



Evaluating Supply Chains

**The development of a model
to evaluate multinational
supply chains**

Bachelor Dissertation
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MBA Dissertation
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Abstract

- Title:** Evaluating Supply Chains – The development of a model to evaluate multinational supply chains
- Authors:** Bartosz Kurek, Dirk Schäfer, Richard Szabó
- Tutors:** Bengt Ferlenius and Viveca Fjelkner
- Purpose:** The purpose of this dissertation was to develop a general model for evaluating multinational supply chains. This model could provide guidelines for process-based manufacturing companies when comparing or choosing between different supply chains in order to make long-term investment decisions.
- Therefore, the authors looked through various measurement, comparison and evaluation theories. The data gained during interviews (case studies) and questionnaires (survey) helped to create a model, which proved to be generally applicable since it occurred that there is no real difference between the evaluation of national and multinational supply chains. Therefore, the model can be applied for domestic as well as for multinational supply chain evaluation purposes.
- Keywords:** Supply chain measurement, evaluation, comparison

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Table of contents

CHAPTER 1	INTRODUCTION.....	1
1.1	Background.....	1
1.2	Problem discussion	2
1.3	Purpose	4
1.4	Criteria for model evaluation.....	4
1.5	Definitions	4
1.6	Limitations.....	5
1.7	Target group.....	6
1.8	Outline of this dissertation.....	6
CHAPTER 2	RESEARCH METHOD.....	9
2.1	Methodological perspective.....	9
2.2	Research approaches.....	9
2.3	Research strategy	10
2.4	Time horizons	10
2.5	Data collection methods	10
2.6	Secondary data.....	11
2.6.1	Case studies	11
2.6.2	Survey	12
CHAPTER 3	THEORETICAL FRAMEWORK	13
3.1	Supply chains and investment decisions.....	13
3.2	Differences between a supply chain and a value chain	16
3.3	The Cost-Volume-Profit analysis	16
3.4	Static methods.....	28
3.5	Dynamic methods	29
3.6	DuPont model	32
3.7	The Supply Chain Operations Reference (SCOR) model	36
3.7.1	Description of the SCOR model.....	36
3.7.2	SCOR's 4 levels.....	39
3.7.2.1	SCOR Level 1.....	39
3.7.2.2	SCOR Level 2.....	40
3.7.2.3	SCOR Level 3.....	40

3.7.2.4	SCOR Level 4.....	40
3.7.3	Performance Measurement and Benchmarking using the SCOR model	41
3.7.4	Boundaries of the SCOR model	42
3.8	Choice of a method.....	43
CHAPTER 4	EMPIRICAL PART	45
4.1	Research limitations.....	45
4.2	Data collection.....	45
CHAPTER 5	CASE STUDIES.....	48
5.1	Case Study: Nolato Alpha AB.....	48
5.1.1	Presentation of the company.....	48
5.1.2	Supply chain studied in Nolato Alpha AB	49
5.1.3	Evaluation methods	49
5.1.4	Varying importance of different evaluation methods.....	50
5.2	Case Study: Bong Ljungdahl Sverige AB	52
5.2.1	Presentation of Bong Ljungdahl Sverige AB	52
5.2.2	Supply chain studied in Bong Ljungdahl Sverige AB.....	52
5.2.3	Evaluating different supply chain options	53
5.2.4	Varying importance of different evaluation methods.....	54
5.3	Case Study: Tetra Pak Packaging Materials AB	55
5.3.1	Presentation of Tetra Pak Packaging Materials AB	55
5.3.2	Supply chain studied in Tetra Pak Packaging Materials AB... 55	
5.3.3	Evaluation methods	55
5.3.4	Varying importance of different evaluation methods.....	56
5.4	Summary of Case Studies.....	56
CHAPTER 6	SURVEY.....	58
6.1	Method of the survey.....	58
6.2	Analysis of the survey	60
6.3	Criticism of the survey.....	62
CHAPTER 7	DEVELOPMENT OF THE MODEL	63
7.1	Developing a general model.....	63
7.2	Simplified tests of the model.....	66

7.2.1	First test	66
7.2.1.1	“Supply chain (and decision problem)”	66
7.2.1.2	“Choice of factors with greatest importance”	67
7.2.1.3	“Theories of evaluation and measurement”	67
7.2.1.4	“Practice (comparison with others)”	67
7.2.1.5	“Measurement of chosen factors”	67
7.2.1.6	Data	68
7.2.1.7	Information	70
7.2.1.8	Decision	70
7.2.2	Second test	71
7.2.2.1	“Supply chain (and decision problem)”	71
7.2.2.2	“Choice of factors with greatest importance”	71
7.2.2.3	“Theories of evaluation and measurement”	71
7.2.2.4	“Practice (comparison with others)”	71
7.2.2.5	“Measurement of chosen factors”	71
7.2.2.6	“Data”	73
7.2.2.7	“Information”	73
7.2.2.8	Decision	73
CHAPTER 8	CONCLUSIONS AND RECOMMENDATIONS	75
8.1	Conclusions	75
8.2	Recommendations	76
REFERENCES	78

