chain actions and existing structures are not considered to influence the perception of SCM. Logistics costing system, on the other hand, is considered to influence the perception of SCM by quantifying the effect of logistics – i.e. if the system is changed, the perception may change. The *IT systems* in their turn enable logistics and supply chain management actions, and the actions

feed back to the IT-system; also, the system processes may be modelled to correspond to supply chain processes, if the perception of SCM is strategic.

Broader organizational factors underlying the previous include the products and production process, top management strategic preferences and firm size. The characteristics of the *production process* (M-T-O, A-T-O etc.) are reflected in the order penetration point, which is suggested as the shifting point of efficiency and time or service as performance priority (Schary 1985). The storability of the end product and the raw material are production process related factors that also influence the position of the order penetration point, as well as the variety of end products. The profit margin level may contribute to the perception of the SCM: if the margin is very small, there may be more pressure to search efficiency gains from supply chain management, whereas with larger profit margin of the product the logistics and purchasing costs may be considered less relevant. These are also regarded to influence to the *perception of the supply chain managemen*t e.g. in terms of choosing the appropriate configurations and management methods for the lean and agile supply chain (Mason-Jones & Towill, 1999), but the (strategic) perception of the supply chain management may also contribute to efforts to reorganize or optimize these. The variety of the products and the complexity of the production process are also likely to influence the IT-systems in place in the organization: a simpler system would be sufficient in a less complex production process with a few end products and raw materials.

Top management strategic preferences, or in the case of a small firms, the strategic preferences of the owner-manager (Halley & Guilhon 1997), are considered as a factor affecting both the *role of management accounting* in the organization, and the perception of SCM. Without top management commitment the vision needed for supply chain excellence cannot emerge, and without a clear mandate the supply chain integration initiatives will be local and promoted in an ad hoc manner by a few individuals scattered throughout the organization. Consequently, the initiatives neither yield results nor produce the visibility to demonstrate SCM's competitive potential. Also, only the highest management levels are able to dedicate the resources and realign the measures and rewards to make SCM an organization-wide priority (Fawcett, Ogden, Magnan & Cooper 2006, 25–26.) In combination with the company size, this may be a matter of resources: smaller firms may not be able to hire supply chain or management accounting professionals. Alternatively, it may be a matter of preference: that the owner-manager prefers to allocate the resources elsewhere.

The factors contributing to the formation of logistics cost discussed so far are firm internal factors (see also Figure 16). Excluding the legislative environment, the most relevant external factors related to the organization of

logistics costing in the firm are the characteristics of *the supply and the customer market*. The features of the supply market affect the information needs of the purchasing, whereas in the distribution end of the intra-firm supply chain the customer market dictates the information requirements for supply chain management. The intensity of competition and the critical success factors needed to succeed in customer markets and determine the emphasis placed to efficiency in the organizational strategy as opposite to other elements of performance such as e.g. innovativeness. Relevant features of the supply market from the perspective of supply chain management costing include the availability of the components or raw material, the volatility of the raw material price, and the relative price level of the component or the product (Bruns & McKinnon 1993).

Figure 16 further divides the possible contingent factors related to the logistics or supply chain cost and other performance firstly in logistics and SCM related aspects, and secondly to other internal organizational and managerial factors. The most relevant external factors possibly contributing to the formation of logistics /SCM cost are presented in the left hand side of the model. The dashed line marks the organizational boundaries, and the arrow indicates the breadth of information required for (strategic) decisions related to the external markets versus the detailed information needed for the essential, day-to-day logistics management to function.

