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ABSTRACT

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Supervisor(s)	Ph.D. Lauri Ojala – M.Sc. Tomi Solakivi		

Abstract

In the last few decades logistics has become increasingly important for companies and other entities around the globe. At the same time, the complexity of supply chains has increased and companies are forced to pay more attention on the costs generated by logistics activities. Logistics costs also plays significant role in national, regional and global context, which can also be identified from the growing number of logistics cost studies published every year. According some studies, logistics costs may generate up to 20% of nation's gross domestic product. However, since no common research methodology is established in this field of research, the comparability of results is low and different studies may even report contradictory findings.

The purpose of this research is to scrutinize the current state of logistics cost research and to create a generic model for measuring logistics costs in national and global context. In order to clarify the picture of the current logistics cost research, the meta-analytical literature review is conducted. The findings of the review are also employed in another purpose as they are combined with the transaction cost approach to form a background for designing a generic logistics costs structure. The created model is then applied into the results of some previous studies to demonstrate the benefits and possible applications of the model. The output of the study is therefore dualistic; it elucidates reader where logistics costs are studied, by which methods and when. Also the generic model for assessing logistics costs is created based on the meta-analysis of previous research.

Based on the review of previous research, three distinguished dimensions can be identified in the research of logistics cost. First one is the methodological approaches, which are divided into the three main groups: questionnaire based studies (surveys), modeling based studies, and case and other studies. The share of each study methodology employed was in relatively same level. Secondly, studies can be categorized by the geographical coverage, which in this study was either single country study or multi country study. It seems that single country studies are more popular compared to multi country studies. The last identified dimension was the thematic broadness of studies. According the review, multi theme studies are rather much more popular than single theme studies. In addition to these findings, thesis output contains a generic logistics cost structure (GLOCS), which can be used on identifying and comparing the level of logistics costs in commensurable form. This taxonomy has several possible applications, of which the one is also illustrated in the empirical part of thesis work.

Key words	logistics, supply chain management, costs, cost estimates, modeling, literature review
Further information	

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TIIVISTELMÄ

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Tiivistelmä

Viimeisimpien vuosikymmenten aikana logistiikan merkitys yrityksille ja yhteiskunnalle on kasvanut joka puolella maailmaa. Samaan aikaan toimitusketjut ovat tulleet yhä monimutkaisemmiksi, mikä on osaltaan lisännyt kiinnostusta logistiikan aiheuttamia kustannuksia kohtaan. Logistiikalla on suuri merkitys yritysten lisäksi myös kansallisella, alueellisella ja globaalilla tasolla, mistä kertoo myös vuosittain kasvava logistiikkakustannuksia käsittelevien julkaistujen tutkimusten määrä. Joidenkin tutkimusten mukaan logistiikkakustannusten osuus saattaa olla jopa 20 prosenttia maan bruttokansantuotteesta. Johtuen yhteisen tutkimusmetodologian puutteesta, eri tutkimusten vertailukelpoisuus on heikko ja osittain tulokset ovat jopa ristiriitaisia.

Tämän tutkielman tarkoituksena on tarkastella logistiikkakustannustutkimuksen nykytilaa ja luoda yhteinen malli logistiikan kustannusten mittaamiseen kansallisella ja kansainvälisellä tasolla. Nykytilan selvittämiseksi luodaan olemassa oleviin tutkimuksiin meta-analyyttinen kirjallisuuskatsaus, jonka tuloksia hyödynnetään yhdessä transaktiokustannusteorian kanssa myös mallin rakentamisessa. Mallin etuja ja mahdollisia sovellutuksia esitellään soveltamalla mallia joihinkin aikaisempiin tutkimustuloksiin. Tutkielman luonne onkin kaksiosainen; kehitetyn mallin lisäksi se kuvailee missä logistiikkakustannuksia on tutkittu, millä metodeilla ja koska. Toisaalta myös tutkielmassa kehitettävä malli perustuu meta-analyyttiseen kirjallisuuskatsaukseen.

Aiemmin julkaistuista tutkimuksista voidaan tunnistaa kolme keskeistä ulottuvuutta, joiden avulla tutkimuksia voidaan luokitella. Ensimmäinen näistä on tutkimusmetodologia, jonka perusteella aiemmat tutkimukset voidaan jakaa kolmeen ryhmään: kyselyt, mallintamiseen perustuvat tutkimukset ja tapaus- sekä muut tutkimukset. Näiden suosiossa ei ole havaittavissa suuria eroja. Toinen tutkimuksia erotteleva ulottuvuus on maantieteellinen laajuus, jonka perusteella tutkimukset on luokiteltu yhden- ja usean maan tutkimusten välille. Kirjallisuuskatsauksen perusteella yhteen maahan keskittyvät tutkimukset ovat alueellisia ja globaaleja tutkimuksia suositumpia. Viimeinen ulottuvuus on tutkimuksen temaattinen laajuus, joka jakaa tutkimukset yhden- ja usean aiheen tutkimuksiin, joista usean teeman tutkimukset ovat selvästi suositumpi lähestymistapa. Näiden tuloksien lisäksi tutkielman tuloksena luodaan yleinen logistiikkakustannusten rakenne, GLOCS (Generic Logistics Cost Structure), joka mahdollistaa kustannusrakenteen ja -tason tunnistamisen ja vertailun eri tutkimuksissa. Myös yksi mallin mahdollisia käyttökohde esitellään tutkielmassa.

Asiasanat	logistiikka, toimitusketjut, kustannukset, kustannusarviot, laskentamallit, kirjallisuuskatsaukset
Muita tietoja	

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MEASURING NATIONAL LOGISTICS COSTS

Designing a Generic Model for Assessing National Logistics Costs in Global Context

Master´s Thesis
in Logistics

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LIST OF ABBREVIATIONS

ANN	Artificial Neural Network (model)
ASEAN	Association of Southeast Asian Nations
ASLOG	Association Française pour la Logistique (French Logistics Association)
BSR	Baltic Sea Region
CHF	Swiss Franc (currency)
CSCMP	Council of Supply Chain Management Professionals
CSIR	Council for Scientific and Industrial Research (South Africa)
DDP	Delivered Duty Paid (Incoterm)
ECB	European Central Bank
ELA	European Logistics Association
EUR	Euro (currency)
EXW	Ex Works (Incoterm)
GDP	Gross Domestic Product
GLOCS	Generic Logistics Costs Structure
GMA	Grocery Manufacturers Association
IMF	International Monetary Fund
ISIC	International Standard Industrial Classification of all Economic Activities
KPI	Key Performance Indicator
LCM	Logistics Cost Model
LPI	Logistics Performance Index
LPIO	Logistics Performance International Observatory
LSP	Logistics Service Provider
NAICS	North American Industry Classification System
NOK	Norwegian Krone (currency)
RMB	Chinese Yan (currency)
SEK	Swedish Krone (currency
SCM	Supply Chain Management
TCA	Transaction Cost Approach
TF	Transportbrukernes Fellesorganisasjon, Federation of Norwegian Transport Users
TOL 2002	Standard Industrial Classification 2002 in Finland
USD	US Dollar (currency)
VAT	Value Added Tax
ZAR	South African Randi (currency)

1 INTRODUCTION

The purpose of the first chapter is to familiarize reader with the subject and background of the study and provide an overview to the study structure. In addition, research problems, limitations and some pivotal concepts are introduced in this chapter.

1.1 The Background of the Study

To be able to fulfill customers' needs company needs to make strategic decisions like how to deliver products and arrange the supply of raw materials. This means that logistics is a vital part of economic activity and influences day-to-day operations of companies. According modern economic theories every entity, whether it is a consumer, a state or a company, tries to maximize its profits. In other words, it is justified to make an assumption that entities try to make their best to minimize costs and improve performance.

Logistics costs represent a part of the business' expenditures, but the weight of these costs is also heavily dependent on the industry. When considering logistics costs as a substantial proportion of product prices, it is possible to see that cost may rise above the quartile of product prices in some industries. As presented in Figure 1, logistics costs also tend be higher in food, metal and chemical industry.

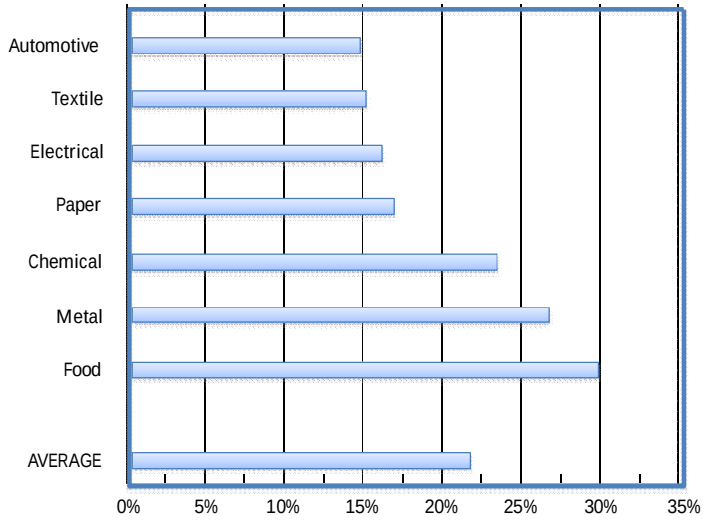


Figure 1 Logistics costs as a proportion of product prices 2007 (Farahani, Asgari & Davarzani 2009, 59)

According Bowersox, Rodrigues and Calantone (2005) the world's logistics costs in year 2002 totaled 6 732 billion USD, which was over 5 per cent up, compared to 6 387

billion USD in 2000. For example in North America, logistics costs equaled 9.9% of GDP in 2002. (Bowersox, Rodrigues & Calantone 2005, 9-10) Due to this fact, it is possible to say that logistic related costs are one cost group, which needs to be seriously scrutinized, when seeking cost savings and pursuing towards better performance.

Farahani, Asgari and Davarzani (2009, 57) stated that insufficient information over the logistics costs is a central obstacle to understand integrated logistics. If managers are unable to get transparent information of logistics costs in all stages of the material flow, they are also unable to improve company's performance. The lack of accurate information also complicates the measurement of the impact of the managerial decisions through the supply chain. (Farahani et al. 2009, 57)

Also nations are trying to increase their attractiveness among enterprises, which seeks new places to establish branches. According United Nations, logistics costs are important factor, which affects to competitiveness of nations (United Nations: Commercial Development of Regional Ports as Logistics Centres). The importance of lowering logistics costs has also been identified in national and global level. Today the discussion, related to logistics costs affects national level policy making and infrastructure investments, as well as other investments (Farahani et. al 2009, 58).

For example Finnish Government has included the aim of improving logistics competitiveness and reducing the logistics costs all over Finland to Governmental Programme of Prime Minister Matti Vanhanen's second Cabinet. (Finnish Governmental Programme 2007, 38) On the basis of Governmental Program's aims, the Ministry of Transport and Communication in Finland has drafted the national logistics strategy. The strategy leans on four strategic objectives, of which two are closely related to themes of this study. These objectives are competitiveness of economy and attractiveness of Finland for companies. (Logistiikkafoorumi, 12) One way to fulfill these two objectives is to lower logistics costs, which eventually improve competitiveness and attractiveness of nation.

Other driver for increased competitiveness of nation is foreign direct investments (FDI), which encourage external trade and establishing of large-scale production (Bogdanova & Orlowska 2008, 107). Various worldwide organizations are developing and publishing equivalent indicators to rank world's countries according their business environment. These indicators like Doing Business report, which measures the friendliness of regulatory environment, and overall indexes like The Global Competitiveness Index are providing necessary information, when locating business. In the field of logistics, one widely-used competitiveness indicator is Logistics Performance Index (LPI), published by the World Bank Group.

The World Bank has now initiated a project, of which working title is called as Logistics Performance International Observatory (LPIO). This project eventually aims to create a global framework for logistics cost research, which would greatly ease the

fragmented situation in this field of research. This thesis work has a strong linkage to this project, since the findings of meta-analytical research review are, and will be used as a foundation of scoping papers and preparatory tasks.

Many countries and research institutions also conduct national and global logistics studies, which treat issues like outsourcing and logistics costs. However, there is a one major problem with the results of these studies; they are contradictory. This is mainly a consequence of several different definitions, measurement techniques and research methodologies, which cause the incomparability of results.

Measuring logistics costs is not the only goal itself. It can be used as a proper indicator for evaluating and monitoring performance in national or even in industry level. The importance of measuring is ever increasing as logistics activities and tightening competition takes place. In recent years, it has been possible to recognize some serious efforts for assessing logistics costs in national level. There are still many steps to take before logistics costs of nations or entities are comparable with each other.

1.2 The Purpose of the Study

The purpose of this research is to scrutinize the current logistics cost research in national and global context. As a result of literature-, journal and other publications meta-analysis, it is intended to create a generic model for measuring and comparing logistics costs. The created model is also applied into the results of some previous studies to demonstrate the output and one possible application of model.

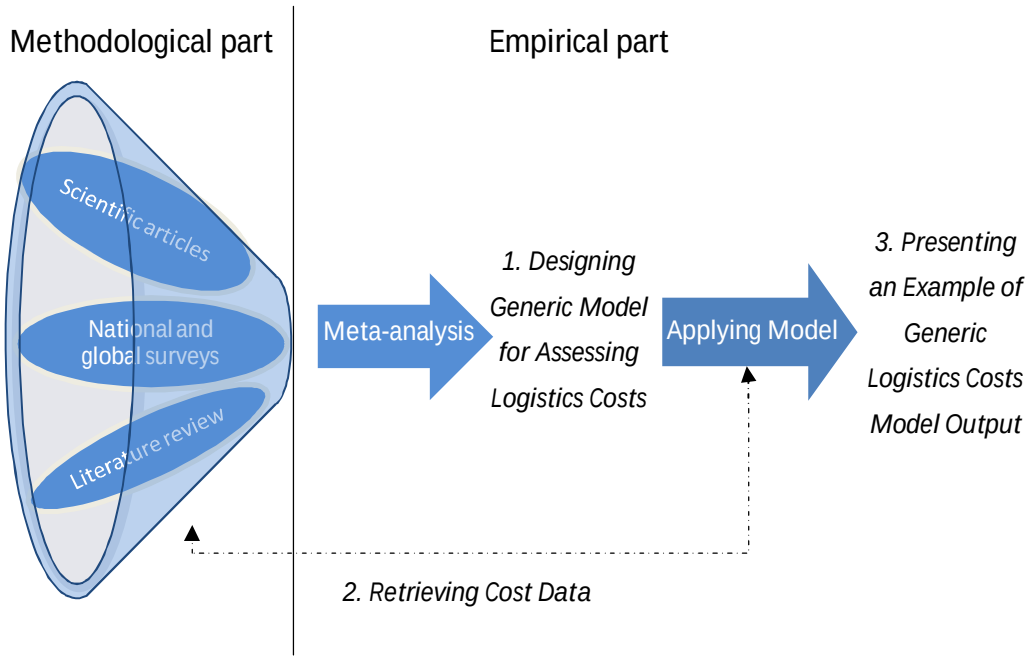


Figure 2 Study Design

This study has strong bindings to previous logistics costs research, which offers a solid theoretical background for meta-analytical discussion that aims to create generic model for assessing and comparing the level and structure of national and areal logistics costs. Also the transaction cost approach (TCA), which is widely used theory in economics, is applied into model designing phase.

1.3 Research Problem, Structure and Limitations of the Study

There are two main research problems in this study. First is to *elucidate where logistics costs are studied, by which methods and when*. Other main problem is to *create a generic model for assessing logistics costs based on meta-analysis of previous research.* To approach these problems, it is possible to identify several sub problems that could be labeled as i) understanding the concept of logistics costs in existing research and ii) creating a taxonomy for re-classifying these concepts under few main groups.

The structure of this study can be divided into five main parts: introduction, theoretical part, methodology, empirical part and conclusion. Chapter one briefly introduces the subject of study, research problems, pivotal concepts and motivates the reader.

Theoretical part, chapters two and three, provides an overview over the existing research. Chapter two concentrates on clarifying the nature of logistics costs research in existing literature and other publications. This chapter intends to answer questions like what was done, when, and by whom. Third chapter concentrates on examining logistics costs in studies. This chapter has been divided into two subchapters, of which first discuss logistics costs in studies, which examines logistics cost in multi-country context. The second subchapter discusses existing single country and case studies. In addition, the studies are further divided, whether the used research method was modeling-, questionnaire- or case study based. Main goal of chapters two and three is to provide a solid meta-analytical background for generic logistics costs creation process.

Chapter four introduces the research process from research design to creation of the model, which is implemented in chapters five. Chapter five also presents an example of applying the model to the results of existing logistics costs research. Conclusion are made in sixth chapter.

Due to the meta-analytical and descriptive approach of this study, no geographical limitations are placed. Theoretical part particularly explores different methods of measuring logistics costs, which are then used as a foundation for generic cost model designing. Few limitations still need to be made. Firstly, only studies and other previous research publications, which cope with logistics costs and otherwise should be considered as reliable, are exposed for scrutinizing. Also source material, that discusses logistics costs in national or global context are included into this study. This excludes for example those studies that cope with logistics cost measurement in companies.

1.4 Pivotal Concepts

1.4.1 Logistics and Supply Chain Management

The term logistics is pivotal for the study, but even though it is widely-used in both, spoken language and literature, the definition is everything but constant. This was proven in the article of Finnish business newspaper, which referred a definition given by the professor of industrial management, who defined logistics as *transportation and warehousing, which is arranged the way that the company will not lose all of its money* (Orrenmaa 2010, 17). Some more appropriate definitions are provided below.

One of the most commonly used definitions is provided by the Council of Supply Chain Management Professionals (CSCMP), which defines logistics management as a:

> *"that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements."* (CSCMP definitions)

In recent years, the term supply chain management has been increasingly used together with logistic. Even the border between these two terms is hard to draw, some terminological clarifications needs to be made for this study.

The concept of logistics has originally employed in military context. According some research, word logistics comes from French word "logis", which refers the facilities that are designated for organizing transportation, supplying and housing army troops of Napoleon. Blanchard (1992, XV) agreed the history of military context related to the term logistics, but according him it was usually conceived only as a downstream function (Blanchard 1992, XV). From the beginning of the 1960s the term has been used in business context to refer physical organization of company and the flow of materials in down- and upstream functions, as well as organizing production. (Farahani et al. 2009, 1; Blanchard 1992, XV)

Although the term logistics has been used widely for many decades, at least in the spoken language, the definition still remains rather blurred than well-established. Ballou (2004, 4) proposed following definition:

> *"Logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements."* (Ballou 2004, 4)

Waters (2003, 23) gives a practical example of the evolution of terminology by comparing the scope of logistics and supply chain management (SCM). He defines logistics management as an interactive process that optimizes material flow and the supply of production factors through the organization and its operations. When this optimization is applied to all of the processes and functions from upstream suppliers to downstream end-customers, it is relevant to use the term SCM. (Waters 2003, 23)

Also the definition of supply chain made after a comprehensive literature review by Mentzer, DeWitt, Keebler, Min, Nix, Smith and Zacharia (2001, 16-19) supports the conclusion, that the term supply chain is the next stage of terminological development in field of logistics research. The definition of supply chain was as followed:

> *"Supply chain management is defined as the systemic, strategic coordination of the traditional business functions and the tactics across these functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole."* (Mentzer, DeWitt, Keebler, Min, Nix, Smith & Zacharia. 2001, 18)

As it is possible to conclude based on these two definitions, the line between logistics and SCM is inconstant. In practice, they promote the same mission (Ballou 2004, 6). Some problems regarding conceptual definition may also occur during the translation of terms from the one language to another. For example Töyli, Häkkinen, Ojala and Naula (2008) pointed out that Finnish term "logistics" is widely used in Finland to cover both supply chain management and logistics (Töyli, Häkkinen, Ojala & Naula 2008, 60).

As it is grounded above, it is almost impossible and also unnecessary to draw the line between these two terms. It seems well justified to make a simplification that terms logistics and supply chain management are one and the same. For terminological simplicity the term logistics costs is used solely for now on, excluding the sub chapter 2.1.2.1, where company level supply chain costing tools are presented at a glance.

1.4.2 Cost Measurement Terminology

One terminological discussion that needs to be debated concerns the terms related to scale of observation. According Logistics Cost Survey 2006, conducted by weekly supply chain and logistics publication "Supply Chain Digest", 40% of respondents used percent of sales as their primary metric of logistics costs. 25% considered absolute costs their primary metric and other respondents based their measurement for percent of weight or activity-based costing methods (Figure 3). (SCD – Logistics Cost Survey 2006)

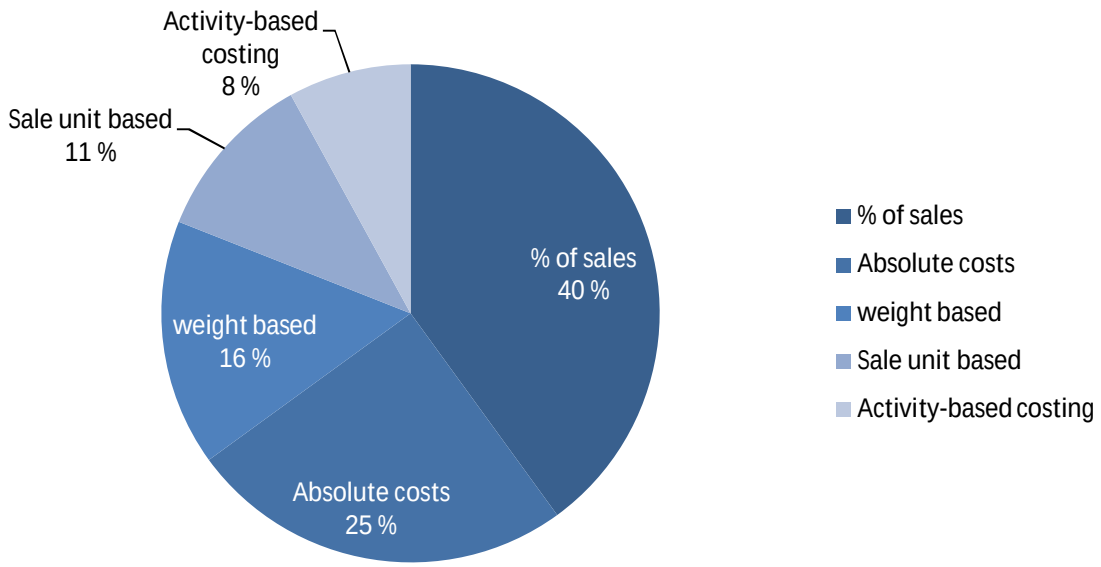


Figure 3 Primary Metric of Measuring Logistics Costs, n=247 (SCD – Logistics Cost Survey 2006)

However, the SCD's Logistics Costs Survey 2006 studied more the ways that companies are measuring their logistics costs in internal context. When assessing logistics costs in national level, there are basically three metrics available. These are:

- % of sales or turnover,
- Absolute costs (indicated as currency)
- % of GDP

Some studies tend to disclose results as a percentage of sales and others as a percentage of turnover. OECD's Statistics Portal defines the turnover as a total invoiced amount by the observation unit during the reference period (OECD Statistics 1). Sales, on the other hand, are defined as operating revenues less rebates, discount, returns and sales taxes on consumers (OECD Statistics 2). Closer look into these terms indicates, that actually those two means basically same thing, with some minor differences concerning the including or excluding the value added tax (VAT). This is highly dependable on the used statistical systems applied in the country in question, which makes it impossible to draw a concrete line between these two. Even though the terms sales and turnover are used as one and the same in this study, the fact that in some cases these may not be fully equivalent, needs to be realized by the reader.

Some studies also report logistics costs as a percent of gross domestic product (GDP). Without adopting a stand on GDP's explanatory competence, the definition of GDP should be provided. GDP measures the value of all final goods and services as

well as the value of export generated in certain area during observation period. GDP can be combined in three different ways, of which one is to sum the final uses of goods and services. (OECD Economics Department)

The decision to use GDP as a comparing factor in this study is justified by the fact that it is more commonly used than other macro economical indicators (like Gross National Product or Purchase Power Parity). In addition, governmental and national statistics institutions tend to estimate it more precisely. (Farahani et. al 2009, 71)

So is there a difference between the results, if study discloses the logistics costs as a % of turnover, % of sales or % of GDP? These terms seems to be meaning the same but there is one difference that may distort the results of questionnaire-based results. This difference is including the exportation. When GDP excludes the exportation, it should be assumed that companies, on the other hand, include it, when assessing their logistics costs as percentage of turnover. The situation is different in modeling and case-study based approaches, which are based on mathematical modeling and can bypass these problems by utilizing economical statistics. Given the magnitude and complexity of the problem of converting these two measurement methods into commensurable, in this study the both ways, % of turnover, % of sales and % of GDP are used to disclose the results. This is acceptable considering the facts that there are only very limited possibilities to convert these into same form and despite of minor differences in results it is still possible to compare these with each other.

Above said also affects the third possible way to disclose the results, which is in absolute costs. These costs can be easily calculated and disclosed as a percentage of GDP with only small variety in the results. Furthermore, presenting the results as a % of GDP is more descriptive than just presenting the absolute costs. To do the conversion, the model designed in this study uses the GDP of respective country from the year the study is conducted. The GDP figures are downloaded from the OECD's Statistical Portal, after which the national currencies are converted into euro. This process is comprehensive explained below. (International Monetary Fund, World Economic Outlook)

Since the study gathers information from many different sources and countries, some figures are declared in local currencies. To put these in common currency, local currencies are converted into euro (EUR), by using the currency rate of the first weekday in January of the year the study is published. Historical currency data is downloaded from the currency database of European Central Bank (European Central Bank, currency data).

Final issue that should be tried to solve, is how to make different respondent groups comparable with each other. Since different studies classify respondents with very irregular basis, only option is to collect the cost data of these sub groups under the main classification. Because of global aspect of study, it is well justified to use international ISIC (International Standard Industrial Classification of all Economic Activities) classi-

fication, developed by United Nations Statistic division. The aim is to gather different respondent groups under the ISIC top level classification (industrial classification A-U). (United Nations Statistics Division) After the re-classifying the sub groups under the top level hierarchy, it is possible to calculate weighted average values of logistics costs for each main industry group. However, sufficient information needs to available to complete the re-classification, which is further presented in Chapter 5.2.

2 THE NATURE OF LOGISTICS COSTS IN PUBLISHED RESEARCH

At the first sight, it seems that many authors have, more or less on purpose, tried not to engage themselves into the discussion of the concept of logistics costs. Considering the fact that the term itself is widely used, this is paradoxical. This supports the impression that the term is too often used without providing proper introduction to a concept itself. This issue has also been recognized by Farahani et al. (2009, 60), who stated that despite of high importance of national logistics costs, this issue has not been properly treated in the literature (Farahani et al. 2009, 60). The purpose of this chapter is to present the results of comprehensive review of previous logistics costs research in literature and scientific publications.

2.1 Complexity of Assessing Logistics Costs

2.1.1 Factors behind the Level of National Logistics Costs and Logistics Performance Index

The maternity of logistics systems differs significantly from country to country. One proper indicator for measuring logistics friendliness of specific country is Logistics Performance Index (LPI), developed by The World Bank Group and The Turku School of Economics. This index measures current logistics environment in six areas: customs, infrastructure, international shipments, logistics quality and competence, tracking & tracing and timeliness (Figure 4). (Arvis, Mustra, Ojala, Shepherd & Saslavsky 2010, 28)

Int. LPI Rank	Country	LPI	Customs	Infrastructure	International shipments	Logistics competence	Tracking & tracing	Timeliness
1	Germany	4.11	4.00	4.34	3.66	4.14	4.18	4.48
2	Singapore	4.09	4.02	4.22	3.86	4.12	4.15	4.23
3	Sweden	4.08	3.88	4.03	3.83	4.22	4.22	4.32
4	Netherlands	4.07	3.98	4.25	3.61	4.15	4.12	4.41
5	Luxembourg	3.98	4.04	4.06	3.67	3.67	3.92	4.58
6	Switzerland	3.97	3.73	4.17	3.32	4.32	4.27	4.20
7	Japan	3.97	3.79	4.19	3.55	4.00	4.13	4.26
8	United Kingdom	3.95	3.74	3.95	3.66	3.92	4.13	4.37
9	Belgium	3.94	3.83	4.01	3.31	4.13	4.22	4.29
10	Norway	3.93	3.86	4.22	3.35	3.85	4.10	4.35
11	Ireland	3.89	3.60	3.76	3.70	3.82	4.02	4.47
12	Finland	3.89	3.86	4.08	3.41	3.92	4.09	4.08
13	Hong Kong, China	3.88	3.83	4.00	3.67	3.83	3.94	4.04
14	Canada	3.87	3.71	4.03	3.24	3.99	4.01	4.41
15	United States	3.86	3.68	4.15	3.21	3.92	4.17	4.19
16	Denmark	3.85	3.58	3.99	3.46	3.83	3.94	4.38
17	France	3.84	3.63	4.00	3.30	3.87	4.01	4.37
18	Australia	3.84	3.68	3.78	3.78	3.77	3.87	4.16
19	Austria	3.76	3.49	3.68	3.78	3.70	3.83	4.08
20	Taiwan	3.71	3.35	3.62	3.64	3.65	4.04	3.95

Figure 4 Screenshot of Logistic Performance Index, Top 20 Performers in 2010 (The World Bank LPI ranking)

Factors determining logistics performance are on a large part same that affects on logistics costs. Quality of infrastructure (transport corridors, telecommunications, IT etc.) is important factor for smooth logistics processes. Other important factor is the quality and competence of logistics service providers, which together with smooth border crossing operations and international shipments ensure better performance and lower logistics costs. Logistics performance tends to be higher in countries, which enjoy low corruption and high transparency of political operations like legislation process. Reliability of logistics processed and timeliness are also factors that lower logistics costs. (Arvis et al. 2010, 14-22)

The relationship between LPI ranking and logistics cost level of is clear. Countries with low LPI score are also suffering high logistics costs. Especially the level of induced costs (cost of non-delivery or avoidance of non-delivery, storage, delivery) is significantly lower for those countries that have high LPI score. Also the level of direct costs (freight and other costs associated to shipment) gets lower, when LPI score improves at the lower scoring levels. (Figure 5).

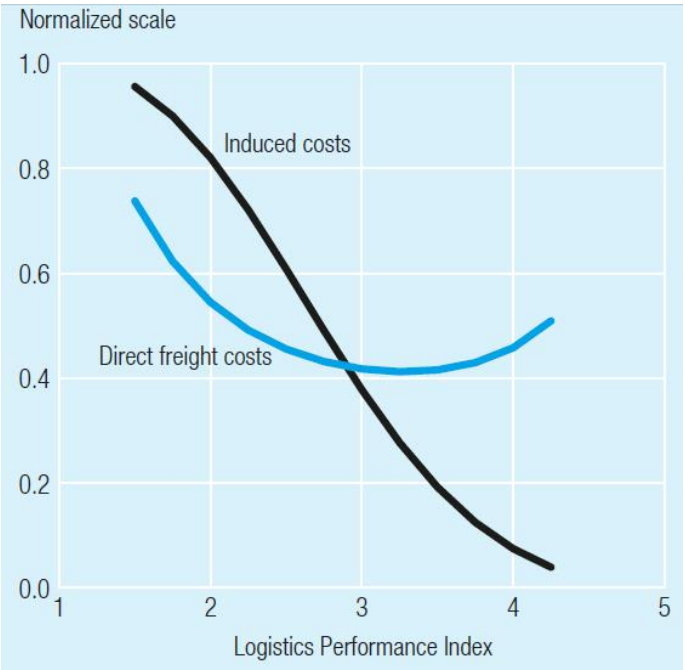


Figure 5 Relationship between LPI and the Level of Logistics Costs (Arvis et al. 2010, 26)

Some of the factors used to formulate LPI ranking are also identified by Farahani et al. (2009, 62-63). The additional factors, added by Farahani et al. are interest rate level and energy price, which are also significant factors that affect the level of logistics costs. One interesting note regarding the geographical situation (closeness of the ports, economic hubs etc.) was that land locked countries suffer up to 50% higher logistics costs than those that have direct access to ocean. Farahani et al. also proposes the term “business legal rules”, which covers custom operations, taxes and insurance costs that has a straight affect on logistics costs. (Farahani et al. 2009, 62-63)

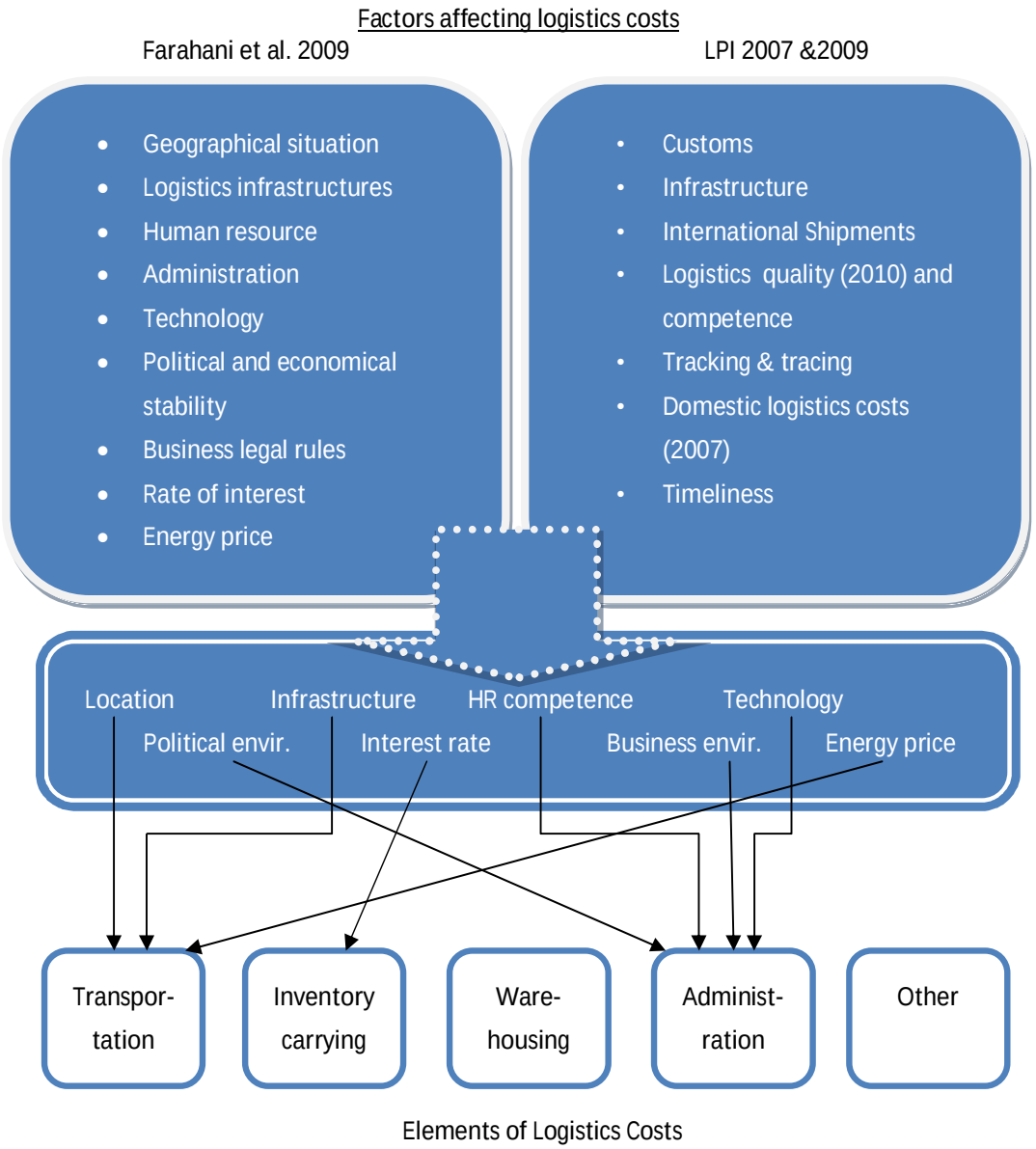


Figure 6 Relationship between the Cost Factors and Individual Costs Components

Figure 6 presents the factors identified by the Farahani et al. and the factors of LPI Index. The arrows in the figure illustrate the relationship between these factors and individual logistics costs components.

2.1.2 Complexity of Assessing

Calculating logistics costs requires complex processes and tools even in a company level and the task gets only harder, when assessing costs in industrial or national level.

This complexity is a consequence of many factors, of which Farahani et al. (2009, 60) have identified two. First of all, logistics processes are very complex and include many dimensions. Also gathering transparent information of all these processes may be challenging task. Secondly, calculating the depreciation of all property and equipments involved logistics activities cause complexity. (Farahani et al. 2009, 60)

Additional problems are caused because of the differences between different strategies and operational choices of companies. Strategic choices may create inhibitors to cost transparency, which may lead to weaknesses in cost information, too narrow view of cost management or differences in overhead cost allocation. Intra-firm costs are also largely driven by trading partners' business practices, which have huge impact to complexity of costing. (Pohlen, Klammer & Cokins 2009, 22-23; 30)

One strategic choice that affect significantly to the level of logistics costs is, whether the company has decided to outsource its logistics operations or to produce these functions internally. Outsourcing of logistics functions has increased its popularity steadily and today the outsourcing rate, for example in domestic transportation, is 85% in Europe. In international transportation and warehousing the same rate is 81% and 71% respectively. (Langley 2008, 13) Outsourcing has its impact on logistics cost and in some cases companies doesn't necessary even consider the cost of outsourcing logistics activities as a costs of logistics. Further more if outsourcing contract bundles several functions, the cost of individual function is hard to assess.

Outsourcing is only one strategic decision that may have major impact on how companies assess their logistics costs. Other factor is how a focal company arranges its inbound and outbound logistics. This defines the functions in the supply chain that company usually considers as its own contribution. One way to recognize company's own contribution is to scrutinize the INCOTERMS used in outbound and inbound logistics. For example a company that purchases its raw material by ex works (EXW) INCOTERMS and ships products on delivered duty paid (DDP) basis, may seem to have larger logistics costs than company that has arranged its logistics in opposite way. All of these factors related to transportation liabilities and might have distorting affect on assessing logistics costs are demonstrated in Figure 7.

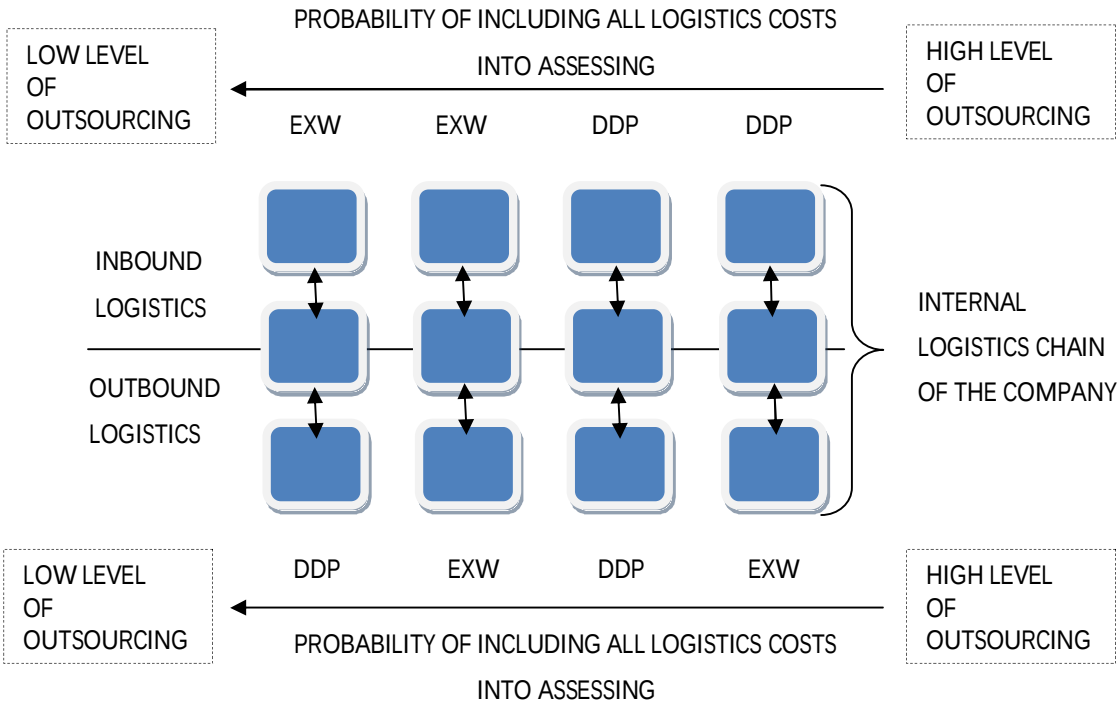


Figure 7 The Impact of Choosing the Incoterms on Logistics Costs (partly adapted from Pohlen et. al 2009, 14; 29)

Compared to national level logistics costs assessing, the possible distortion of certain factories is more significantly, when assessing costs in a focal company level. This is due to the fact that the common definition of supply chain management in companies is missing and used costing tools and methods vary significantly (Pohlen et al. 2009, 12; 18-20). When broaden the assessment into national level or above, the complexities are more often related to availability and reliability of statistical or questionnaire data.

There are some distinctive problems in all, modeling-, questionnaire- and case-based methods that are applied in national level assessments. Generally, it is possible to state that statistics plays vital role especially, when estimating logistics costs by using modeling or case-based method. On the other hand, if the assessing is based on questionnaire-based surveys, the reliability is amplified in sample size, sampling techniques and the clarity of questionnaire form. These methods are presented in more detail in chapter 2.1.2.2.

2.1.2.1 Measuring Logistics Costs in Companies

The focal point of interest in this study is the structure of logistics cost in national level and above. Despite this, it is justified to introduce some commonly used methods of

measuring logistics costs in a company level. These methods are closely related to cost accounting and can be applied different ways in different companies.

Harrison and van Hoek (2002, 56) identified some problems with traditional cost accounting methods to used to measure logistics costs. First of these is that the truly costs of different customer types, channels and markets are poorly understood. The second one is that traditional accounting tends to aggregate costs at too high level. Also the costing is functionally oriented at the expense of output. For last, the emphasis on full cost allocation to products ignores customer costs. (Harrison & van Hoek 2002, 56)

Zeng and Rossetti (Zeng & Rossetti 2003) have grouped costing methods into two streams according the literature review. First one of these groups deals with logistics cost optimization, when other one focuses on strategic aspect of the logistics costs. The latter one basically refers logistics cost analyzing techniques. Optimization-based method attempts to optimize the total logistics costs, including main cost elements, like transportation and inventory holding costs. Analyzing techniques can be summarized into three categories as demonstrated in Figure 8. The same figure also illustrates the line between assessing methods in company's internal level and single- or multi-country studies.

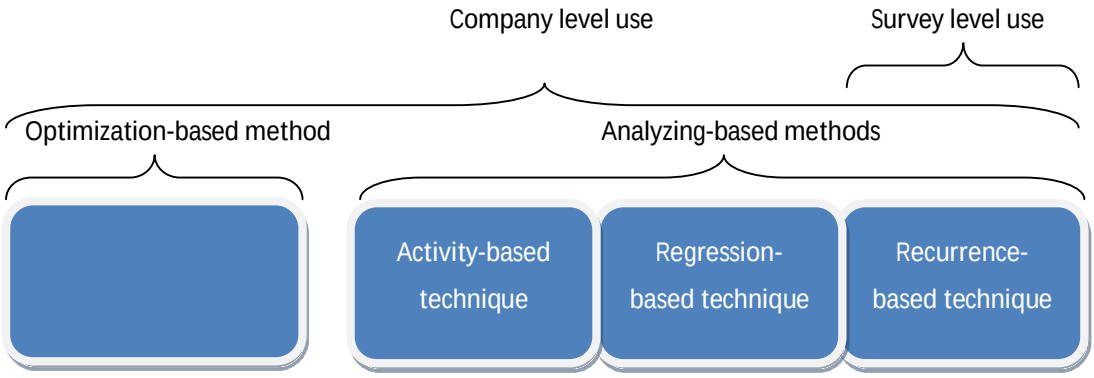


Figure 8 Grouping of Logistics Cost Analyzing Methods (Zeng & Rossetti 2003, 789-790)

Activity-based costing is a cost accounting approach, which gives important financial information, which can also be used when analyzing and making decision regarding the logistics costs and functions. Regression-based techniques are used to examine influences of certain variables and factors for measuring i.e. logistics cost drivers. The rightmost technique is called as recurrence-based technique, which aims to identify and classify the relevant cost factors. (Zeng & Rossetti 2003, 789-790)

In addition of introducing the grouping of cost analyzing methods, Figure 8 also illustrates the difference between assessing logistics costs for internal and study level usage. Techniques used for assessing costs in company level do not directly provide the

kind of information, which is needed to assess costs in broader level. Foregoing still doesn't mean that this kind of broader level evaluation wouldn't be useful for company's purposes. Most commonly used techniques and tools in company level costing will be introduced later on.

One possibility for grouping costing tools is to scrutinize their adaptability into different stages of supply chain. The possible grouping adapted in this study is followed: i) intra-firm, ii) upstream/inbound and iii) downstream/outbound. Applied grouping is illustrated in Figure 9.