Figures

Figure 1: Outline of this dissertation.....	8
Figure 2: Research approach and strategy	12
Figure 3: Fixed costs	18
Figure 4: Proportional variable costs	18
Figure 5: Dependence between the amount of fixed costs applied to each unit of a product and the volume of production	19
Figure 6: Dependence between fixed costs and production volume.....	20
Figure 7: Degressive and progressive variable costs	21
Figure 8: Total costs.....	22
Figure 9: Costs and revenues of a production line.....	23
Figure 10: Costs of two possible supply chains	24
Figure 11: Strategies for fixed and variable costs	25
Figure 12: DuPont model	33
Figure 13: Logistics impact on ROI.....	34
Figure 14: The impact of margin and asset turn on ROI.....	35
Figure 15: The 4 levels of SCOR.....	41
Figure 16: Differences in the evaluation of multinational and national supply chains in Sweden.....	61
Figure 17: General model	63

Tables

Table 1: Definitions of SCOR performance	42
Table 2: Analysis of the survey	60
Table 3: Overview of the first model's test.....	70
Table 4: Payback period measurement	72

Appendices

Appendix 1: Example of a SCORcard.....	83
Appendix 2: Questionnaire for interviews (final version).....	84
Appendix 3: Questionnaire (Swedish text).....	85
Appendix 4: Questionnaire (English text).....	87

Chapter 1 Introduction

1.1 Background

During the 1990s, a lot of major changes have occurred within the international business area. The most significant of these have been growing globalisation, skyrocketing competition, rising differentiation of products, focusing on core competencies, shortening product life cycles and rising quality demand (Gerdin, 1995, 20).

Consequently, companies have been under constant pressure to cut costs, to be increasingly responsive – but at the same time flexible – and to shorten lead times. Pressures coming from more demanding customers than ever before, increasing requirements on all levels have mostly triggered these changes. Other factors, such as development of the Internet, have been affecting these changes as well. It cannot be forgotten, however, that these factors have also constituted severe threats to lose market shares and thus to depreciate companies' shareholders value and profitability.

This development is not just affecting all types of business sectors but all levels within one business sector as well. All levels means from raw material production until the end customer is reached by the end product. Therefore, all companies facing these changes are forced to realize that they are not just suppliers of a part or producers of an end product. Instead all parties – involved in one particular product – have to understand that they are part of a product or supply chain, often with a large number of companies linked together.

Reduced cycle-times, short lead times and desire to lower inventories are no new concepts. The same desires have been there for a long time. The difference is that the companies have started to integrate themselves within supply chains. It is worth mentioning that parties cooperating today might have been competitors not too long ago. This new type of thinking is forcing

competitors to cross their own company borders and start cooperating. That is something that would have been unthinkable just 10 years ago. While competition during the nineties occurred between rival firms, today it is on a much bigger scale.

Nowadays, companies have entered an era of supply chain competition, meaning that the focus is shifting from the individual company's competitive advantage towards the entire supply chain's competitive advantage (Lindroth, 2001, 4).

The underlying philosophy behind today's supply chain concept is the planning and coordinating of the product flow from source to end user as an integrated system, rather than managing the flow as a series of independent activities (Keebler, 1999, 33; Aronsson, 2000, 6-7).

That is why it has become more and more important for all companies to evaluate supply chains they are involved in. After the evaluation process, these supply chains should be compared to each other in order to find out which one is more profitable for a company. Some of the companies are also in the planning stage of where to invest their financial resources. Since these resources are usually invested in different kinds of supply chains, there has been a need to compare investment possibilities. Furthermore, it may not be so easy for the company to withdraw its financial resources from new-built supply chains, so each company should be able to know in the beginning what to expect from a particular project.

1.2 Problem discussion

Usually, a single company processes a few steps in a supply chain before sending it to the next company. Therefore, even evaluating smaller parts of a supply chain requires looking beyond one single company's boundaries.

Additionally, many companies operate internationally and thus parts of their supply chains are situated abroad. That is why the evaluation of supply

chains requires the outlook at every part of the supply chains from the country-border-crossing perspective. The problem in this dissertation is, if the international supply chains could be evaluated in the same way as national supply chains.

This is in clear contrast to Henry Ford's manufacturing of the T-ford when the control of the production process was complete. Ford owned every little manufacturing facility and even the raw material supplies such as the rubber plantation to make tires. Practically he was covering the whole supply chain of the T-ford, something that would be impossible in today's segmented business environment (Helander, 2000, 6).