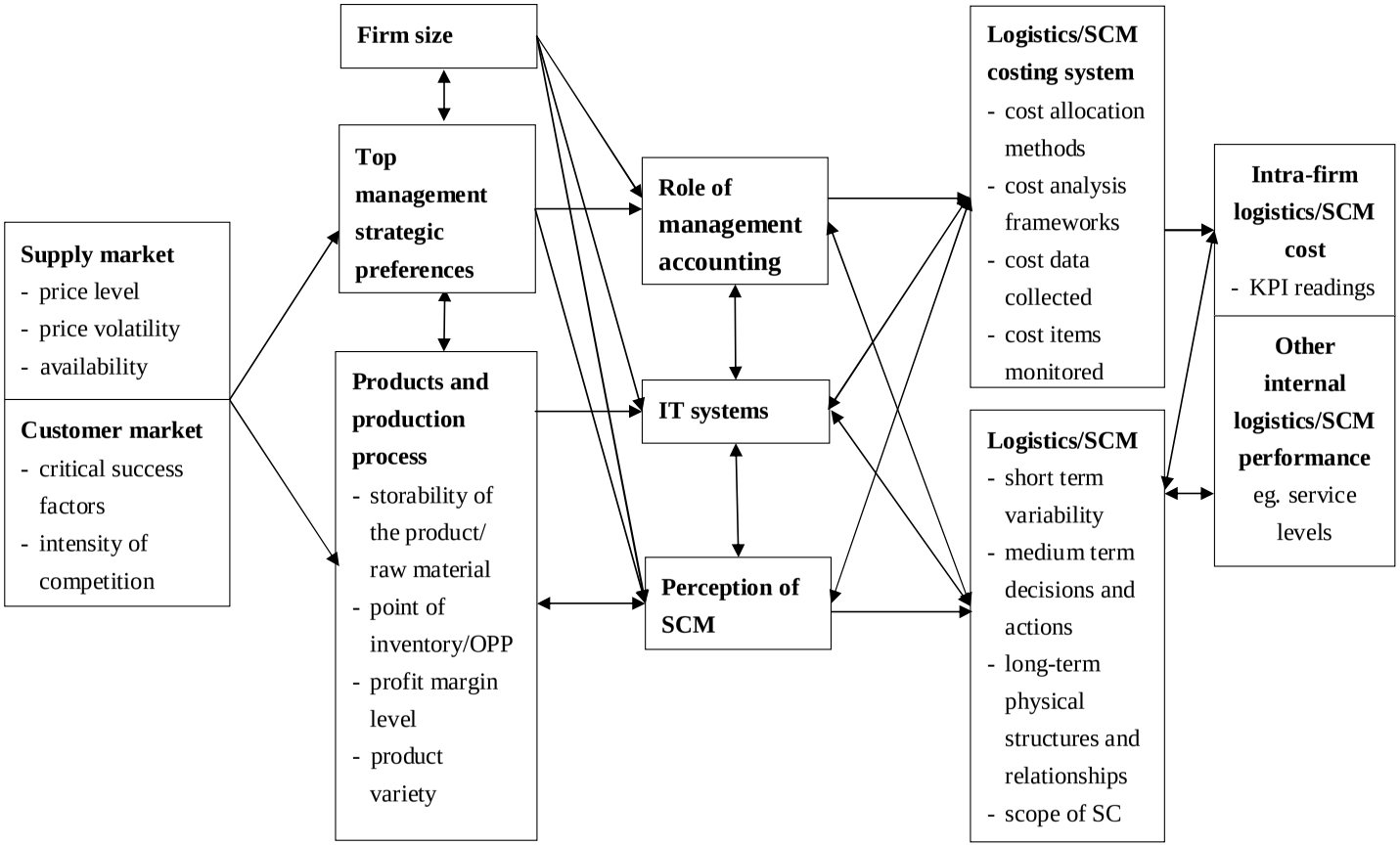

Figure 15 Factors contributing to the intra-company supply chain cost measurement

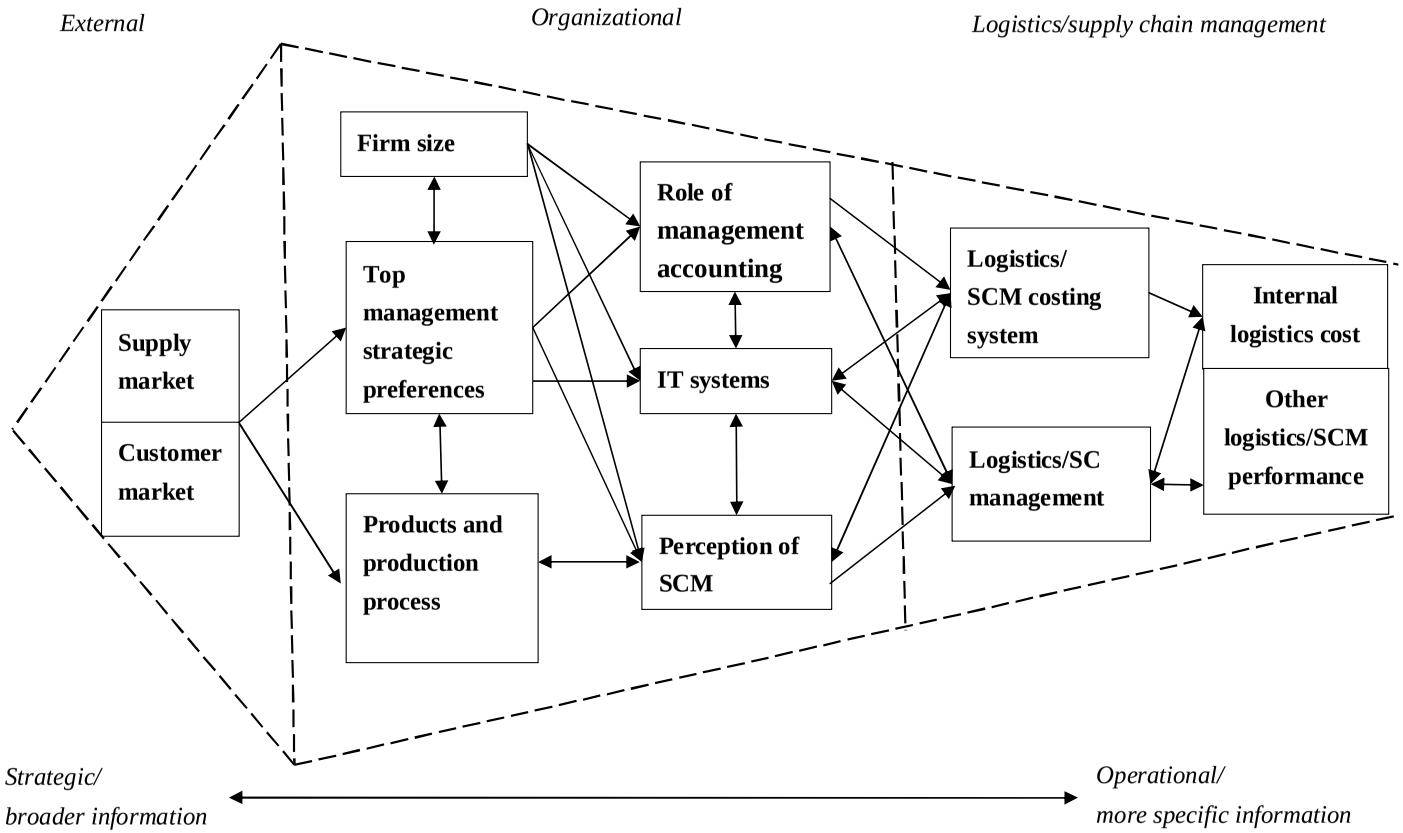

Figure 16 Logistics/SCM cost related factors and information needs at different levels

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