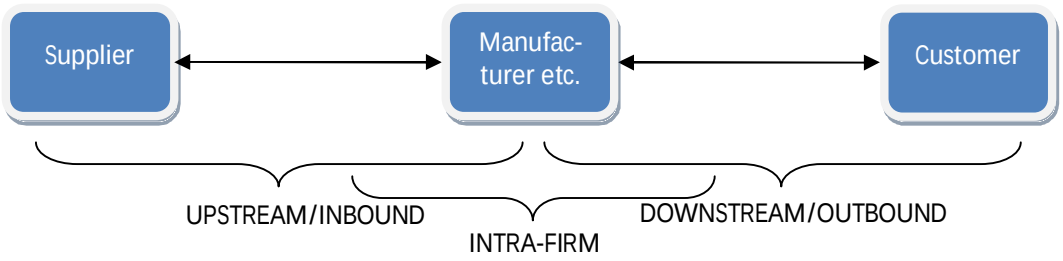


Figure 9 Grouping of Supply Chain Costing Tools

Grouping the tools makes it easier to understand the purposes and results provided by the tools. The grouping above is not exhaustive and it should be noticed that some of these tools might overlap each other.

Table 1 introduces the most commonly used costing tools, provides a brief description of each tool and indicates some central management applications of the tool in question. The classification used in the table follows the grouping provided in Figure 9.

Table 1 Intra-firm Logistics Costing Tools (Pohlen et al. 2009, 58-63)

Tool	Description	Management Applications
Activity-Based Costing (ABC)	Assigns direct and indirect costs to activities, which consume resources. Then combines the costs in respect with used resources.	• Decision making, outsourcing and profitability analysis • Information of cost elements
Activity-Based Management (ABM)	Continuously improving end-user delivered value and profitability by focusing management	• Performance measurement • Cost reduction • Process engineering
Balanced Scorecard	Performance measurement in four perspectives: financial, customer, internal business process and innovation/learning	• Performance measurement • Evaluating customer service, suppliers, 3PL and financial performance etc.
Economic Value Added (EVA)	Assesses the profit generated by firm by subtracting charge of capital from net operating profit	• Translate non-financial information into financial • Evaluates the created value
Kaizen Costing	Aims to reduce costs in production stage	• Cost reduction of product currently in production
Standard Costing	Develops standard costs for activities that are tried to meet.	• Budget planning • Cost control • Simplifying activities

As presented in Table 1, intra-firm costing tools are concentrating in measuring and improving the performance mainly in company's internal functions. Table 2 present the costing tools that are focused on measuring costs in supplier side upstream (inbound functions).

Table 2 Costing Tools for Upstream/Inbound Functions (Pohlen et al. 2009, 58-63)

Tool	Description	Management Applications
Cost Estimation	Focuses on determining expected costs of the product in respect with known factors	• Determining what products should be produced • Estimating costs of product
Cost –To-Serve (CTS)	Assigns non-production costs by customer- and cause-basis to determine total cost	• Customer profitability estimation • Network optimizing • Production scheduling • Inventory level decisions
Cost Transparency	Sharing in-house cost information with suppliers (extendible to downstream method by sharing information with customers as well)	• Reducing costs through joint development • Trading ideas
Open Books Costing	Supplier provides "open book" information regarding cost structure to customer and for return customer helps supplier to reduce costs. (Not extendible to downstream functions)	• Sourcing decisions, cost reduction • Evaluating performance of suppliers, 3PL, etc. downstream functions
Target Costing	Costing method for new products that determines customer requirements. It uses information from upstream to adjust downstream functions to meet upstream requirements. The method can be used in downstream as well.	• Cost reduction • Switching pressures to downstream functions
Value Chain Analysis	Analyzing activities from supplier in order to understand the activities and processes performed. Can	• Affecting activities and costs, outsourcing decisions • Identifying cost drivers • Reconfiguring supply chain and exploiting linkages and buyers.
Total Cost of Ownership (TCO)	Determines the total cost of some acquisition by associating all the costs from sourcing to returns. This means that tools examines costs in whole supply chain.	• Evaluating supply sources • Measuring total costs of some acquisition • Purchasing decisions

The opposite end of the supply chain is upstream functions, which could also be referred as outbound side of the supply chain. Tools related to assessing costs in downstream are introduced in Table 3.

Table 3 Costing Tools for Downstream/Outbound Functions (Pohlen et al. 2009, 58-63)

Tool	Description	Management Applications
Cost Transparency	Sharing in-house cost information with suppliers (extendible to downstream method by sharing information with customers as well)	• Reducing costs through joint development • Trading ideas
Customer Profitability Analysis (CPA)	Allocating revenues and costs to end side of supply chain to determining the profitability.	• Determining customer or segment profitability • Re-allocating resources • Reducing costs • Network optimizing • Production scheduling • Inventory level decisions
Interorganizational Costing	Structural approach that aims to move cost pressures from upstream to supplier side.	• Improve functionality and quality through improved design, value engineering and cost reduction
Life Cycle Costing	Involves all of the costs associated with a systems or product during its lifetime. The technique may be extended into supply side.	• Reducing costs of upstream functions • Provides information of all stages in supply chain for decision making
Landed Costing	Captures the costs of activities to move product to final destination. Includes freight, handling etc.	• Provides information for LSP selection • Network optimization and outsourcing decisions • Process re-engineering

The classification above is not absolute. Some of tools can be implemented, at least with small changes, in different parts of the supply chain. Some tools like TCO, Cost Transparency, Life-Cycle Costing or Interorganizational Costing can be applied in several parts of the supply chain. Figure 10 gathers all the tools and demonstrates the part of the supply chain, where they are usually applied. Also the classification developed by Zeng and Rossetti (see Figure 8) is included to Figure 10 to illustrate the relationship and differences between company's internal costing techniques and methods implemented, when assessing costs above the company level.

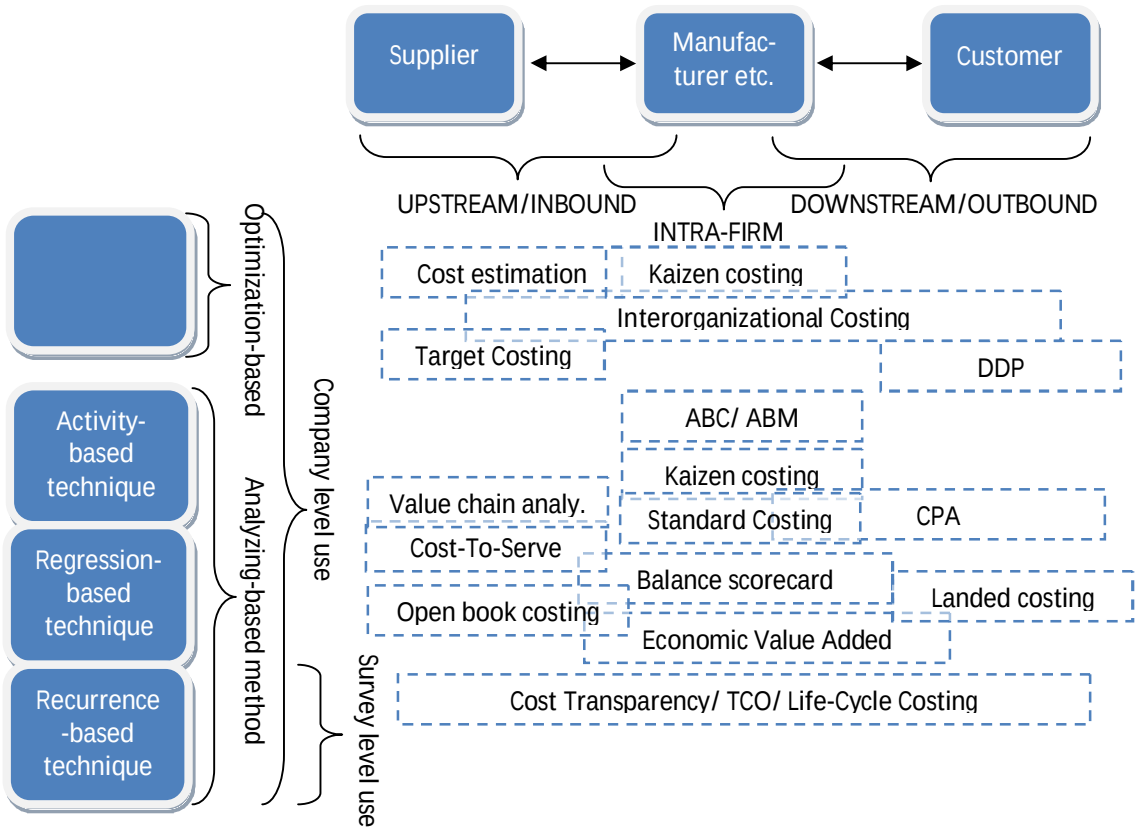


Figure 10 Positioning of Supply Chain Costing Tools

The suitability of tools is dependent from various factors. To be able to choose proper tool, company needs to know what kind of information is needed and which activities should be considered as cost drivers. To illustrate one cost possible breakdown used in company level, the Figure 11 presents the logistics costs of PSA Peugeot Citroën.

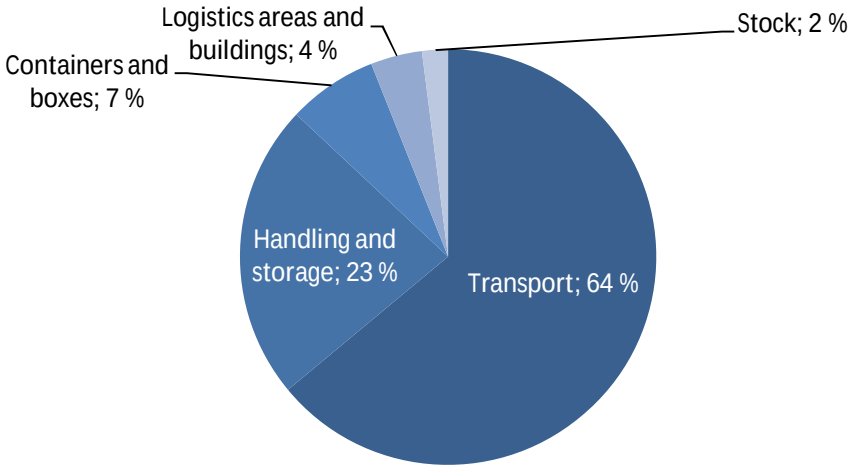


Figure 11 Logistics Cost Break Down of PSA Peugeot Citroën as a % of Total Costs 2008 (Wiklund 2008, 17)

As seen in Figure 11, transportation costs are the largest individual cost group for PSA Peugeot Citroen. Also handling and storage are generating a significant portion of logistics costs.

2.1.2.2 Methods of Assessing Logistics Costs in Studies

As it is stated above, there are many different ways to measure logistics costs in companies. Many of these methods are the kind that adapting these into, for example national level studies, is impossible. Studies, on the other hand, utilize different ways of assessment depending on various things, like availability of existing data and reliability of statistical sources. Since studies usually gather data from various companies, industries or even countries, the adequate data may not always be available.

This basically leaves three options to conduct a study. The first one is to gather data by using questionnaire, in which respondent answer to several questions. These studies are referred as surveys in this paper. The second group of studies is those, which are based on case-study method. The third way is to create a model by combining existing data from different statistical sources. Ojala (1992, 17) identifies three approaches applied in modeling based studies. These are: 1) econometric, 2) analytic and 3) simulation approach. Econometric models present phenomena as a causal relationships network between internal and external variables. Analytic models employ mathematical manipulation to achieve a solution for the problem in question. Analytic models require that variables are quantifiable and represented with mathematical symbols. Simulation models seek to describe the behavior of complex phenomena over extended periods of time based on real-world models. (Ojala 1992, 17-18)

There are also optional ways to classify the methods, for example Hansen & Hovi (2008, I) have named three different research methods. These are: 1) national accounting based studies, 2) opinion questions based surveys and 3) studies based on estimating costs. (Hansen & Hovi 2008, I) In this study, estimation- and national accounting based studies are considered as the same, which leaves two methodological approaches. These approaches are demonstrated in next sub-chapters. In structural level this study applies rough grouping of methods by dividing these into three categories; modeling based studies, questionnaire based surveys and case-studies. The same grouping is used in Chapter 3 Logistics Studies.

Calculation of logistics costs is a multidimensional and complex issue. The first methodology related to this issue was presented by Heskett, Glaskowsky and Nicholas in 1973. (Farahani et al. 2009, 67; Bowersox, Calantone and Rodrigues 2003, 21)

Heskett et al. projected the logistics costs as a sum of four types of activities (Figure 12). These activities were transportation, inventory, warehousing and order processing.

This classification has remained relatively unchanged, and for example the CSCMP's Annual State of Logistics Reports employs the grouping developed by Heskett et al. (Bowersox et al. 2003, 21-22)

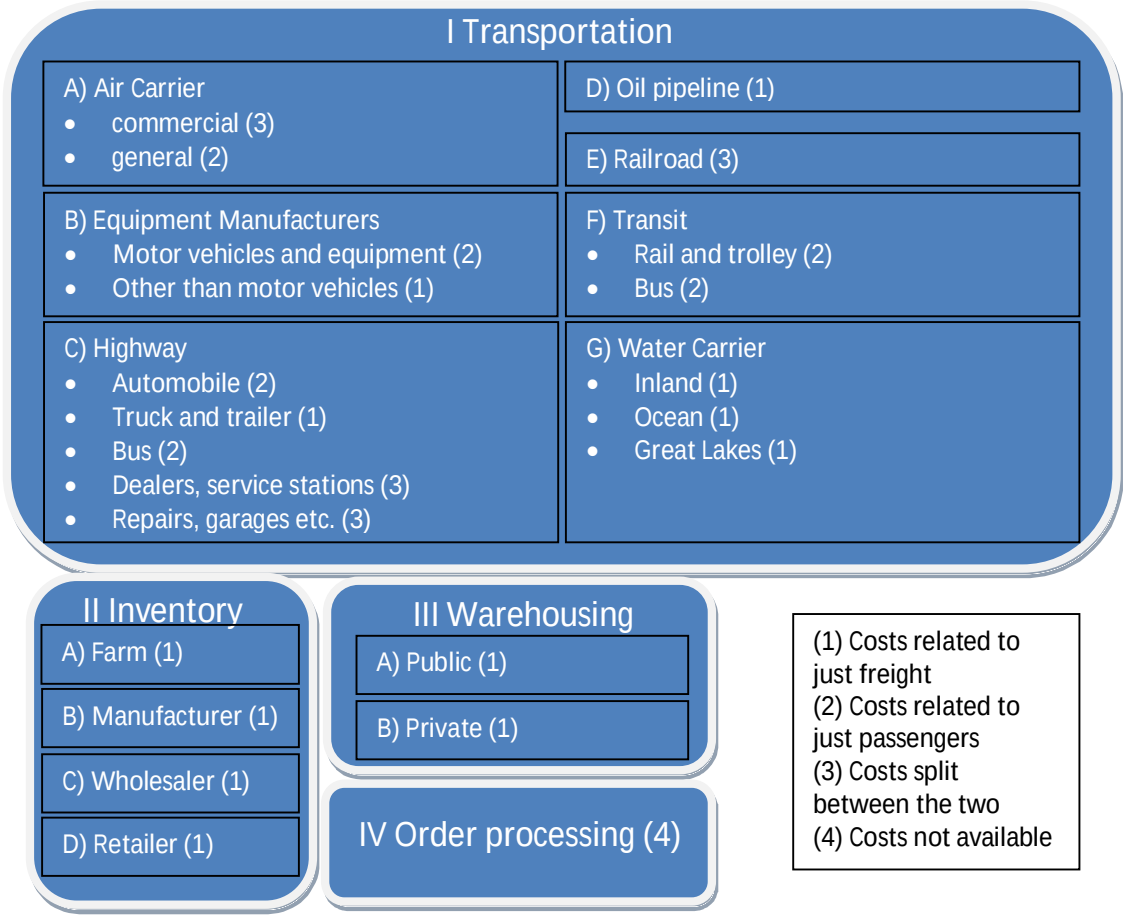


Figure 12 Logistics Costs Assessing Methodology Proposed by Heskett et al. 1973 (Bowersox, Calantone and Rodrigues 2003, 22)

The model developed by Heskett et al. has provided a background for evolution of the logistics cost assessment by modeling and case-study methods. The model has been further developed widely. The most significant methodologies based on Heskett et al. model are Delaney's model, employed in Annual State of Logistics Reports (see 3.2.2.1), as well as the estimation methodology developed by Bowersox et al. between 1992 and 2003. Even thought the model of Bowersox et al. does not directly respond our taxonomic related problems, the importance of understanding the methods that global logistics costs can be modeled, justifies a brief introduction of the methodology.

As mentioned above, Bowersox et al. have developed their model partly based on the methodology created by Heskett et al. in 1973. Bowersox published his study "*Framing Global Logistics Requirements*" in 1992 and presented an estimation of global logistics

costs based on four pillars (Figure 13). These pillars were Total GDP, Government Sector Product, Industrial Sector Product and Total Trade Ratio.

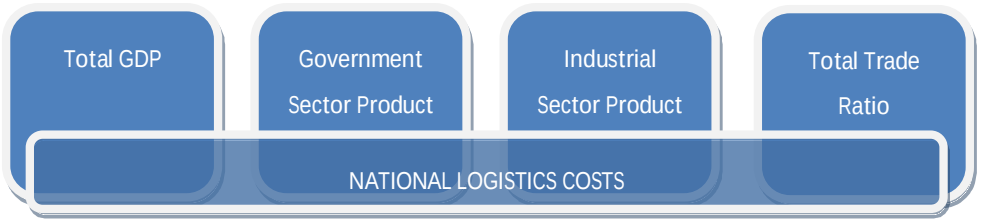


Figure 13 Logistics Costs Assessment Methodology Proposed by Bowersox et al. 1992 (Bowersox et al. 2003, 23-24; Farahani et al. 2009, 68-69)

Total GDP and Total Trade Ratio were included for assessing the size of individual economies. The Total Trade Ratio was calculated by summing the imports and exports and dividing the result by the GDP of respective country. The two other pillars were included to take expenditures of logistics activities of transportation, inventory and warehousing into account. (Bowersox et al. 2003.23-24; Farahani et al. 2009, 68-69)

Ojala proposed already in 1992 that newest approaches in port planning may be incorporated with techniques, which are based on advantages in artificial intelligence. (Ojala 1992, 17) In 1998 Bowersox and Calantone refined their methodology by introducing the Artificial Neural Network (ANN) model, which is based on collections of mathematical models that emulate biological nervous systems. The basic units of ANN are neurons, which basically has multiple inputs, which can be weighted differently and the output unit. Neurons are located in layers, of which this model includes six (input, four hidden layers and output layer). The model is illustrated in Figure 14.

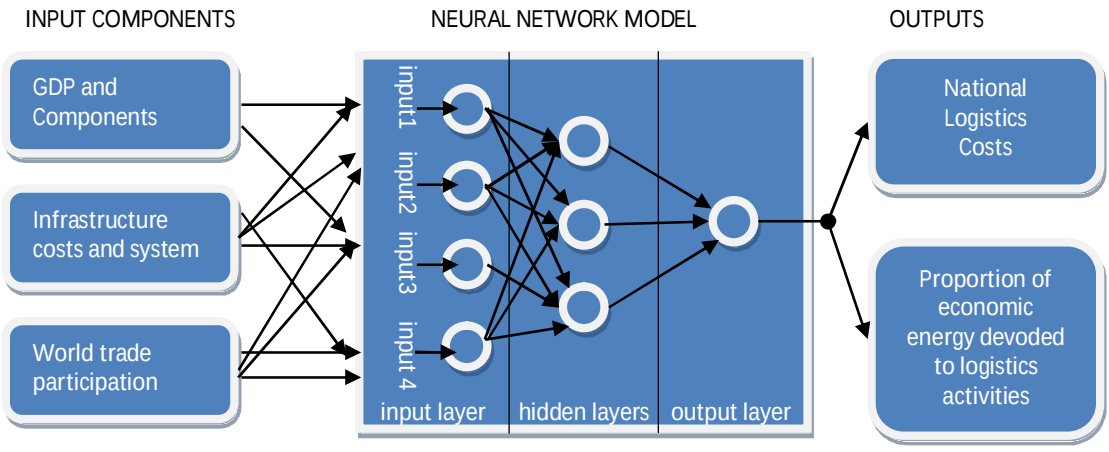


Figure 14 Logistics Costs Assessment by Using Artificial Neural Network Model (partly adapted from Bowersox et al. 2003, 25; 27)

One of the challenges of the model is to find available and reliable input data. The input variables used by Bowersox et al. can be divided into five main categories: Geographical Region Variables, Economy Variables, Income Level Variables, Transportation Variables and Country Size Variables. These variables are forced through the Neural Network Model, which is adjusted in respect of previous research results, like Annual State of Logistics Study. Authors entitle this adjustment procedure as a training of the ANN. (Bowersox et al. 2003, 24-28; Farahani et al. 69-70)

Since the studies made by using the ANN model do not categorize or classify costs or respondents into different segments, the results do not necessary provide information, which is in the center of interest in this study. Still the purpose of introducing the model is important in the way of understanding the methodology behind of conducting the logistics costs studies. The results generated by Bowersox et al. by using Neural Network model are presented in the Chapter 2.2.2.

2.2 The Structure of Logistics Costs

To be able to compare and illustrate logistics costs between entities, it is necessary to identify the main components of logistics activities. Unfortunately there is no exhaustive definition or standard for the components of logistics costs (Farahani et al. 2009, 60; Hansen & Hovi 2008, I). Hansen & Hovi have made a serious effort to identify logistics cost component of different studies in 2008. The problem of this review is narrow background material, which has mainly been gathered from Scandinavia. (Hansen & Hovi 2008, 25)

In Chapters 2.2.1 and 2.2.2, outlook over the literature and journal articles regarding logistics cost research, is provided. The results of this extensive literature and other research review are illustrated in tables at the end of each sub paragraph.

2.2.1 Literature review

Many of the textbooks seemed to adapt the approach, that they simply quote previous research, when it comes to breaking down the logistics costs. However, the referred study varies depending on publishing year and author. It still would be important that logistics management could utilize the cost analysis to understand the level of resources that logistics systems require. (Abdallah 2004, 9)

2.2.1.1 The Total Cost Concept

The goal of logistics management should be to reduce the total costs of logistics activities as a whole. When management is focused on one cost group, the other costs may rise, which has negative effect on the total costs. Lambert, Grant, Stock & Ellram (2006) indentifies six main cost categories, which are closely examined below. (Lambert, Grant, Stock & Ellram 2006, 11; Fröderberg 2006, 12)

The first activity and cost group is place / customer service level. The cost trade-off of customer service level is the cost of lost sales, which is one of the major costs in this group. Also the cost of retuned goods is considered to belong in this cost group. (Lambert et al. 2006, 17) Even though the costs related to customer service may cause a relatively large share of total logistics costs, these costs are not necessarily perceived as logistics costs.

Transportation costs, on the other hand, are usually easily perceived as a portion of logistics costs. Since the moving of materials and products is most visible logistics activity, transportation costs usually cover large part of total logistics costs. Transportation costs are usually influenced by several factors. The main factors, influencing transportation costs are product-related (e.g. density, stowability and easiness of handling) or market-related (e.g. location of markets, available transport modes and seasonality). (Lambert et al. 2006, 18-20; 200-201)

Warehousing- and inventory carrying costs are closely related to each other. Warehousing costs are created by warehousing and storage activities, as well as costs of locating warehouse. Inventory carrying costs can be originated in four activities; capital or opportunity costs, inventory service costs, storage space costs and inventory risk costs. (Lambert et al. 2006, 21; Fröderberg 2006, 14-15)

Lot quantity costs are due the procurement and production quantities that vary in respect of changes in order- or production size or frequency. These costs consist on setup costs (for example configuration time), capacity lost (for example during the changeover), material handling, price differences in different quantities and order costs (order placement and handling). (Lambert et al. 2006, 20)

The last cost group is order processing and information systems costs, which are related to such activities as order processing, communications and forecasting. These functions are extremely important and impose a major impact to other cost groups. (Lambert et al. 2006, 21) The cost groups are presented in Figure 15, which also illustrates the relationships between groups.

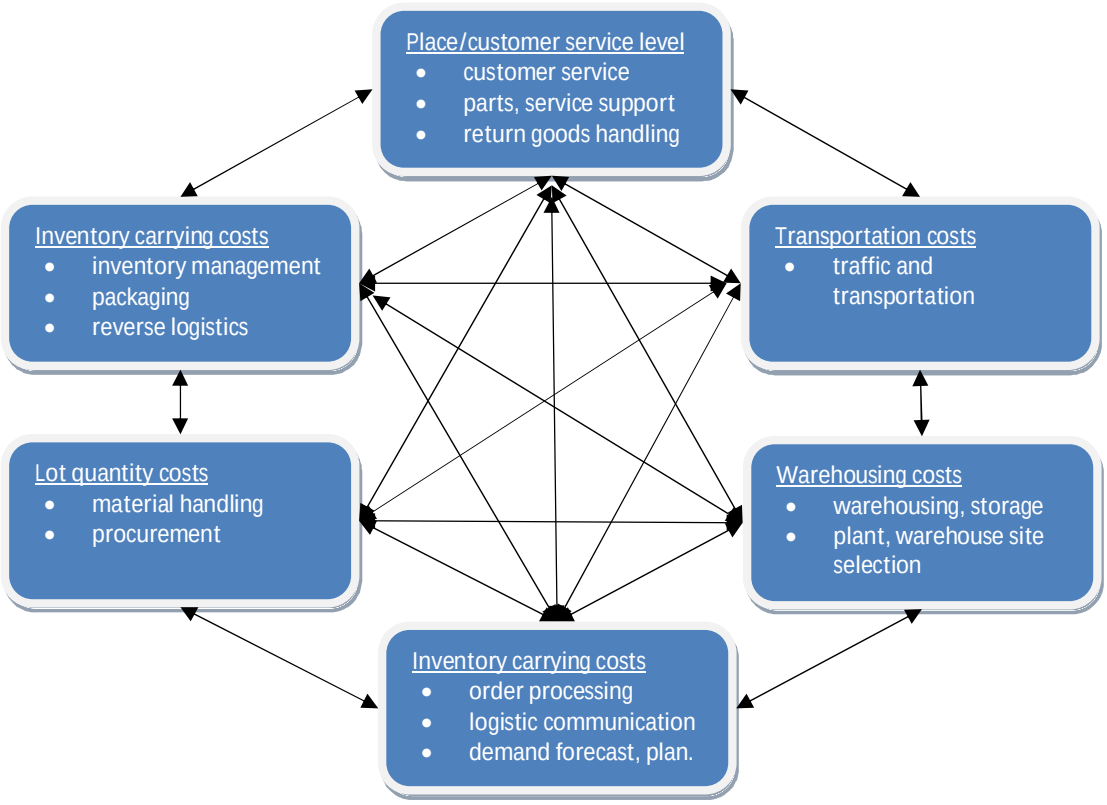


Figure 15 Logistics Costs and Relationship between Individual Cost Groups (Lambert et al. 2006, 11)

As Figure 15 illustrates, there are visible relationship between every cost groups. This explains why the concept of total logistics costs should be applied in decision making operations in management level. Identifying sub costs helps managers to measure the performance of different functions and activities inside the company.

2.2.1.2 Other Motions for Cost Structuring

In Handbook of Logistics and Distribution Management, authors Rushton, Croucher and Baker introduced two different classifications. The first one is based on categorization, in which the cost groups are allocated into four subgroups. These are transportation, inventory carrying, storage /warehousing and administration costs. This classification was used, for example by Herbert W Davis & Company in 2005 and ELA in 2004.

Authors also proposed five level cost breakdown, which was used in industry cost audit, carried out in the United Kingdom by Dialog Consultants Ltd. The fifth level of costs added to classification of Davis & Company was overall logistics costs. (Rushton, Croucher & Baker 2006, 10-13) Christopher has also found some similar cost elements, while studying the principles of logistics costing. He has also paid a lot of attention into the true costs of inventory and identified among other the pilferage costs. (Christopher

2005, 101-102) Depending on the industry and some other variables, the pilferage may count a rather large share of logistics costs. The cost of pilferage is also identified by Rushton et al. as a part of inventory holding costs (Rushton et al. 2006, 204).

Straube and Pfohl (2008, 46) have gathered some of the key logistics indicators in their work called Trends and Strategies in Logistics. The responses for the study were gathered from 897 Germany based and 155 EU-based respondents. Authors identified the research problem of this study by claiming that cost components are not sufficiently standardized, either in the real world or on the scientific front. They also stated that it is conspicuous that some logistics professionals cannot name all the relevant cost components at all. Authors identified six different cost components, which were as follows (Straube & Pfohl 2008, 46-49):

- Administration costs
- Value-added services costs
- Packaging costs
- Transport costs
- Inventory costs
- Warehouse costs

According the authors, the logistics costs rose by 0.5% (from 6.5% to 7.0%) between 2005 and 2008 in industrial sector. The situation in trading sector was opposite; logistics costs fell from 17% to 15.9% between 2005 and 2008. This trend might still be changing in future, since savings generated by technological solutions and advantage gained by outsourcing activities diminishes. Logistics costs are primary driven by rising energy expenditures, transportation costs and growing personnel costs. The development of logistics costs in industry and trading sectors is illustrated Figure 16. (Straube & Pfohl 2008, 46-49)

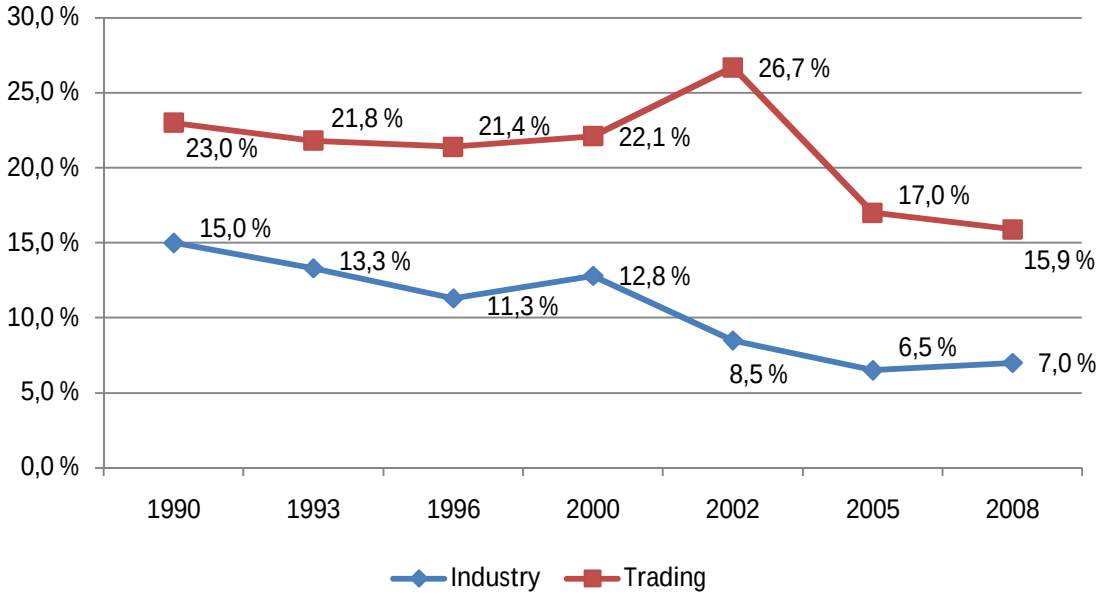


Figure 16 Development of Logistics Costs in Industry and Trading as a % of Total Costs 1990-2008 (Straube & Pfohl 2008, 47)

It is possible to see from Figure 16 that even the costs are in different levels, the decreasing trend in recent years is identifiable. According the study, the costs have fallen by almost 50% from 1990 to 2008.

Kivinen and Lukka have conducted a study regarding the services required in logistics management system. In this study authors have created a cost structure of services, which includes totally 12 processes. These processes causing the costs were identified as followed (Kivinen & Lukka 2004, 25; Kivinen & Lukka 2002, 55-56):

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

Some of these cost concepts are in line with other studies, but few groups, like manufacturing and quality control are processes, which are used also by other than logistics

functions. Certainly all of these groups include logistics costs, but the contribution of logistics activities to total costs is probably relatively small in certain groups.

Ayers (2006, 63) considers associated labor as an own cost group, when other authors sees labor costs as included in some other cost group. Another interesting difference between cost grouping of Ayers and other authors is, that also purchased materials are considered as individual cost group. Four other groups identified by Ayers are transportation, warehousing, inventory, and packaging. (Ayers 2006, 63) While Ayers is using the more traditional way to classify the logistics costs, Coyle, Bardi and Langley (1988, 29) classified the logistics costs by the origin of cost in their analysis. Classification was based on three main groups (plant logistics costs, transportation costs and warehouse costs), which was further divided into subgroups (Figure 17). (Coyle, Bardi & Langley 1988, 29)

Figure 17 Costs in Logistics System by Coyle et al. (Coyle et al. 1988, 29)

There are certainly some advantages in precise classification, but what makes the model in Figure 17 interesting is the usage of fixed costs subgroup, which departs from otherwise strict grouping.

2.2.1.3 The Summary of Logistics Costs in Literature

Table 4 summarizes the findings of literature review by presenting the used grouping of cost components in each source, the amount of logistics if indicated, years of conduction, method of measurement, covered area and some other information appeared.

Table 4 Summary of Logistics Costs Components Based on Literature Review

Publication	Rushton 2006	Straube 2008	Kivinen 2004	Lambert 2006	Ayers 2006	Coyle 1998	SUM
Cost components							
Transportation costs	✓	✓	✓	✓	✓	✓	6
Inventory carrying costs	✓	✓		✓	✓	✓	5
Warehousing costs	✓	✓	✓	✓	✓	✓	6
Administration costs	✓	✓				✓	3
Packaging costs	✓	✓	✓		✓	✓	5
Fixed costs						✓	1
Value-added services		✓	✓				2
Manufacturing			✓				1
Customer service			✓	✓			2
Procurement			✓				1
Quality control			✓				1
Reverse logistics			✓				1
Recycling logistics			✓				1
Logistics technology			✓				1
Consultancy			✓				1
Lot quantity				✓			1
Order processing/information				✓			1
Associated labor					✓		1
Purchased materials					✓		1
Logistics costs							
Manufacturing		7					
Wholesale & retail trade		15.9					
Method of Measurement							
% of sales / turnover	✓						
Other (of total costs)		✓					
Time series							
-1990		✓					
1991-1995		✓					
1996-2000		✓					
2001-2005		✓					
2008		✓					
Recent trend							
Expectations in future regarding cost develop.							
Area covered		EU, USA, CHI					

As seen in the table above, only few literature sources indicate the level of logistics costs. Still some valuable information concerning the grouping of logistics costs was gathered. In following chapters, where other studies are discussed, the more information of level of costs should be gathered. Paragraph 2.2.2 discusses the concept of logistics costs in scientific articles.

2.2.2 Cost Assessing in the Scientific Articles

2.2.2.1 Zeng and Rossetti 2003

Comparing the text books, scientific publications offer more information regarding the level of logistics costs. Thought many articles concentrate more on specific issues, like measuring costs in certain industry, cost dimension is discussed in many cases. The review of academic publications offers a broad outlook of cost components commonly used in research papers.

Zeng and Rossetti (2003, 785) has studied potential framework for evaluating logistics costs in global outsourcing processes. Building the model begins by identifying the elements of logistics costs that are significant to process in question. To be able to do this, authors have defined six cost categories and described individual costs included these categories (Table 5). (Zeng & Rossetti 2003, 785-793)

Table 5 Components of Logistics Costs by Zeng and Rossetti (Zeng & Rossetti 2003, 793)

Logistics cost category	Sub components
Transportation	• Freight charge • Consolidation (cost of small shipments) • Transfer fee (changing transport mode) • Pickup and delivery
Inventory holding	• Holding during transfer • Safety stock
Administration	• Order processing • Communication • Other overhead costs
Customs	• Custom clearance • Brokerage fee • Allocation fee (custom's bill)
Risk and damage	• Damage, loss, delay • Insurance
Handling and packaging	• Terminal handling (fee charged by transportation company) • Material handling (salaries and facility cost) • In/out handling • Disposal charge • Packaging materials • Storage (warehouse rent)

The classification of logistics costs created by Zeng and Rossetti is rather specific, which in most cases, is useful, when creating comparable data. It must still be notified

that the more specific the model is, the more likely is situation, where all necessary information is not available. There is also a danger that some costs are calculated twice, when the line between sub groups begins to blur. The balance between strict and loose classification has to be found in respect of available data, research structure (model v. questionnaire) and the purpose of the research. It should also be noticed that the very same cost components are usually included to other components in harsher classifications.

2.2.2.2 ANN Model by Bowersox et al. 2005

In Chapter 2.1.2.2, the methodology of the ANN model, employed by Bowersox et al., was briefly explained. This study is currently the only available source of global logistics costs. The results are presented in actual costs and as a part of GDP in 24 chosen countries in all five continents. According the study, the world's logistics expenditures in 2002 were approximately 6 387 billion USD (2000 6 732 bn. USD) or 13.7% (2000 13.4%) of world's accumulated GDP. This means that logistics costs has increased faster than economy has growth. Study also divides results in respect with geographical regions. Results per area can be seen in Figure 18. (Bowersox et al. 2005, 9)

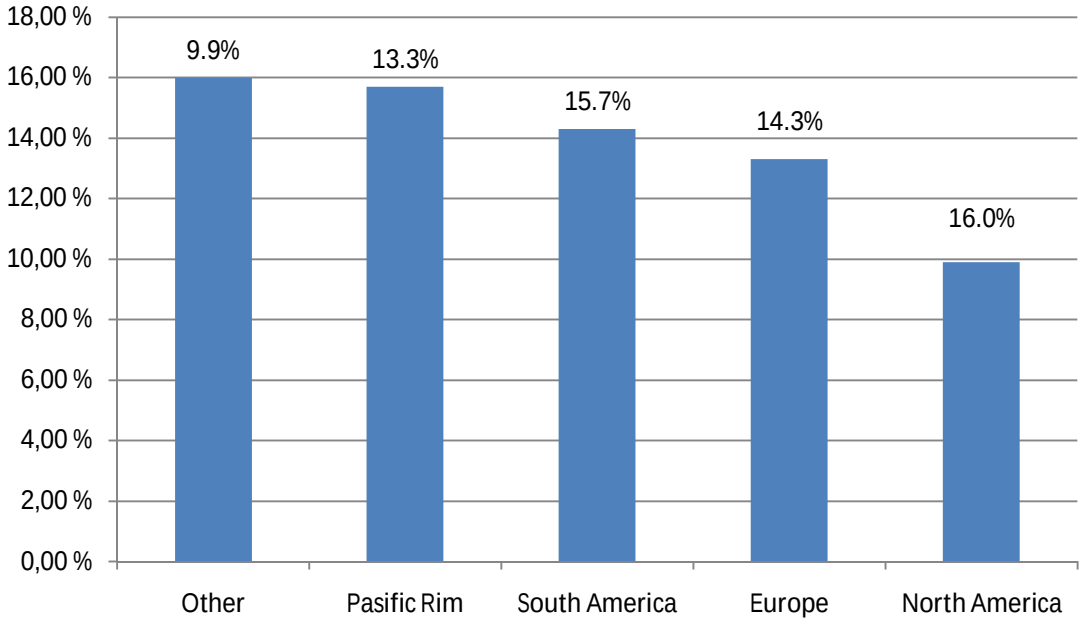


Figure 18 Logistics Costs Comparison between Geographical Regions as a % of GDP (data source: Bowersox et al. 2005, 9)

Even the study conducted by Bowersox et al. is unique, it doesn't group costs elements but bundles all the costs together, despite of different characteristics of different

regions. This fact diminishes the informational value of the study. On the other hand, this is the only real attempt to assess global logistics costs and serves the needs of certain interest groups relatively well.

2.2.2.3 Jensen 2007

Jensen (2007, 2-3) defines the logistics cost as a group of costs, which have occurred in the whole supply chain from raw material suppliers to end customers. Also the recycling and return logistics are included to total logistics costs. According Jensen, the actions that cause logistics costs are related transportation, warehousing, administration, order processing, IT management, documentation and planning. The costs originated to these actions can be classified in six main costs categories, which are followings (Jensen 2007, 2-3):

- Transportation costs (incl. material handling)
- Warehousing costs (the cost for premises and material handling in warehouse)
- Cost of capital tied in inventory
- Administration costs
- Transport packaging costs
- Indirect logistics costs (e.g. obsolescence, damages etc.)

Jensen states that there were no relevant studies regarding logistics costs in Sweden (in 2007). The nearest similar study is Finland State of Logistics 2006, and according the author, the results of this study can be used to describe the logistics environment in Sweden as well. (Jensen 2007, 4)

2.2.2.4 Choi & Lee 2009

Since the liberation of markets in 1990, China has become more and more significant powerhouse of the world economy. According to China Federation of Logistics and Purchasing, the national logistics costs of China were 4 500 billion Yuan in 2007. The growth compared to 2006 was 18.2%. (Choi & Lee 2009, 83-87). Figure 19 shows the amount of logistics in the beginning of the 21st century.

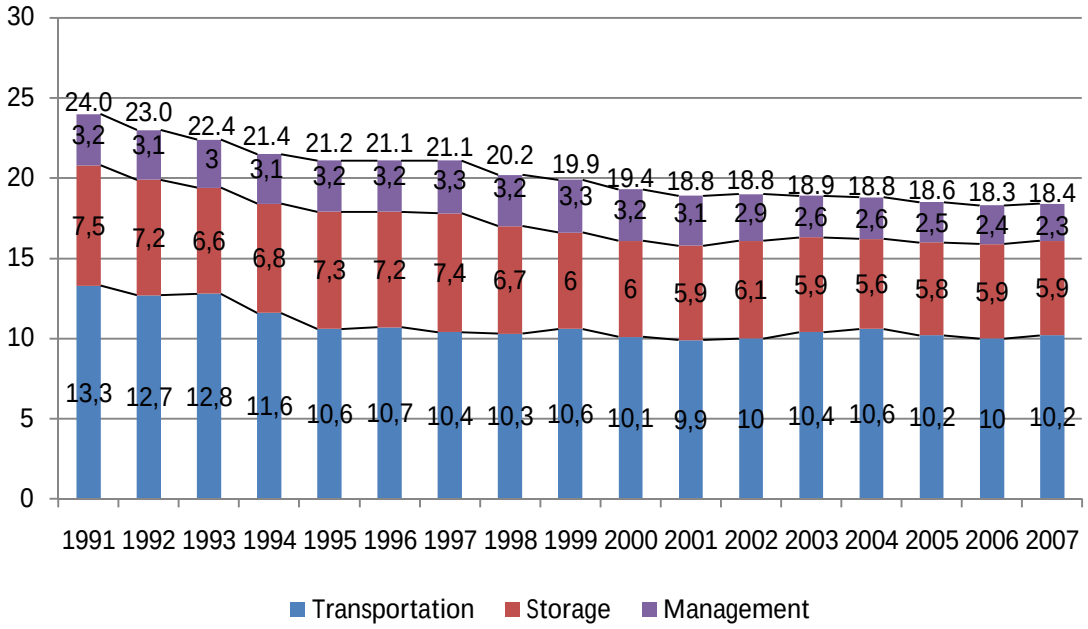


Figure 19 Logistics Costs in China 1991-2007 as % of GDP (Choi & Lee 2009, 87)

As seen above, the transportation contributes the largest share of total logistics costs. Domestic transportation is dominated by the road transport, which represents 63.2% of total transportation costs. Second biggest cost component is storage costs, which totals 32.9% of total logistics costs. This also indicates the significance of storage sector in China. Even though China has succeeded to reduce the amount of logistics costs, it still has relatively high total logistics costs, at least when compared to developed economies.

2.2.2.5 Hansen & Hovi

As mentioned above, Hansen & Hovi have reviewed several logistics cost studies mainly in Scandinavia. Most of the reviewed studies are introduced in this study in their own subchapters with the very latest versions. Authors have also introduced some of the earlier studies, of which results are briefly presented below.

Kalstad (1984) has studied the costs of transportation and communications in different industries. The goal was to examine the effects of these cost groups to Norwegian industry and individual companies. The total costs of transportation and communications are calculated by summing the cost of outsourced transportation, internal transportation costs and communication costs. The data is gathered from the national accounting system and results are presented as a percentage of GDP. In 1981 this figure was 13.7-15%. (Hansen & Hovi 2008, 2)

The more interesting study, reviewed by Hansen & Hovi is *Transport og konkurranseevne, Effektivisering av Norges internasjonale godstransporter* (author translation:

Transport and competitiveness, the efficiency of Norway's international freight transport), which was initiated by the Norwegian Government in 1988. This initiative aimed to examine the costs related to foreign trade, and to propose actions to reduce these costs. For this purpose, the study derives the export related logistics costs into different groups, which are illustrated in Table 6. (Hansen & Hovi 2008, 2-3)

Table 6 Logistics Costs per Cost Component as an Absolute Costs in Norway 1988 (Hansen & Hovi 2008, 3)

Cost component	Millions Norwegian krones (NOK)	Percent of total export value
Transportation costs	6 200	9.2%
Warehousing costs	3 660	5.4%
Cost of capital tied (trans.)	330	0.5%
Insurance	250	0.4%
Packaging (only sea cont. freight)	520	0.9%

The first cost group is transportation and forwarding costs, which are based on 1986 data. Warehousing costs consists on capital tied in inventory and stock keeping costs (handling, salaries etc.). Third cost group is more or less related to second group and it is referred as cost of capital tied in inventory during the transportation. The fourth and fifth cost groups are insurance and sea container packaging costs. (Hansen & Hovi 2008, 2-3)

Bjørnland and Lægreid (2001) have studied logistics costs in long-term phases, based on previous research and statistics. They presented results as a percentage of all logistics costs in 1997. The results were following; warehousing (17.6%), packaging (14.5%), insurance during the transport (3.8%), the cost of capital tied in inventory during the transportation (6.2%) and transportation costs excluding internal transport (57.9%). (Hansen & Hovi 2008, 4)

Same authors also published the very latest figures of Norwegian logistics costs in 2010. According this study, logistics costs constituted on average 14.2% of turnover in 2007. Industry weighted figures are presented in Table 7. (Hovi &Hansen 2010, i)

Table 7 Industry Weighted Total Costs of Logistics in % of Turnover for Norway 2007 (Hovi & Hansen 2010, i)

Industry	Cost of Logistics
Manufacturing	13.7%
Wholesale	16.7%
Building and construction	13.0%
Others (not weighted by industry)	13.2%
Average	14.2%

In their definition, the authors defined the cost of logistics to be combined on following cost elements (Hovi & Hansen 2010, ii):

- Transportation (incl. inbound, outbound and internal transport)
- Warehousing
- Capital tied in transportation and warehousing
- Packaging
- Insurance
- Obsoleteness and wastage
- Logistics administration

The definition follows the same principles than several other studies. However, due to the date of promulgation, the findings of this study couldn't be included to aggregated tables or models designed in this study.