Therefore, it may be hard for an insider of a particular company to evaluate a certain supply chain, especially that lack of time, funds and knowledge may be a restriction to create a supply chain evaluation model.

That is why the main objective has been – by using in-depth interviews combined with general questionnaires – to receive all available information from companies, which operate in the production and manufacturing industry, on what methods are used in the process of evaluation of supply chains.

The main problems that can occur in multinational supply chains are:

- different inflation rates and
- different risks of cash flows because of the political and economic environment.

These problems are at the same time the additional features of multinational supply chains compared to national supply chains.

Our work has considered and provided for two different perspectives: The first one has been to investigate if the complexity of the product the company produces has any influence on the methods in evaluating supply

chains. The second perspective has been to define the differences in evaluation between national and international supply chains.

Therefore, the following two research questions evolved:

- Do different companies use the same methods to make supply chain investment decisions?
- Are there any differences in the evaluation of multinational and national supply chains within big companies in Sweden?

1.3 Purpose

The purpose of this dissertation has been to develop a general model for evaluating multinational supply chains. This model could provide guidelines for process-based manufacturing companies when comparing or choosing between different supply chains in order to make long-term investment decisions. If possible, the model should be applicable in as many companies and sectors as possible.

1.4 Criteria for model evaluation

During our research, we saw the need to identify criteria to evaluate our model. These criteria are:

- Consideration of different inflation rates
- Consideration of different risks of cash flows because of the political and economic environment
- Consideration of qualitative and quantitative factors.

1.5 Definitions

Supply chain:

A supply chain is the sum of all manufacturing and logistical activities (flow of goods, manufacturing, information and finances) along the value chain from the supplier of raw materials (Kuhn & Hellingrath, 2002, 10) to the “point of use”, such as retail stores or end-customers (www.visionar-

yoasis.com/05_Value_Supply_Chain_Strategies.html). For a more detailed definition, see section 3.2.

Multinational company:

A multinational company is a company, which is involved or operates in several countries (e. g. production in another country than the headquarters).

Decision-maker:

Decision-makers should be understood as all persons, who make decisions on the choice of creating different supply chain possibilities i. e. choosing between different investment possibilities. It does not matter where this decision-maker is placed within a supply chain.

Long-term:

Long-term in this dissertation is defined as “relating to or extending over a relatively long time” (<http://www.hyperdictionary.com/dictionary/long-term>).

Model:

A model is a simplified framework of how to achieve a certain goal. However, the names of the DuPont model and the SCOR model used in this dissertation were not changed as they will be regarded as methods for the evaluation of supply chains.

1.6 Limitations

It is of great importance to declare what limitations our dissertation intends to have. Supply chain research is a huge area, therefore, if not limited successfully, our project risks being too extensive and exceeding our time limit.

The research was concentrated on big Swedish multinational production and manufacturing companies. We have concentrated in this area because process-based manufacturing companies have the most measurable data of their products and should give enough valuable facts to evaluate supply chains.

The selected companies are situated in their respective supply chains anywhere between raw materials and end products.

The model itself should be applicable to evaluate – in order to compare – two or more long-term investments in multinational supply chains, not regarding to if they are already existing or still in the planning phase.

1.7 Target group

This dissertation was written for our fellow students who are about to start their professional careers and for our tutors, facilitators and teachers at Kristianstad University. Additionally, people who are already involved in the business area or are generally interested in supply chain evaluation and comparison might find this dissertation of use in their activities. The dissertation might also be a useful guideline for those, who make decisions on which supply chain to choose in their companies. Furthermore, if one would like to find out more and learn about the most common methods of evaluation and comparison of supply chains, that person may use this dissertation as the basis for further studies and as a comparative study with other publications.

1.8 Outline of this dissertation

This dissertation consists of eight different chapters. Each chapter is more or less interdependent, as they jointly create an entity throughout our research work. These chapters are displayed together in Figure 1 including their respective connections to each other.

Chapter 1 – Introduction – contains background, problem description, purpose, limitations, target group and outline of our dissertation.

Chapter 2 – Research Methodology – describes the work that has led to the writing of this dissertation. The methodological framework is introduced, together with the type of methods that have been used to collect the information required.

Chapter 3 – Theoretical Framework – describes the theories regarding supply chain evaluation concepts. This chapter provides the reader with common evaluation methods, which is the starting point for further discussion. Seven major concepts are introduced: Cost-Volume-Profit analysis, Payback Period method, Average Rate of Return ratio, Net Present Value method, Internal Rate of Return method, DuPont model and the SCOR model.