2.2.2.6 The Summary of Logistics Costs in Scientific Articles

Table 8 summarizes the pivotal information regarding logistics costs in scientific articles. Again the breakdown of logistics costs in each study is provided with method of measurement and the level of costs.

Table 8 Summary of Logistics Cost Components in Scientific Articles

Publication	Zeng 2003	Bowersox 2005	NOU 1988	Bjørnland 2001	Jensen 2007	Choi 2009	SUM
Cost components							
Transportation costs	✔		✔	✔	✔	✔	5
Inventory carrying costs	✔						1
Warehousing costs	✔		✔		✔	✔	4
Administration costs	✔				✔	✔	3
Customs	✔						1
Risk and Damage	✔						1
Packaging costs			✔	✔	✔		3
Insurance			✔	✔			2
Tied capital costs (transportation)			✔	✔			2
Cost of capital tied (inventory)					✔		1
Indirect logistics costs					✔		1
Logistics costs and the scale of measurement							
% of sales / turnover					✔		
% of GDP		13.8					
Actual costs	✔	7449					
Other			✔	✔			

As seen in table above, the breakdown of logistics costs varies also in scientific articles. Only one article (Bowersox et al.) declared any figures concerning the level of logistics costs. In next chapter, one possible approach of identifying logistics costs is proposed based on review of previous researches in Chapter 2.

2.3 Proposed Approach for Logistics Costs Taxonomy

Cost components, which are directly related to physical flow of goods, are usually well-perceived as a part of logistics costs. In this study these are referred as direct costs of logistics. On the other hand, logistics processes cause costs, which are generated by the general functions (for example administrations) that are not used only by the logistics activities. The identification of these, indirect costs, is considerably more difficult. One possible approach for identifying and categorizing logistics costs is now proposed.

2.3.1 Fourfold Table of Logistics Costs

The fourfold table is commonly used way to categorize different units, which in this context helps to divide logistics costs into smaller subsets. This is useful especially when identifying those costs that are not related to physical material flow. There are two central classifications in model, first is the classification between direct and indirect logistics costs (see also 3.1.1.3). Another one is the classification between alternative or overhead costs and activity related costs (Figure 20). This grouping has adapted for example in Finland State of Logistics 2009 and State of Logistics in the Baltic Sea Region 2007 surveys. (Naula, Ojala, Solakivi, Takalokastari, Rantanen, Kalske, Engblom, Häkkinen, Essén, Töyli and Stenholm 2006, 17; Solakivi, Ojala, Töyli, Lorentz, Hälinen, Rantasila and Naula 2009, 20-21; Ojala, Solakivi, Hälinen, Lorentz & Hoffmann 2007, 36; Harrison & van Hoek 2002, 56)

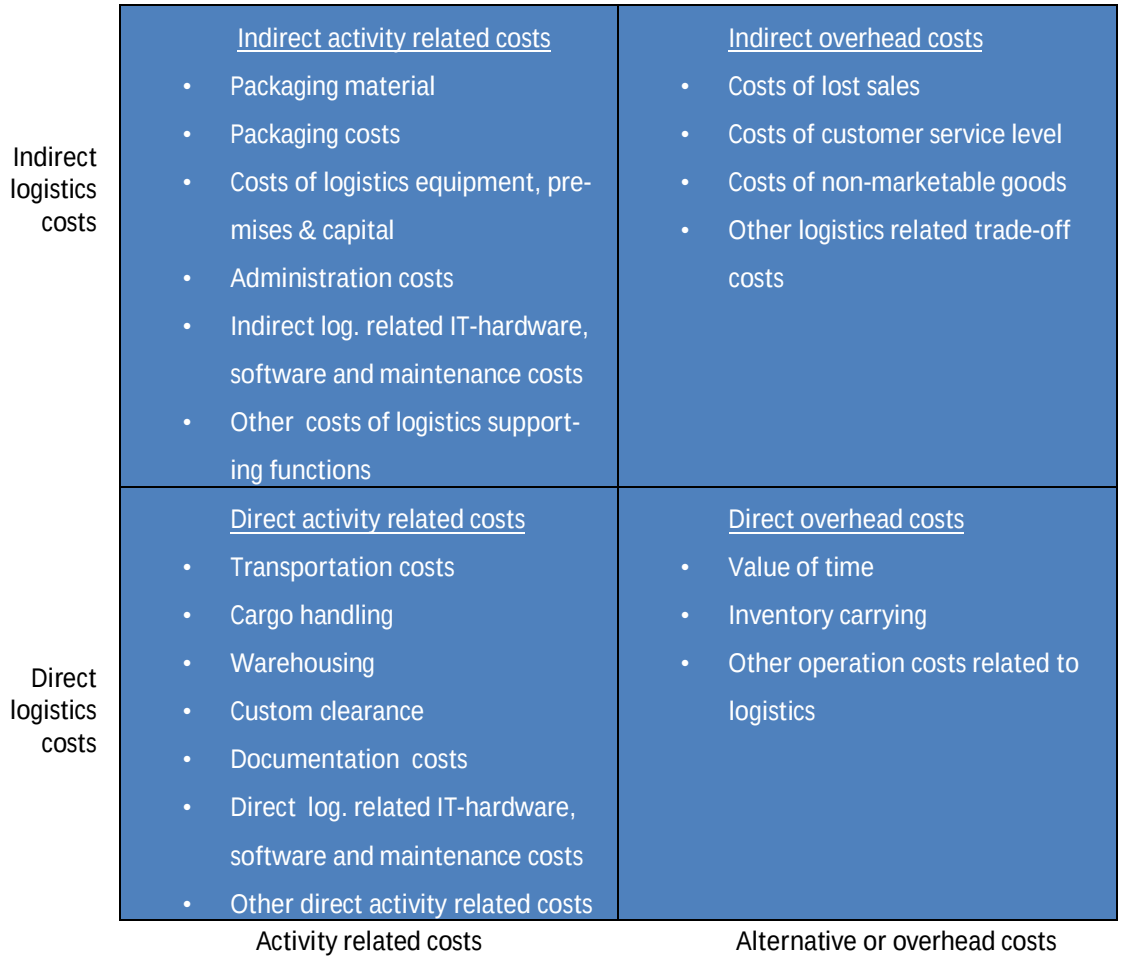


Figure 20 Logistics Costs Positioning on the Fourfold table (deducted from the State of Logistics in the Baltic Sea Region, Ojala et al. 2007, 35-36)

Figure 20 divides costs into subset to ease the grouping of costs caused by the logistics activities. Direct logistics costs are a group of costs that occurs in association with specific logistic activity or can be tied to one. These costs are usually related to the most tangible functions of performing logistic activity, like transportation and warehousing, of which costs can be easily traced back to the cost object. (Pohlen et al. 2009, 64-65; Harrison & van Hoek 2002, 60)

The opposite of direct logistics costs are indirect logistics costs, which are expenditures that cannot be related to particular logistic activity, but are necessary for supporting functions of executing logistics activities. Indirect costs are common to more than just one cost object, which also makes them uneasily traceable back to individual cost object. Indirect costs cover all costs that cannot be tied in specific function like transportation. (Pohlen et al. 2009, 64-65; Harrison & van Hoek 2002, 60)

Direct and indirect costs can be furthermore divided in respect of activity related and alternative or overhead costs. Alternative or overhead costs are the group of costs that are necessary for doing business, even though they are not straight related certain activity. Activity related costs, on the other hand, are the costs that are incurred because of certain activity.

When combining these two counter concepts, it is possible identify four different cost groups, which can be labeled as follows:

- Direct activity related costs
- Direct overhead cost costs
- Indirect activity related costs
- Indirect overhead costs

Direct activity related costs are usually the kind of costs, which are caused by tangible logistics functions that are easily identified and traced back to certain activity. For example transportation costs or warehousing costs are commonly perceived as logistics costs, since they are related to certain tangible activity. In discussion regarding the warehousing costs, it is important to draw the line between the warehousing costs, which are direct and activity related and inventory carrying costs, which refers the costs that occurs when capital is tied in the inventory itself. The nature of inventory carrying costs is overhead.

Direct overhead costs are overhead or alternative costs that are compulsory for company to offer its products to customers. These costs are also directly related to logistics functions, like value of time or previously mentioned inventory carrying costs, but still cannot be allocated for only one logistic activity, like single truck load.

Indirect overhead costs are costs that can occur if logistics functions are not working as planned. One could say that the costs in this group are realized only in the situation of failure in the logistics functions. In this case, the risk is realized for example due to the lost sales or non-marketable goods. Even though the risk would not be realized, the costs of avoiding the risk still incur.

Finally, the indirect activity related costs are the kind of costs, which are not directly linked to logistics function but activity. For example, it is impossible to allocate the cost of packaging material or new forklift to certain transported product. However, these supporting functions are essential for fluent logistics activities.

Four subsets of logistics costs in respect of four parameters are defined above. The model of logistics costs needs now to be elaborated in company level. This is done by applying the transaction cost approach (TCA) and by presenting logistics costs as a portion of company's total costs.

2.3.2 Applying Transaction Cost Approach

Transaction costs occur when commodities or services are traded. Transaction cost can also been referred as costs of carrying out any exchange, which can take place within the entity or between companies. Related to relationship between supply chain and transaction cost economies, Williamson underlines the encompassing character of previous literature (Williamson 2008, 14). Transactions costs can be divided into three main classes, which are information costs, negotiation costs and enforcement costs. (Williamson 1981, 552-553; Hobbs 1996, 17)

Transaction Costs Approach (TCA) is based on four key factors: uncertainty (or informational asymmetry), bounded rationality, opportunism and asset specificity. These factors are the main reasons that cause transaction costs. Uncertainty refers to changes in the business environment that are out of parties' control or cannot be foreseen. Information asymmetry occurs, when parties of a transaction have asymmetrical information, which is the case in almost every business relationship. Bounded rationality means that parties are unable to make rational decisions, even they wanted. Bounded rationality is closely related to asymmetric information and opportunism, which refers situations, where entity or individual seeks ways to exploit a situation to their own advantage. The last concept is called asset specify, which arises when assets (human resources or physical) have became specific to a particular transaction relationship. This is usually related to situations with a low number of suppliers in the market, which makes it difficult, or impossible to bargain or change a supplier. (Ojala 1995, 27-28; Hobbs 1996, 17-18)

Together with production costs, transaction costs generate an economic entity's total costs. Ojala (1995, 38-40) has applied TCA to classification of logistics costs (Figure 21).

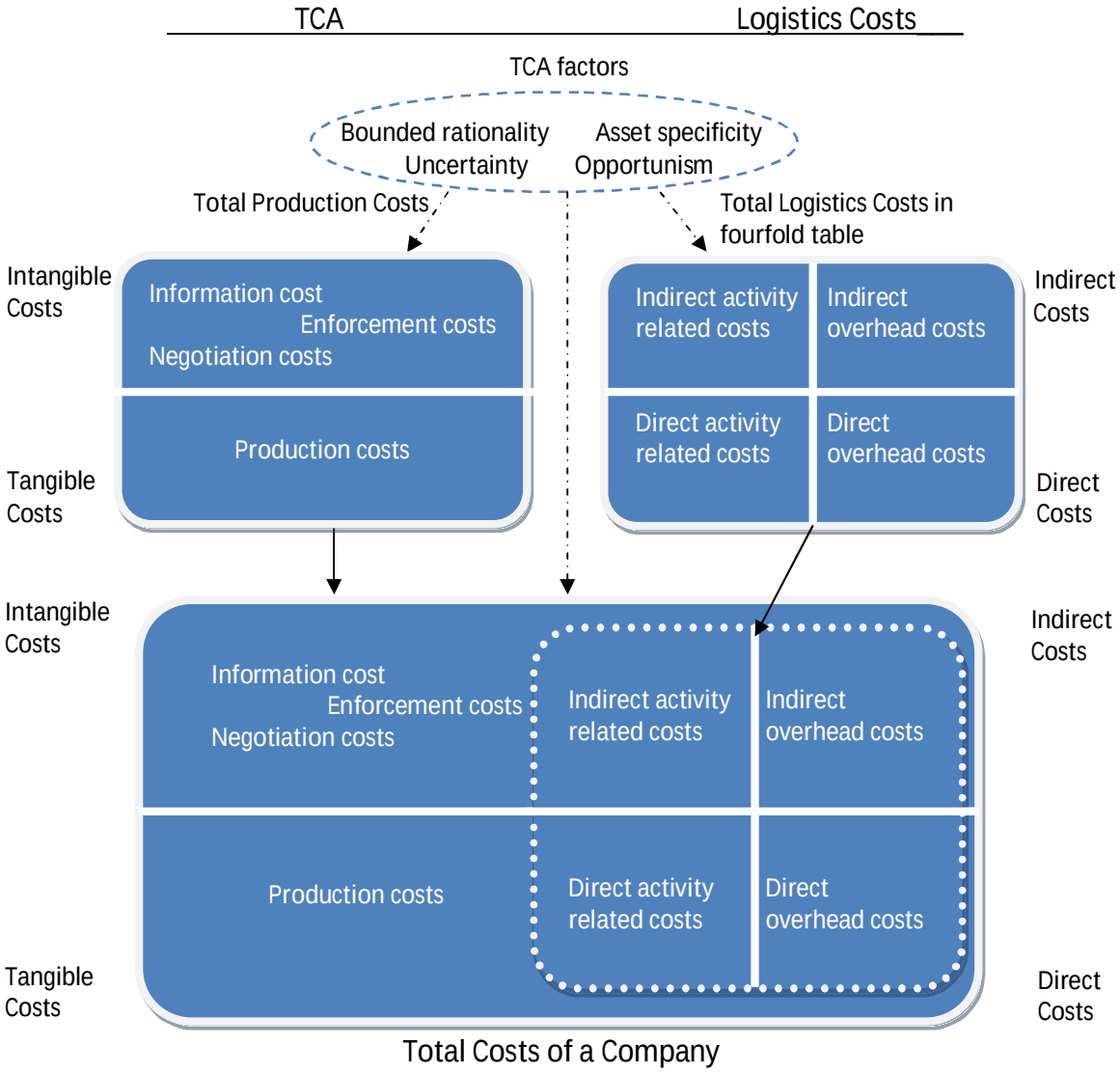


Figure 21 Adapting the TCA to Production- and Logistics Costs (partly adapted from Ojala 1995, 38-40). The sizes of the blocks are illustrative only.

As illustrated in Figure 21, the commonalities between TCA and logistics costs are visible. In addition the relationship between tangible and direct costs, as well as between intangible and indirect costs is clear. TCA helps to recognize different costs components and especially their relations to operations. Chapter 3 - Logistics Studies, presents the results of comprehensive study review.

3 LOGISTICS COSTS IN PUBLISHED RESEARCH

In this chapter, studies are categorized in view of their geographical scope as follows:

- Multi country studies
- Single country studiesCase studies

It is possible to identify three different levels of observation in conducted studies. These levels are certain specified entity (e.g. certain industry), single-country and multi-country levels. This study only concentrates on above single-entity level studies (Figure 22). There are two main arguments for this. First, the scope of study cannot be expanded into too broad level. Secondly, the access to the valid data in company level is not available. Also, as grounded in Chapter 2.1.2.1 the methods of measuring costs inside the companies varies significantly from methods used in the studies. According the classification above, the third chapter of this research is divided into two main sections; 1) multi-country and 2) single country and case studies.

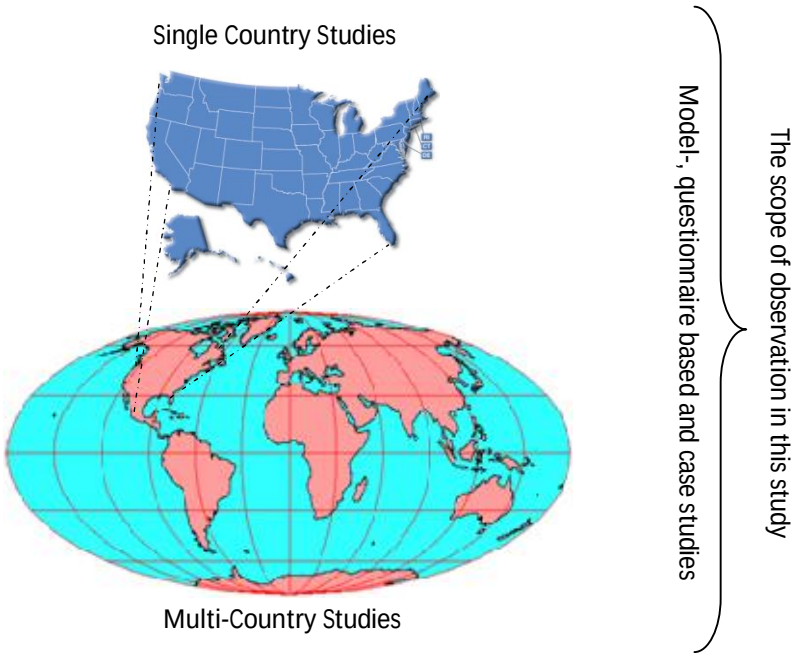


Figure 22 Level of Observation and Scope of Research in Logistics Studies

Second level chapter breakdown can be further divided into subchapters, of which have been classified by the basis of research methods. These third level chapters are named as modeling, case study or questionnaire based studies.

The goal of this chapter is to provide as comprehensive picture of logistics research as possible regarding studies that deal with logistics costs. This background is later on used as a foundation for generic logistics costs model.

3.1 Multi-country Studies

3.1.1 Questionnaire Based Surveys

3.1.1.1 The Davis Logistics Cost and Service Database

The Davis Database, maintained by the Establish management consultants specialized in the supply/demand chain, is ongoing survey that allows companies to benchmark their logistics costs and service level. The database is based on internet survey and it is internationally recognized source of cost information. However it should be noticed that even the coverage of the survey is theoretically global, respondents of this study are usually located in developed countries, mainly in United States. The database was established in 1975 and its results are yearly disseminated at the CSCMP. (Davis Logistics Cost and Service Database; Davis Database Presentation 2009, 2)

Davis Database reports costs in five-level break down as a percentage of sales. Total logistics costs of the average company in 2009 were 8.48% of sales (9.28% in 2008). There are five different cost groups in study, which are transportation, warehousing, inventory carrying, customer service/order entry and administration. Figure 23 presents the costs average company per cost component.

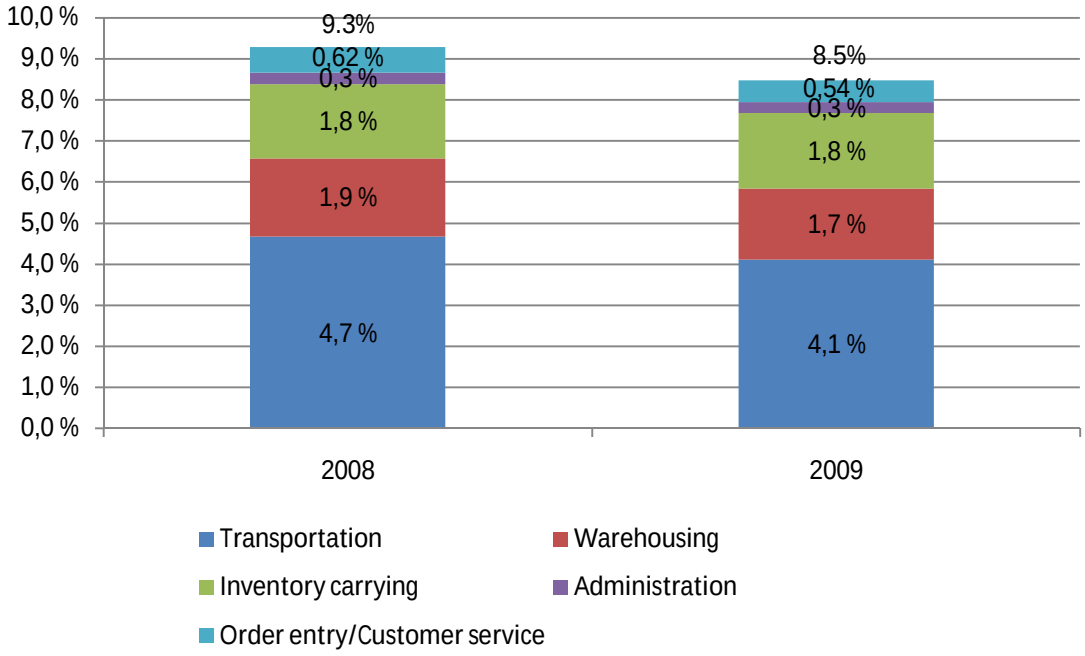


Figure 23 The Logistics Costs of an Average Company as a % of Turnover and as a % of all Logistics Costs in 2008 and 2009 according the Davis Database (Davis Database Presentation 2008, 16; Davis Database Presentation 2009, 13)

According the Davis Database, the transportation costs have formed almost half of total logistics costs in recent years. The second biggest group has been inventory carrying costs (22% in 2009), followed by the warehousing costs (20% in 2009). Customer service/order entry and administration costs are relatively small compared to top-three groups. Results are also reported in respect of company size classification. Generally one could state that the smaller the company is, the bigger are the logistics expenditures. Also, the costs of small companies have increased from year 2008 to 2009. (Davis Database Presentation 2008, 16-20; Davis Database Presentation 2009, 13-15)

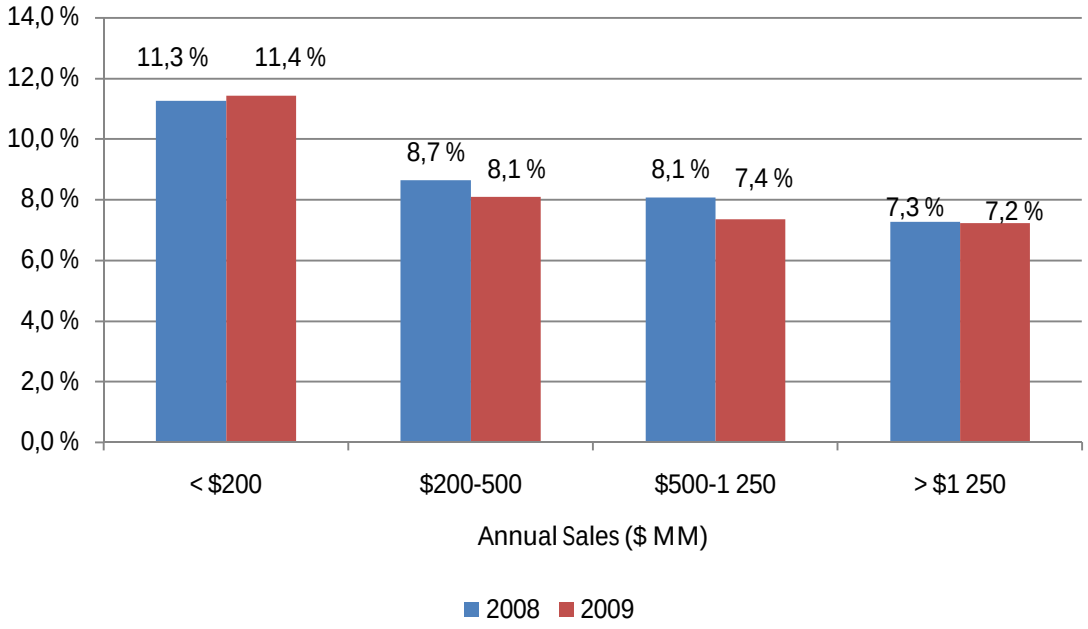


Figure 24 Global Logistics Costs in Davis Database in respect of Company Size as a % of Sales in 2008 and 2009 (Davis Database Presentation 2008, 20; Davis Database Presentation 2009, 15)

Davis Database also provides a broad historical outlook over the logistics costs from the year 1962. As seen in Figure 25, the first drop in costs was in the beginning of 1970s, when the level of logistics costs dropped as low as five percentages of sales. In the end of the 70th decade, the costs had risen back to nine percent line. After this, the trend has been slightly downward, except few sharp increases followed by almost immediate corrections.

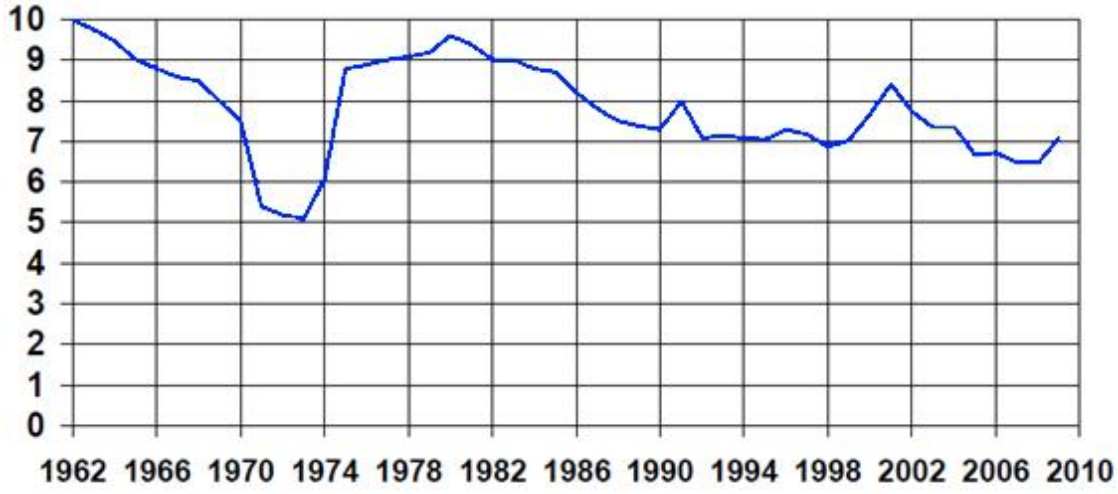


Figure 25 Historical Development of Global Logistics Cost from 1962 as a % of sales (Davis Database Presentation 2009, 16)

The method of collecting the data by open web-based questionnaire may seem unreliable at the first look. However the questionnaire form is well structured and especially logistics cost components are defined clearly. The transportation costs are assessed in primary- and secondary transportation. The inventory carrying costs are calculated by multiplying the average inventory of last fiscal year by 0.18 (see also Appendix 2). (Davis Database Instructions)

3.1.1.2 Surveys of the European Logistics Association

European Logistics Association (ELA) is a coalition of 30 national organizations. This covers almost every part of Western and Central Europe. ELA provides a forum and source of information for individuals and societies in the field of logistics. (ELA homepage, About us)

From the year 1982, ELA has published various researches under several topics. The latest ones are published in 2009, 2007 and 2004. The topic of the 2007 study was *Innovation Excellence in Logistics – Value Creation by Innovation*, which focused on indentifying the top innovators and added value, which they create by applying innovations in the field of logistics. (Innovation Excellence in Logistics – Value Creation by Innovation 2007, 9; Supply-Chain-Excellence in der globalen Wirtschaftskrise; 6)

Even though the 2007 study didn't directly employ the concept of logistics costs, it states that shippers and logistics service providers (LSPs) could reduce their logistics costs between 7% and 14%. There was also other interesting finding made. According the study in 2007, reducing logistics costs was the most important objective for innovation. (Innovation Excellence in Logistics – Value Creation by Innovation 2007, 5)

From the viewpoint of logistics costs, more interesting studies are *Supply-Chain-Excellence in der globalen Wirtschaftskrise (2009)* (author translation: Supply Chain Excellence in the Global Economic Crises) and *Excellence in Logistics 2004 – Differentiation for Performance*, conducted by ELA and A.T. Kearney Management Consultants. The study, conducted in 2009, allocates logistics costs components into five categories: administration, inventory, warehousing, transportation and transportation packaging. According ELA's study the logistics costs have decreased significantly from 12.1% of sales (1987) to 7.3% (2008). When analyzing development in different cost components, it is possible to state that many cost groups have decreased by almost 50%. However, this development seems to be stabilizing and in recent years, the level of logistics costs per some of the cost components has started to increase (Figure 26).

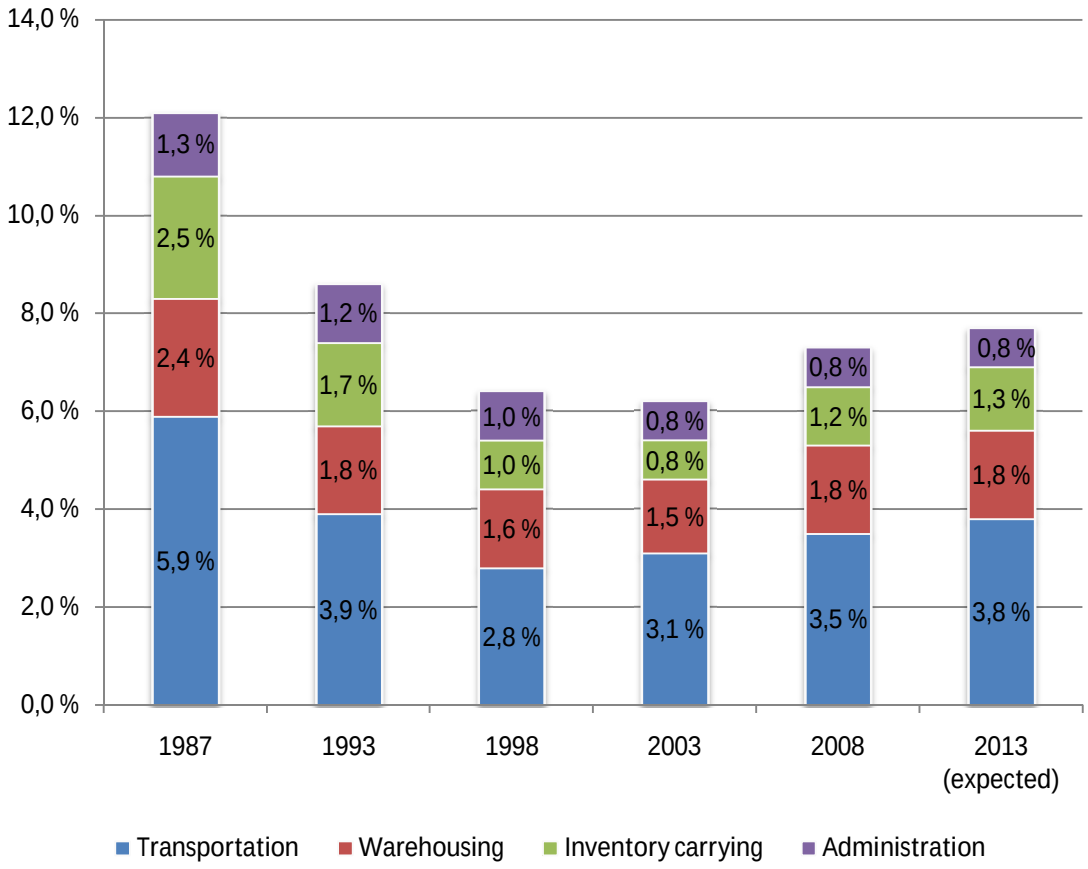


Figure 26 Development of the Logistics Costs in Europe as a % of Sales (Supply-Chain-Excellence in der globalen Wirtschaftskrise 2009)

Transportation costs represented the largest cost group and totaled 3.8% of sales in 2008. The trend has been downward between 1987 and 2003, which was mainly due to the liberalization and removing tariffs. Transportation costs hit all-time low in 2003 but after this, the rise in fuel prices and road tolls have caused the increasing in costs. The globalization has also led into situation, where transportation distances gets longer, which together with the rise in sea freight prices drives high transportation costs. (ELA - Differentiation for Performance Excellence in Logistics 2004, 11-21; Supply-Chain-Excellence in der globalen Wirtschaftskrise 2009, 13-14) Data was gathered before the global recession in late 2008, after which the transportation costs has probably decreased because of the shippers' over-capacity and drop in oil barrel prices.

Inventory carrying and warehousing costs have decreased in half of the 1987 level (from 2.5% of to 1.3%). In the last couple of years, these cost groups have thought increased relatively lot, which was unexpected. The portion of logistics administration cost has remained unchanged in recent years. In future, the most of the costs groups are expected to remain in stable level, except of transportation costs, which are predicted to reach 3.8% of sales in 2013. (Supply-Chain-Excellence in der globalen Wirtschaftskrise 2009, 13-14)

3.1.1.3 State of Logistics in the Baltic Sea Region

State of Logistics in the Baltic Sea Region study was part of LogOn Baltic project, which was an initiation, funded by the European Regional Development Fund. The data for the study was collected from manufacturers, trading firms and logistics service providers in eight countries in the Baltic Sea Region (BSR). The total number of respondents in this study, published in 2007, was 1 234, which represented the largest available database in its region. (Ojala et al. 2007, 17-21)

One of the interests in the study was the logistics costs for manufacturing and trade firms in the BSR. The study addresses the current state of logistics costs and future expectation according to company size and region. In addition, the structure of logistics costs is discussed in accordance of manufacturing and trading, respectively. The logistics costs were divided into four categories, in respect of direct and indirect costs. Direct logistics costs cover the transportation (incl. cargo handling and packaging) and warehousing costs. Inventory carrying costs (incl. capital tied in inventory) and logistics administration costs are considered as indirect costs. See also Figure 20, which is partly adapted from this study. (Ojala et al. 2007, 35-36)

As mentioned above, the study presents the results of logistics costs in respect of company size, industry and country, which gives reader a more comprehensive understanding on differences between industries and nations. The accumulated (manufacturing and trading in all areas) logistics costs varies from 16% (micro companies) to 11% (large companies) of turnover. Between these two extremes, the logistics costs of small companies were approx. 14% of turnover and medium-sized companies achieved slightly over 13% of turnover level. (Ojala et al. 2007, 37)

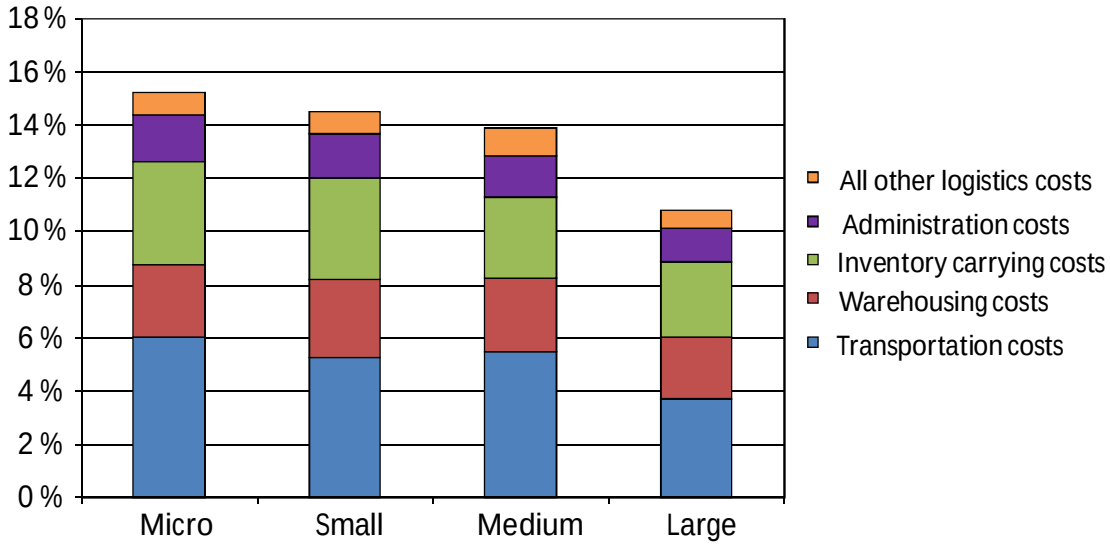


Figure 27 Logistics Costs in the BSR as a % of turnover in 2007 (Ojala et al. 2007, 38)

It is possible to regocnize the negative correlation of logistics costs and the size of the company. The transportation costs are the largest individual cost group, followed by the inventory carrying and warehousing costs. Other logistics costs represent relatively small portion of total costs in all company sizes. To illustrate the regional differencies, the costs groups are presented also in regional context below (Figure 28).

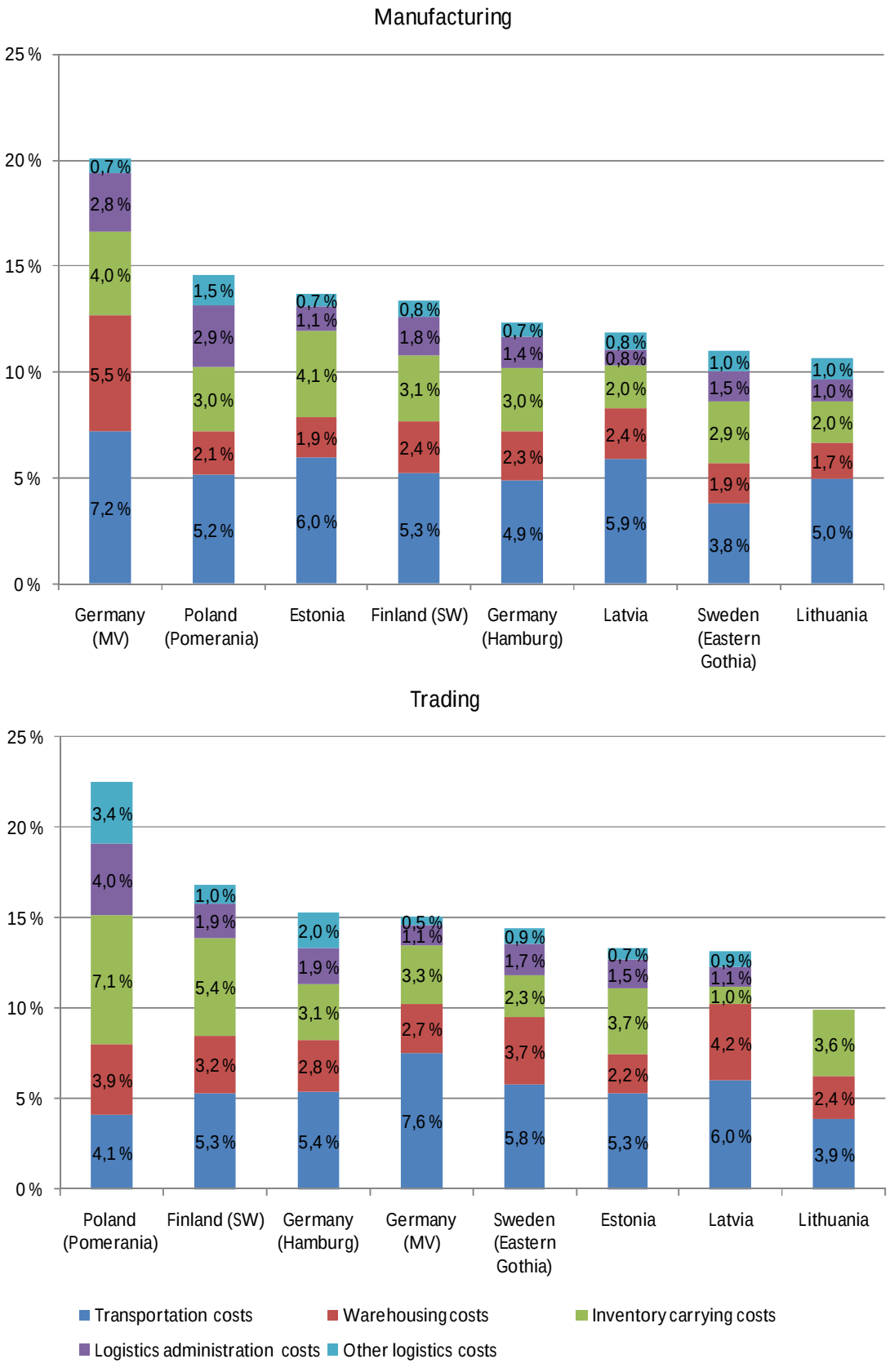


Figure 28 Regional Logistics Costs in Retail and Manufacturing Companies in 2007 as a % of turnover (Ojala et al. 2007, 40-43)

Transportation, inventory carrying and warehousing costs retained their places as a largest cost groups across the regions among trading and manufacturing companies. The range of the level of logistics cost in trading varied (23% - 10%) and (20% - 8%) in manufacturing. (Ojala et al. 2007, 40-43)

3.1.1.4 The GMA 2008 Logistics Survey

The 2008 logistics survey by the Grocery Manufacturers Association (GMA) gathered the opinions of logistics executives in 45 companies within the GMA membership. The distribution of respondents was as follows: eight micro companies (<500 M USD of turnover), four small companies (500 M – 1 bn. USD of turnover), 14 medium size companies (1-5 bn. USD of turnover) and eight large companies (>5 bn. USD of turnover). The average of total logistics costs in 2008 was 6.9 percent of sales (6.9 % in 2005). The largest individual cost group of total costs was the outbound customer transportation costs (Figure 29). (The GMA Logistics Study 2008, 5; 10)

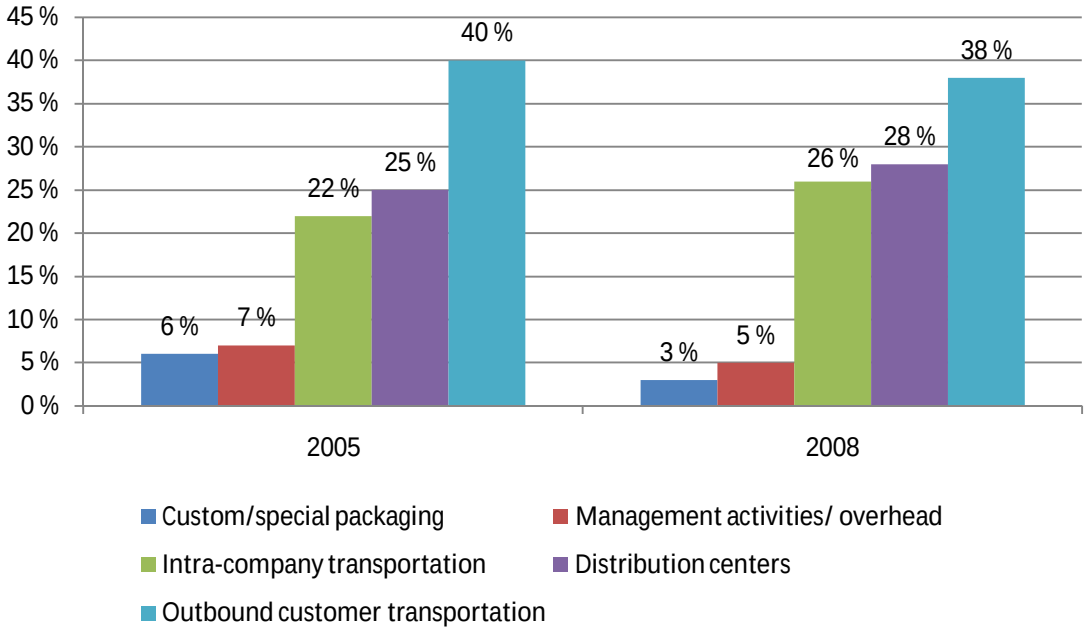


Figure 29 Level of Logistics Cost Components in GMA Surveys 2005 and 2008 as a % of Total Logistics Costs (The GMA Logistics Study 2008, 10)

Outbound and intra-company transportation together totaled 64% of total logistics costs, which was in same level with 2005 level. The second largest category was distribution centers with 28 % of total logistics costs (25% in 2005). The share of other cost groups decreased from 2005, which can be attributed to a focus on cost management in these categories. Even the total costs as a percentage of sales remained the same, the

cost per case and cost per hundredweight increased in every cost group except custom/special packaging. (The GMA Logistics Study 2008, 11)

3.1.2 Modeling Based Studies

3.1.2.1 Top 100 in European Transport and Logistics Services 2007and 2009/2010

Authors Klaus & Kille (2007, 42) have attempted to measure the total logistics costs in European business logistics system. They estimated that the total annual expenditure on logistics services in the European economy is around 800 bn. EUR. This includes all freight transportation, storage, transshipment, order picking, all inventory maintenance expenditures, order processing, planning, management and administration expenditures. These cover both, in-house and outsourced logistics services. The two partly overlapping methods, applied by the authors, are introduced below. (Klaus & Kille 2007, 42-43). In 2008, the total volume of logistics services in Europe increased, and was estimated to at 930 bn. EUR or 7.1% of GDP (Klaus, Hartmann & Kille 2009, 55).

The first methodological approach is related to volumes, distances and types of freight, which are relatively well documented. The information of freight tonnages transported on road, are used to extrapolate all up- and downstream functions. Based on these measurements in road transport sector in Germany, it is possible to evaluate the size of European road transport and total logistics market by adjusting the German analysis to include national differences. This adjusting was made by three factors, which represent the respective stages of logistical development. The factors are labor costs, geographical condition in the country and aggregate correction factor, which notes the positive or negative percentage by which the theoretical extrapolation of the transportation costs should be adjusted in country's case. Logistics development factor is represented by the GDP per population. Labor cost is represented by average labor cost in month and geographical condition by weighted average distance by road/rail. By doing the same kind of extrapolation for all transportation modes, it is possible to evaluate the total revenues in European freight transport, which were 344 bn. EUR. To produce a preliminary estimate of total expenditures, the authors have projected the expenditures to cost breakdown in Davis Logistics Database 2005 cost (see also 3.1.1.1). (Klaus & Kille 2007, 45-56) After this extrapolation the total logistics expenditures are available for several European countries (Figure 30). For comparison, the figures are provided in accordance of 2005 and 2008 studies.

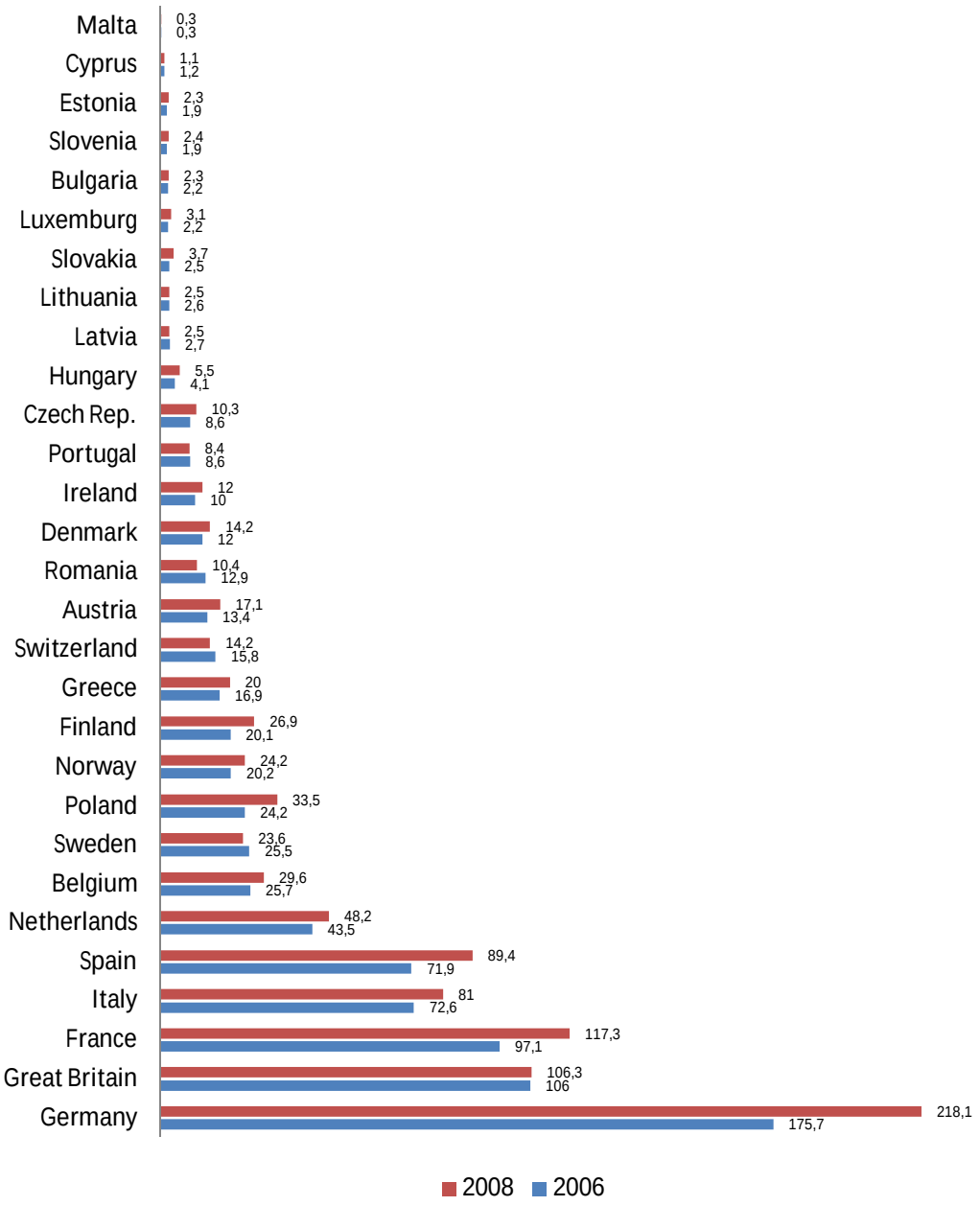


Figure 30 Volume of Logistics Market in European Countries in 2005 and 2008, bn. Euro (Klaus & Kille 2007, 56; Klaus et al. 2009, 55)

The other approach is to utilize national economy's network of value-creating activities. Based on numerous individual case studies and reliable statistical data, it is should be possible, according the authors, to combine the logistics costs for each country. For obvious reasons, the attributes based on case studies are not further presented by the authors. However, the results that have gotten by using the second approach do not significantly differ from the results of first approach. By applying the second approach, the total logistics expenditures were 803.4 bn. EUR. Corresponding level by using the first approach was 799.6 bn. EUR. According to these two individual estimates, authors as-

sessed that the size of logistics expenditures in 2005 were 800 bn. EUR, which was corresponding to 7.0% of combined GDP in the same area. As mentioned above the corresponding figures in 2008 were 930 bn. EUR or 7.1% of GDP (Klaus et al. 2009, 55). The costs per logistics function are illustrated in Figure 31.

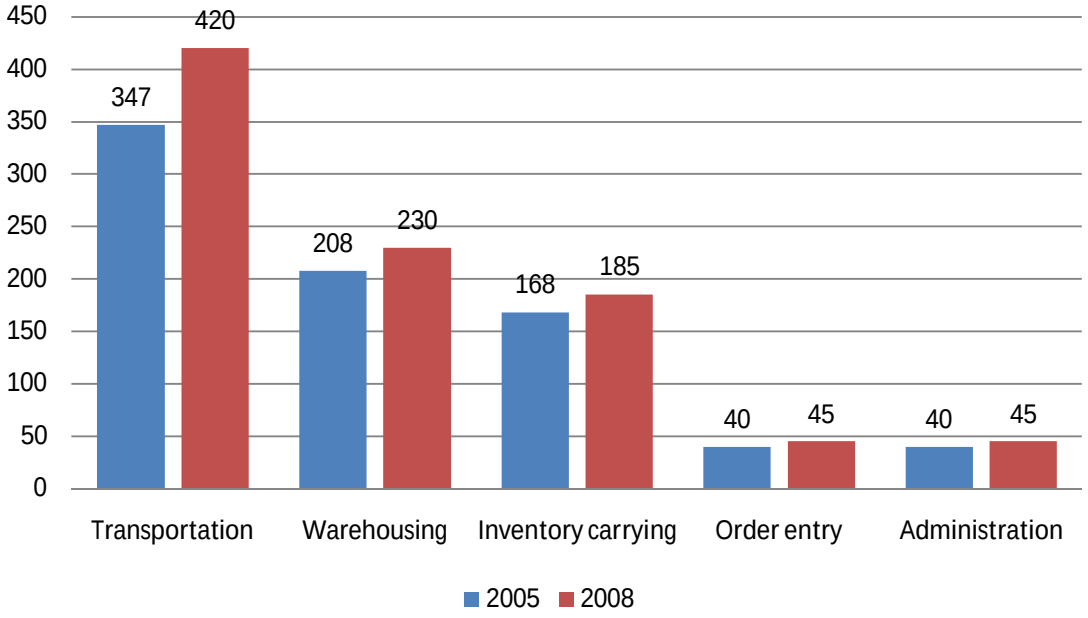


Figure 31 Logistics Costs per Cost Component in Europe 2005 and 2008, bn. EUR (Klaus & Kille 2007, 63, Klaus et al. 2009, 53)

As illustrated in Figure 31, logistics costs have increased in all components. The increase in percents has been fastest in transportation costs, which has increased by over 20% while other growth in other components has been around 10%.

Also the results of Top 100 in European Transport and Logistics Services deliver the same kind of results than other studies. The transportation costs are the biggest cost group, followed by warehousing and inventory carrying. The share of other groups is relatively small compared to these three.

3.1.2.2 Canada/United States Logistics Analyses and State of Logistics Report 2008

In 2005, Industry Canada launched a project dedicated to create assessment toolkit for logistics costs. The toolkit defines three components of costs, classifies cost activities categories and related components. SCM and Key Performance Indicator (KPI) Analyses and State of Logistics: The Canadian Report 2008 studies were later conducted by the Supply Chain & Logistics Association Canada, Canadian Manufacturers & Exporters and Industry Canada. The purpose of these studies is to gather information regarding the logistics trends and to provide tools for benchmarking the logistics activities in

Canada and U.S. (State of Logistics: The Canadian Report 2008, 2; Industry Canada – Logistics Cost and Agility Assessment Tool, 2)

The methodology used in the reports is based on the in-house developed economical model, originally elaborated for 2006 studies together by the partner organizations and Jacobson Consulting. These models and analyses are draw upon the datasets collected by Statistics Canada and Bureau of Economic Analysis (U.S). There is also a direct linkage between data collected for CSCMP's Annual reports (see 3.2.2.1) and Canadian reports. (State of Logistics: The Canadian Report 2008, 2; SCM and KPI Analysis – A Canada / United States Perspective 2006, 24)

For some reason results are reported in various measurement methods. SCM and KPI Analyses 2006 reported the results in three different ways: i) as a percentage of GDP, ii) as a % of sales or iii) as a share of gross margin. In addition most of results are only illustrated by charts, without adding the actual figures in charts or appendices. This is the reason that the earlier data cannot be presented in corresponding figures with the very latest results in State of Logistics: The Canadian Report 2008, which reported the results as a % of sales. Reports employs the North American Industry Classification System (NAICS) codes for Canada, which means that industry classified results are directly comparable with ISIC classified results.

Even thought there are some deficiencies in result reporting, the research methodology is explained in very comprehensive way. Reports apply a three-level breakdown of logistics costs, which classifies the costs into following groups: Internal costs, Outsourced costs and Inventory carrying costs. This method of grouping is not completely unambiguous and differs from activity based grouping, which is employed in many other studies. To illustrate the methodology of cost calculating in the reports, an artificial example presented in Figure 32, is drawn up. (Industry Canada – Logistics Cost and Agility Assessment Tool, 4-5)

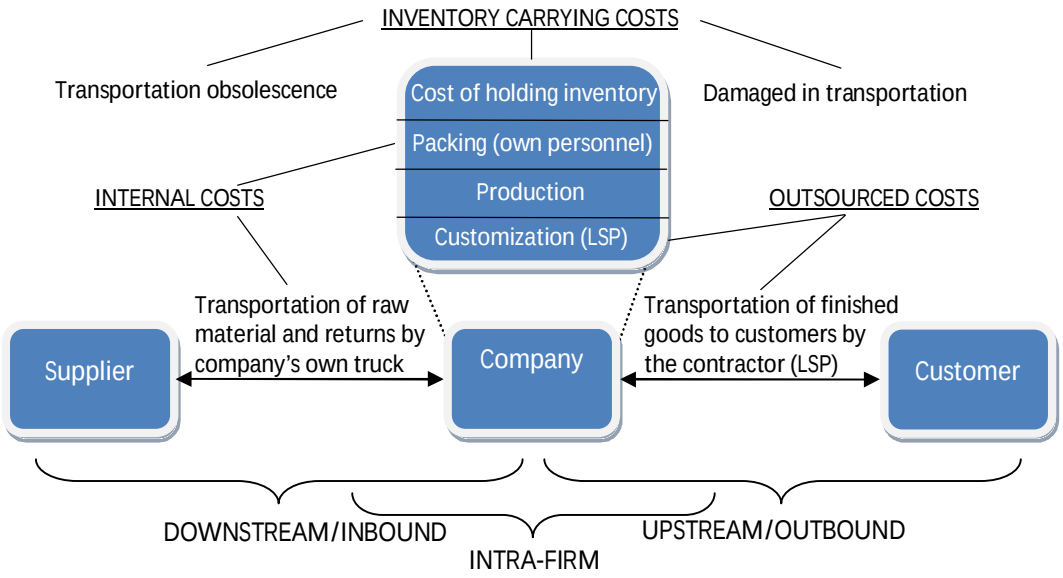


Figure 32 Grouping of Logistics Costs (State of Logistics: The Canadian Report 2008)

First of the cost groups, internal costs, covers those logistics costs that occurs internally within the firm, excluding the outsourced activities and production processes. Internal costs were compiled by first determining the occupational types (21 occupations), which are related to internal logistics costs activities. After determining the occupational types, the types were assigned into one of the four logistics main activities (Distribution center DC, Office work OW, Truck transportation TT and Other transportation OT). After assigning the occupation to logistics main activities, authors found out the number of persons working in industrial subsectors. There were sixty subsectors in manufacturing and thirty in wholesale, as well as in retail. Finally authors needed to find the logistics' supplier equivalent to four logistics main activities and calculate the wage bill of activities after occupations were linked to them. The ratio of the total costs divided by the wage bill was then allocated to totally 120 subsectors. After allocation, the costs of other internal costs components are estimated based on salaries. (SCM and KPI Analysis – A Canada / United States Retail Perspective 2006, 25; State of Logistics: The Canadian Report 2008, 3; Industry Canada – Logistics Cost and Agility Assessment Tool, 8-9)

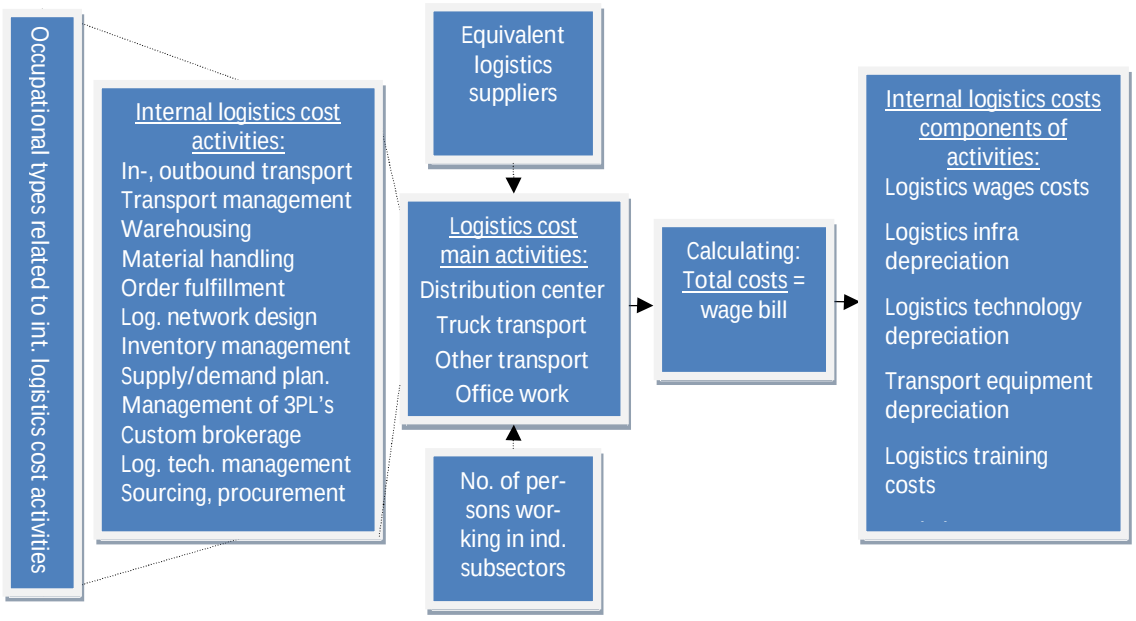


Figure 33 Calculating Internal Logistics Cost in Canadian Studies (partly adapted from SCM and KPI Analysis – A Canada / United States Retail Perspective 2006, 25; Industry Canada – Logistics Cost and Agility Assessment Tool, 9-11)

Second cost group is the opposite of internal costs and covers the costs that are born through outsourcing of activities to logistics service providers (LSP). This cost group is referred as outsourced costs. The data for this cost group was adapted from Statistic Canada that indicates how much each industry requires a production of each other industry to produce its own output. (SCM and KPI Analysis – A Canada / United States Retail Perspective 2006, 25-26; State of Logistics: The Canadian Report 2008, 3)

The last cost group is inventory carrying costs, which in this report, covers opportunity costs (cost of holding inventory), shrinkage (damages etc.) and obsolescence in all stages from inbound to outbound logistics. The inventory carrying cost rate is applied on the average annual inventory in order to estimate the cost of having inventory into a certain firm, which in this study is accepted to be 20%. (State of Logistics: The Canadian Report 2008, 3; SCM and KPI Analysis – A Canada / United States Retail Perspective 2006, 26-27) For example in Swedish study, presented later on, the corresponding rate is 25%.

As explained above, due to the shortages in reporting methods, it is only possible to present the latest cost figures, which are based on the results of Canadian Report 2008. Between years 2005 and 2007, total logistics costs increased by 3% for the Canadian economy. The growth was fastest among retail industry, where costs increased almost by 22%. This was due to the growing inventory levels, which led to rise in inventory carrying costs. On the other hand, the rise in costs was only around 1% in manufacturing and wholesale sectors. Compared to U.S, Canada suffered 12% higher total logistics

costs in manufacturing, 18% higher in wholesaling and 30% higher in retail industry. (State of Logistics: The Canadian Report 2008; 2-3)

Figure 32 explains how different kind of cost grouping makes it almost impossible to compare studies with each other. As one may see, for example transportation costs, which is one of the most commonly used main cost groups in many studies, is divided between outsourced and internal costs, depending on activity producer. Of course it is possible to sum the costs of different producers but for readers convenience it would be best if results would be reported in commensurable form. The results of the Canadian Report 2008 are presented in Figure 34.

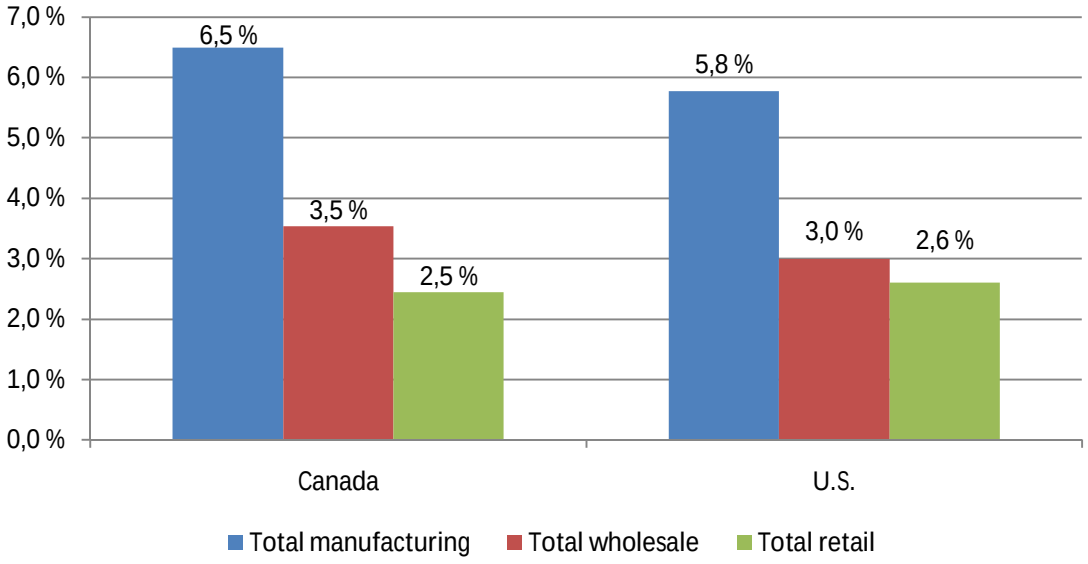


Figure 34 Logistics Costs as a % of Sales in Canada and U.S. 2008 (State of Logistics: The Canadian Report 2008, 13)

As presented in Figure 34, U.S. based companies are enjoying a slightly lower logistics costs in all industries than Canadian ones. Figure 35 presents the results in respect of cost component.

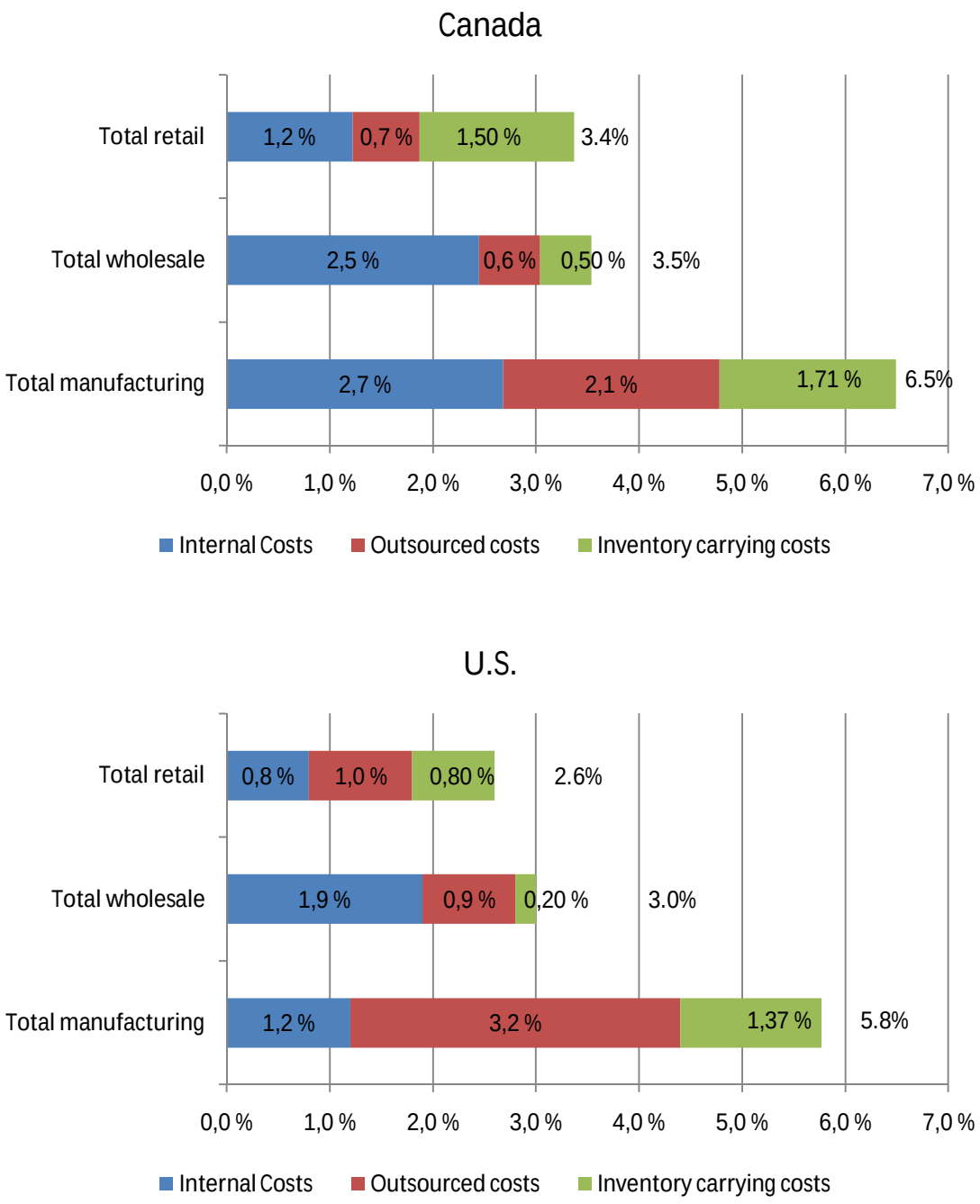


Figure 35 Logistics Costs per Cost Component as a % of Sales in Canada and U.S. 2008 (State of Logistics: The Canadian Report 2008, 13)

Figure 35 also brings out one interesting point of view. Outsourced costs in the U.S. are higher in every industry than in Canada. Since companies are usually able to lower their total costs by outsourcing activities, this may partly explain the lower total costs in U.S. There are, of course, also several other reasons for this, but unfortunately these are beyond the limitations of this study.

3.1.2.3 Other Selected Modeling Based Multi-country Studies

Radelet and Sachs (1998) researched the shipping and transportation costs and the relationship of these costs to trade and economic growth in developing countries, especially in East-Asia and Africa. Authors also defined the determinants of shipping costs and discussed about the differences in transportation costs between landlocked and coastal nations. (Radelet & Sachs 1998, 1-6, 10-11)

Logistics indicators are also researched by Hausman, Lee and Subramanian (2005), who examined the effect of logistics cost and time on bilateral trade. The study utilizes a data for global logistics indicators from 80 economies to create three-stage estimation process to develop a single logistics index, which would comprise several logistics indicators. Authors also apply the total landed cost model, which includes following logistics cost components:

- Transportation (shipping) costs
- Trade-related costs (processing, customs clearance, port operations and alike)
- Inventory holding costs for in-transit inventory
- Inventory holding costs for safety stock inventory

These logistics indicators are used to explain the residuals of the gravity model's variables (GDP, corruption and regional trade agreement dummy variable). Last, the single logistics index is created based on coefficients derived by logistics indicators. (Hausman et. al. 2005, 1-4; 19-21)

3.1.3 Summary of Multi-Country Studies

Figure 36 and Table 9 gather the results of modeling and questionnaire based, multi-country studies. Figure 36 presents the level of logistics cost in the latest available year. The areal and industries coverage of the study in question is indicated after the name of the study below the chart axis.

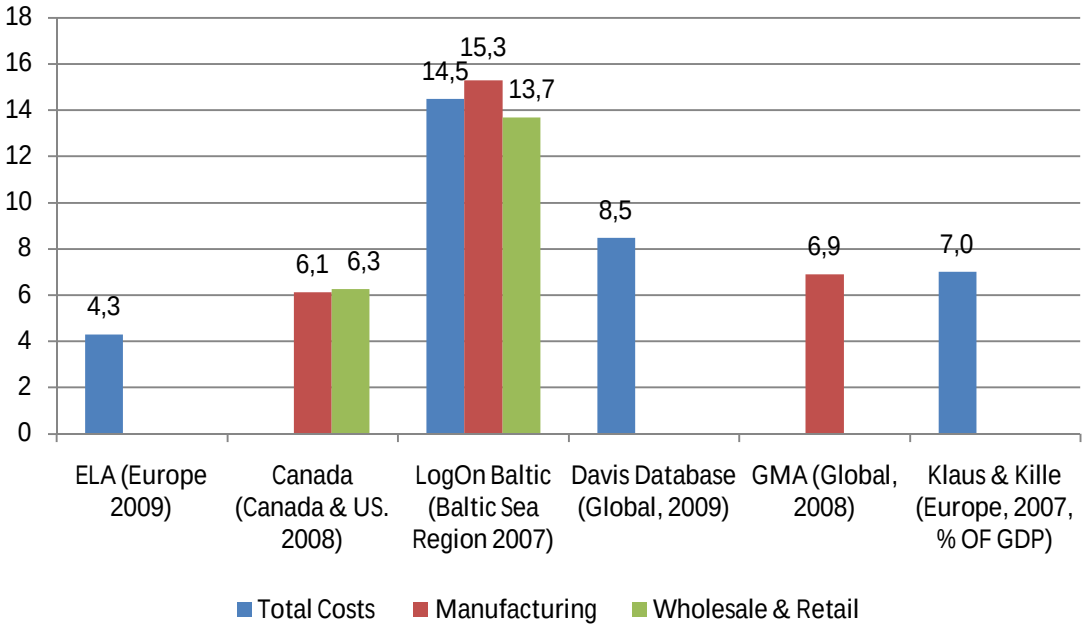


Figure 36 Level of Logistics Costs in Multi-Country Studies as a % of Sales or Turnover

As seen in Figure 36, the level of logistics costs varies rather much within the studies even in same geographical area. Some of the difference could be explained by the different years of conduction, as well as differences in study methods and sample sizes. This is why the figure above should not be considered as an absolute comparison of different areas but as prove of fragmented field of research. Table 9 specifies logistics cost components per study and gathers some other aspects concerning the logistics costs, which appeared during the literature review.

Table 9 Summary of Multi-country Logistics Studies and Costs

Survey	ELA 2009	Canada 2008	LogonBaltic 2007	Hausman et. al. 2005	Davis Database 2009	GMA 2008	Klaus 2007	SUM
Type of cost research	Q	M	Q	M	Q	Q	M	
Cost components								
Transportation costs	✓		✓	✓	✓	✓	✓	6
Inventory carrying costs	✓	✓	✓	✓	✓		✓	6
Warehousing costs	✓		✓		✓		✓	4
Administration costs	✓		✓		✓		✓	4
Other logistics costs			✓					1
Internal logistics costs		✓						1
Outsourced logistics costs		✓						1
Trade-related costs				✓				1
Customer service/order entry					✓			1
Custom/special packaging						✓		1
Management/overhead						✓		1
Distribution centers						✓		1
Order entry							✓	1
Industry classification								
Manufacturing		6.13	15.3			✓		
Wholesale & retail trade			13.7					
Wholesale trade		3.27						
Retail trade		2.99						
Total costs	✓		✓		✓		✓	
Time series								
-1990	✓				✓			
1991-1995	✓				✓			
1996-2000	✓				✓			
2001-2005	✓				✓	✓	✓	
2006		✓			✓			
2007			✓		✓			
2008		✓			✓	✓		
2009					✓			
Scale of measurement and logistics cost in the most recent study								
% of sales / turnover	6.1	✓	14.5		8.48	6.9		
Other								
% of GDP							7.0	
Recent trend	⊙				⊙	⇄		
Expectations in future regarding cost develop.	⊙		⊙					
Company size classification, no. of classes			4		4	4		
Area covered	EU	CAN/ USA	BSR	Glob.	Glob.	Glob.	EU	

Table 9 cross tabulates the findings of multi-country studies. Firstly the table indicates the study method, which is questionnaire (Q) or modeling (M). Also the cost components used in study and years of conducting are indicated. The most important infor-

mation in the table is the level of logistics costs (also indicated in respect of industry if possible) and scale of measurement, of which the last one indicates whether the costs are disclosed as a percentage of turnover or sales or as a percentage of GDP. For the last, applied company size classification and covered area are disclosed.

3.2 Single-Country and Case Studies

3.2.1 Questionnaire Based Surveys

3.2.1.1 Finland State of Logistics Studies

Finland State of Logistics 2009 survey continues the series of Finnish logistics surveys published in 1993, 1997, 2001 and 2006. For 2009 survey the responses of 2 705 firms (manufacturing 37%, wholesale / retail trade 29% and logistics companies 34%) were gathered via online questionnaire. The respondent enterprises were further classified into four groups in accordance with enterprise size (micro 61.1%, small 18.3%, medium 9.2% and large 11.4%). This is the most comprehensive database gathered in the world. (Solakivi et al. 2009, 2; 32)

The logistics cost components are combined based on the cost items linked with companies' physical flows including the costs of storage and capital tied in inventory. To clarify the concept of logistics costs, authors have utilized the fourfold table to systemize the classifications of logistics costs (see also 2.3.1). Based on the fourfold table systemization, six logistics cost groups were formed. These were transportation, warehousing, inventory carrying, transport packaging and other logistics costs. Compared to previous report (2006), the costs seemed to increase slightly. (Solakivi et al. 2009, 20-12; 57)

The largest individual cost group is transportation costs, which represented 5.5% of sales (4.1% in 2006). Second and third largest groups were inventory carrying and warehousing costs, which were followed by the smaller cost groups of logistics administration, transportation packaging and other logistics costs. All cost groups, excluding logistics administration costs increased from 2006 and the total costs were 1.3% up compared to 2009. The growth was most significant in transportation costs (Figure 37).

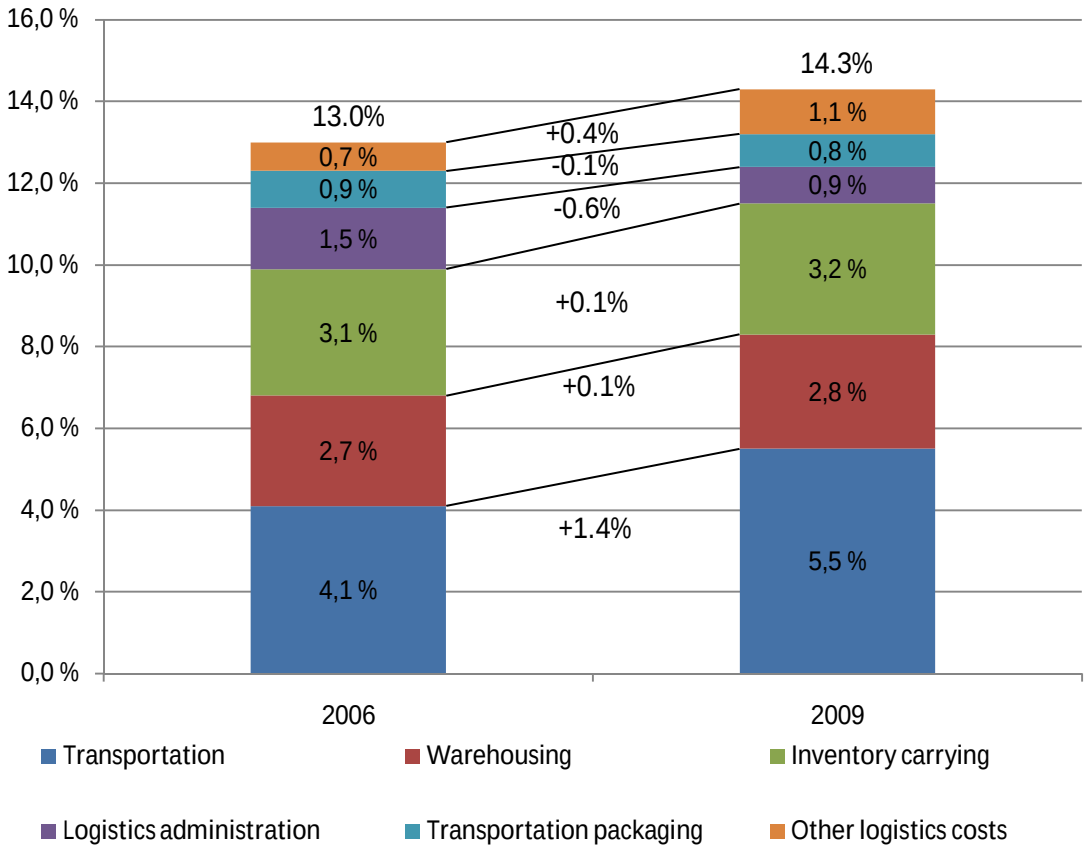


Figure 37 Logistics Costs in Finnish Manufacturing and Trading Enterprises Weighted by Respondent Enterprises' Turnover and the Turnover of Industries as a % of Sales in 2005 and 2009 (Solakivi et al. 2009, 57)

Figure 37 depicts the logistics costs in Finnish manufacturing and trading companies. As one can see, the transportation costs have increased fastest and consolidated its position as a largest individual cost group. Also the growth rate in this group between years 2005 and 2008 has been relatively high. The main reasons behind the rise are increased crude oil price, overheating in world economy and the rise in salary costs. The rise in crude oil price has led into situation, where growing costs are transferred to fuel price, which increases the transportation costs. Overheating in world economy has created a growth in demand, which was compensated by increasing the prices. Also the salary costs in logistics services have risen faster than general development of costs. (Solakivi et al. 2009, 58-59)

Second largest cost group is inventory carrying costs, which can be partly explained by the long transportation distances in Finland, which may encourage companies to increase their inventory levels. The third major cost group is warehousing costs, which is followed by smaller cost groups of administration, transportation packaging and other logistics costs. Decreasing costs in some of the cost groups, like administration costs, may indicate that the internal efficiency of Finnish companies has improved. Total lo-

gistics costs in 2009 were 14.3% (Table 10) of sales, which is 1.3% higher than 2006 (13.0%).

Table 10 Comparison of Logistics Costs in Finland as a % of Turnover between 1990 and 2008 (Solakivi et al. 2009, Annexes)

Key figure/ year of comparison	1990	1995	2000	2005	2008
Logistics costs in manufacturing and trading	20.4 bn.€	16.4 bn.€	20.9 bn.€	28.2 bn.€	34.7 bn.€
Logistics costs as percentages of turnover	11.0 %	10.3 %	10.2 %	11.5 %	12.3 %
Transportation costs as percentages of turnover	4.8 %	4.7 %	4.5 %	5.0 %	6.3 %
Logistics costs as percentages of GDP	17-18%	14-15%	14-15%	17 %	19 %

As it is presented in Table 10, the level of logistics has remained around 10-12% of turnover in last two decades. However, the transportation costs have increased heavily in recent years.

Because of the usage of several background variables in Finland State of Logistics 2009, the authors have been able to report some interesting results concerning the relationship of logistics costs and enterprise size, as well as the impact of manufacturing mode to logistics costs. Figure 38 illustrates the relationship between company size and logistics costs including the industry classification. In 2006, it seemed that the cost level gets smaller, when the company size increases. This applied in both, manufacturing and trading companies. The 2009 survey reported more dissonant results. The logistics costs for large manufacturing and construction companies were somewhat higher than smaller companies. On the other hand, the large companies in trading industries reported the lowest cost, when micro and medium sized companies suffered of higher logistics costs. (Solakivi et al. 2009, 60)

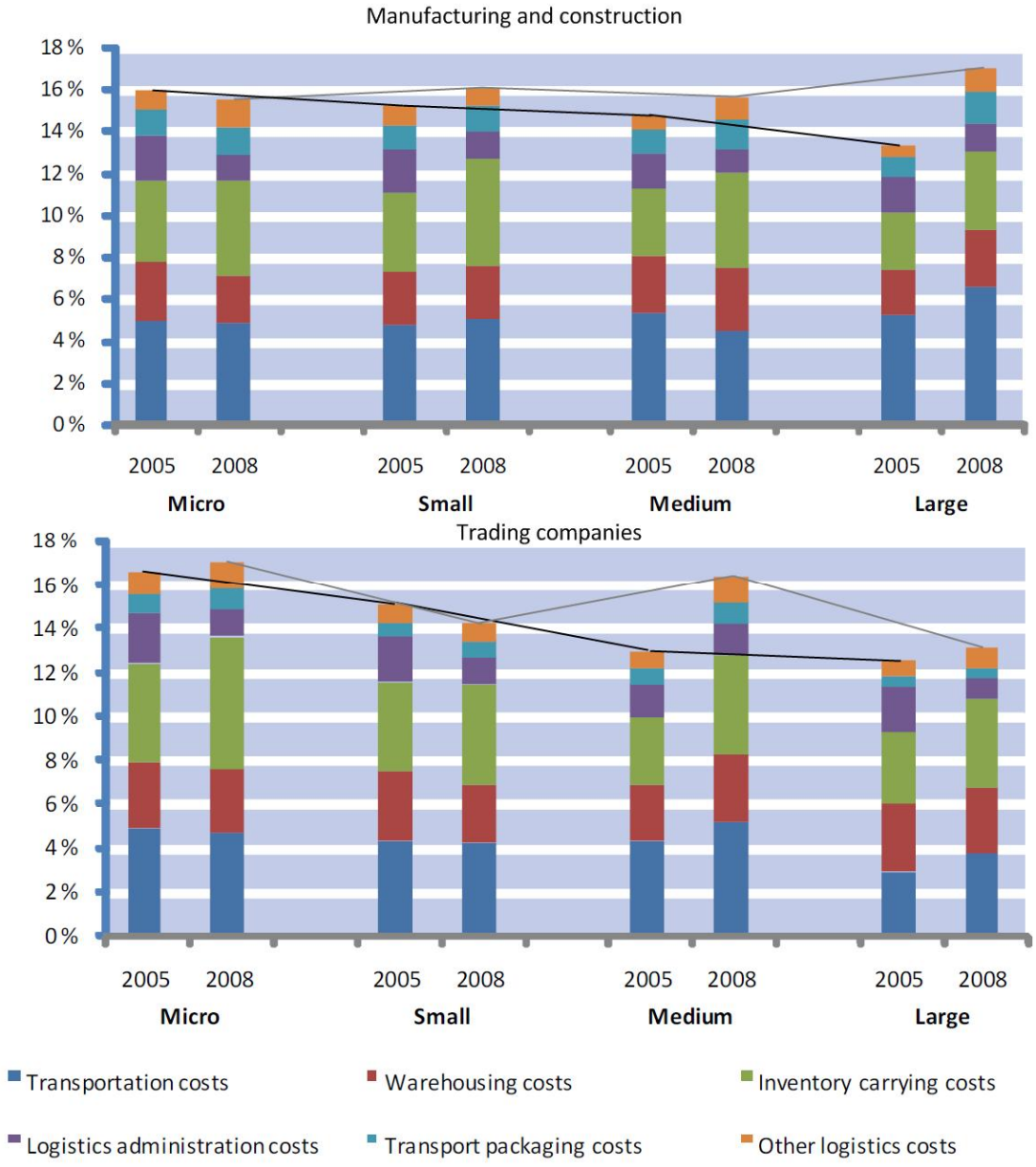


Figure 38 Logistics Cost per Cost Component in accordance of Company Size as a % of Turnover (Solakivi et al. 2009, 60)

There is also one interesting aspect in Figure 38 concerning the development of transportation costs and total logistics costs. Except the micro-sized trading companies, the changes in total logistics costs have always followed the development of transportation costs. This supports the perception, according which the transportation costs determine the development trend in all costs.

Finland State of Logistics 2009 also discloses some interesting results regarding the level of logistics costs in various geographical areas in Finland. Generally, the logistics cost are lowest in the southern Finland and the highest costs are measured in central and eastern parts of the country. Study also compares the impact of level of internationali-

zation and production mode on the logistics costs. Between 2006 and 2009, the total logistics costs have risen in exporting and international companies, when domestic companies enjoyed decreasing of logistics costs. Figure 39 illustrates the impact of production mode on the total logistics costs.

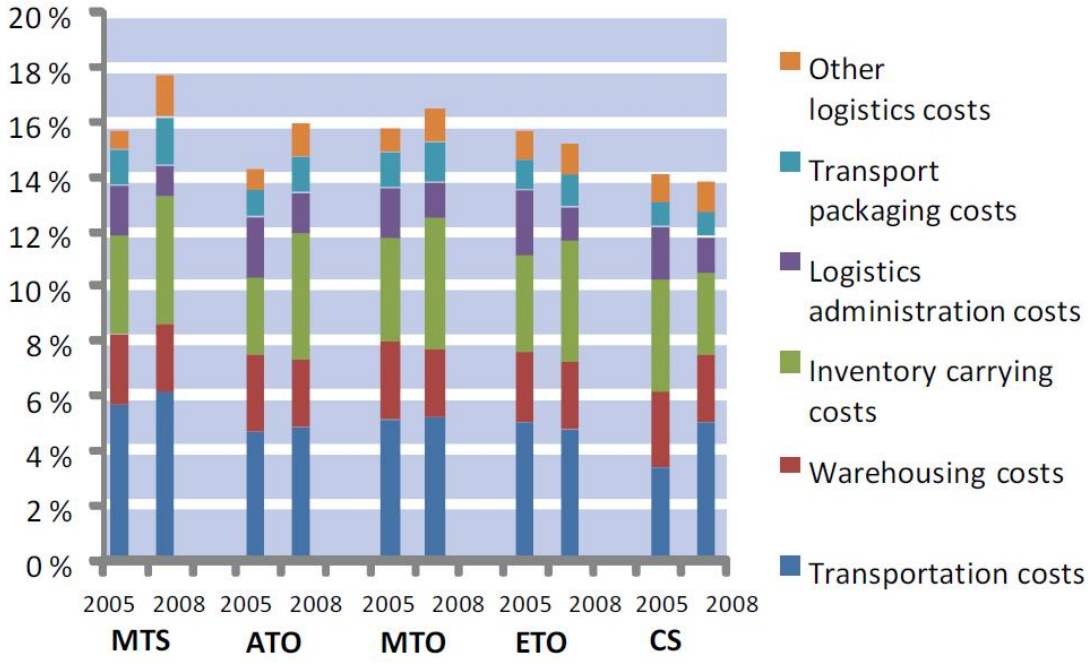


Figure 39 Impact of Production Mode (manufacturing industries) to Logistics Costs as a % of Turnover in 2005 and 2008 (Solakivi et al. 2009, 62)

The production mode of company is one factor that can partly explain the differences in logistics costs (Figure 39). The logistics costs seemed to be highest (17.5% on average of turnover) among MTS (make-to-stock) companies, who face high inventory carrying and transportation costs, which are related to production mode. Also in MTO (make-to-order) and ATO (assembly-to-order) companies, the logistics costs have risen slightly. In 2008, the logistics costs of MTO companies were 16.3% and 15.8% in ATO companies. The share of logistics costs for ETO (engineer to order) and CS (capacity selling) seemed to be declined. (Solakivi et al. 2009, 61-62)

3.2.1.2 Studies of Transportbrukernes Fellesorganisasjon, Federation of Norwegian Transport Users (TF)

TF has published two researches regarding the industry's logistics costs and resource utilization (1997 and 2003). In 1999 organization also published the same kind of research regarding the trading companies. The number of respondents in these questionnaire based studies varied between 127 (1999) and 430 (2003) respondents (Hansen &

Hovi 2008, 24; Industriens logistikk - en studie av logistikkostnader og ressursbruk i norskindustri 2003, 2 (author translation: Industry's logistics – study of logistics costs and resource utilization in Norwegian manufacturing companies)).

The number of respondents (companies over 20 employees) in the latest study, conducted in 2003, was 430. According the study the sum of logistics costs has been increased in the larger number of companies than it has decreased. Logistics costs were highest among process industry companies, of which logistics costs totaled 10.4% of turnover. (Industriens logistikk 2003, 4-5)

Study divides costs into six groups, of which the transportation costs comprise 67% of all costs. Other cost groups were warehousing, administration and other costs. The levels of the logistics costs in different cost elements are illustrated in Table 11. (Industriens logistikk 2003, 19)

Table 11 Logistics Costs in Norway 2001, bn. NOK (Industriens logistikk - en studie av logistikkostnader og ressursbruk i norskindustri 2003,19)

Cost component	bn. Norwegian krones	Portion of logistics costs
Transportation costs	18.5	67%
Warehousing costs	4.3	15.6%
Inventory holding costs	2.8	10.2%
Administration and planning costs	1.5	5.4%
Other costs	0.5	1.8%
TOTAL	27 600	

Transportation costs consist on both, inbound and outbound transport. Warehousing costs cover handling related costs like employees, premises and packaging, when inventory holding costs mean the costs of interest and obsolesce. Administration and planning costs are the costs, which are related to production planning, purchasing, ICT etc. Study also discloses the results as a part of turnover, but for one reason or another the costs are bundled into three cost groups, which are transportation (5.62%), warehousing (2.55%) and administration/planning/other costs (0.93%). The total costs as a part of the turnover have slightly decreased from 1997 to 2001. (Industriens logistikk 2003, 19-20; Hansen & Hovi 2008, 25)

In retail business, the costs are slightly smaller than among manufacturing industry. According the year 1999 study, the total costs were 9.2% of turnover, of which 4.1% was accrued of transportation costs and 1.0% of administration costs. Warehousing costs totaled also 4.1 % of turnover. (Hansen & Hovi 2008, 25)

3.2.1.3 Norsk Logistikkbarometer (Norwegian Logistics Barometer)

Norsk Logistikkbarometer study is sponsored by the logistics company DHL, and it has been conducted as a questionnaire based in every second year from 2003 Hansen & Hovi 2008, 16). The total logistics costs in year 2003 were 155 MEUR (162 MNOK), which equals 14.5% of turnover. (Norsk Logistikkbarometer results 2003)

In year 2005 logistics costs increased to 20.7% of turnover, of which the transportation costs were 4.6% and warehousing costs 9.4%. Again in 2007 the average of logistics costs decreased back to between 10-15 % of turnover (Hansen & Hovi 2008, 16). The study has employed very different methods and standards in submitting results. After 2005 study, the results were no longer presented in different cost groups, but below a rough figure. (Norsk Logistikkbarometer results 2007)

The latest 2009 report, however, categorizes cost into several groups. These groups and the average value of group in question are presented in Figure 40.

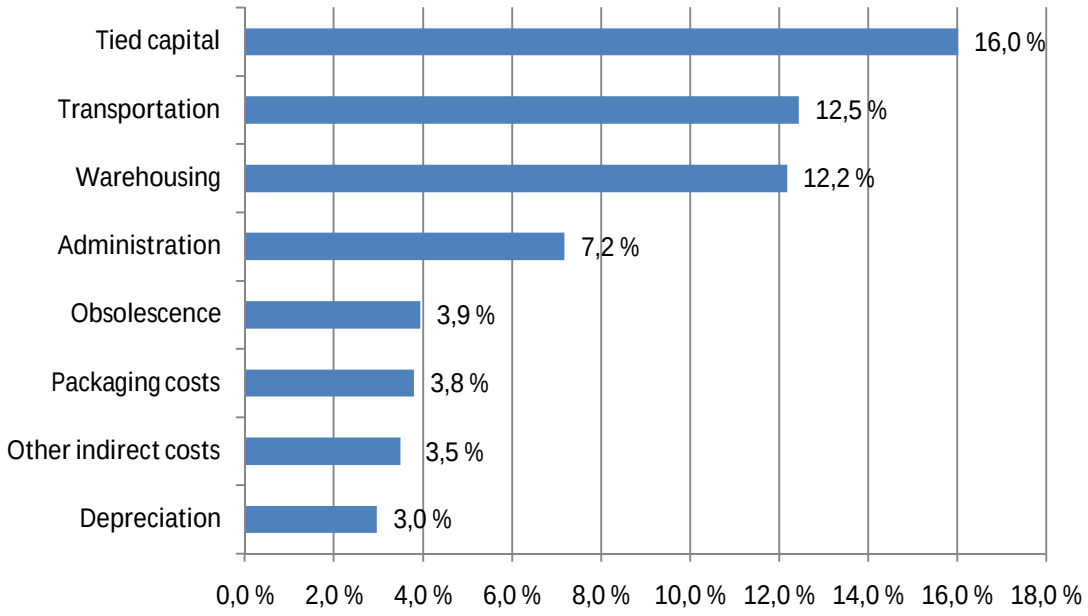


Figure 40 The Level of Logistics Costs per Component in Norway 2009 as a % of Total Logistics Costs (Norsk Logistikkbarometer results 2009)

Tied capital, which is largest cost group, is calculated as an average percentage of all purchases. Second largest group, transportation costs consist of all costs of physical inbound and outbound transportation. (Norsk Logistikkbarometer 2009 results)

3.2.1.4 SCI Verkehr Logistikbarometer, Germany

SCI Verkehr is an independent consultancy company, which is focused on traffic economy and traffic engineering (SCI Verkehr website). Among other studies, SCI also publishes monthly logistics barometer, which analyses the logistics indicators, chosen by 200 managers in transport and logistics industry. The first barometer was published in June 2003. (SCI Verkehr Logistikbarometer November 2009, 5) Even though the barometer doesn't straight open the different elements or disclose the value of logistics costs, it indicates the current trend in cost development (Figure 41).

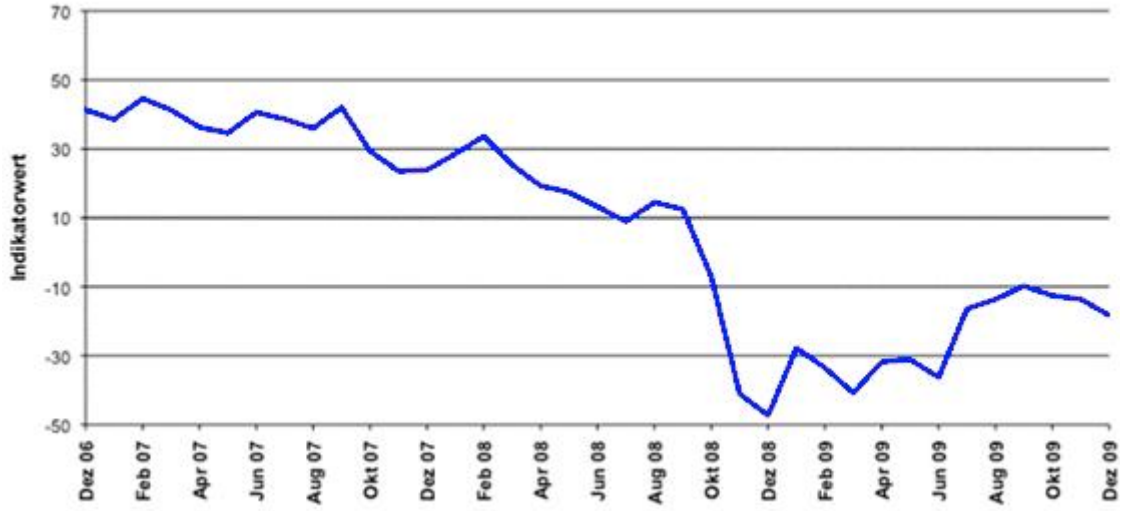


Figure 41 SCI Logistikbarometer (SCI Verkehr Logistikbarometer November 2009, 2)

According, the latest barometer available, published in November 2009, the logistics costs have stabilized in past months. 90 % of respondents declared that costs haven't change in last three months. 83 % of respondents also believe that costs will remain in stabilized stage for next three months. (SCI Verkehr Logistikbarometer November 2009, 2)

3.2.1.5 ASLOG – L'etat de l'art de la Locistisque Française (The State of the French Locistics)

The first French logistics study was conducted in year 2005/2006 and the latest one is published in 2008/2009. The purpose of the study was to assess the state of logistics in France and to gather information for creating metrics that allows comparison with other

countries in terms of logistics costs. The data for the study is based on interviews in 346 French companies, of which 18 were small (turnover less than 10 bn. EUR and less than 50 employees), medium-sized (turnover less than 50 bn. EUR and less than 250 employees) and 58% large companies. (ASLOG 2008/2009)

The total logistics costs were 11.9% (2008/2009) of turnover, which was higher than 9.9% in 2005/2006. The costs were highest in retail industry (14.3% of turnover), when the lowest cost level was measured in automotive industry (9.9%). Study classifies costs into three main groups, which were transportation, warehousing/inventory carrying and administration costs (Figure 42). (ASLOG 2008/2009)

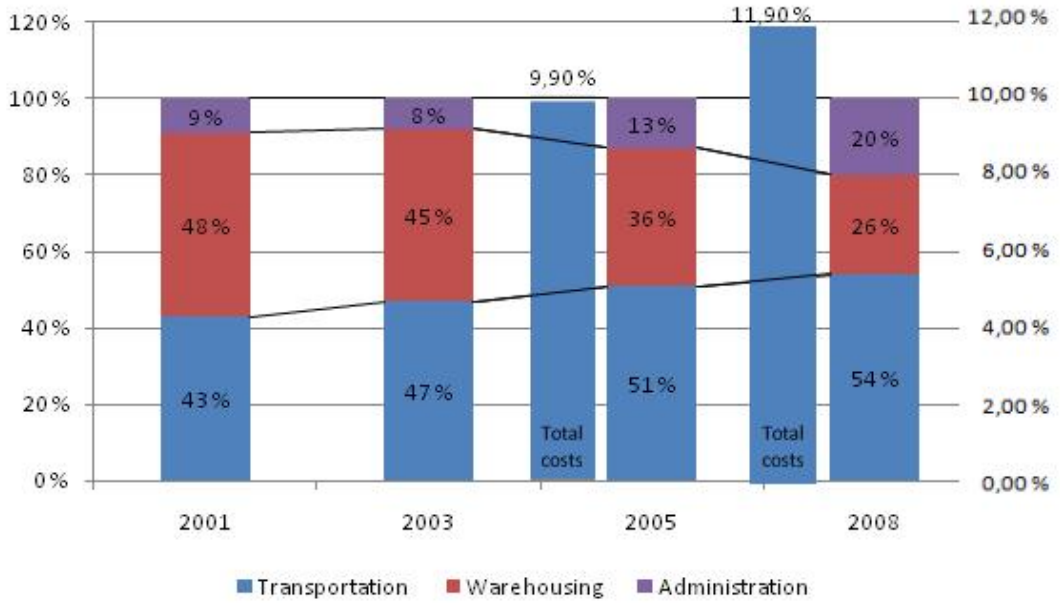


Figure 42 Logistics Costs per Cost Component in France 2001-2008 as a % of Total Logistics Costs and Total Costs as a % of Turnover (ASLOG 2008/2009)

The largest contribution to the total logistics costs has come from the transportation costs, which has increased its share every year. Correspondingly the share of warehousing costs has decreased by almost half from year 2001 level. Still the total logistics costs have risen by two percent between 2005 and 2008. (ASLOG 2008/2009)

3.2.1.6 Logistics in China

Consultancy firm PricewaterhouseCoopers conducted the study called Sourcing and Logistics in China 2008. It gathered the opinions of 203 German procurement and logistics managers concerning their experiences with sourcing and logistics in China. The

respondents represented five different sectors, namely manufacturing of machinery and equipment (42%), automotive (14%), electronics (11%), chemicals and pharmaceuticals (10%), retailing (9%) and service providers (7%). (Sourcing and Logistics in China 2008, 3)

Study includes several cost groups into logistics cost. Shipping/freight costs represents the largest share (8-10% of total cost of procurement) of total costs. The other cost groups in the study were: insurance, customs, delivery, warehousing, damage, management and appraisal costs. The results per cost groups are not disclosed in exact figures, but in four-level opinion scale (high – less high – low – can't say). However the logistics costs of some sub-industries in manufacturing were disclosed. The costs were highest in automotive industry (15-20% of procurement), followed by machinery (12-14% of procurement costs) and chemical and pharmaceutical industry (8-12% of procurement costs). By weighting these figures by the percentage of respondents, the total logistics costs of manufacturing are 13.54 of procurement costs (see Appendix 1). The costs of other industries are not disclosed in the study. (Sourcing and Logistics in China 2008, 20-21)

Also another global consultancy firm, KPMG, has published their insight of China's logistics markets. According this outlook published also in 2008, the expenditures of logistics services, transport, storage and management functions reached 3.8 trillion RMB in 2006. This figure was 13.5% higher than previous year's figure and was equivalent to 18% of GDP in China. It was further more estimated that the logistics market grew by 11% in 2007. (KPMG: Logistics in China 2008, 1-2)

The study in question breaks down logistics costs in three categories. These were transportation, storage and management. Transportation accounts for the largest share of total logistics costs (2.1 trillion RMB) followed by storage costs (1.2 trillion RMB) and management costs (500 billion RMB). The cost components and the development of costs are illustrated in Figure 43.

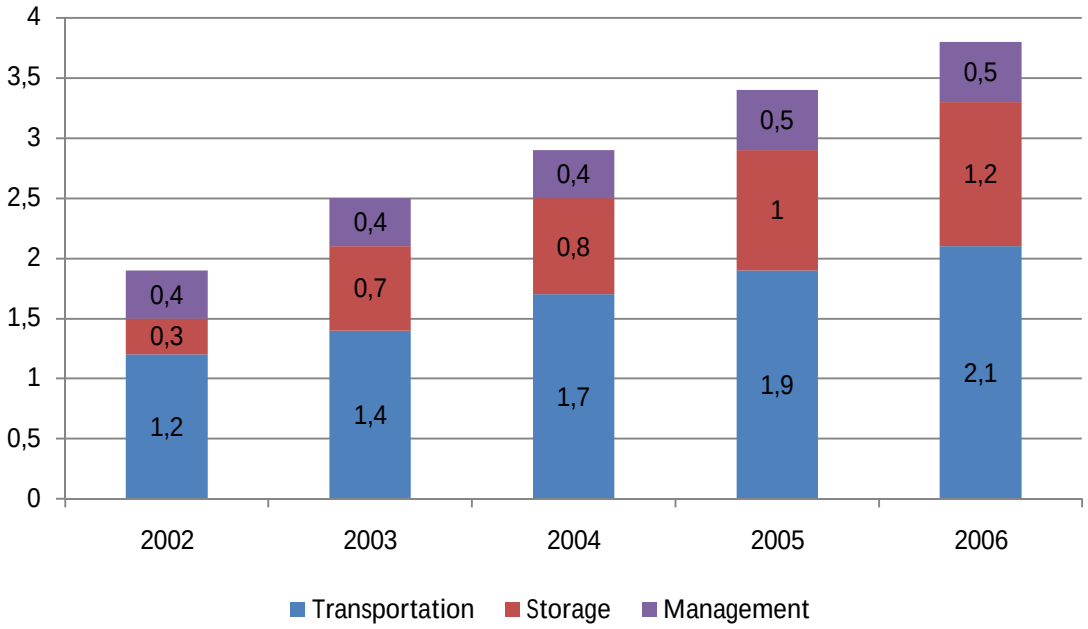


Figure 43 The Development of Logistics Costs in China 2002-2006, trillion RMB (KPMG: Logistics in China 2008, 2)

It is possible to recognize the upwards trend in cost development. However, compared to GDP the level of logistics costs has remained relatively stable from year 2001. Still the figure is high, compared to developed countries. (KPMG: Logistics in China 2008, 2)

3.2.2 Modeling Based Studies

3.2.2.1 CSCMP's Annual State of Logistics Report (USA)

Council of Supply Chain Management Professionals (CSCMP) publishes the Annual State of Logistics Report, which defines the current state of business logistics costs and outlook of business logistics in United States. The study is published on yearly basis. The latest report, which was published in June 17th 2009 cope with very topical issues occurred due to the global recession. The title of 20th Annual State of Logistics Report is *"Riding Out the Recession"* and it is conducted with similar methodology than previous reports, which makes the results comparable with each other.

The report is written in very reader-friendly form and it gives quick outlook to current situation. The model of cost calculations is not opened in the reports but the methods between these calculations are explained below. In the recent years, State of Logistics Reports has presented logistics costs in respect of four main cost groups (Figure

44). This is based on methodology employed by Bowersox and Calantone 2003, which was adapted into the State of Logistics Report in 2003. After adapting this model, one change has been made in cost classification. Original methodology employed the model of three main cost components, which meant that shipper related costs were included into transportation costs. At a later stage, shipper related costs was presented as a top level costs, which is only a technicality and has no affect on results. The methodology employed is called as CASS methodology, which derived from the name of the company, which established the methodology, namely Cass Information System Inc.

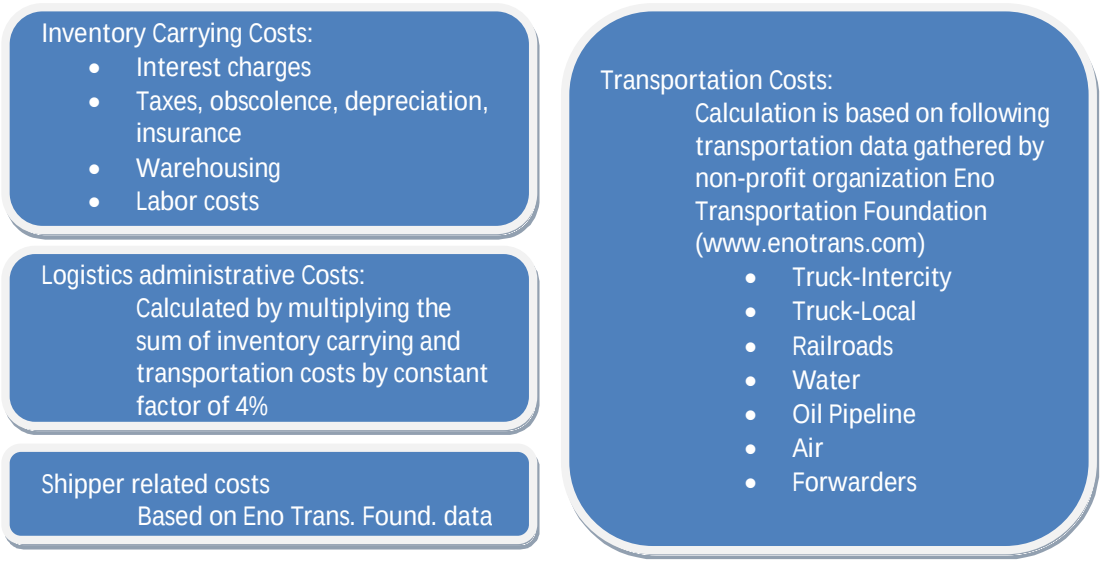


Figure 44 The Components of Logistics Costs in CSCMP's Reports (partly adapted from Farahani et. al 2009, 68; Wilson 2009, 2)

As one can see in Figure 44, the inventory carrying costs includes all the costs that are associated with holding goods in storage. These can be divided into four main groups, which are: capital costs for inventory investments (interest charges), inventory service costs (taxes, insurance, labor etc.), storage space costs (warehousing) and inventory risk costs (obsolescence, damages etc.). (Farahani et al. 2009, 75-76)

Transportation costs include the charges of transporting goods in all modes. These estimations are based on the data provided in annual Transportation in America report, which is published by the Eno Transportation Foundation. This report provides a broad data regarding movements of people and goods along the highways, railroads, waterways, public transportation and by air in the United States. Based on this data the expenditures of seven subgroups are calculated. (Farahani 2009, 76-77)

Logistics administration costs include the costs of indirect management and supporting staff, as well as IT-expenses. Administration costs are set at 4% of sum of three other main cost groups (transportation, inventory carrying and shipper related costs).

This same methodology has been employed since the first data series was published in 1973 (Table 13). (Farahani 2009, 77)

Table 12 Cost Components in CSCMP's Reports and CASS Method Data Sources (partly adapted from Farahani 2009, 78; Wilson 2009, 2)

Main cost components	Sub components	CASS data source
Carrying Costs	• Interest	• Annualized Commercial Paper Rate
	• Taxes, obsolescence, depreciation, insurance	• Alford-Bangs production formula
	• Warehousing	• Expenditure on public warehousing census
Transportation Costs	• Truck-Intercity	• *
	• Truck-Local	• *
	• Railroads	• *
	• Waterways	• *
	• Oil Pipelines	• *
	• Air	• *
	• Forwarders	• *
Shipper Related Costs		• *
Logistics Administration Costs		• 4% of total logistics costs

* Based on Eno estimates, which are derived on the basis of truck vehicle miles

In 2008, the logistics costs decreased from 10.1% (1397 billion USD) in 2007 to 9.4% (1334 billion USD) of the GDP. This is mainly due to the fact that recession has caused the situation, where abundant capacity, particularly in road transport and ocean shipping pushes rates even below the costs. Even thought the absolute costs of transportation have risen, the rise has been slower than rise of the GDP. Figure 45 illustrates the development of absolute costs and costs as a percentage of GDP. (CSCMP's 20th Annual State of Logistics Report 2009, 1)

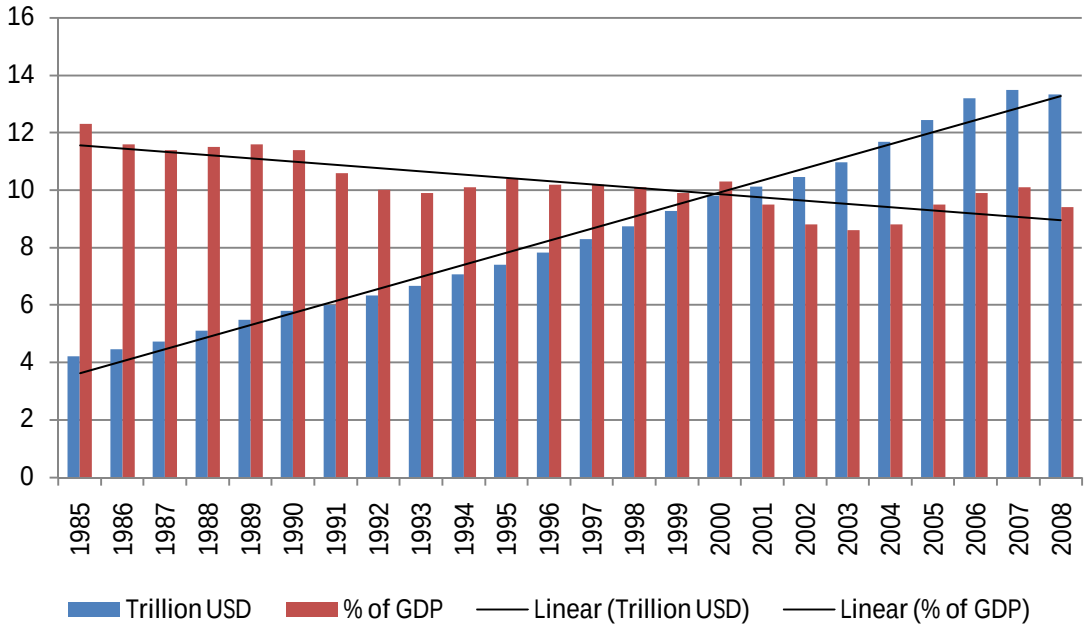


Figure 45 Logistics Costs in United States between 1985-2008 as a % of the GDP and as absolute costs, trillion USD (CSCMP's 19th Annual State of Logistics Report 2008, 30)

As it is possible to conclude from figure, the level of logistics costs has almost steadily decreased as a % of GDP, even the absolute value has increased. This means that economy has grown faster than logistics costs have increased, which further more means that the development has been a positive, at least from logistics' perspective.

The most significantly drop was in inventory carrying costs, which fell by 13%. This means a drop from 34% to 31 % as a share of total logistics costs. There are two main reasons for this decline, first the drop of 2.2% in inventories and 11.2% drop in inventory carrying rate. Furthermore the interest rates fell to 2.38% from 5.07%, which meant over 50% decreasing compared to 2007. Also the accumulated sum of taxes, insurance, obsolescence and depreciation was down by 7%. Only the warehousing costs rose by 9.5%, which was mainly due to the investments and developed value added services. (CSCMP's 20th Annual State of Logistics Report 2009, 2-4)

Transportation costs still continued rising, thought the growth was significantly slower compared to year 2007 results. Transportation costs still are clearly the largest individual cost component and accounts nearly 65% of total logistics costs. Almost 80% of transportation costs are road transportation costs. Shipper related costs has been relatively flat for recent years but logistics administration costs has fallen by 3.5% compared to 2007. (CSCMP's 20th Annual State of Logistics Report 2009, 2-8)

The development of logistics costs per main cost components as a % of GDP is illustrated in Figure 46.

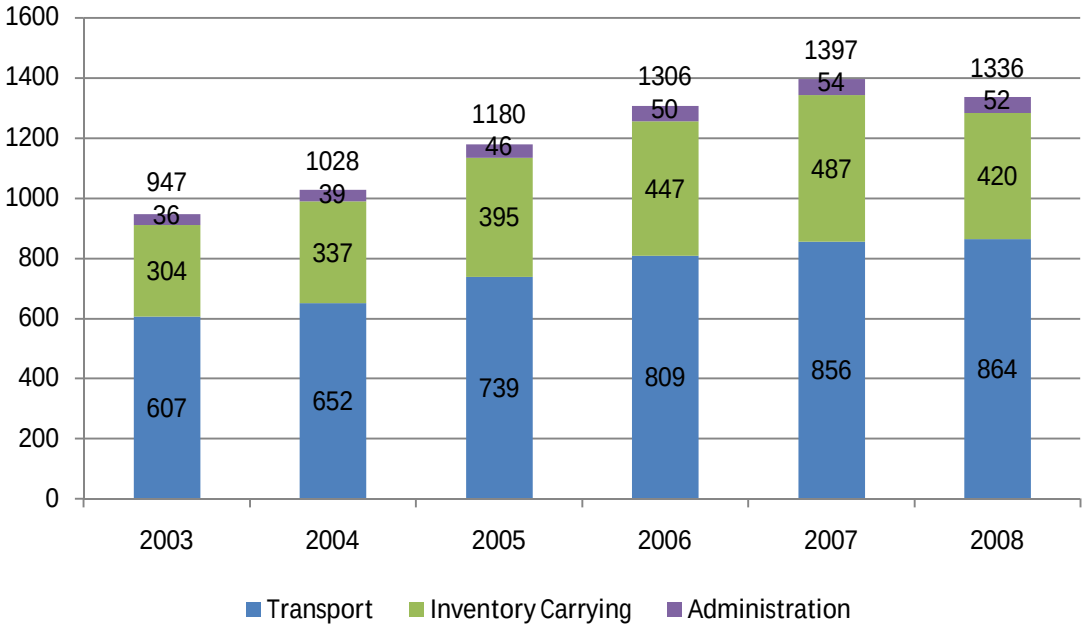


Figure 46 The Development of Logistics Costs per Cost Component in U.S. between 2005-2008, billion USD (data source: CSCMP's 19th Annual State of Logistics Report 2008, 30; Wilson 2009, 2)

As it is possible to conclude from Figure 46, inventory carrying costs has reduced most significantly and there has also been a reduction in administration costs. On the other hand, the transportation costs have risen slightly. Investments in new capacity have dropped and companies are trying to get rid of the overcapacity, which may lead into rising costs in future.

3.2.2.2 Vinnova - Svensk Makrologistik 1997-2005 (Macro Level Logistics in Sweden)

The aim of Svenks Makrologistik study was to create a tool for measuring macro level logistics in Sweden annually. Background variables of Svensk Makrologistik study are based on national statistics, which are collected in line with international statistics standards. The study is strongly concentrated on creating logistics costs database in industry and national level, as well as presenting the development of logistics costs in Sweden between 1997 and 2005. The comparison with international results and measuring techniques has also been made. (Elger, Lundquist & Olander 2008, 7-9)

The components of logistics costs in the study are grouped in four-level breakdown. The first cost group, direct transportation costs, consists of all costs that are occurred due to the transportation of goods. Warehousing costs covers all costs related to holding an inventory. These costs can be further broke down into cost of actual warehousing and

inventory carrying costs. Administration costs are defined as costs that are related to planning, implementing and tracking of transportation or warehousing. Results are presented for small (0-49 employees) and large (over 50 employees) enterprises, as well as by industry. (Elger et al. 2008, 17; 19-21)

Direct transportation costs are combined by summing the costs of internally produced transportation activities and bought (external) activities. Inventory carrying costs are combined by calculating the interest of 25% for inventory value and adding the warehousing costs, which are considered as the costs of warehousing premises and other costs related to these premises. Administrations costs are measured by calculating personnel costs and other overhead costs, which are related to logistics activities. The total logistics costs are the sum of all cost subgroups. (Elger et al. 2008, 21-23)

The absolute costs of logistics in 2005 were 233.3 bn. SEK (25.7 bn. EUR), of which the inventory carrying costs represented the biggest share of total costs (Table 13). Transportation costs have increased mostly between the years 1997 and 2005, reaching 85.5 bn. SEK in 2005.

Table 13 Logistics Costs in Sweden 1997-2005, bn. SEK (Elger et al. 2008, 24)

Year	Direct transport costs	Inventory carrying costs	Warehousing costs	Administration costs	Total costs
1997	49.8	109.3	5.9	30.6	195.5
1998	56.9	112.4	4.5	37.4	211.1
1999	61.9	114.3	4.4	38.7	219.3
2000	72.5	129.7	4.9	43.1	250.2
2001	77.4	130.1	5.3	44.8	257.6
2002	74.6	122.5	4.9	42.2	244.2
2003	74.2	86.8	5.3	39.4	205.7
2004	77.7	89.1	5.6	40.2	212.7
2005	85.5	100.7	6.2	40.8	233.3

Figure 47 illustrates the structure of logistics costs in Sweden between 1997 and 2005. The levels are presented in percents of total logistics costs.

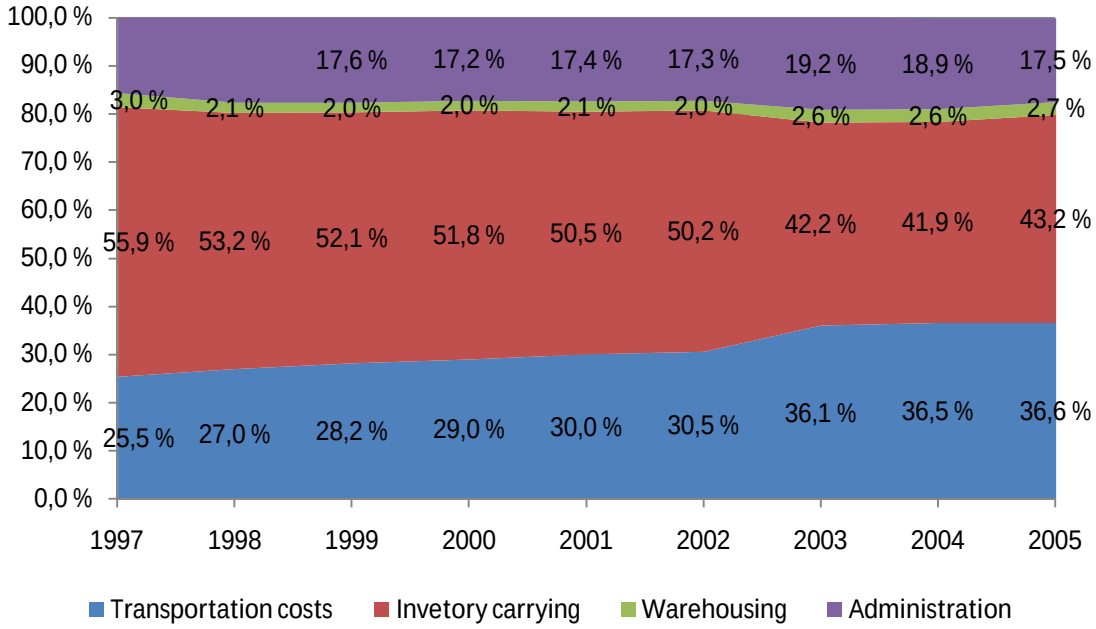


Figure 47 Logistics Costs in Sweden 1997-2005 as a % of Total Logistics Costs (data source: Elger et al. 2008, 24)

Figure 47 indicates that proportionally the transportation costs have risen the most. Correspondingly the warehousing costs have decreased most, when inventory carrying and administration costs have remained in stable level.

3.2.2.3 State of Logistics Surveys for South Africa

Annual State of Logistics Survey for South Africa has been published annually from 2004 by the Council for Scientific and Industrial Research (CSIR). Fifth edition was published in 2008 and in the case of logistics cost, it follows the same structure, which was employed in earlier versions. The theme for this study was "Logistics value and cost drivers from macro-economic perspective" and it focuses on value and cost drivers that have influence on South Africa's global competitiveness. (State of Logistics Survey for South Africa 2008, 6)

In the case of the logistics costs, studies have adopted formal and quantitative approach. Since the first study in 2004, all editions have consequentially employed the same modeling technique as a tool of assessing national logistics costs. The model starts from a point, where it computes the total logistics costs by using a product specific data regarding the transportation mode, transported- and stored tonnage, transportation distances and -costs, transit times and opportunity cost of time during the transport. (State of Logistics Survey for South Africa 2004, 4-9) This model is called as Logistics Cost Model (LCM), which employs the bottom-up approach to compute logistics costs by

aggregating primary input elements (amount of commodities produced) and the costs of performing additional activities (transport, storage and handling). (State of Logistics Survey for South Africa 2007, 14-15)

The model has gone through many improvements during the recent years. In addition, the results have been later adjusted to match with the revised country specific data like GDP. (State of Logistics Survey for South Africa 2008, 6-10) Due to these facts, it is reasoned to present only the most recent data, which also includes the backdated figures from previous studies.

The logistics costs in South Africa for 2007 totaled 15.9% of GDP. This is slightly bigger than in 2006, when total logistics costs were 15.7% of GDP. Before 2007, the costs were reduced per 0.2% of GDB compared to 2003 (Figure 48). (State of Logistics Survey for South Africa 2008, 14)

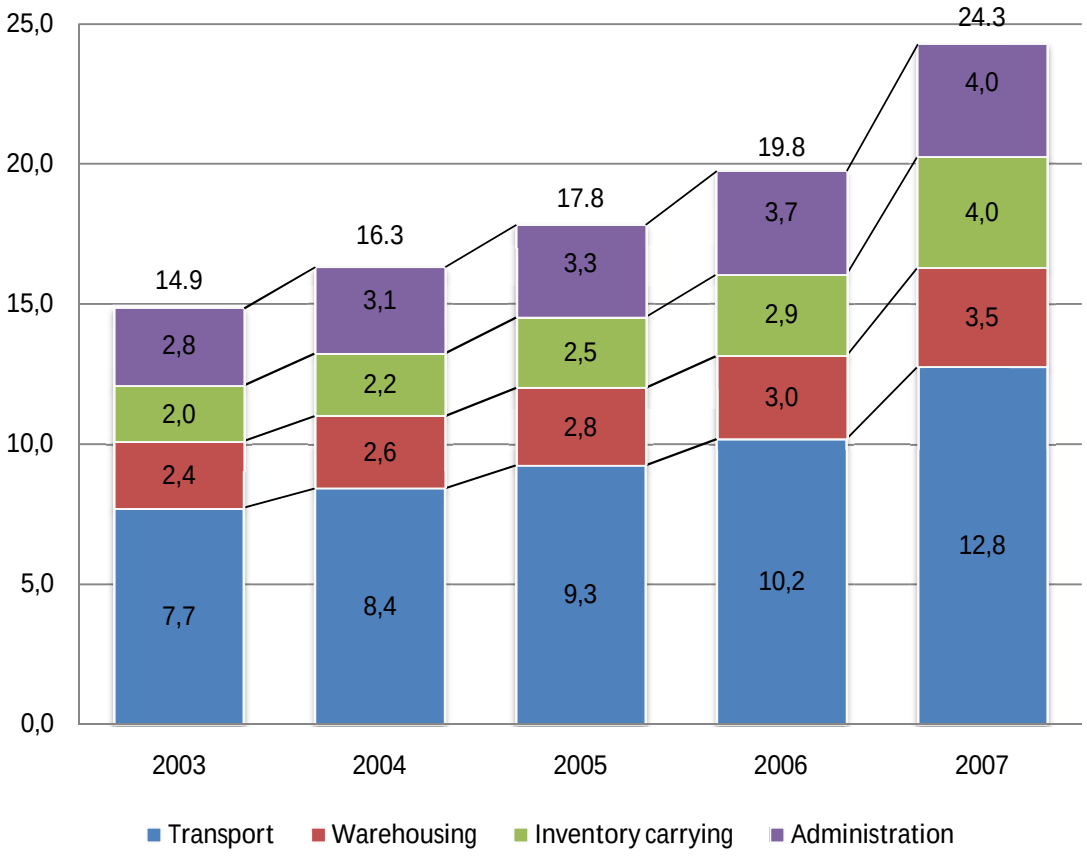


Figure 48 Total Logistics Costs per Cost Component in South Africa 2003-2007 as a % of GDP (data source: State of Logistics Survey for South Africa 2008, 14)

From 2004 study, logistics costs are divided into four categories: transportation, inventory carrying, storage & ports and management & administration & profit. In 2007 the percentage contribution of transportation costs to total costs was 53%. Comparing

this to world's average contribution (39%), the portion is rather high. Also the level of inventory carrying costs growth significantly. According the research, this was mainly because of considerable growth of stock tied in inventory and raise in average interest rates. Growth on stocks was mainly due to long transportation distances in South Africa, which lead, not only to increase in transportation costs, but also in inventory carrying costs. (State of Logistics Survey for South Africa 2008, 15-17; Farahani et. al 2009, 80)

3.2.2.4 Logistikmarktstudie Schweiz 2010 (Study over the Logistics Markets of Switzerland)

According the logistics market study of Switzerland, conducted by the St. Gallen University, the volume of Switzerland logistics markets was approximately 36.754 bn. CHF (24.7 bn. EUR). As a percentage of cumulated turnover of all industries, this totals 3.6%. The total figure divides among four main cost groups, namely transportation, handling, warehousing and other logistics costs (Figure 49). (Stölzle, Hoffmann & Gebert 2009, 145-149)

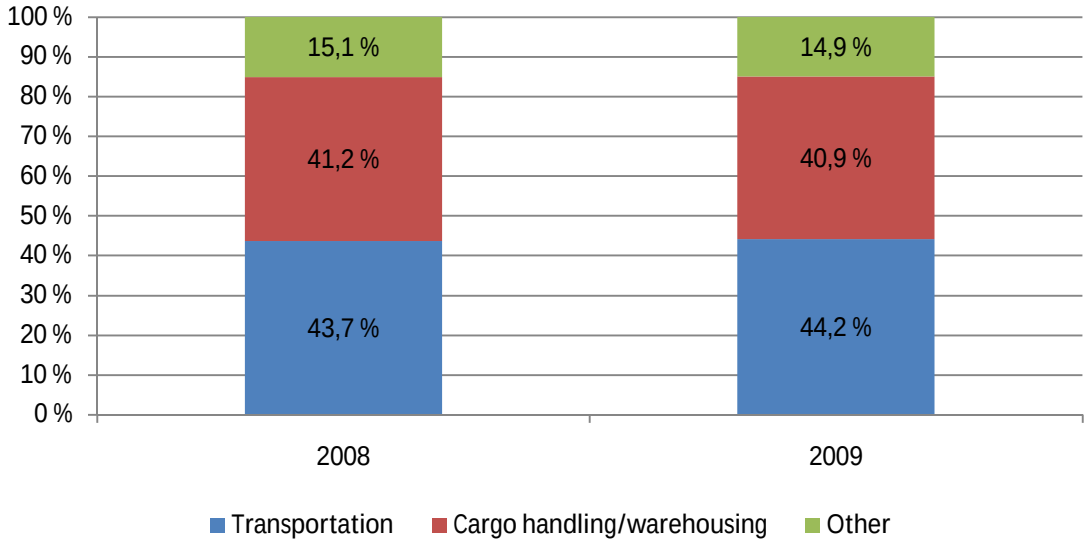


Figure 49 Share of Logistics Cost Components of Total Logistics Costs in Switzerland 2008 and 2009 (data source: Stölzle, Hofmann & Gebert 2008, 87; Stölzle et. al 2010, 135)

The share of transportation costs in 2009 accounted 15.6 bn. CHF (10.5 bn. EUR), corresponding figure in 2008 was 15.6 bn. CHF (9.8 bn. EUR). Cargo handling/warehousing costs were a bit smaller, 14.4 bn. CHF (9.7 bn. EUR) but increased 0.6 bn. CHF from 13.8 bn. CHF (9.3 bn. EUR) in 2008. The group of other logistics

costs totaled 5.2 bn. CHF (3.5 bn. EUR) in 2009, which was almost same than 5.1 bn. CHF (3.4 bn. EUR) in 2008. (Stölzle et. al 2008, 57; Stölzle et. al 2010, 135)

The latest study published in 2010 provides very comprehensive statistics regarding the industry specified logistics costs. Study presents logistics costs in 43 different branches and cost component specified results in seven main industries. (Stölzle et al. 2009, 146-149)

3.2.3 Summary of Single Country Studies

Figure 50 and Table 14 gather the results of reviewed modeling and questionnaire based studies, which concentrate on logistics costs in one country. Also the results of studies conducted in Morocco, Thailand and Nederland are included. These studies are presented in next paragraph under the topic "Other Studies". The figure below presents the level of total logistics cost as a percentage of GDP in different countries.

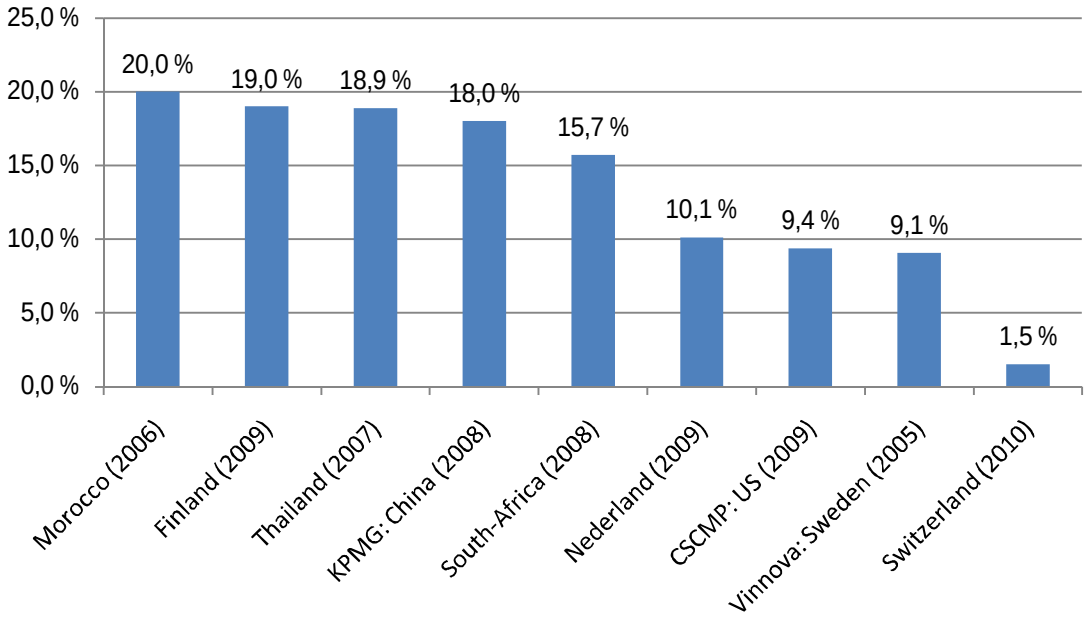


Figure 50 Level of Total Logistics Costs in Single Country Studies as a % of GDP

As seen in Figure 50, the level total logistics costs is higher in developing countries excluding Finland, which also has a high logistics costs. This can partially be explained by Finland's geographical factors like long transportation distances and the low density of inhabitants. Table 14 gathers the essential aspects of reviewed single country studies.

Table 14 Summary of Single Country Level Logistics Studies

Survey	S- Africa 2008	CSCMP 2009	TF 2003 (ind.)	TF 2003 (retail)	Nor.log. bar. 2009	PwC 2008	SCI 2009	Vinnova 2005	Thailand 2007	KPMG 2008	Aslog 2008/2009	Nederlands 2009	Morocco 2006	Switzerland 2010	Finland 2009	COUNT
Type of research	M	M	Q	Q	Q	Q	Q	M	M	M	Q	M	M	M	Q	
Cost components																
Transportation	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	13
Inventory carrying	✓	✓	✓		✓			✓	✓			✓	✓		✓	9
Warehousing	✓		✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	13
Administration	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	13
Transport pack.					✓								✓		✓	3
Other logistics			✓											✓	✓	3
Shipper related		✓				✓										2
Obsolescence					✓								✓			2
Other indir.log.c					✓											1
Depreciation					✓											1
Delivery						✓										1
Insurance						✓							✓			2
Appraisal						✓										1
Customs						✓										1
Damages						✓										1
Plan/mngmnt												✓				1
Cargo handling													✓	✓		2
Documentation													✓			1
Communication													✓			1
R&D													✓			1
Equipments													✓			1
Internal services													✓			1
Customer serv.													✓			1
Industry classification																
Manufacturing			✓	✓		✓										
Total costs	✓	✓							✓	✓	✓	✓	✓	✓	✓	
Time series																
-1990		✓													✓	
1991-1995		✓													✓	
1996-2000		✓	✓					✓							✓	
2001-2005	✓	✓	✓		✓		✓	✓		✓	✓				✓	
2006	✓	✓					✓			✓	✓	✓	✓			
2007	✓	✓			✓	✓	✓		✓							
2008	✓	✓			✓		✓				✓	✓		✓	✓	
Scale of measurement and logistics cost in the most recent study																
% of sales/turnover			9.1	9.2	✓						11.9			3.6	14.3	
% of GDP	15.7	9.4						9.08	18.9	18			20	1.51	19	
Absolute costs (bn.€)	24.3	916	28.8					25.7	33.7	355		46		22.9	34.7	
% of procurem.						✓										
Recent trend	↑	↓	↓		↑		⇄	↑	↑	⇄		↑		↑	↑	
Expectations in future cost deve.							⇄							⇄	↑	
Company size classification, no. of classes	2					2		2							4	
Area covered	RSA	USA	NOR	NOR	NOR	CHN	DEU	SWE	THA	CHN	FRA	NLD	MAR	SUI	FIN	

As in Table 8, the method (Q/M), respective cost components and years of conducting are indicated. Also the level of logistics costs (also indicated in respect of industry if possible), scale of measurement, company size classification and study area are provided.

3.2.4 Case Study-based Methods and Other Studies

In this chapter, some studies that cannot be categorized as modeling or questionnaire based studies are briefly presented. These studies can be roughly divided between case studies and other studies, which both are discussed with examples below.

3.2.4.1 La Logistique du Commerce et la Compétitivité du Maroc 2006 (Logistics and Trade Competitiveness in Morocco)

La Logistique du Commerce et la Compétitivité du Maroc 2006 was initiated by the cooperation between The World Bank and Ministry of Transportation in Morocco. The report measures the logistical competence of Morocco, as well as makes some development proposals. Study is combined based on previous research results, national statistics, national accounts and hearings of several actors in different industries, governmental bodies and export- and import organizations. An analysis was drawn in industries, which are important for economy of Morocco, namely automotive-, electronics-, textile- and fruit/grocery industry. (La Logistique du Commerce et la Compétitivité du Maroc 2006, 5-6; 111)

The total logistics costs in Morocco were approximately 20% of GDP. This is relatively high compared to other developing economies like Mexico or Brazil, where logistics costs were around 15-17% of GDP. These can also be seen as an opportunity to improve Morocco's competitiveness. The components of logistics costs in this study are categorized by using the fourfold table (see also 2.3.1.), which divides costs between direct and indirect costs, as well as production and overhead costs (Figure 51).

According the study, indirect logistics costs formed a half of total logistics costs, which is corresponding to 10% of GDP. For example the transportation costs for textile industry in Morocco are more than twice the figure in U.S., China or Thailand. (La Logistique du Commerce et la Compétitivité du Maroc 2006, 5; 19-20)

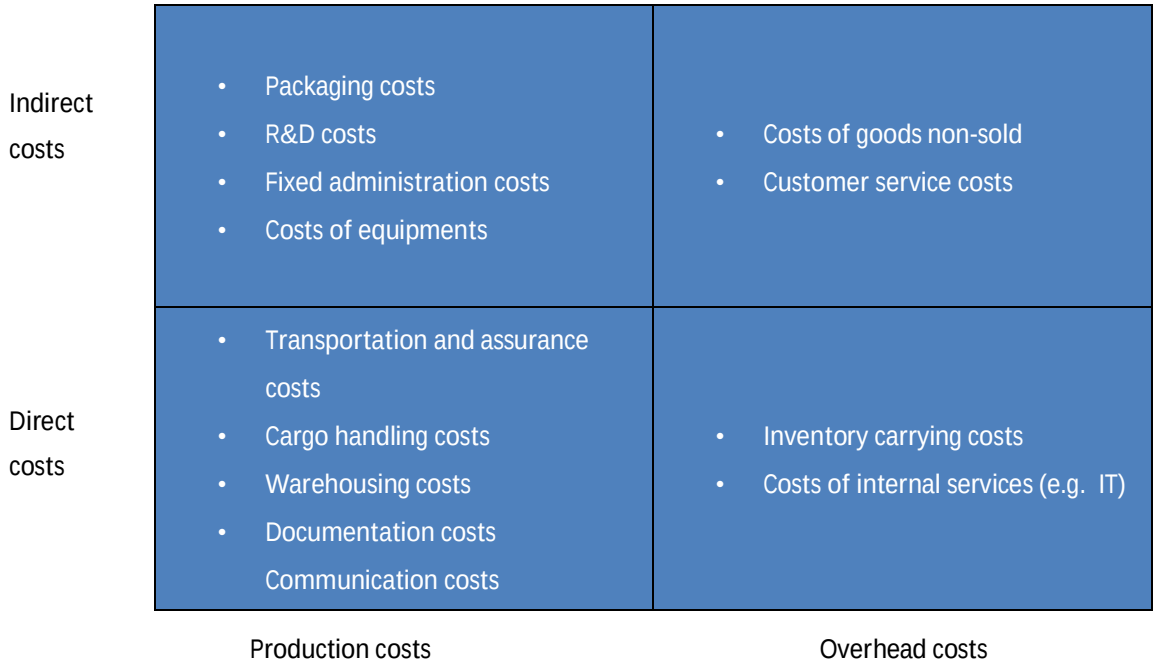


Figure 51 Components of Logistics Costs in La Logistique du Commerce et la Compétitivité du Maroc 2006 (La Logistique du Commerce et la Compétitivité du Maroc 2006, 112)

The largest individual logistics cost group is transportation and assurance costs, which total 60% of all direct logistics cost. Remaining 40% of direct logistics costs split for other cost groups (non-transport costs). (La Logistique du Commerce et la Compétitivité du Maroc 2006, 112)

3.2.4.2 Logistics Report 2007 Thailand

Office of the National Economic and Social Development Board (NESDB) in Thailand has developed a model and database to announced official Thailand's logistics since 2003. The first report was published in 2007 based on several studies conducted in collaboration with universities. The logistics costs as a percentage of GDP in 2007 were 18.9%, which equals with 1.6 trillion Baht. The figure includes 46% (or 736.2 billion Baht) of transportation costs, 45% (721.8 billion Baht) inventory holding costs and 9% (145.8 billion Baht) of logistics administration costs (Figure 52). (Logistics Report 2007 Thailand)

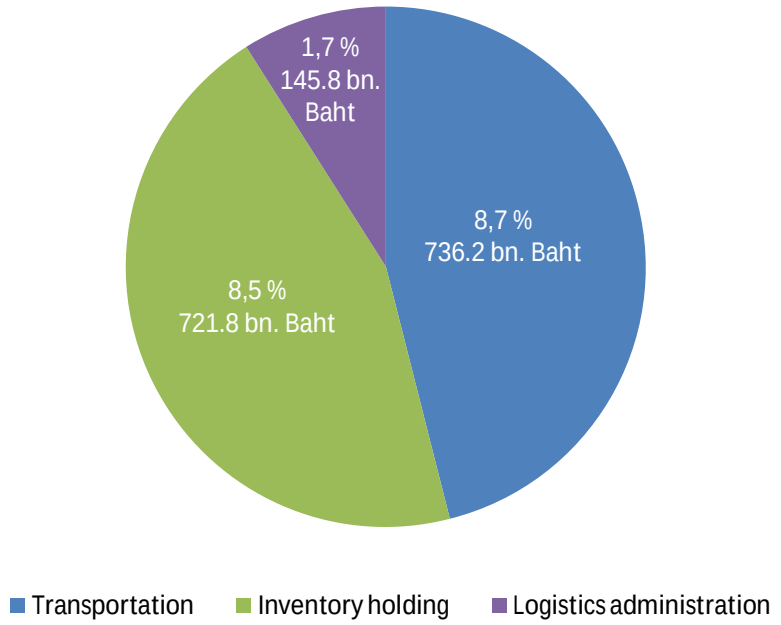


Figure 52 Thailand's Logistics Costs in 2007 as a percentage of GDP and absolute costs (Logistics Report 2007 Thailand)

Transportation and inventory holding costs were relatively high in terms of values and proportions. Furthermore, the growth rate of inventory holding costs has been high, 8.9 % per year, which exceeds the growth of transportation costs (6.4% annum).

3.2.4.3 De logistieke kracht van Nederland 2009 –Study (The Logistical Strength of the Netherlands 2009)

De logistieke kracht van Nederland 2009 was published for the second time in 2009. The logistics costs in the Nederlands are increasing 2.5% yearly and in 2009, total costs were a little over 46 billion EUR. The total costs are divided into five groups. These were transportation, warehousing, inventory carrying, administrative and management/planning costs. (De Logistieke Kracht van Nederland 2009, 22-23)

Transportation costs counted for biggest share of total logistics costs by 20.5 billion EUR or 43% of total logistics costs. Second biggest cost group was warehousing costs (11.5 bn. EUR), followed by inventory carrying costs (9.7 bn. EUR). The total expenditures for administrative and management/planning costs were close to 5 billion euro. (De Logistieke Kracht van Nederland 2009, 23) According the study, the cost structure was quite similar with studies conducted in same geographical area.

3.2.5 Case Studies

This chapter briefly goes through the results of the studies conducted by using the case study-approach. This approach is primarily employed in countries, where sufficient statistical data is unavailable or the environment is otherwise unfavorable for data collecting (e.g. low-income level countries). Since the relevance and comparability of the results in these studies fluctuates greatly, only some of the most focal studies, which can be considered as reliable, are discussed below.

The World Bank Group has published many papers concerning the trade logistics and logistics costs. One of the latest ones is called *Improving Logistics Costs for Transportation and Trade Facilitation* (Policy Research Working Paper 4558) published in 2008 by Gonzalez, Guasch and Serebrisky. The results regarding the logistics costs in this study are presented as a part of total costs in Figure 53. (Gonzalez, Guasch & Serebrisky 2008, 10)

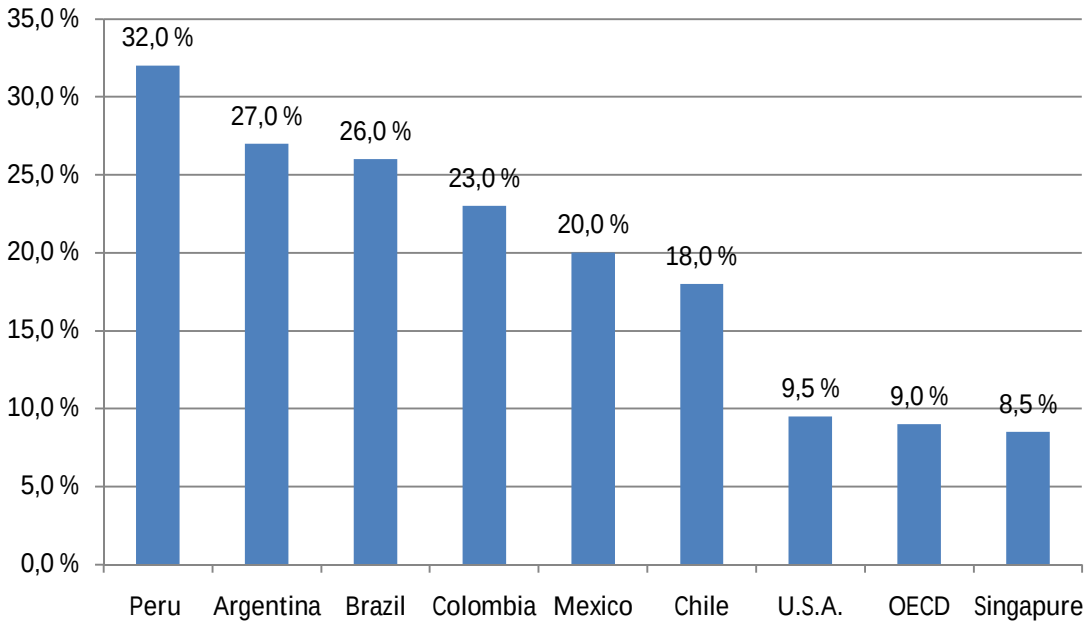


Figure 53 Logistics Costs in Latin America and Chosen Developed Countries as a % of GDP (Gonzalez et al. 2008, 10)

In several World Bank reports, a three level break down is applied in logistics costs grouping. It has been considered that logistics costs include: 1) transaction costs (costs related to transport and trade processing of permits, customs and standards), 2) financial costs (inventory, storage, security) and 3) non-financial costs (insurance). This same grouping is also employed in *Argentina – The Challenge of Reducing Logistics Costs* (report no. 36606-AR) and by Gonzales, Guasch and Serebinsky in their report *Latin America: Addressing High Logistics Costs and Poor Infrastructure for Merchandise*

Transportation and Trade Facilitation. (World Bank reports 1, 19; World Bank reports 2, 6; Gonzalez, Guasch, & Serebrisky, 2008, 8)

In Working Paper 4258 (2007), Arvis, Raballand and Marteau have proposed a different grouping of logistics costs. This is mainly due to the subject of their study, which examines logistics costs in landlocked countries. This particular character allows author to assess the level of logistics cost by measuring transit transportation. In their grouping, the total logistics costs are also consisted on three components, which are 1) transportation costs, 2) other logistics costs and 3) delay hedging costs. Transportation costs are fees that are paid for actual transit transportation services to trucker or rail operators. Other logistics costs combine transit overheads, like fees, procedures and facilitation payments. This cost group also includes the fixed costs of shipment. The last cost group is called as delay hedging costs, which includes the costs of moving inventory in transit, as well as induced costs to hedge unreliability inventory and warehousing costs, or shift to faster or more expensive mode of transportation (Arvis, Raballand & Marteau, 15-16)

According the World Bank estimation, logistics costs as a percentage of GDP (or sale value of the product) in Latin America was significantly higher than OECD average (Figure 54). Argentina is suffering the highest logistics costs in region (27%), followed by Brazil (24.5%) and Colombia (21%). The figures are combined in 2002. (World Bank reports 1, 20-21)

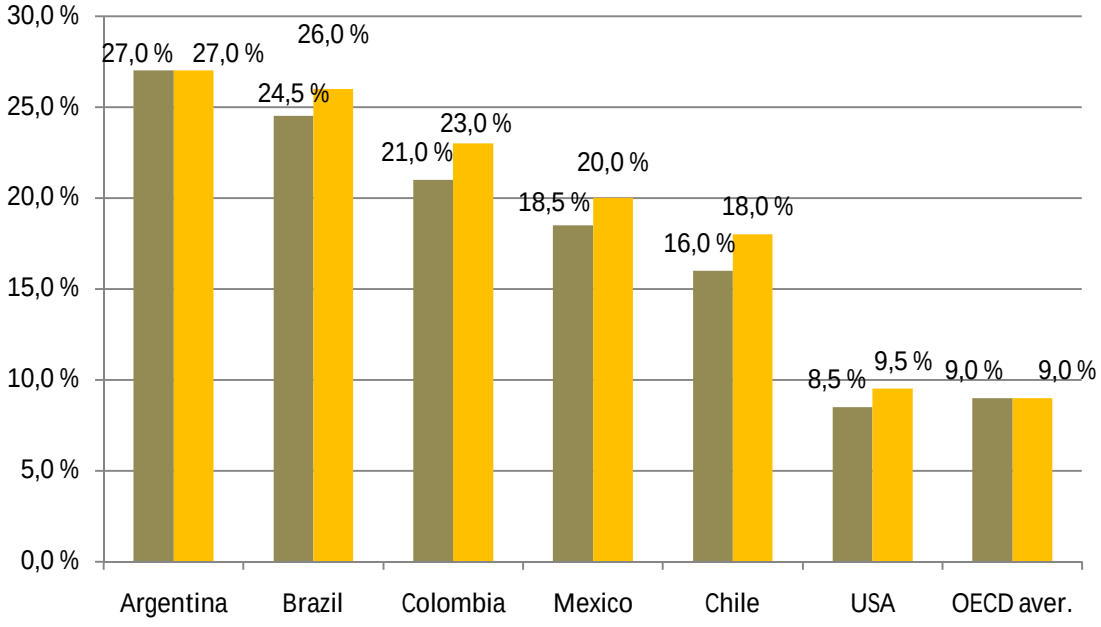


Figure 54 Logistics Costs in Latin America, USA and OECD Average as a % of GDP in 2002 and 2004 (World Bank reports 1, 20-21; World Bank reports 2, 8-9; Arvis et al., 9-10)

As illustrated in Figure 54, the cost trend has been upward between 2002 and 2004 in almost every country. In this trend, Argentina makes an exception by remaining the costs in practically same level.

There are also several other researches published for the World Bank by various academic and research institutions. For example Ojala has published a research regarding the trade logistics issues in Albania 2008. The results of this and similar studies are presented in Table 15.

Table 15 Logistics Costs in Chosen World Bank Studies

Study	Area	Year of the study	Total logistics costs as a % of GDP (USD million)
MOLDOVA TRADE DIAGNOSTIC STUDY, Chapter 7: Trade Facilitation Constraints related to Transportation and Logistics (Ojala)	Moldova	2003	22.2 % (356)
TAJIKISTAN TRADE DIAGNOSTIC STUDY, Transportation and Trade Facilitation (Ojala, Kitain & Touboul)	Tajikistan	2004	27.2% (318)
Ojala: Albania Country Economic Memorandum, Trade Logistics input. (mimeo)	Albania	2008	19.2% (2,042)
Ojala: Ukraine: Trade and Transit Facilitation Study (mimeo)	Ukraine	2009	18-20%

Banomyong, Cook & Kent (2008) have presented, among the other topics, in their journal article *Formulating regional logistics policy: the case of ASEAN*, the logistics costs in ASEAN region. ASEAN consists of Brunei, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. The results of this study were based on seven questionnaires related to logistics activities in following sectors: customs, ports and maritime transport, rail-, road-, inland waterway- and air transport as well as logistics services. (Banomyong, Cook & Kent 2008, 360-362) The ratios of selected export logistics costs as a percentage of sales in ASEAN are presented in Table 16.

Table 16 Export Logistics Costs in ASEAN as a % of Sales (Banomyong et al. 2008, 367)

Industry	Sourcing cost (%)	Inventory holding (%)	Ware-housing (%)	Transpor-tation (%)	Export process costs (%)	TOTAL (%)
Food	0.3	0.2	0.5	1	2	5
Textiles	4	2	2	6	3	17
Wood	3	3	2	5	11	24
Auto	2	1	2	5	6	16
Electrical goods	3	1	2	2	2	10
Average costs	2.5	1.4	1.7	4	4.8	14.4

As seen in Table 16, the logistics costs in ASEAN are in most businesses considerable higher than in western countries. Logistics costs seem to be highest in wood industry, in which costs are over 5% higher than second industry, textiles.

3.3 The Profile of Logistics Costs Measurement in Previous Studies

In paragraphs 3.1 and 3.2, the information is gathered by carrying out an extensive and multi dimensional review of attempts to measure logistics costs in national or multinational level. As presented above, there are three main lines of study methodologies implied in logistics costs research. These are: 1) modeling based studies, 2) questionnaire based surveys and 3) case- and other studies.

In addition to these two dimensions, coverage and method, studies may be positioned according the themes of studies. Some of the studies have concentrated just to assess the level and structure of logistics costs, but in many cases logistics costs are dealt with as a part of some more general study. Figure 55 illustrates the positioning of all previous studies presented in this chapter in accordance of these three dimensions. The numbered order of studies follows the same order the studies were discussed in previous sub chapters.

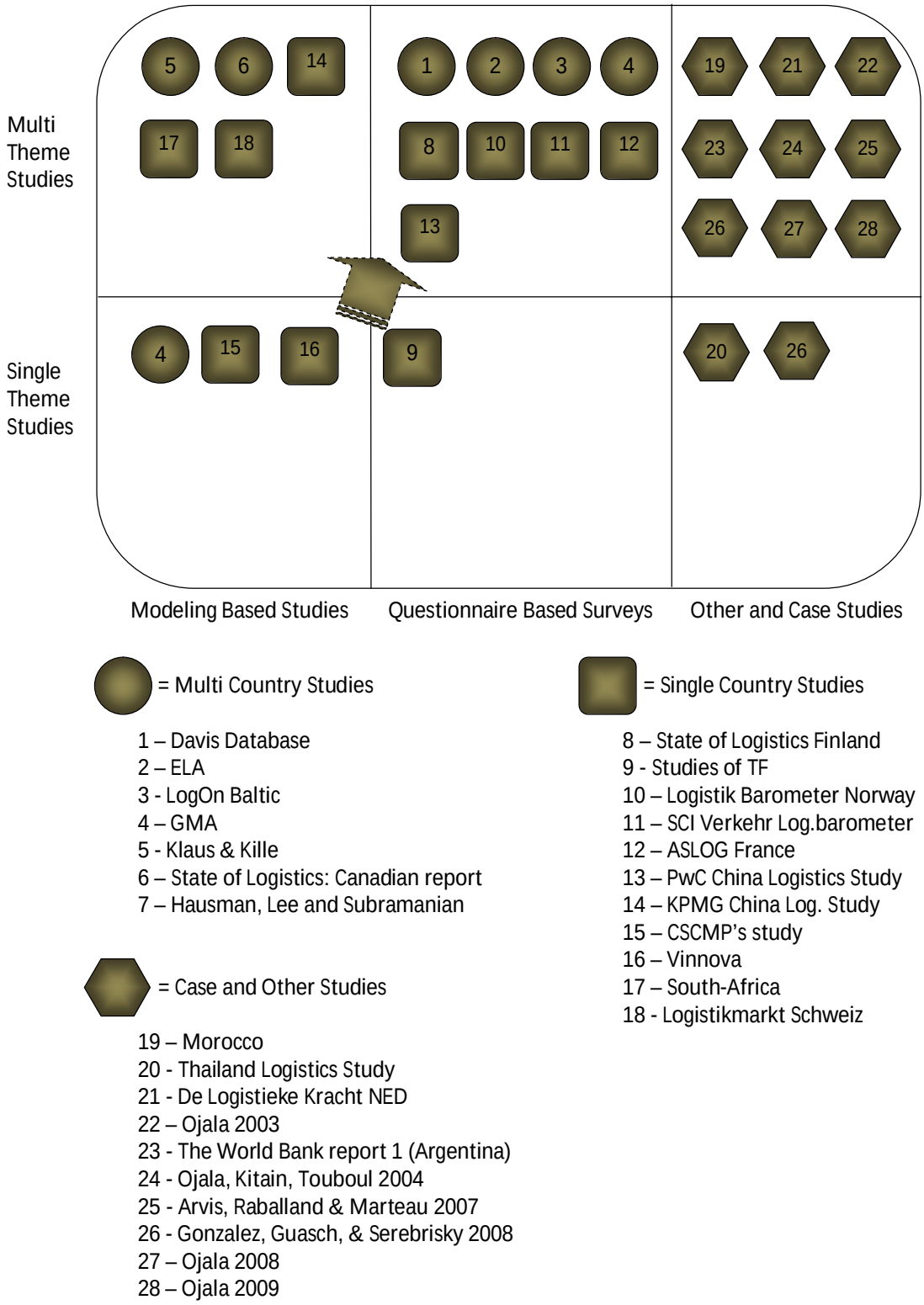


Figure 55 Positioning Logistics Studies in Accordance of Coverage, Themes and Methodologies (due to the thematic reasons, this figure excludes some studies like Straube & Pfohl 2008)

As seen in Figure 55, logistics costs are usually studied in modeling based studies and questionnaire based surveys as part of a multi theme study. Concerning the method of study, questionnaire based surveys and modeling based studies seems almost as popular. However, questionnaire based surveys usually deals with a number of themes, while modeling based surveys are more equally divided between single- and multi theme studies. The dotted arrow illustrates the weighting of previous modeling studies and questionnaire surveys, of which the multi theme questionnaires seems to be the most common way of assessing logistics costs. Also case studies usually handle several themes instead of concentrating on just the logistics costs theme. Of course this distribution, especially among case studies, is heavily dependent on the broadness of concept of single theme. It is also possible to recognize the increasing trend (Figure 56) in a number of studies conducted.

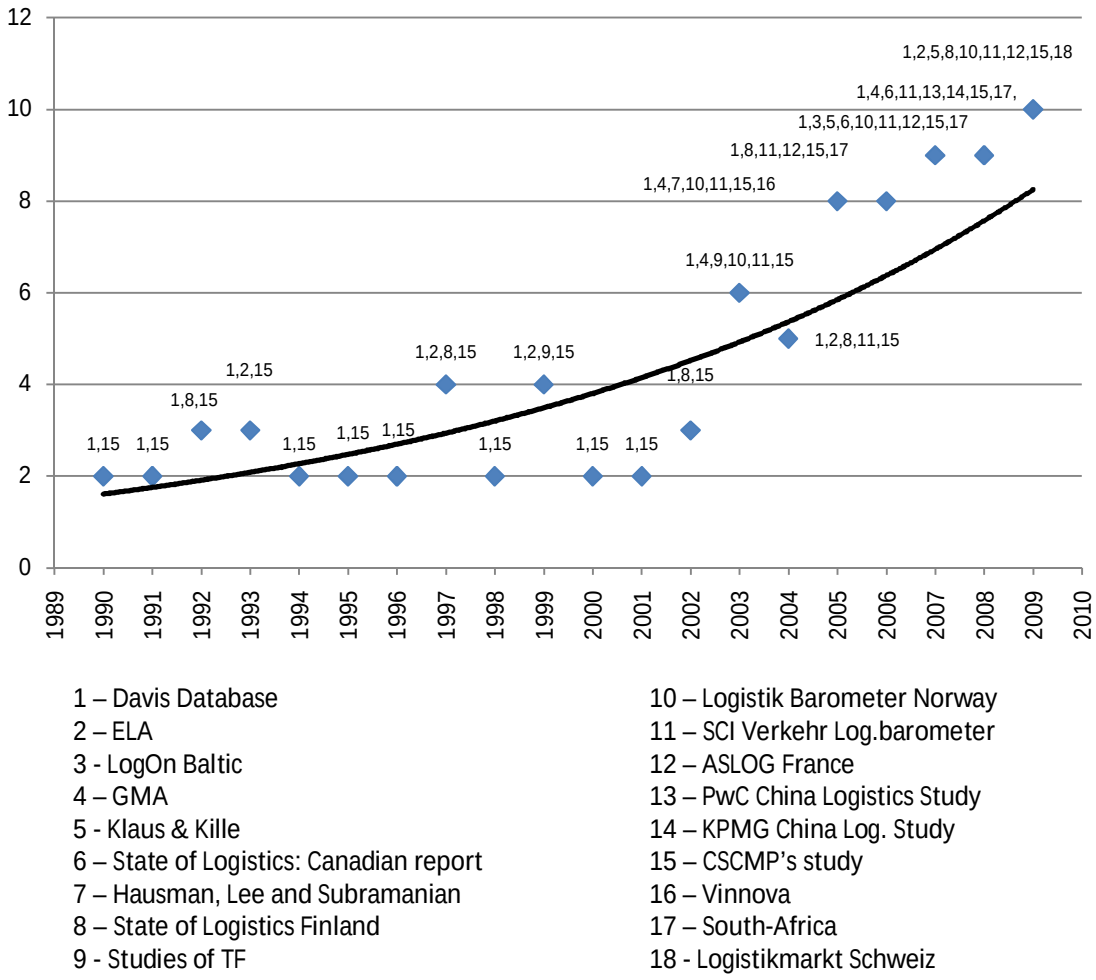


Figure 56 The Number of Conducted Logistics Costs Studies since 1990 (excluding case and other studies)

The upwards trend, presented in Figure 56 reflects the growing interest towards the better understanding of logistics costs' development. The number of conducted studies has growth steadily in last 20 years, reaching the line of 10 studies per year in year 2009. Furthermore the figures do not include case studies, which would increase the total number further on. It should also be noticed that some of studies have been published already before the year 1990. These kinds of studies are e.g. Davis Database reports and CLM/CSCMP's studies.

It's also possible to illustrate the geographical distribution of conducted studies (case-studies are excluded). This is demonstrated by using the LPI (see also Figure 4) world map and pinpointing the countries, where studies have been conducted (Figure 57).

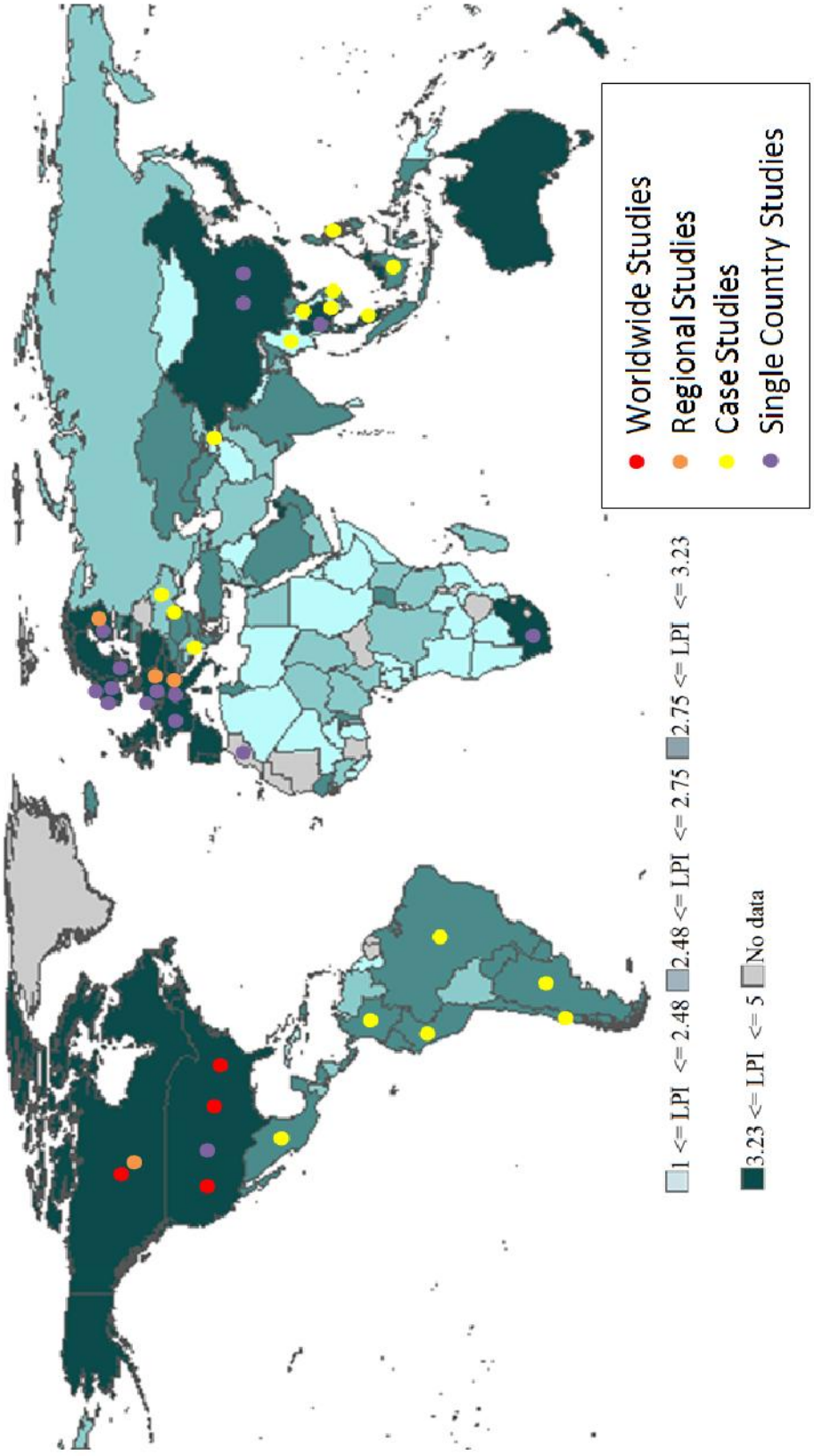


Figure 57 Geographical Spread of Studies Conducted and LPI Performance (map source: The World Bank LPI ranking)

The interesting aspect is a relationship between LPI ranking and areas, where the studies are conducted. The countries with high LPI level are the same, where logistics costs have been studied (excluding case studies). This reflects, at least in some level the importance and impact of logistics cost studies to level of logistics efficiency. In a general level, it is possible to conclude that studying the logistics costs is strongly concentrated in developed countries, which of course posses the best resources for this kind of research. The studies conducted in developing countries are mainly funded and initiated by such organizations like The World Bank Group. Europe and North-America can be seen as powerhouses of logistics costs research, even though many case studies have also been conducted in other continents. The comparative value of these case studies is however, arguable due to the various methods applied.

4 THE COMPLETION OF THE RESEARCH AND RESEARCH METHODS

4.1 The Research Approach

Research methods are the guiding principles for creating knowledge. To be effective, these methods must fit the problem under consideration and ultimate presumptions. Ultimately these methods guide the choosing of techniques and tools used in research. This is why choosing the consistent and constructive method is crucial. Methodology, on the other hand, is the understanding of how methods are constructed. (Arbnor & Bjerke 1997, 8-9; 16)

Traditionally, three research strategies are identified. These are experimental research, survey-research and case study (Hirsjärvi, Remes & Sajavaara 2003, 125). Indications of this allocation can be found also in classification of the studies and surveys into subchapters in Chapter 3. Furthermore, the methods used, can be divided into two mainstreams, which are quantitative and qualitative methods. According According Kotzab, Seuring, Müller and Reiner (2005, 16) quantitative methods optimize control and generalizability, when qualitative methods maximize realism (Kotzab, Seuring, Müller & Reiner. 2005, 16). Still, drawing the line between these two methods is not simple and sometimes even unnecessary. In addition, many researches include both, quantitative and qualitative elements that are used alongside. (Hirsjärvi et al. 2003, 127-128).

Mentzer and Kahn stated in their article *A Framework of Logistics Research* that much of logistics literature and research is largely managerial and lacks a rigorous orientation toward theory development. They also proposed that the current logistics research published in North American journals is heavily quantitative. (Mentzer & Kahn 1995, 231-233) Kotzab et al. (2005, 18) agreed.

The essential characters of quantitative studies are the importance of earlier conclusion and theories, concept definitions (alongside with data collection) and analyzing methods (Hirsjärvi et al. 2003, 131). This study is a typical quantitative study that includes many of characteristics mentioned above.

Arbnor and Bjerke indentified three methodological approaches in today's business research. These are analytical, system approach and actors approach. Analytical approach is the oldest and the most widely used in modern business research and consulting. (Arbnor & Bjerke 1997, 49-50) The prerequisites for using the analytical approach are existing theory and techniques that make rendering the verification or falsification possible. Analytical approach will explain reality by reproducing causal relations (seeking the explaining effects) by finding the prior or current cause. The greater the

number of proven causes is, the stronger the explanation is. As a result, this approach produces pure cause-effect relations, logical models and representative cases. (Arbnor & Bjerke 1997, 56) The analytical approach has numerous of characters that can be identified in the approach of this study. It may be stated that according the classification of Arbnor and Bjerke, the analytical approach is applied in this study.

The analytical approach aims to work up pictures of objective reality. These pictures can be illustrated in models, which contain quantitative elements. Models, in the research context, are pictures or prototypes that simplify the whole by bringing out the relevant characteristics of reality. Although the theory contains models, these two should not be equated but models should be seen as tools of constructing theory. Still, models do have their valuable contribution to research process (see also Figure 59). (Arbnor & Bjerke 1997, 82-83; Hirsjärvi et al. 2003, 136)

Analytical approach has a cyclical nature, which means that approach starts and ends with the facts. The theories are formed through the inductive reasoning based on the facts in empirical world. Afterwards the theories formed are deductively applied to facts in the real word again. Model is also applied to the real world data by analyzing the existing data in accordance of created model. The cyclic nature of analytical approach, together with the phases of this study, is illustrated in Figure 58. (Arbnor & Bjerke 1997, 91-92)

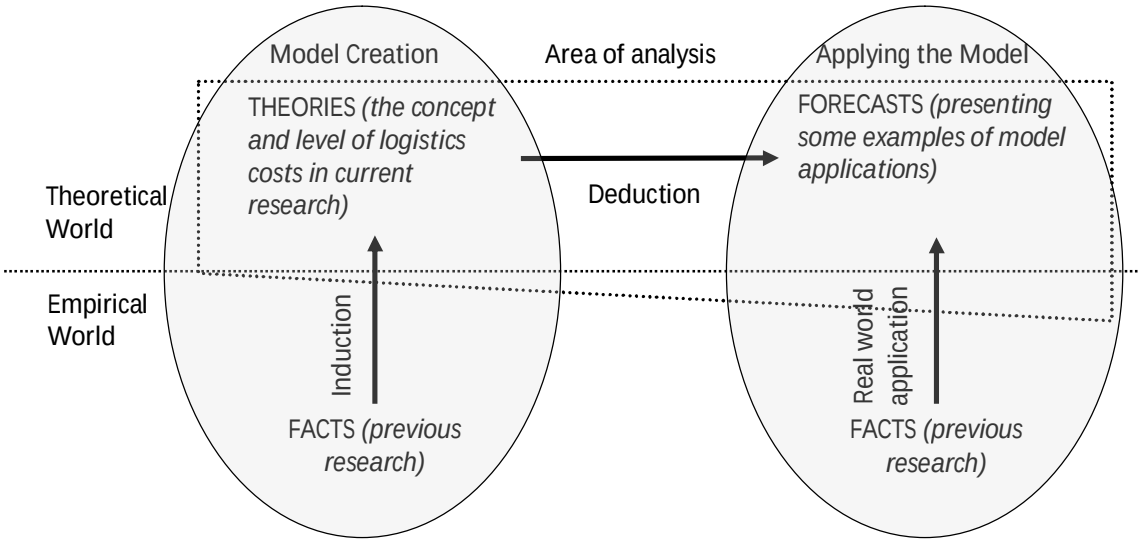


Figure 58 Analytic Approach in the Study (partly adapted from Arbnor & Bjerke 1997, 92)

As seen in Figure 58, this study includes both, inductive and deductive characteristics. However, the main task is to create general conclusion out of the special facts, which positions the research slightly towards inductive dimension.

Study needs to have purpose or function, which can be e.g. explanatory or descriptive. The purpose of the descriptive study can be just to measure the phenomenon, not only trying to establish "logical consequences". Again, due to the unique approach and not so well-established concepts applied in the current research, this study includes also descriptive and even normative (pursuing the "pure" concept of logistics costs) characteristics. (Arbnor & Bjerke 1997, 84-85; Hirsjärvi et al. 2003, 149) Descriptive research is characterized by presenting accurate descriptions regarding the studied phenomena, as well as precise documentation of interesting observations. Descriptive study can be qualitative or quantitative. (Hirsjärvi et al. 2003, 129-130)

Because of descriptive and meta-analytical characteristics, as well as uniqueness of the study, creation of traditional hypothesis is difficult in this study. Foregoing still doesn't mean that this study do not have clear objectives, but the objectives are the kind that should not restrained in a form of strict hypotheses, which in this case would constraint the model- and knowledge creation.

4.2 The Research Process

4.2.1 The Overview of the Process

The research process begins with idea generation, which in this research has begun by the review of existing literature. Mentzer & Kahn recognize three types of literature reviews; integrative, methodological and theoretical. (Mentzer & Kahn 1995, 231-233) Due to the complexity of research problems and fragmentation of earlier research, the literature review in this research serves dual purpose. Firstly, the literature review examines various approaches for conducting research (methodological literature review) in earlier research. Secondly, the present literature review serves as a foundation for model creation (theoretical literature review). The framework of research process is presented in the Figure 59.

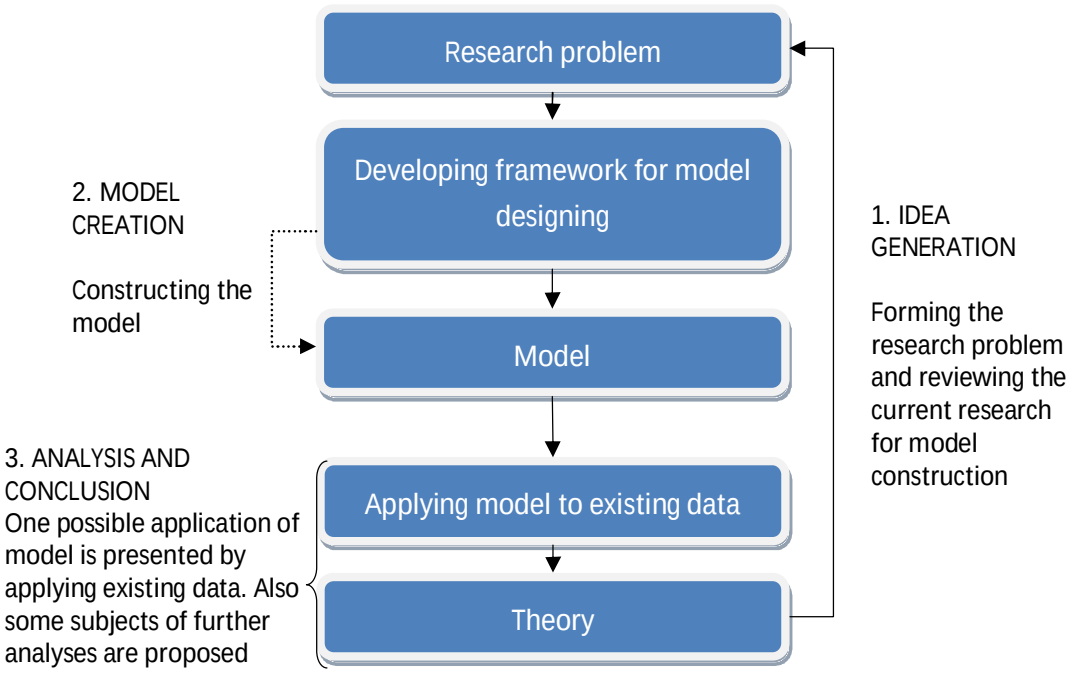


Figure 59 The Research Process (partly adapted from Hirsjärvi et al. 2003, 136; Mentzer & Kahn 1995, 234)

Model in this study is a proposition or an assumption that is justified by the previous research (idea generation). The model construction is created based on the meta-analytical review of previous research. After constructing the model, one possible application of it is presented by applying some data of source material. Since the limited broadness of master's thesis work, the model cannot be comprehensive tested and only some of previous output data will be re-processed through the model. In last chapter, several propositions for future research will be placed.

Formulating the model can be characteristic for quantitative research, which still does not necessarily start with forming the hypotheses. (Arbnor & Bjerke 1997, 84-85; Hirsjärvi et al. 2003, 149) While conducting the research, it must be kept in mind that author must either use previous constructs, drawn from the theory base or generate new constructs. Research design outlines the strategies for performing the research. This also goes with issues related to data collecting, sampling and other data analysis procedures. (Mentzer & Kahn 1995, 237) Issues related data collection and model construction are described below.

4.2.2 Description of the Data

The empirical part of the study is combined on two separate parts. First part, the meta-analytical literature review or data gathering serves the actual model construction by

collecting results of several previous sources. Steps of the second part, model construction, are presented in chapter 5.

The literature, chosen for review consist totally 34 national and international surveys, articles and textbooks. More specific classification of used sources is presented in Table 17.

Table 17 Specification of Literature Sources

	Textbook	Scientific journals	Surveys;	,of which national	,of which regional or global
No. of sources	6	6	22	(15)	(7)

Since there was no comprehensive literature review concerning the concept logistics costs available, the gathering of the background data for model construction, needed to be started from a scratch. Against this background, only literature review might be seen as an adequate and practicable research methodology (Kotzab et al. 2005, 97). Performing this broad literature review wouldn't be possible without the resources and contacts provided by the Logistics' staff in Turku School of Economics.

Since internet is today one of the most important sources of information, it was widely utilized also in study to ensure the broad coverage of included studies. On the other hand, special caution should be followed in reliability assessments of different sources. Several different keywords and combinations of keywords were employed during the data search. Due to the documentation reasons, these are provided in Table 18.

Table 18 Keywords Used in Data Search

Key words	Defining words (also plural forms were applied)
Logistics	'study', ' survey' , 'research', 'report', 'barometer', 'trends', 'questionnaire',
State of logistics	'data', 'value', 'findings' , 'annual', 'master'
Logistics market	
Logistics costs	

Keywords refer those words that were considered as a core of the data searching process. Defining words were applied to narrow the scope of searching into certain type of sources. These words, which further defined the actual keywords, were combined with each keyword for maximum coverage of results. Also the plural forms of defining words were applied.

Textbooks and journals are mainly used to clarify the concept of logistics costs. However, some of these sources also provide estimates of logistics costs, which are utilized in comparison with other surveys. The most important sources of model constructing are logistics studies, conducted around the world. This also ensures the comprehensiveness of geographical coverage. Five sources provided the estimates of logistics costs in global context, two in EU level and one in the BSR. The coverage is ensured by 15 national logistics surveys, which guarantees a broad outlook over the logistics costs in global context.

4.2.3 Designing and Testing the Model

Because of the descriptive character and extensive meta-analysis of previous research, the main purpose in this study is to create a generic model for assessing logistics costs. Developing the model begins in paragraph 2.1 with review of previously conducted research. In paragraph 2.3, one possible approach and logistics costs fourfold table is introduced. The attributes for model is gathered in previous research analysis in Chapter 3.

Actual model is designed, based on meta-analysis, in Chapter 5. Phases of constructing the model itself is comprehensively presented and justified in Chapter 5, which makes it unnecessary to go through the whole model at this point. However, the overview of model construction methodology is illustrated in Figure 60.

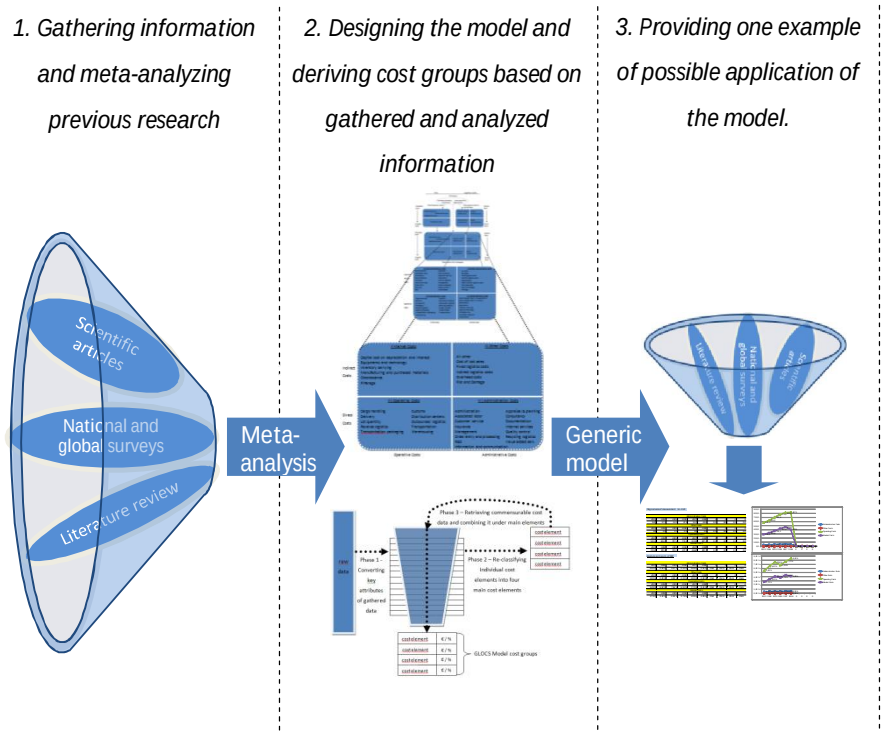


Figure 60 Phases of Designing and Applying the Generic Logistics Costs Assessing Model

Designing the model starts from the review of previous research (1), in which gathered information is utilized in phase 2. Generic logistics cost model is originated in two cornerstones, transaction cost approach (TCA) and meta-analysis of conducted studies. Based on these two, the generic model of logistics costs is designed and justified. In phase 3, the cost data of some previous studies is retrieved and processed in the model to provide an example of model applications. Also some recommendations for future research are made and grounded.

4.3 Reliability and Validity of the Research

Despite of the fact that every researcher tries to avoid mistakes, the reliability and validity varies from study to another. Therefore, the level of these two needs to be evaluated in studies. Reliability refers the repeatability of results, which in other words means research's ability to generate non-random results. Therefore reliability means also the accuracy of results. Generally, smaller samples produce more random results

than large samples, which have higher reliability. (Hirsjärvi et al. 1997, 216; Heikkilä 2000, 30, 187)

In this study, the created model is based on data gathered in the extended literature review. The number of total sources was 34 and the geographical coverage was broad. However, due to the lack of centralized documentation of conducted studies, it is impossible to confirm that no relevant sources have neglected. Still, there are some strong facts in favor of sufficient coverage of background study. First of all, the strong professional as well as personal networks and contacts of the logistics staff in Turku School of Economics to other research and academic organizations worldwide have ensured the broadness of background study collecting. The searching of sources was not limited only in English, but sources in seven different languages were included. The study is also linked to World Bank's Logistics Performance Index Observatory, which has ensured that some professionals with extensive experience have reviewed the background of the model construction.

Another important concept is the validity of study. Validity refers the ability of chosen metrics and methods to present pursued results. In another words this means that study measures the issues it is supposed to measure. Two dimensions can be recognized in the concept of validity. These are internal and external validity. Internal validity is the validity of causal relationship between theories and empirical results. External validity, in turn, reflects the similarity of interpretations between author and other researchers. (Heikkilä, 1998, 29; 186)

The problems related to usage of questionnaires are mainly related to problems with interpretation, or even misunderstanding of question. Problems might occur especially, as it is proved in this study, with the concept of logistics costs, which seems to be rather inconstant. This could lead to different interpretations among respondents. The interpretations made by respondents may be narrower or broader than the concept has originally meant to be. Again, large samples reduce the possibility of errors caused by these interpretations. (Heikkilä 1998, 29)

5 TOWARDS A MODEL FOR ASSESSING LOGISTICS COSTS

After comprehensive review of literature, articles and studies, the aim of this chapter is to exploit this data into more common level. Chapter 5 first introduces the model and then employs it to compute average of logistics costs for each cost element.

The concept of logistics costs in earlier research, as well as the level of logistics costs has been presented in chapters two and three. The aggregated results are illustrated on the figures and tables at the end of the subchapters. These results are based on extensive review of published research and studies. The classification of cost components is transferred into tables as given. The object of this chapter is to create Generic Logistics Costs Structure (GLOCS) that is based on research and study review conducted in Chapters 2 and Chapter 3.

After designing and demonstrating the three phases of GLOCS Model and MS Excel based GLOCS Tool, which helps to regroup the cost elements, the attempt of applying industry classification to GLOCS Model is explained.

5.1 GLOCS Model

GLOCS (Generic Logistics Costs Structure) Model includes three phases. First of all, to be able to create comparable results, the first phase of the process is to convert the key attributes of studies into commensurable form (Phase 1). As explained in the Chapter 1.4.2, there are some minor differences in results, when using % of GDP or % of sales or turnover as a unit of measurement. Converting these units is not possible within the limitations of this study. If results are reported as absolute costs, the GLOCS Tool systematically retrieves the nations GDPs from the database of the International Monetary Fund's (IMF) World Economic Outlook and calculates the absolute costs also as a percentage of GDP. (International Monetary Fund, World Economic Outlook). Since studies also report results in different currencies, it is mandatory to convert national currencies into common currency, which in this study is euro. The method of currency conversion, which is automatically carried out by the GLOCS Tool is explained in the Chapter One. The operating principle of the GLOCS Model is illustrated in Figure 61.

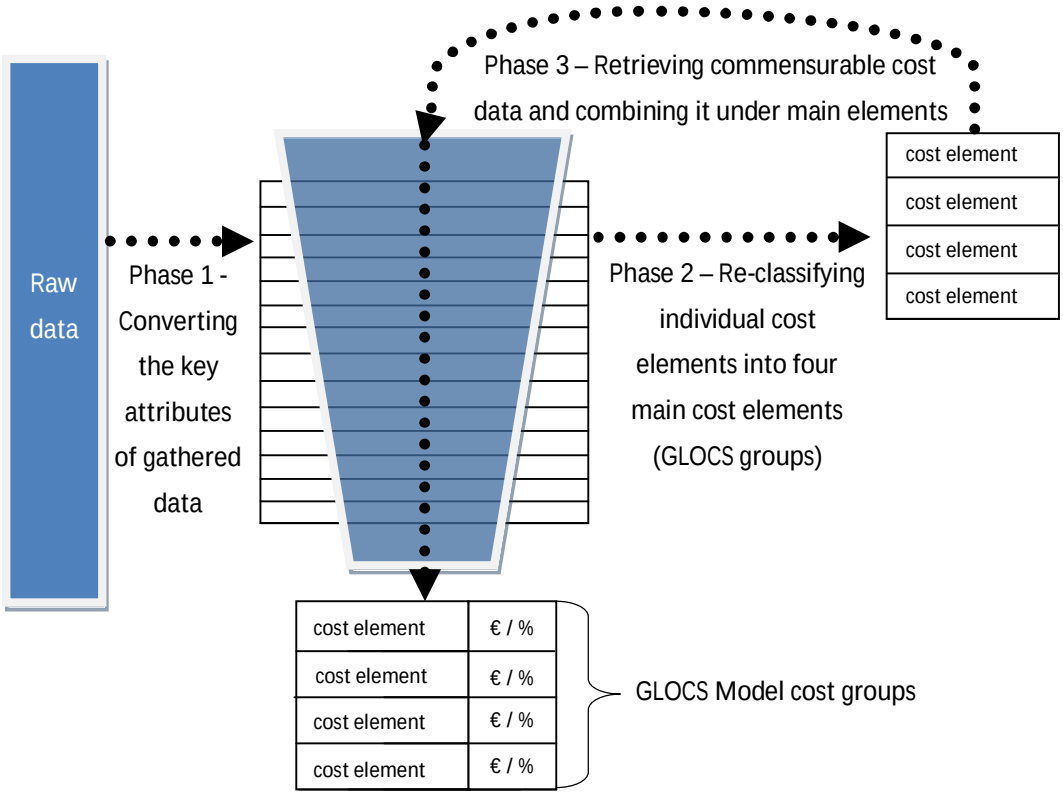


Figure 61 The Operating Principles of the Generic Logistics Costs Structure (GLOCS) Model (the number of elements and the size of areas are illustrative only)

After converting the gathered data into common currency and measurement unit, the next step (Phase 2) is to create the model that systematically seeks similarities among different costs classifications and re-classifies individual costs elements into main cost elements (GLOCS Model cost groups). Third phase is to retrieve the commensurable cost information of individual cost groups and combine these under the four GLOCS groups (Figure 61). After this, it is possible to assess the dispersion of results and also calculate the average level of main cost groups.

5.1.1 Creating Main Cost Groups

The main purpose of this chapter is to allocate different costs groups implemented in previous research under four main cost groups, which later referred as GLOCS groups or GLOCS elements. These four costs groups are grounded to fourfold table and TCA model, presented in Chapter 2.3. Based on the dimension presented in these models, the

cost croups created in respect of direct/indirect costs and activity related/alternative logistics costs are labeled as followed:

- Indirect activity related costs
- Indirect overhead costs
- Direct activity related costs
- Direct overhead costs

First the subgroups of logistics costs, appeared in previous research, are identified by reviewing the summary tables. After this the number of occurrences for each subgroup used is summed up. This allows us to clarify the most commonly used terms and to eliminate duplicate cost groups. All cost groups mentioned in previous research are presented in the Table 19. More information about combining the summary tables is presented in Appendixes 3A and 3B.

Table 19 Aggregate of Cost Components in Previous Research

Sub Component of Logistics Costs	COUNT	Sub Component of Logistics Costs	COUNT
Administration	22	Management	2
Appraisal	1	Manufacturing	1
Associated labor	1	Obsolescence	2
Cargo handling	2	Order entry	2
Communication	1	Order processing	1
Consultancy	1	Other	4
Cost of capital tied in inventory	1	Other indirect log. costs	1
Cost of capital tied in transportation	2	Outsourced logistics	1
Customer service	4	Overhead	1
Customs	3	Packaging	8
Damages	1	Planning	1
Delivery	1	Procurement	1
Depreciation	1	Purchased materials	1
Distribution centers	1	Quality control	1
Documentation	1	R&D	1
Equipments	1	Recycling logistics	1
Fixed log. costs	1	Reverse logistics	1
Indirect logistics costs	1	Risk and Damage	1
Information	1	Shipper related	2
Insurance	4	Special packaging	1
Internal logistics	1	Trade-related	1
Internal services	1	Transport packaging	3
Inventory carrying	21	Transportation	24
Logistics technology	1	Value-added services	2
Lot quantity	1	Warehousing	31

Table 19 gathers all cost components that have occurred in previous research reviewed in chapters 2 and 3. Also the count of occurrences per cost component is indicated in light orange cells. Next the TCA model (see Chapter 2.3.2) is applied to position the cost components into fourfold table with respect of dimensions of direct/indirect costs and administrative/operative costs.

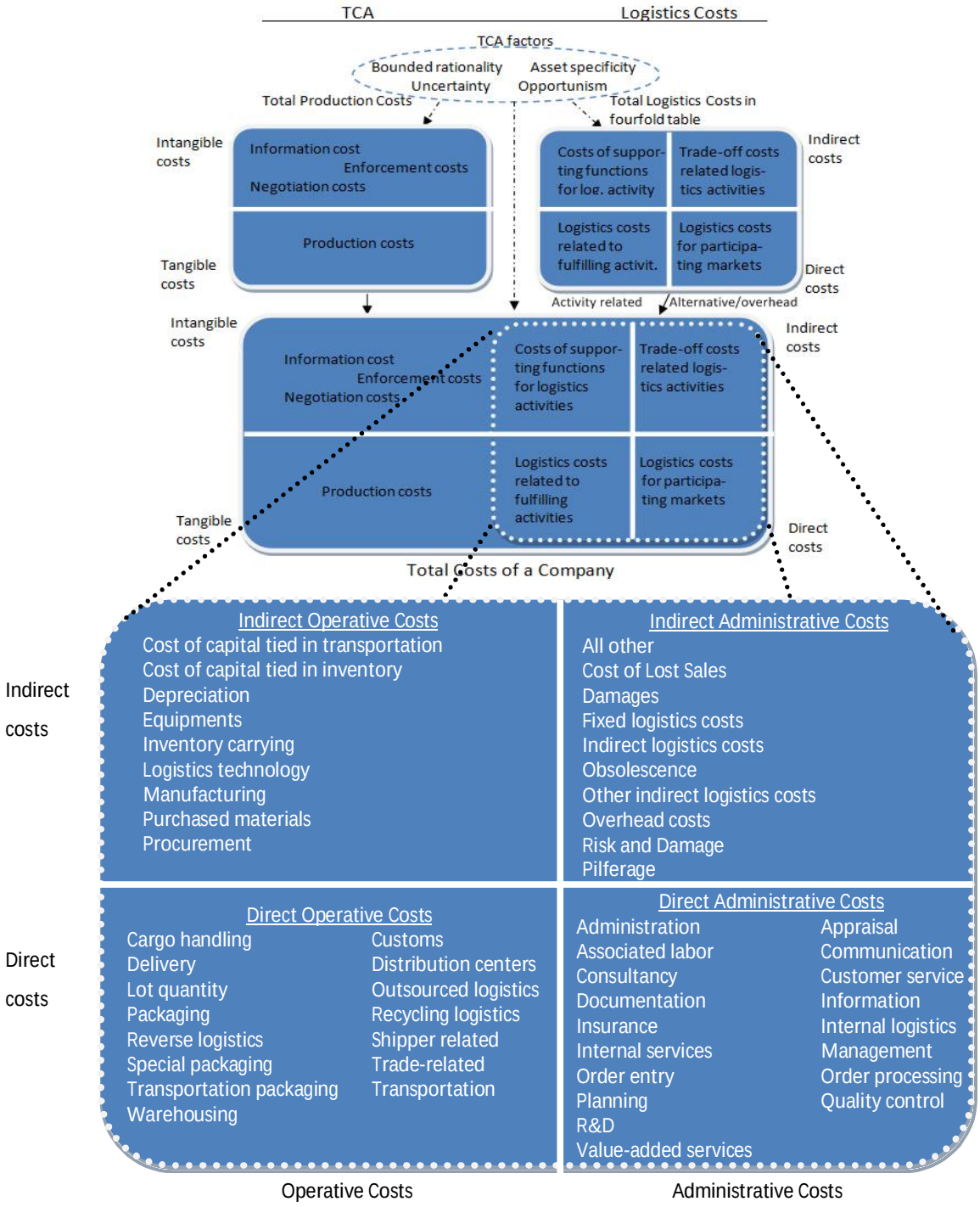


Figure 62 Combining TCA and Cost Elements into GLOCS Main Components

Figure 62 has three dimensions, which are results of influence of four TCA factors. These dimensions, presented as three opposite concepts, are direct/indirect costs, tangible/intangible costs and activity related/alternative costs. Understanding of these dimensions helps us to identify and position the logistics cost elements. Due to the methodological reasons, original dimension of TCA model is modified by adapting the opposite concepts of operative/administrative costs and direct/indirect costs. This eases the positioning process of the cost elements.

Operative costs are the recurring expenses that are related to the logistics operations of a business, function, equipment or facility. Other concept adapted in the figure is administrative costs, which are incurred in controlling and directing the organization and planning activities. These costs cannot be directly identified nor linked with operations like production or marketing. Administrative costs are related to whole organization, not just individual functions. The comprehensive explanation of the differences between direct and indirect costs is provided earlier. Basically direct costs can be easily addressed to certain cost object like department or product. Indirect costs, on the other hand, are difficult to assign to a certain cost object.

Since all costs groups were transferred directly to fourfold table in Figure 62, the model is simplified by eliminating few costs groups with slightly different names, but identical purposes. Also the final cost groups of GLOCS Model (Figure 63) are renamed and transferred to GLOCS Tool, which is presented later.

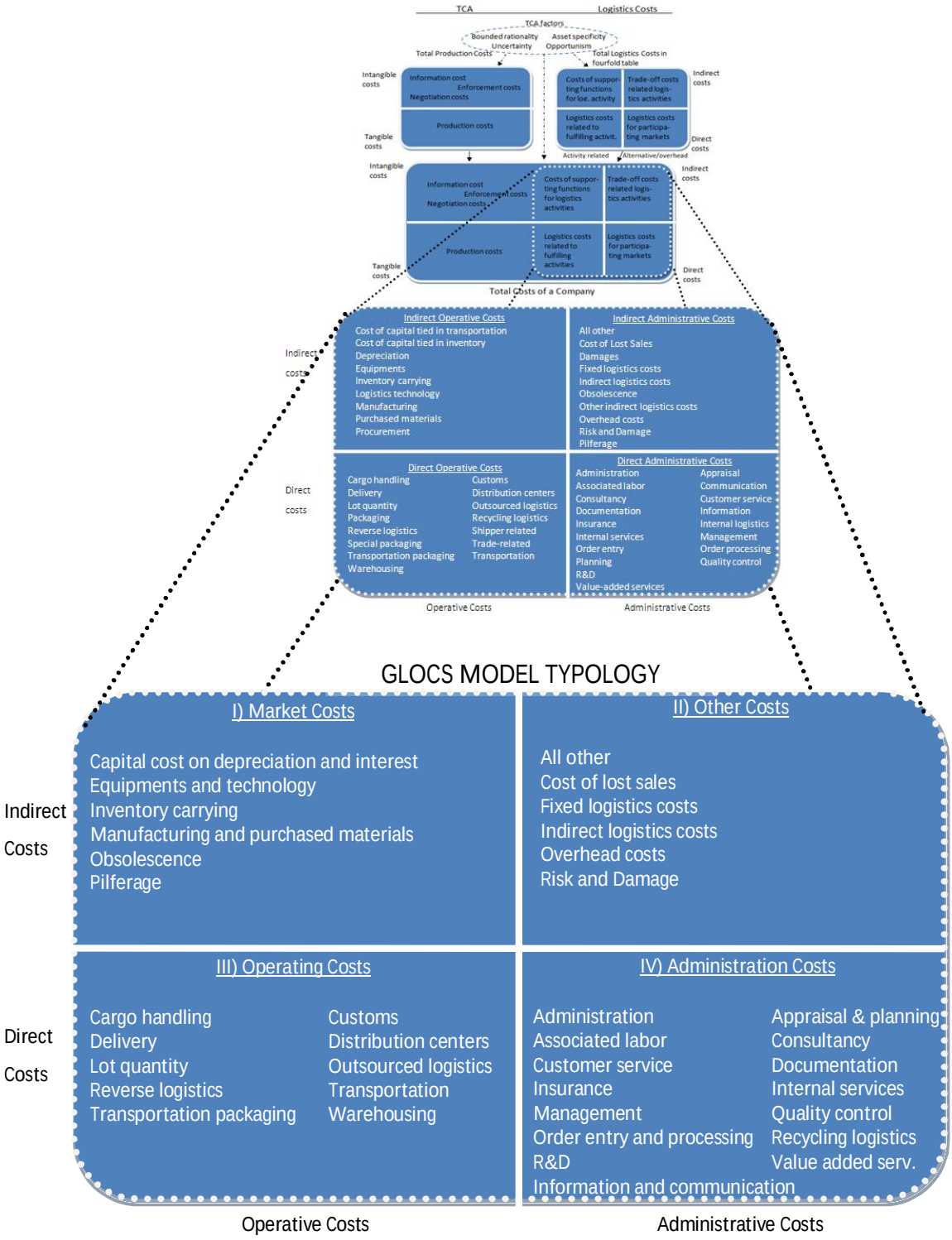


Figure 63 Combining the Final Cost Groups for GLOCS Model

Starting from the top left corner in fourfold table of Figure 63, the first GLOCS Model cost group created in respect of TCA, is *I) Market Costs*. These costs are indirect but can be still related to certain logistics operation. Typical cost element in this group

is inventory carrying costs. Characteristic for the costs in this group is that costs are linked to operative activities, which do not necessarily (but may) create added value for the customers, but still need to exist. For example inventory carrying costs can be high due to the high inventory levels, which guarantee shorter delivery times.

Second GLOCS Model cost group is *II) Other Costs.* This sector includes the costs, which can be characterized as indirect costs that cannot be directly related to certain logistics operation. Some common costs in this group are the risk & damage costs and fixed logistics costs, which both are usually caused by several operations and cannot be easily addressed to certain operation.

Moving to direct operative costs leads to the GLOCS Model cost group, which is usually considered as a core of logistics costs. This is named as *III) Operating Costs.* Transportation, warehousing and packaging costs are typical elements in this cost group, of which elements can be easily attached to direct logistics operations.

The last GLOCS model cost group is *IV) Administration Costs*. The costs in this group are direct and related to administrative activities. The term administrative should not be understood too tightly in this context. The typical cost elements in this box are such as administration and management costs, as well as customer service and documentation, which are linked to controlling and directing the organization

The four GLOCS Model main cost groups is defined together with positioning of the individual cost elements in these groups. Next the general attributes of each GLOCS Model cost groups are defined. First, the attributes of GLOCS Model cost group I are presented in the Table 20.

Table 20 Attributes of GLOCS Cost Groups

	Cost Element	Costs include:
I) Market Costs	Capital cost on depreciation and interest	Cost of capital (debt and equity) acquired for certain operations from different sources. Realized as paid interests or depreciation
	Equipments and technology	Purchase expenditures of equipments and technology for logistics operations
	Inventory carrying	Costs of holding finish products in inventory or during the transportation. Includes cost of capital and service of inventory operations
	Pilferage	Costs of internal and external pilferage
	Obsolescence	Obsolescence that can be addressed to certain logistics function
	Manufacturing and purchased materials	Cost of holding work-in-process (manufacturing) and raw (purchased) materials in stock
II) Other Costs	All other costs	Includes all logistics costs that are not directly related to certain operations and cannot but cannot be assigned to any other group
	Costs of lost sales	Lost incomes due to the inability to fulfill orders
	Fixed logistics costs	Logistics costs that are not operation related and remain relatively same regarding the output level
	Indirect logistics costs	Costs of joint usage of logistics functions
	Overhead costs	Indirect overhead costs that cannot be assigned with certain goods or service
	Risk and Damage	Costs of downsizing risk and avoiding damages in whole organization
III) Operating Costs	Cargo handling	Costs of loading, moving and unloading the cargo
	Customs	Costs related directly to custom clearance
	Delivery	Cost of transferring goods or services to customer
	Distribution Centers	Direct costs of maintaining distribution center
	Lot quantity	Costs of inability to meet economic lot quantity
	Outsourced logistics	Costs of outsourced logistics operation
	Reverse logistics	Costs related to reuse of products incl. pulling back of defective ones
	Transportation	Costs occurred of moving items from one location to another
	Transportation packaging	Costs of packaging product for transportation
	Warehousing	Costs of physical functions associated with storage of goods and materials
IV) Administration Costs	Administration	Costs of staff in administrative and supporting functions
	Appraisal and planning	Costs of staff in analytical and planning functions
	Associated labor	Costs of labor associated to administrative functions not related directly to certain operation
	Consultancy	Cost of consultancy related to directing organization
	Customer service	All costs incurred due to the interactions between organization and customer
	Documentation	Costs of preparing commercial documents for general use
	Insurance	Cost of insurance for organization
	Internal services	Costs of supporting services for whole organization
	Management	Management costs, which are incurred in controlling and directing the organization and planning activities
	Quality control	Costs of quality control functions for all operations
	Order entry and processing	Costs of work related to processing orders in organization
	Recycling logistics	Costs of recycling logistics as a part of organization's supporting functions, not as a core business
	R&D	Costs of functions discovering solutions to problems or creating knowledge.
	Value-added services	Cost of function aimed to create competitive advantage in order to add value of services and products
	Information and communication	Costs of physical solutions and staff working with information and communication tasks in organization level.

Finally one needs to retrieve the gathered data from previous studies and regroup the cost groups and data in respect of four GLOCS Model cost groups. However this can be done only in accordance of those studies that declare component specified cost figures

or other similar information. Paragraph 5.1.2 first introduces the Excel based GLOCS Tool, which significantly helps data processing by providing efficient and accurate data processing tool, which also converts currencies and scales automatically.

5.1.2 Retrieving Cost Data with Excel based GLOCS Tool

Retrieved cost data is combined under four GLOCS main components by filtering the data through MS Excel GLOCS Tool, which is constructed based on the GLOCS Model cost groups. The operational principles and the phases of GLOCS Tool are demonstrated below.

The first phase (Figure 64) of GLOCS Tool is called as data input phase, which allows user to enter the background information (country, year, currency and scale of measurement) of the study in question. Background cells also include a built-in drop-down lists, which allows user to enter only such values that have a counterpart in currency exchange rate and country specified GDP database sheets.

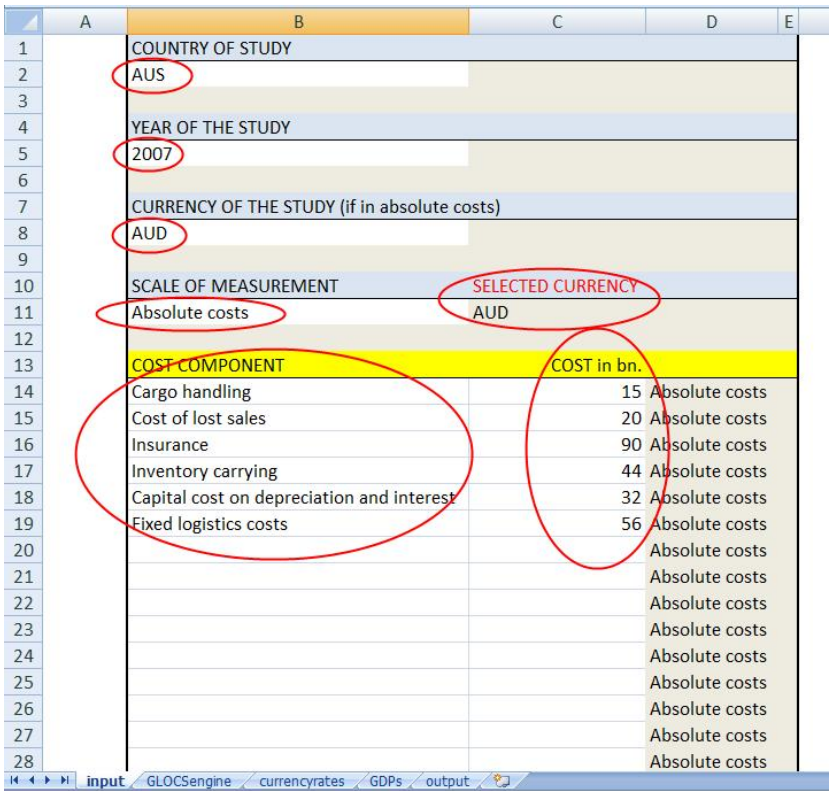


Figure 64 Screenshot of GLOCS Tool Input Phase (inputs are illustrative only)

Country of study –cell specifies the country, where the source study is conducted. This is important box, since GLOCS Tool is otherwise unable to convert the cost scale from absolute costs into a percentage of GDP scale by retrieving the GDP data from the

country in question. The purpose of specifying the year of the study has two aspects. First of all, the year specification allows GLOCS Tool to retrieve the GDP data from the same year's statistics the study was conducted. GLOCS Tool has also in-built currency rate converter, which converts original study's currency into Euro by retrieving the right currency exchange rate in accordance of selected year (scale 1980-2010). GLOCS Tool's database covers the GDP information in 182 countries from 1980 to 2010 (estimation) in current prices. Currency exchange rates are available in 39 currencies from the year 1970 in every year's first week day rates. Data is based on the statistical database of European Central Bank (ECB) and International Monetary Fund (IMF).

User also needs to choose the scale of measurement in source study among three options: 1) % of GDP, 2) absolute costs or 3) % of sales or turnover. The actual cost input is done under cost component field. In this cell user can pick the cost component from 47 logistics cost components based on previous research and deducted in accordance with TCA (see paragraph 5.1.1). User may enter up to 16 different cost components from ten different years, which allows GLOCS Tool to create output results from chosen period.

Based on the background variables and cost components inputted by the user, GLOCS Tool combines the cost data under four GLOCS main components. GLOCS also automatically converts the currency in Euro, based on the exchange rate in year the source study was conducted. The interface and operational principles of GLOCS engine sheet is explained and demonstrated below (Figure 65).

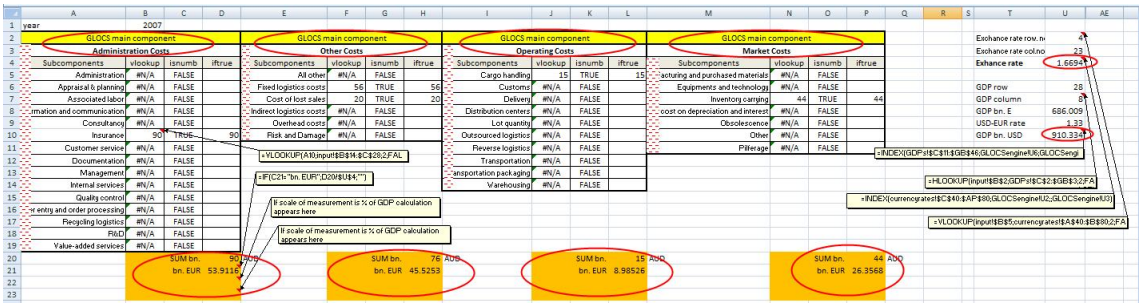


Figure 65 GLOCS Tool Calculation Engine (figures are illustrative only)

As seen in the Figure 65, the calculation phase of GLOCS Tool combines the subcomponents (marked with dashed red line) of logistics costs and re-classifies those into four GLOCS main components (circled with thin red line). As mentioned above, these main groups are: Administration Costs, Other Costs, Operating Costs and Market Costs. After re-classification, the sums of main components are calculated in the one of the orange cells depending on the scale of measurement chosen. If chosen scale of measurement is absolute costs, GLOCS engine also retrieves the currency exchange rates in respect of the inputted year and currency into rightmost of the table (thin red circle).

After this, the costs per GLOCS group are appears in the orange cells. Also the GDP data per country is presented below currency rates in right. This allows GLOCS engine to calculate costs as a % of GDP, if the method of measurement in input data was absolute costs. If user chose the % of GDP or % of sales or turnover as a scale of measurement, these portions also appear in orange cells. The calculation engine is able to reclassify the cost components from ten different years at the time. Outline of currency rates and GDP datasheets are presented in Appendix 4.

Finally the output phase of the GLOCS Tool (Figure 66) is introduced. Based on calculations generated in the GLOCS engine, the cost results per GLOCS component is first presented as an original scale of measurement (upper result box) in each year respectively. Also the chart in the right side of the box is automatically generated by the GLOCS Tool.

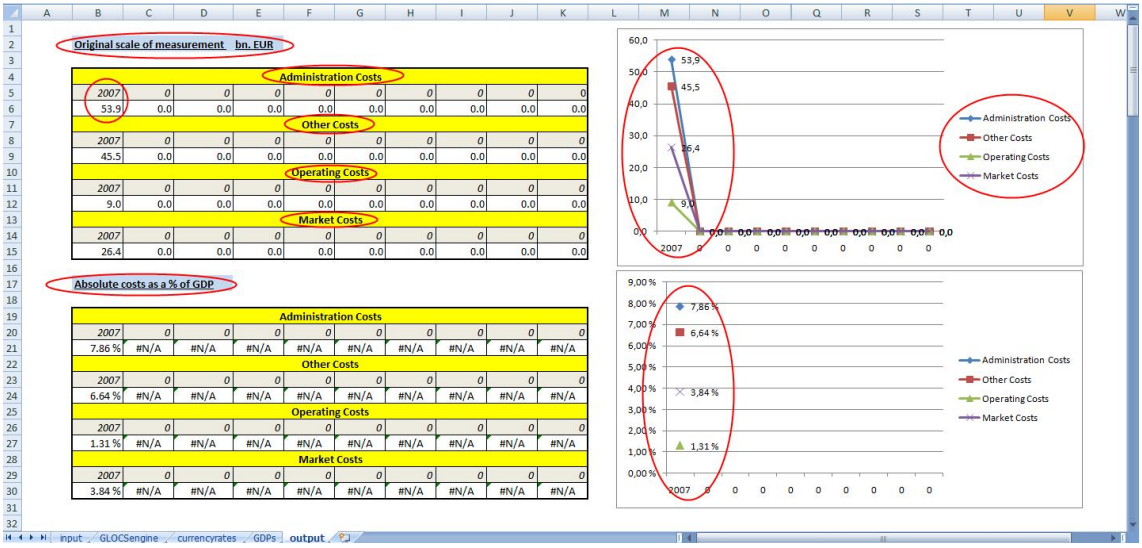


Figure 66 GLOCS Tool Output Phase (figures are illustrative)

If input scale of cost measurement was absolute costs, the GLOCS Tool automatically generates the share of costs as a percentage of GDP per GLOCS component, which is presented in the lower box. Also the chart is generated automatically again. Chapter 6 presents the actual data of logistics costs, gathered in extensive survey of previous research, re-classified through GLOCS Model with the assistance of GLOCS Tool.

5.2 Applying Industry Classification to GLOCS Model

As seen in the study review, different authors may group costs in very different ways. The same goes with grouping the respondents. Some studies may present the results in

high accuracy, when many of them employ looser grouping. Since different industries differ from each other quite significantly, presenting only aggregated results would diminish the informational value of the study.

The problem of applying the industry classification to GLOCS model is that many sources of previous research do not report the necessary information needed for applying the industry classification. Only seven studies out of 33 declare, either industry classified results or adequate data (breakdown of respondent industries) for calculating industry classified results. However, one possible approach for conducting industry classification is proposed.

Even if the sufficient is available, some problems are caused because of minor divergence in grouping methods in different industry classification. To make results comparable together, one need to group the results according of some international classification.

In this study the International Standard Industrial Classification of All Economic Activities (ISIC), of which the first version was adopted in 1947 is adopted. ISIC is developed and maintained by United Nations Statistical Division and since its launch it has become widely used in data classification in both, national and international context. It has also been broadly utilized by numerous nations as a basis for developing their own industrial classification. (United Nations Statistical Division: ISIC Statistical Paper Rev.4, ix-x)

The latest review of ISIC took place in 2000, when the objective was to strengthen its relevance and compatibility with other classifications like ANZSIC (Australia and New Zealand), NACE (Europe) and NAICS (North-America) around the world. (United Nations Statistical Division: ISIC Statistical Paper Rev.4, ix-x) The classification used by Eurostat (NACE Rev.2) is consistent with the ISIC Rev.4, which guarantees the international compatibility. (Eurostat Indicators Newsletter February 2009, 2)

5.2.1 Detailed Structure of ISIC

ISIC employs four-level structure of mutually exclusive categories. The highest level categories are called as sections, which are identified with alphabetic letters A-U. Each section is divided into more detailed categories, which are referred as divisions. These divisions are numerically coded with two-digit numbers. The same numeric coding is also applied in third level classification (three-digit coding), in which the sub-divisions are referred as groups. In level four (four-digit coding), the units are called as classes (Figure 67). (United Nations Statistical Division: ISIC Statistical Paper Rev.4, 3; 11)

- A-U SECTIONS (i.e. C –Manufacturing)
    - 01-99 DIVISIONS (i.e. 10 –Manufacture of food products)
        - 011-990 GROUPS (i.e. 107 -Other food products)
            - 0111-9900 CLASSES (i.e. 1072 –Sugar manufacturing)

Figure 67 Detailed ISIC Structure with Examples (United Nations Statistical Division: ISIC Statistical Paper Rev.4, 3)

Compared to earlier ISIC structures, the fourth review provides more detailed classification in all levels. This together with the comparability to national and regional statistic classifications provides a strong foundation for grounding the industry classification to ISIC.

5.2.2 The Theory of Applying Industry Classification

In theory, industry classification component allows to apply the classification in all levels from first level (Sections) to fourth level (Classes). In this study it is attempted to apply first level classification (Figure 68), which means that theoretically all different respondents groups are grouped into 21 (the number of ISIC first level sections) main groups. The decision to use level one classification is mainly due to one reason. The more accurate the classification is, the smaller is the number of respondents, which in some groups might be too small to draw up reliable conclusion.

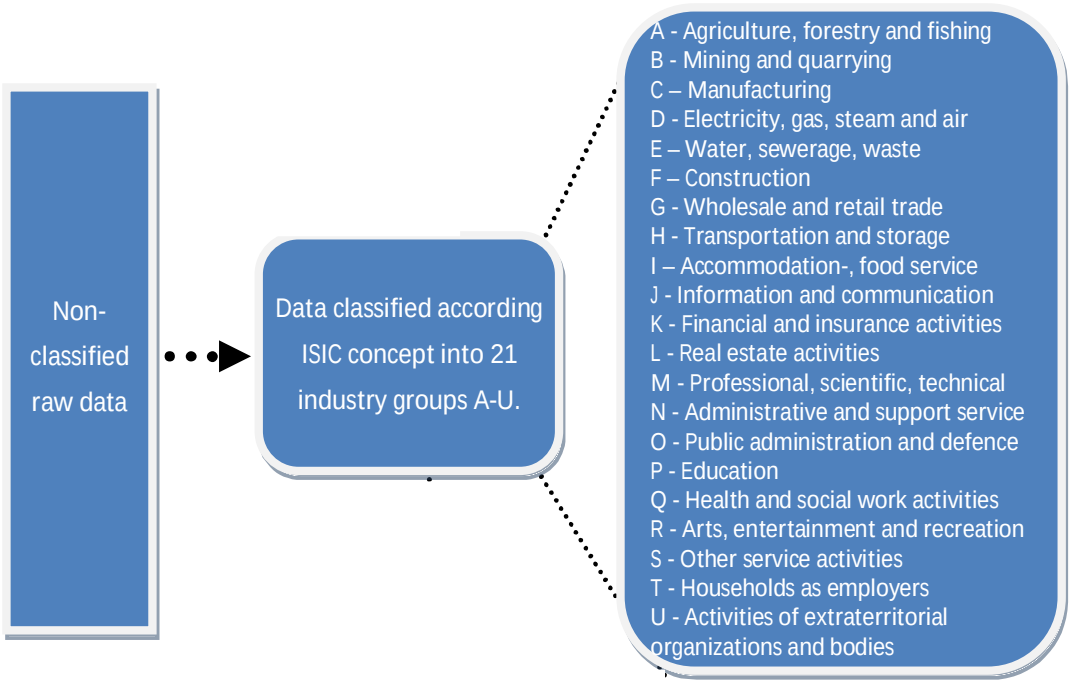


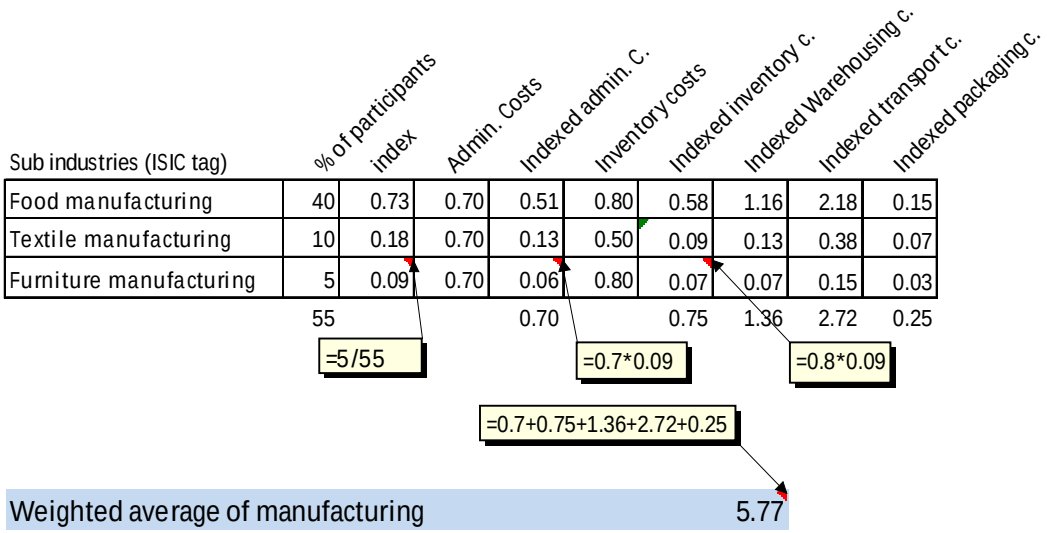
Figure 68 Industry Classification Process (partly adapted from United Nations Statistics Division)

As illustrated in Figure 68, also the first level classification is rather accurate. This is the reason, why more accurate classification may cause the situation, in which the sample size gets too narrow to make reasoned deductions. Of course it is possible and even recommended to use more accurate classification if study is involved in certain industry or data is mainly gathered from a certain group of respondents.

The purpose of applying industry classification is to increase the value and compatibility of results. Because of the comprehensive and internationally harmonized classification (ISIC), industry classification can be applied in various nations, located in different continents.

The fact that studies may have presented the results in very different accuracies, one need to somehow take the weights of the respondent quantities in different industries into account. This can be done by calculating the index weighted averages for each respondent subgroup and summing these to get the weighted average of first level group. This technique is demonstrated in the Table 21, in which the weighted average of section C – Manufacturing is calculated the by combining the values of index weighted classes.

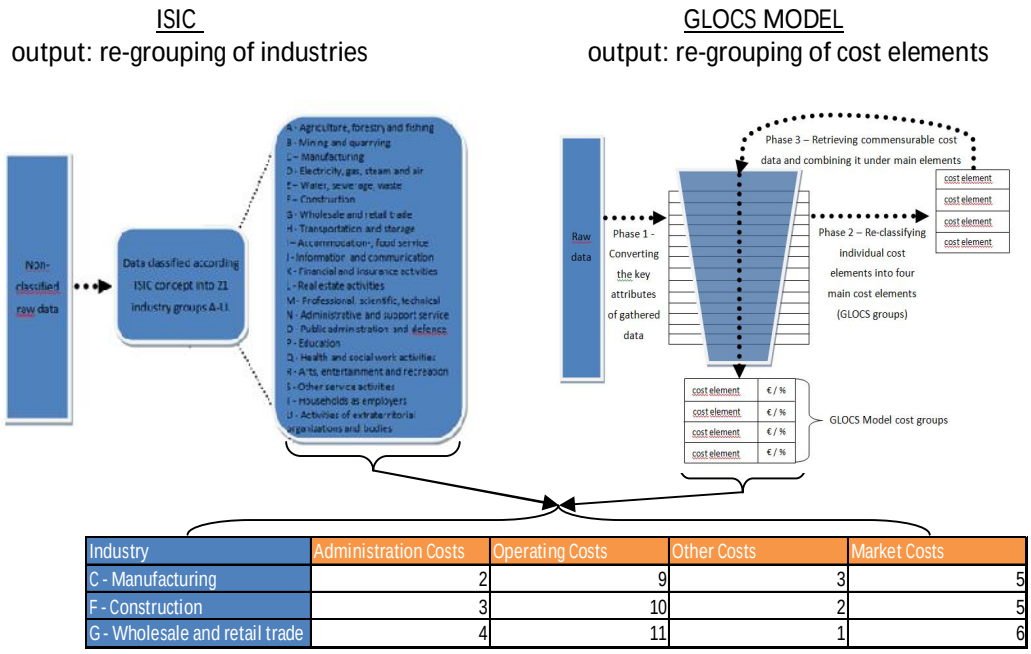
Table 21 Example of Calculating Weighted Averages (figures are illustrative only)



Calculation of weighted averages is only possible when sufficient information is provided. At least the share of respondent group per all respondents needs to be available with respective group's cost information. Results of attempting to apply industry classification with results are presented next.

5.3 Applying Industry Classification to GLOCS Model Results

The theory of GLOCS Model and proposed industry classification, which in ideal situation could also be applied to increase the informational value and aspects of logistics cost research (Figure 69) is introduced in previous chapter. GLOCS model alone provides important information regarding logistics costs of different cost elements. GLOCS Model is also an efficient tool to analyze and compare the logistics costs of nations or regions. The classification of results in accordance with ISIC makes it possible to scrutinize the differences between industries. Unfortunately this, at least in most cases, is impossible due to the deficient information.



Industry	Administration Costs	Operating Costs	Other Costs	Market Costs
C - Manufacturing	2	9	3	5
F - Construction	3	10	2	5
G - Wholesale and retail trade	4	11	1	6

Figure 69 Applying Industry Classification to GLOCS Model (figures are illustrative only)

After re-classification of cost elements (GLOCS Model) and industries (according ISIC), it is possible to calculate weighted costs per industry and costs element. This will be done by calculating weighted averages as explained above.

In next Chapter, the results of some previous research, introduced in Chapter 2 and Chapter 3 are processed through GLOCS Model as an example for future model research propositions. This could be done to all previous researches in coming studies. Only few studies (7 out of 35) provided sufficient information to apply the industry classification. In addition some problems were caused on the small number of respondents in certain industries. If sufficient information is available, industry classification is advised to be applied first and GLOCS Model after that.

6 APPLYING THE GLOCS MODEL ON SELECTED RESEARCH FINDINGS

Chapter 5 comprehensively introduced the GLOCS Model, GLOCS Tool and suggested industry classification process. Also the attributes, basis and problems related to applying industry classification were discussed. The main purpose of Chapter 6 is to demonstrate few examples of processing the results, gathered during the previous research review, through the GLOCS Model.

It should be noticed that the model couldn't be comprehensively tested, due to the limitations in Master's thesis work. However, giving some examples of model output allows to present operational principles and to recognize the benefits of applying the model into results of previous research. Testing and applying the model to all studies presented in Chapter 3, as well as developing additional applications of the GLOCS Model will be subject of future research.

This chapter is divided into two subchapters, of which the first example attempts to apply industry classification to the results of the study of ELA. Second subchapter demonstrates the applying of GLOCS Model itself, as well as the output of the model after re-processing the results of CSCMP's State of Logistics study.

6.1 Applying Industry Classification to the Results of the Studies conducted by European Logistics Association (ELA)

The study of ELA in 2009 (see also 3.1.1.2) has reported logistics costs in five industry sectors: machinery / electronic, process, consumer / media, automotive and retail. To make the results commensurable with other surveys' results, it is necessary to take average of those sectors that belongs under same main category in ISIC. The first step is to classify the reported logistics costs in five industry sectors according the ISIC. This is demonstrated in Table 22.

Table 22 Re-classification of Industries according ISIC

Study	Industry sectors	ISIC division ID	Corresponding ISIC section ID
ELA	Machinery / electronics	*28/27*	C - manufacturing
	Process	*16,24*	C– manufacturing
	Consumer / media	*47/58*	G- Wholesale and retail trade
	Retail	*47*	G- Wholesale and retail trade
	Automotive	*45*	G- Wholesale and retail trade

Letter in the rightmost column indicates the ISIC section (level one classification), which is the obtained accuracy of industry classification in this study. Since sectors are now regrouped into two main groups, C – manufacturing and G – wholesale and retail trade, it is possible to calculate weighted averages for these groups. This is demonstrated in the table below.

Table 23 Computing Weighted Average Costs for Trading Companies in the Study of ELA as a % of Sales (data source: Supply-Chain-Excellence in der Globalen Wirtschaftskrise 2009)

Sub industry	% of participants	index	Administration	Inventory	Warehousing	Transportation
Consumer	25	0.51	0.10	1.07	1.12	1.99
Automotive	13	0.27	0.13	0.27	0.40	0.80
Retail	11	0.22	0.09	0.07	0.27	0.36
	49		0.32	1.40	1.79	3.14
Weighted average of wholesale and retail trade					6.66	

Table 23 demonstrates the process of calculating weighted average costs for trading companies according the study of ELA. In Table 24, the same process is reproduced in accordance of manufacturing companies.

Table 24 Computing Weighted Average Costs for Manufacturing Companies in the Study of ELA as a % of Sales (data source: Supply-Chain-Excellence in der globalen Wirtschaftskrise 2009)

Sub industry	% of participants	index	Administration	Inventory	Warehousing	Transportation
Machinery	19	0.56	0.73	0.67	0.61	1.96
Process industry	15	0.44	0.57	0.62	0.53	2.12
	34		1.13	0.88	1.45	3.11
Weighted average of manufacturing					6.57	

After standardization and calculating weighted averages, the logistics costs in wholesale and retail trade is 6.66 % of sales. Corresponding amount for manufacturing is 6.57

% of sales. These results presented in Table 23 and Table 24 are comparable to survey results that are standardized to be corresponding with ISIC Rev. 4 classification.

6.2 Processing the Cost Data of Previous Research through GLOCS Model

Since the operational principles of GLOCS Model and GLOCS Tool are comprehensively explained above, the input attributes (year, currency and cost components) and output results, with illustrative charts of each research are presented at this point.

As mentioned above, ELA's latest study allowed the applying of industry classification according the ISIC. These industry classified results of GLOCS Model are presented in Figure 70 (trading) and Figure 71 (manufacturing)

COUNTRY OF STUDY											
		Original scale of measurement	SUM % of sales/turnover.								
YEAR OF THE STUDY											
2008		Administration Costs									
		2008	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0
CURRENCY OF THE STUDY (if in absolute costs)		0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Other Costs									
		2008	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
SCALE OF MEASUREMENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% of sales/turnover		Operating Costs									
		2008	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
COST COMPONENT	Costs of component	4.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Administration	0.32 % of sales/turnover	Market Costs									
Inventory carrying	1.4 % of sales/turnover	*2008*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Warehousing	1.79 % of sales/turnover	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation	3.14 % of sales/turnover										

Figure 70 GLOCS Output, ELA's Study 2008 (Trading)

The input variables in ELA's study were administration, inventory carrying, warehousing and transportation. The largest GLOCS cost element for trading companies was operating costs, which contributed 4.9% of sales. Second largest cost group was market costs, 1.4% of sales. Logistics administration costs were 0.3% of sales in 2008. The accumulated logistics costs were 6.6% of sales.

COUNTRY OF STUDY											
		Original scale of measurement	SUM % of sales/turnover.								
YEAR OF THE STUDY											
2008		Administration Costs									
		2008	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0
CURRENCY OF THE STUDY (if in absolute costs)		1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Other Costs									
		2008	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
SCALE OF MEASUREMENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% of sales/turnover		Operating Costs									
		2008	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
COST COMPONENT	Costs of component	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Administration	1.13 % of sales/turnover	Market Costs									
Inventory carrying	0.88 % of sales/turnover	*2008*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Warehousing	1.45 % of sales/turnover	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation	3.11 % of sales/turnover										

Figure 71 GLOCS Output, ELA's Study 2008 (Manufacturing)

According the study of ELA, operating costs of manufacturing companies in 2008 were 4.6% of sales. The figure was slightly lower than in trading. Also the market costs were lower in manufacturing, which is mainly due to the lower inventory carrying costs. On the other hand administration costs in manufacturing were almost four times bigger than in trading industry. Nevertheless, the total logistics costs remained in same level with trading industry. It is also possible to make historical comparison of logistics costs in accordance of GLOCS Model (Figure 72).

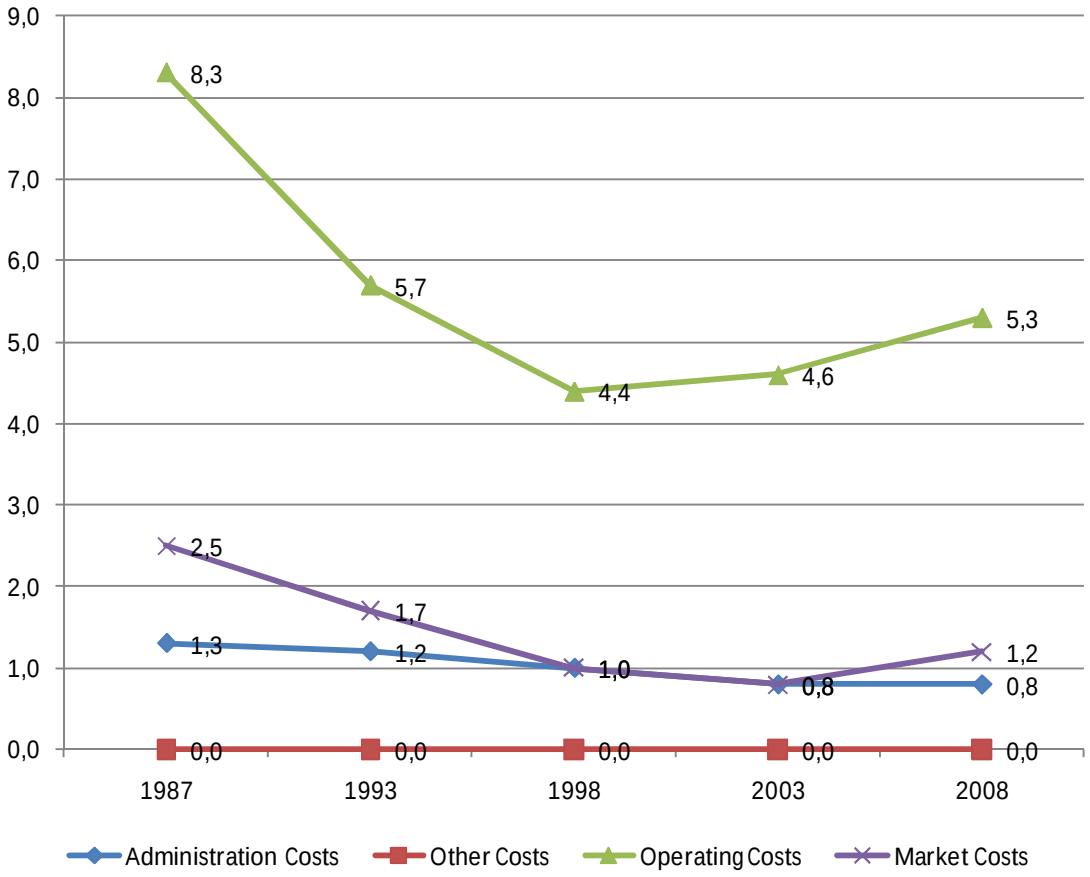


Figure 72 Logistics Costs in ELA's Studies 1987-2008 as a % of Sales

As presented in Figure 72, the development in different cost components has followed the same trend. The level of logistics costs has declined from 1987 to 1998 by almost 50 percent. In 21st century the costs have increased slightly.

Also the results of CSCMP's State of Logistics between 2003 and 2009 studies were processed in GLOCS Model. The output of GLOCS Tool is illustrated as absolute costs and as a percentage of DGP in Figure 73. The costs are automatically converted into euro and calculated as a percentage of GDP in GLOCS Tool. The principles of currency converting and GDP data retrieving are explained in Chapter 5.

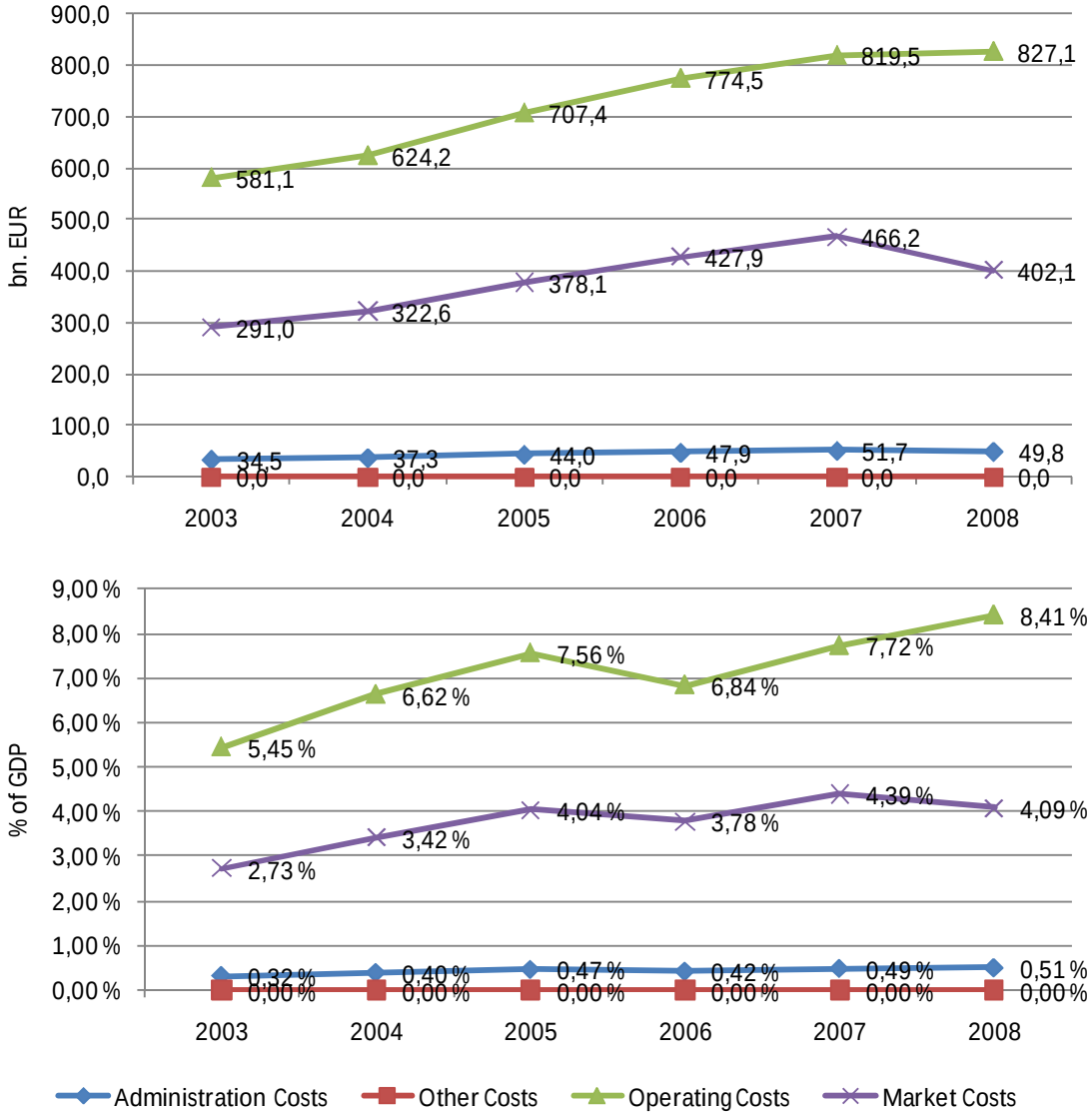


Figure 73 Logistics Costs in U.S. 2003-2008 as Absolute Costs and as a % of GDP

As presented in the figure above, absolute costs have risen year after year. The more informative part of the figure is the costs as a portion of GDP, which reveals the actual growth rate compared to general economic growth. According to this, costs have constantly risen in period under review, excluding the decline in 2006. In recent years operating costs seems to be grown rather fast and at the same time market costs have turned down. Administration costs have remained in stable and relatively low level.

This chapter concentrated on presenting few examples of GLOCS Model processed results in accuracy of individual cost component. It is possible to process the results of each study, presented in Chapter 3, through the GLOCS Model. This, however, is beyond the purpose of this study and should be comprehensively treated as its own subject. There are also some promising prospects of additional appliances of the model that should be discussed in future research.

7 CONCLUSION

Chapter 7 - Conclusion is divided into two subchapters. First of these, State of Logistics Costs Research in Global Context, concentrates on concluding the history and the current state of logistics costs research. It summarizes the findings of meta-analytical review of previous research. Chapter 7.2 evaluated the possibilities of GLOCS Model, created in this study, to meet the challenges in national level logistics costs assessing, recognized in previous literature review.

7.1 The State of Research on Logistics Costs

The level and structure of logistics cost are widely discussed topic in the field of logistics' research. In addition, the interest towards cost measuring is rising constantly, which can also be seen in increasing number of studies conducted each year. As proved in Chapter 3, the interest towards logistics cost is also a truly global phenomenon. In recent years, logistics costs are studied in several continents and by various entities, like national organs, NGOs, private sector and global organizations (e.g. World Bank).

The first purpose of this study was to pursue the genuine concept of logistics costs by conducting an extensive meta-analytical review of previous research in the field of logistics cost research. All together, six literature sources, six scientific publications and 19 studies (plus 10 case studies) were reviewed for better understanding of how the concept of logistics costs is conceived in different studies. Based on this review, all individual cost components were identified and listed, after which the list contained almost 50 different cost components. These components were then further arranged in respect of their nature (see also Appendixes 3A and 3B). This systemization, together with some other theories, served as a basis of GLOCS Model construction phase, presented in Chapter 7.2.

Also some interesting findings, related to current logistics cost research methodology, were made during the literature review. There are few main dimensions in cost research that allows recognizing of some pivotal differences and categorize studies on these bases. Being able to identify these differences promotes better understanding concerning the concept of logistics costs.

First dimension was the applied study methodology, which includes the method of collecting- and refining the data in source studies. Three main approaches were identified in this context:

- Questionnaire based studies (surveys)
- Modeling based studies
- Case studies and other studies

The first group, questionnaire based surveys, gather data by using questionnaires, in which respondents answer to several questions. Questionnaire can be executed for example by on-line surveys or interviews. The chosen method depends on several factors like sample size and available budget. The common factor in the surveys is that the results are based on subjective answers of chosen sample. The second group, modeling based studies, is formed by those studies, which results are based on created model that utilizes the existing data from different statistical sources. Third group, case studies and other studies, gathers the studies, of which results are deducted by applying case study methodology or otherwise cannot be addressed in other groups. Case study methodology is usually applied in countries, where sufficient or reliable data is not available. In these cases researchers combine several different methods to drawn up the results.

Second fundamental difference between conducted studies was thematic broadness of the study. Based on the previous study review, it was possible to categorize studies by the thematic broadness. Depending on the number of themes discussed in the source study, two different groups are identified. These are:

- Multi theme studies
- Single theme studies

Multi theme studies deal with numerous themes (for example logistics costs and outsourcing) in the same study. These themes may still be discussed as an individual subjects. On the other hand single theme studies only concentrate on assessing logistics costs.

It is also possible to recognize third dimension that allows classification of studies. This is different metric of reporting logistics costs, employed in previous studies. Following metrics aroused during the review of previous research: % of sales, % of total costs, % of turnover, % of GDP, % and % of purchases. In addition, some studies reported costs as absolute costs in several different currencies. Three main metrics were derived from above-mentioned in this study. These are:

- % of GDP,
- % sales or turnover
- absolute costs

As discussed in previous chapters, two of these metrics, percentage of GDP and percentage of sales or turnover, do not necessary differ each other significantly. Still, due to the reliability of the study, it is justified not to assume these to be exactly same. Metrics dimension also has direct linkage to GLOCS Model. Since it is possible to convert different currencies and to present these absolute costs as a portion of respective country's GDP, GLOCS Model automatically report results also in this form.

These dimensions, presented above, allow illustrating the current state of logistics research and prevailing trends based on the meta-analysis of previous research. First the popularity of different reporting metrics is illustrated in Figure 74.

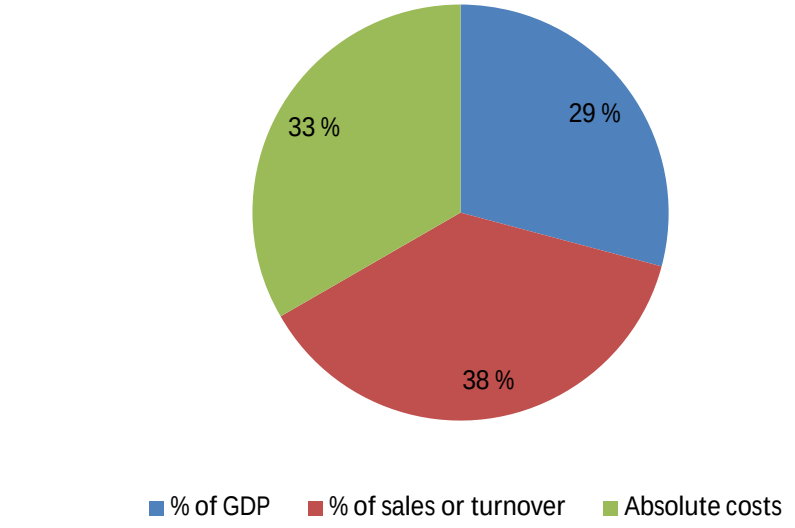


Figure 74 Employed Reporting Metrics in Previous Research

As seen in Figure 74, different reporting metrics are used more or less evenly. Percentage of sales or turnover metric seems to be the most popular one with 38% share. However, it should be reminded that two other reporting metrics, percentage of GDP and absolute costs, can be fairly easily converted into same format. In this case they would represent 62% of studies. Next, the distribution of studies is illustrated in respect of thematic broadness and data collection method (Figure 75).

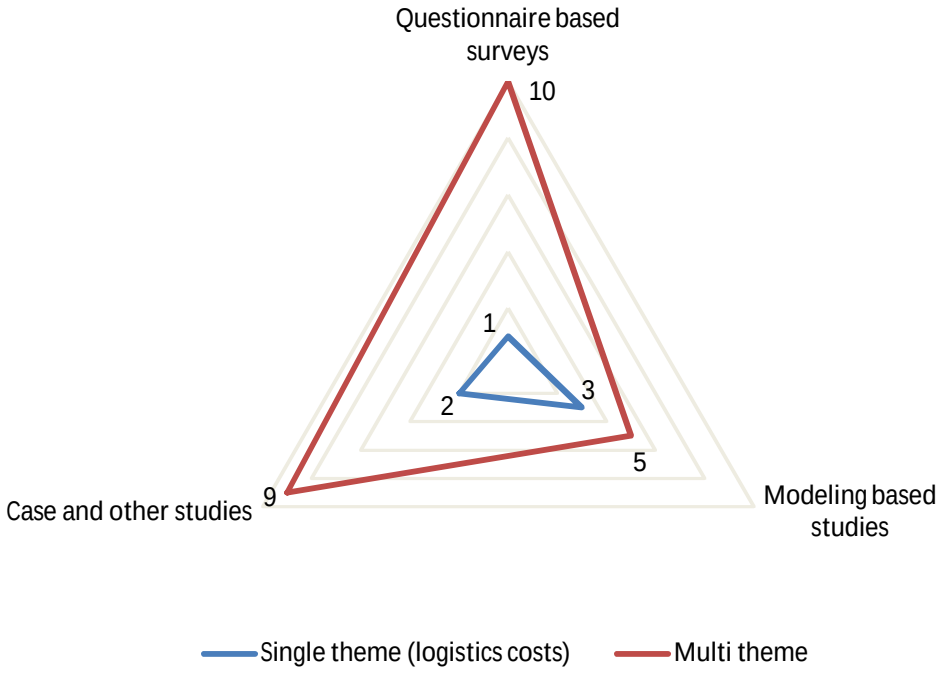


Figure 75 The Distribution of Logistics Cost Study Methods according the previous Research

As presented in the figure above, multi theme studies are more popular than single theme ones. This is probably because of the multi dimensional characteristic of logistics chains, which encourages researchers to discuss several issues at the same time instead of just one. This can be clearly perceived also from the fact that 10 out of 11 questionnaire surveys were multi theme studies. The other way round, half of the single theme studies were conducted by using modeling based method, which can be explained by the fact that modeling approach is usually lighter to put into practice (at least in terms of data collecting). Among multi theme studies, questionnaire based methods seems to be more popular than modeling ones. It is not possible, or even necessary, to conclude, which method generates more accurate or reliable results, since there are both pros and cons in both. However, it could be stated that case study methodology should not be applied if resources, statistics and data gathering methods allows to apply whether modeling or questionnaire based study methods.

As discussed in the beginning of this subchapter, these findings serve a dual purpose. Firstly, they draw a picture over the current state and trends in logistics costs research, which helps to further developing common measurement framework. Secondly, meta-analysis served as a basis of GLOCS Model construction by systemizing the blurred concept of logistics costs. Chapter 7.2 summarizes the pivotal attributes of GLOCS Model and concludes its abilities to respond to the challenge of making nation level logistics cost comparison possible.

7.2 The Proposed GLOCS Model and its Benefits

The main purpose of this study was to design a model for assessing national level logistics costs. Since many entities have already conducted logistics cost studies, the chosen approach was to construct a model that would utilize the results of current research and convert it into comparable form. Since different studies measure logistics costs with very different methods, the subject needed to be approached from the meta-analytical point of view.

To tackle the problem various research methods, the GLOCS (Generic Logistics Cost Structure) Model was developed in this study. By converting the different individual cost groups into four GLOCS Model cost groups, the model processed results should be comparable to each others. GLOCS Model cost groups were determined by scrutinizing the appearance density and definitions of individual cost group in previous research. This information was then combined to TCA theory and fourfold table classification of logistics costs, which both eased the conceptual analysis of gathered information.

Original purpose was also to include the industry classification component into the model to make different industry classifications commensurable. In Chapter 5.2, the

technique for meeting this objective was developed, explained and illustrated comprehensively. Still, due to the insufficient information, provided in previous research sources, it had to be faced that industry classification couldn't be applied in many studies. In more general level, the possibility of making industry classifications commensurable should be questioned because of the significant variance in reporting methods and standard industry classification used in studies. Still, since there are some global industry classifications (like ISIC) available, and many countries are adapting these to their national statistics, the technique proposed in this study could be proved to be useful in the future.

As explained above, the operational principle of GLOCS Model is grounded on three linchpins, which are:

- Meta-analysis of previous logistics cost research
- Transaction Cost Approach (TCA) theory
- Fourfold table of logistics costs -systemization

This study includes one of the most comprehensive reviews of previous research related to assessing logistics costs in national level. The object of the review was to gather the relevant logistics cost data for meta-analysis, which, by combining the different concepts used in previous research, offered solid basis for constructing the GLOCS Model. TCA theory, originally developed by the 2009 Nobel Prize winner Oliver E. Williamson, was employed to systemize the individual cost elements into main elements (see also Paragraph 2.3.2). The third linchpin of model construction was fourfold table of logistics costs, which promotes the categorizing of logistics costs in respect of direct/indirect and activity related/overhead logistics costs (see Paragraph 2.3.1). This categorizing is employed in several studies around the world. The dimensions of these theories are employed into the model construction for systemizing the logistics costs and identifying the pivotal characteristics of individual cost groups. Based on these three linchpins, GLOCS Model with four main cost groups was constructed (Figure 76).

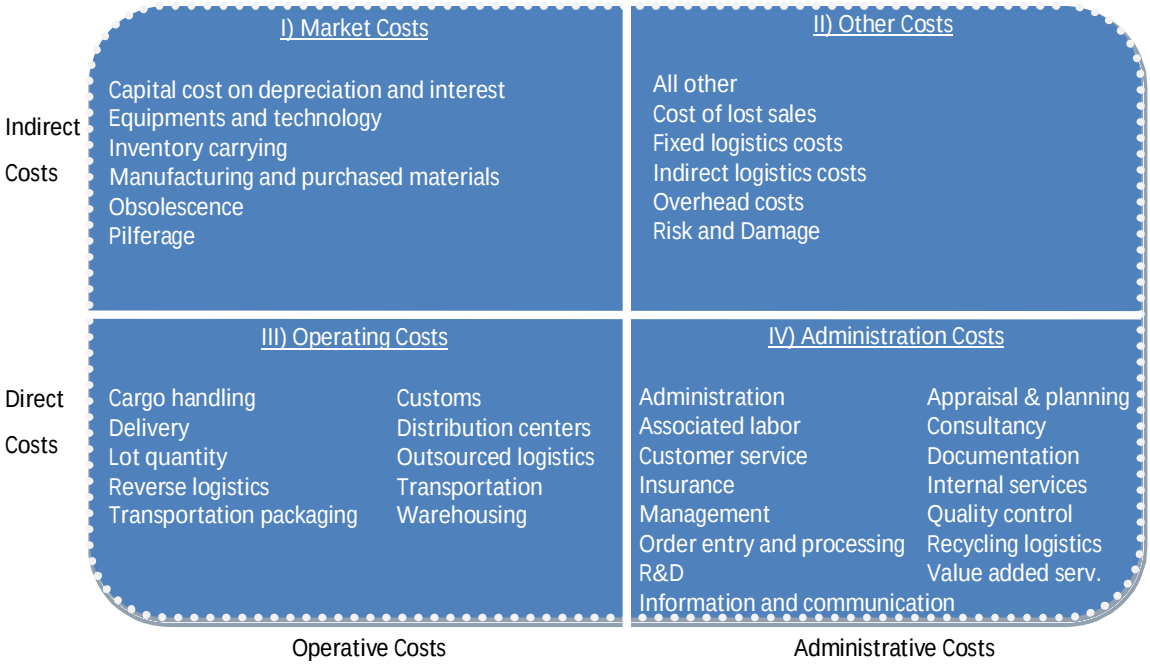


Figure 76 GLOCS Model Typology

To increase the usability of the GLOCS Model, an Excel based GLOCS Tool was also introduced. This tool provides an effective and user-friendly instrument for solving the assessment problems identified earlier in this study. First of all, the GLOCS Tool re-classifies different cost groups, identified in the literature, under four GLOCS Model cost groups presented in Figure 76. Categorizing individual cost groups under the four GLOCS Model groups may not be a sufficient output if results have been reported in different currencies. This is why GLOCS Tool also possesses a built-in currency converter that converts absolute costs into common currency (Euro). GLOCS Tool also presents the absolute costs as a % of GDP of respective country, which is more illustrative method when several studies are compared.

Applying the GLOCS Model certainly offers some benefits and added value for studying logistics costs across countries. Because the model is constructed based on the background variables of previous studies, it may be applied to most previous published research. Together with strictly limited cell inputs in GLOCS Tool, this ensures that variables produce a comparable output. Furthermore, presented cost systematization itself may be used in different managerial- (e.g. identifying the structure of logistics costs in companies) and theoretical implications (e.g. recognizing the level of logistics costs in certain industries). Built-in converter for currencies and percentages of logistics costs in GLOCS Tool greatly reduce errors. Tool also allows the comparison of longer time series and illustrates the result with line charts. An additional benefit of GLOCS Model is the rather small amount of data needed, which allows the model to be applied for most of the existing studies.

The logistics cost systemization model designed in this study has several possible applications, which could be scrutinized future research. One likely application could be research of industry specific logistics cost structure, which could help to identify the typical structure and level of logistics costs in different industries. This also comprises the preliminary research problem of author’s doctoral thesis, the GLOCS development.

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APPENDICES

Appendix 1 Sourcing and Logistics in China 2008

% of responden	Index 100/66=1.52	% of respondent	cost	Weighted cost		
14	21.28	0.2128	17.5	3.724	=E4*D4	
10	15.2	0.152	10	1.52		
42	=1.52*42 63.84	0.6384	13	8.2992	=SUM(F2:F4	
		Manufacturing average costs		13.5432		

Appendix 2 Davis Database Questionnaire Form

Logistics Cost and Service Database

Company Name _____ **Contact Name** _____
Address _____ **Title** _____
_____ **Telephone** _____ **Fax** _____
_____ **Email** _____

CLASSIFICATION DATA

Company's Industry Description and Principal Products _____
Nature of Business: **Products are Primarily:**

☐ Manufacturing ☐ Wholesale/Distributor ☐ Retail Chain ☐ Other ☐ Durable ☐ Non-Durable ☐ Consumer ☐ Industrial

SIZE OF BUSINESS

A. **Net US Sales Dollars** $ _____
B. **Weight Shipped to Customers** _____ lbs.
C. **Number of Customer Shipping Points** _____
D. **Number of Sales Orders** _____
E. **Number of Sales Order Lines** _____

TRANSPORTATION COST TERMS TO CUSTOMERS

Percent of Sales on which Freight is:

Paid by You _____ %
Paid by Customer _____ %
Picked up by Customer without Allowance _____ %
Other _____ _____ %
Total **100 %**

LOGISTICS COSTS **Data for 12 Months Ending** _____/_____/_____

A. **Finished Goods Transportation**
1. **Primary Transportation.**
Domestic (From domestic plants/vendors to DCs and DC transfers) $ _____
International (From international plants/vendors to DC's excluding duty) $ _____
2. **Secondary Transportation.** Delivery to customers. $ _____
Total Transportation $ _____

B. **Finished Goods Warehousing.** Plant, DC, public, and third-party warehouse costs for storage and handling of finished goods. Costs should include the following: labor, space, energy, equipment, computers (hardware and software), and material for packing and shipping. **Warehousing** $ _____

C. **Order Entry/Customer Service (OE/CS).** Costs should include the following: labor, space, energy, computers (hardware and software), and supplies. **OE/CS** $ _____

D. **Administration of Distribution.** Personnel and support costs for indirect management (central distribution staff, computers (hardware and software), inventory control, and transportation and traffic). **Administration** $ _____

E. **Finished Goods Inventory Carrying Cost**
Average Inventory Value at Standard Cost $ _____
Average Finished Goods Inventory Turns _____
Carrying Cost (Inventory Value x 0.18) $ _____

To value the cost to carry inventory, does your company use: **Total Logistics Cost** $ _____
☐ A specific rate for inventory carrying ☐ An internal hurdle rate ☐ Not sure/don't know
What is the rate currently used by your company to value the cost to carry inventory? _____%

CUSTOMER SERVICE PERFORMANCE MEASURES

A. **Total Order Cycle Time** (Customer PO to Delivery of Shipment) _____ calendar days
B. **Percent of Orders Shipped Complete on the First Shipment** _____ %
C. **Percent of Lines Shipped Complete** _____ %
D. **Percent of Units Shipped Complete** _____ %

Appendix 3A Cost Element Aggregate

Single country studies	COUNT
Administration	13
Appraisal	1
Cargo handling	2
Communication	1
Customer service	1
Customs	1
Damages	1
Delivery	1
Depreciation	1
Documentation	1
Equipments	1
Insurance	2
Internal services	1
Inventory carrying	9
Obsolescence	2
Other	3
Other indirect log. costs	1
Planning/mngmnt	1
R&D	1
Shipper related	2
Transport packaging	3
Transportation	13
Warehousing	13
SUM	75

Literature	COUNT
Administration	
Associated labor	1
Consultancy	1
Customer service	2
Fixed log. costs	1
Inventory carrying	5
Logistics technology	1
Lot quantity	1
Manufacturing	1
Order processing / information	1
Packaging	5
Procurement	1
Purchased materials	1
Quality control	1
Recycling logistics	1
Reverse logistics	1
Value-added services	2
Warehousing	6
SUM	35

Multi-country studies	COUNT
Administration	4
Custom/special packaging	1
Customer service/order entry	1
Distribution centers	1
Internal logistics	1
Inventory carrying	6
Mngmnt/ overhead	1
Order entry	1
Other	1
Outsourced logistics	1
Trade-related	1
Transportation	6
Warehousing	4
SUM	29

Articles	COUNT
Administration	3
Cost of capital tied in transportation	2
Cost of capital tied in inventory	1
Customs	1
Indirect logistics costs	1
Insurance	2
Inventory carrying	1
Packaging	3
Risk and Damage	1
Transportation	5
Warehousing	4
SUM	24

Appendix 3B Cost Element Frequency

COST COMPONENT	COUNT	Gathering component	COUNT
Warehousing	27	Warehousing	34
Transportation	24	*Cargo handling*	
Administration	23	*Obsolescence*	
Inventory carrying	22	*Depreciation*	
Packaging	8	*Distribution centers*	
Insurance	4	*Lot quantity*	
Other	4	Transportation	31
Customer service	3	*Customs*	
Transport packaging	3	*Shipper related*	
Cargo handling	2	*Custom/special packaging*	
Cost of capital tied (trans.)	2	*Delivery*	
Customs	2	*Trade-related*	
Internal services	2	Administration	45
Obsolescence	2	*Customer service*	
Shipper related	2	*Value-added services*	
Value-added services	2	*Internal services*	
Appraisal	1	*Appraisal*	
Associated labor	1	*Associated labor*	
Communication	1	*Communication*	
Consultancy	1	*Consultancy*	
Custom/special packaging	1	*Customer service/order entry*	
Customer service/order entry	1	*Documentation*	
Damages	1	*Indirect logistics costs*	
Delivery	1	*Mngmnt/ overhead*	
Depreciation	1	*Order entry*	
Distribution centers	1	*Order processing / information*	
Documentation	1	*Other indirect log. costs*	
Equipments	1	*Planning/mngmnt*	
Fixed log. costs	1	*Procurement*	
Indirect logistics costs	1	*R&D*	
Logistics technology	1	Inventory carrying	22
Lot quantity	1	*Manufacturing*	
Manufacturing	1	*Cost of capital tied in transportation*	
Mngmnt/ overhead	1	*Purchased materials*	
Order entry	1	Packaging	8
Order processing / information	1	*Transport packaging*	
Other indirect log. costs	1	Other	4
Outsourced logistics	1	*Insurance*	
Planning/mngmnt	1	*Damages*	
Procurement	1	*Fixed log. costs*	
Purchased materials	1	*Logistics technology*	
Quality control	1	*Outsourced logistics*	
R&D	1	*Recycling logistics*	
Recycling logistics	1	*Reverse logistics*	
Reverse logistics	1	*Risk and Damage*	
Risk and Damage	1	*Quality control*	
Trade-related	1	*Equipments*	
SUM	163	SUM	163

Appendix 4 Screenshots of Currency Rate and GDP in GLOCS Tool

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
4	WEO Subject Code		NGDPD	NGDPD	NGDPD	NGDPD	NGDPD	NGDPD	NGDPD	NGDPD	NGDPD	NGDPD	NGDPD	NGDPD	NGDPD	NGDPD	NGDPD	NGDPD
5	Country		Afghanist	Albania	Algeria	Angola	Antigua a	Argentina	Armenia	Australia	Austria	Azerbaija	Bahamas	Bahrain	Banglade	Barbados	Belarus	Belgium
6	Subject Descriptor		Gross doi	Gross doi	Gross doi	Gross doi	Gross doi	Gross doi	Gross doi	Gross doi	Gross doi	Gross doi	Gross doi	Gross doi	Gross doi	Gross doi	Gross doi	Gross doi
7	Subject Notes		Values ai	Values ai	Values ai	Values ai	Values ai	Values ai	Values ai	Values ai	Values ai	Values ai	Values ai	Values ai	Values ai	Values ai	Values ai	Values ai
8	Units		U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla	U.S. dolla
9	Scale		Billions	Billions	Billions	Billions	Billions	Billions	Billions	Billions	Billions	Billions	Billions	Billions	Billions	Billions	Billions	Billions
10	Country/Series-spe		See note:	See note:	See note:	See note:	See note:	See note:	See note:	See note:	See note:	See note:	See note:	See note:	See note:	See note:	See note:	See note:
11	1980	1	n/a	1.833	42.346	5.428	0.11	209.018	n/a	160.494	80.218	n/a	1.621	3.072	19.507	0.884	n/a	121.31
12	1981	2	n/a	2.099	44.372	5.08	0.125	169.759	n/a	185.657	69.51	n/a	1.679	3.468	19.011	0.973	n/a	100.877
13	1982	3	n/a	2.162	44.78	5.08	0.138	84.297	n/a	184.095	69.5	n/a	1.891	3.646	17.408	1.017	n/a	88.75
14	1983	4	n/a	2.184	47.529	5.294	0.153	103.989	n/a	176.403	70.413	n/a	2.105	3.735	18.243	1.079	n/a	83.959
15	1984	5	n/a	2.156	51.513	5.612	0.174	116.758	n/a	194.029	66.423	n/a	2.248	3.877	20.741	1.176	n/a	79.952
16	1985	6	n/a	2.202	61.132	6.914	0.202	88.187	n/a	171.94	68.026	n/a	2.448	3.658	21.337	1.231	n/a	83.258
17	1986	7	n/a	2.436	61.535	6.473	0.246	106.045	n/a	178.441	96.526	n/a	2.646	2.862	22.37	1.352	n/a	115.417
18	1987	8	n/a	2.417	63.3	7.4	0.287	108.725	n/a	210.137	120.71	n/a	2.913	3.101	24.679	1.488	n/a	143.482
19	1988	9	n/a	2.382	51.664	8.027	0.339	127.35	n/a	266.715	132.409	n/a	3.029	3.832	26.637	1.583	n/a	155.784
20	1989	10	n/a	2.617	52.558	9.338	0.374	81.706	n/a	302.486	132.064	n/a	3.414	4.113	29.344	1.752	n/a	157.715
21	1990	11	n/a	2.091	61.892	10.278	0.392	141.337	n/a	317.722	165.259	n/a	3.543	4.528	30.497	1.757	n/a	197.38
22	1991	12	n/a	1.255	46.67	9.963	0.411	189.594	n/a	319.721	172.779	n/a	3.533	4.615	31.432	1.733	n/a	202.445
23	1992	13	n/a	0.794	49.217	7.682	0.426	228.776	0.108	313.19	193.516	1.193	3.461	4.75	31.439	1.623	4.115	225.031
24	1993	14	n/a	1.376	50.963	5.575	0.456	236.505	0.835	304.593	188.39	1.309	3.419	5.199	32.954	1.69	3.662	215.774
25	1994	15	n/a	2.223	42.426	4.06	0.501	257.44	0.651	347.146	201.638	2.258	3.631	5.565	35.802	1.743	4.854	235.545
26	1995	16	n/a	2.714	42.066	5.066	0.494	258.032	1.287	371.247	238.55	2.417	3.796	5.848	39.58	1.871	3.384	276.48
27	1996	17	n/a	3.013	46.941	6.535	0.541	272.15	1.597	417.176	234.234	3.177	4.01	6.1	41.516	1.997	14.5	275.04
28	1997	18	n/a	2.164	48.178	7.675	0.58	292.859	1.639	418.048	207.126	3.963	4.3	6.35	43.388	2.195	14.098	249.751
29	1998	19	n/a	2.738	48.188	6.506	0.621	298.948	1.892	373.029	212.439	4.28	4.812	6.183	44.757	2.37	15.222	255.55
30	1999	20	n/a	3.444	48.845	6.153	0.652	283.523	1.845	401.998	211.206	4.581	5.298	6.617	46.529	2.478	12.138	253.996
31	2000	21	n/a	3.64	54.749	9.135	0.678	284.204	1.912	389.956	191.761	5.273	5.65	7.966	47.048	2.559	10.418	232.626
32	2001	22	n/a	4.065	54.745	8.936	0.71	268.697	2.118	368.129	190.319	5.708	5.761	7.969	47.194	2.554	12.355	231.871
33	2002	23	4.009	4.442	56.748	11.386	0.718	97.732	2.376	412.902	206.684	6.236	6.077	8.489	49.56	2.476	14.595	252.732
34	2003	24	4.435	5.694	67.802	13.956	0.754	127.643	2.807	527.753	252.516	7.276	6.187	9.745	54.476	2.695	17.825	310.681
35	2004	25	5.393	7.306	85.144	19.8	0.819	151.958	3.577	640.544	289.419	8.682	6.189	11.233	59.12	2.824	22.716	359.314
36	2005	26	6.489	8.188	102.721	30.632	0.873	181.549	4.9	713.205	303.447	13.245	6.797	13.456	61.127	3.005	30.21	376.99
37	2006	27	7.723	9.112	116.825	45.168	1.006	212.71	6.384	755.202	321.649	21.027	7.28	15.848	65.204	3.191	36.962	400.304
38	2007	28	9.659	10.865	135.343	59.263	1.155	260.402	9.206	910.334	371.144	31.287	7.498	18.443	73.689	3.409	45.276	459.029
39	2008	29	11.709	12.964	159.669	84.945	1.224	324.767	11.917	1,013.461	414.828	46.378	7.564	21.236	84.196	3.67	60.302	506.183
40	2009	30	13.318	11.726	134.797	69.708	1.18	301.331	8.683	920.01	374.417	42.505	7.403	19.361	92.121	3.595	49.043	461.489
41	2010	31	15.406	11.797	154.843	87.718	1.196	296.109	8.238	982.826	389.002	51.916	7.409	21.567	99.088	3.63	53.137	480.154

input | GLOCSengine | currencyrates | **GDPs** | output

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
38			EUR	USD	JPY	BGN	CZK	CYP	DKK	EEK	GBP	HUF	LTL	LVL	MTL	PLN	RON	SEK	SIT	SKK	CHF
39			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
40	2010	1	1	1.4389	133.62	1.9558	26.285		7.4415	15.6466	0.8914	269.85	3.4528	0.7093		4.103	4.2253	10.193			1.4873
41	2009	2	1	1.3866	126.64	1.9558	26.825		7.4499	15.6466	0.961	265.48	3.4528	0.7083		4.1638	4.035	10.8425			1.4874
42	2008	3	1	1.4688	163.83	1.9558	26.364		7.4552	15.6466	0.7413	253.22	3.4528	0.6988		3.6013	3.583	9.4257		33.586	1.6529
43	2007	4	1	1.327	157.76	1.9558	27.525	0.5782	7.4566	15.6466	0.6735	251.44	3.4528	0.6984	0.4293	3.8287	3.3829	9.0245		34.383	1.6104
44	2006	5	1	1.1826	139.56	1.9558	29.03	0.5735	7.4601	15.6466	0.6865	252.69	3.4528	0.6962	0.4293	3.8665	3.6825	9.3977	239.5	37.865	1.5536
45	2005	6	1	1.3507	138.84	1.9559	30.361	0.58	7.4371	15.6466	0.70725	245.58	3.4528	0.6964	0.4343	4.0774	39230	8.9758	239.78	38.655	1.5444
46	2004	7	1	1.2592	134.72	1.9557	32.398	0.58637	7.4452	15.6466	0.70545	261.93	3.4525	0.6715	0.4316	4.7029	41122	9.05	236.85	41.145	1.5615
47	2003	8	1	1.0446	124.4	1.9557	31.59	0.57353	7.4272	15.6466	0.652	235.78	3.4533	0.6134	0.4183	4.005	35012	9.127	230.325	41.412	1.4528
48	2002	9	1	0.9038	119.53	1.9519	31.707	0.57527	7.4388	15.6466	0.6262	244.58	3.6143	0.5665	0.4047	3.5608	28687	9.2825	216.7703	42.728	1.4833
49	2001	10	1	0.9423	108.26	1.9557	35.112	0.57451	7.4611	15.6466	0.6315	264.58	3.7706	0.5814	0.4098	3.8625	24467	8.888	213.4667	43.859	1.5218
50	2000	11	1	1.009	102.75	0.5767	36.063	0.57451	7.4404	15.6466	0.6246	254.53	4.0454	0.5916	0.4151	4.1835	18273	8.552	198.8925	42.317	1.6043
51	1999	12	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
52	1998	13	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
53	1997	14	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
54	1996	15	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
55	1995	16	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
56	1994	17	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
57	1993	18	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
58	1992	19	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
59	1991	20	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
60	1990	21	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
61	1989	22	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
62	1988	23	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
63	1987	24	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
64	1986	25	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
65	1985	26	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
66	1984	27	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
67	1983	28	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
68	1982	29	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
69	1981	30	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
70	1980	31	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
71	1979	32	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
72	1978	33	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
73	1977	34	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
74	1976	35	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
75	1975	36	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
76	1974	37	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
77	1973	38	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
78	1972	39	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
79	1971	40	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
80	1970	41	1	1.1789	133.73	0.58231	35.107	0.57451	7.4501	15.6466	0.7111	251.48	4.717	0.6668	0.4432	4.0712	13111	9.4696	189.045	42.991	1.6168
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