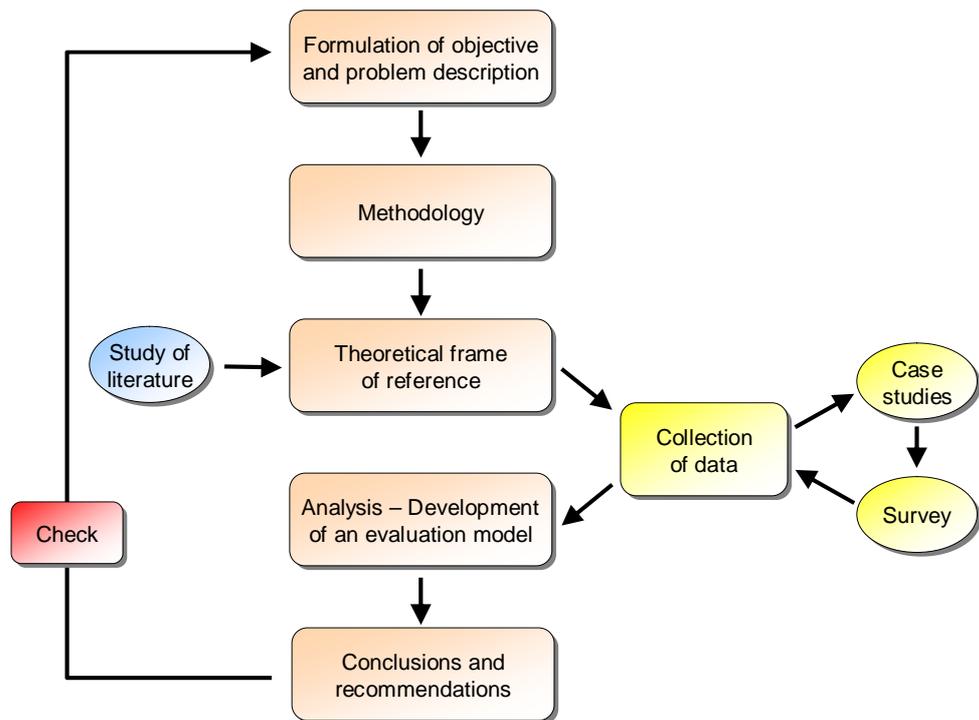
Chapter 4 – Empirical part – describes the strategy we used for gaining the knowledge on methods for supply chain evaluation. Additionally, it describes the data collection process and the research limitations.

Chapter 5 – Case studies – describes the interviews with three companies: Nolato Alpha AB, Bong Ljungdahl Sverige AB and Tetra Pak Packaging Materials AB.

Chapter 6 – Survey – concentrates on the investigation of the answers from our questionnaires.

Chapter 7 – Development of the model – describes the development of the general model for the evaluation of supply chains. Additionally, this chapter contains a test of this model.

Chapter 8 – Conclusions and recommendations – contains conclusions and recommendations for further studies in the field of supply chain evaluation, where the authors of this dissertation could not devote themselves to describing these problems since it would have been too extensive for this paper..

Figure 1: Outline of this dissertation

Chapter 2 Research method

This chapter aims to provide the reader with a picture of the line of action and to give an understanding of the choices made during this dissertation.

2.1 Methodological perspective

The research philosophy is a way of thinking about how knowledge is developed. Three different types seem to be the most important: positivism, interpretivism and realism (Saunders, Lewis & Thornhill, 2003, 82-85). For this dissertation, interpretivism seems to be the dominant philosophy for certain reasons. The area of research here is too complex and too unique to use general laws. Furthermore, in order to create a usable model, it has to be tailored to certain needs.

2.2 Research approaches

Authors can choose between two different research approaches: The deductive and the inductive approach. The deductive approach suggests to start with a theory, to deduce a hypothesis and test this with an empirical enquiry. The inductive approach is a bit more flexible since it allows to look at more variables, factors and connections between those. With this kind of approach, ideas can be developed. Furthermore, the inductive approach requires rather qualitative than quantitative data, which allows the use of a far smaller sample of subjects to define a theory.

Since the idea of this paper is to create a model, it is essential to already have some existing theories, which can be used to define important factors. That is why international literature has been studied. The authors of this dissertation have used publications coming from the USA, England, Sweden, Germany and Poland. As a result, quite a few already existing theories have been discovered. These theories could be used to solve the problem of evaluating supply chains.

In the end, the research approach of this paper shall be a combined inductive-deductive one with emphasis on the more flexible inductive part. The reason for that is that not only existing theories are taken into consideration but also empirical studies on the companies while creating a general model of the evaluation of multinational supply chains.

2.3 Research strategy

A research strategy is a general plan of how the research questions will be answered (Saunders et al., 2003, 90-95). Different strategies can generally be employed: Experiment, Survey, Case study, Grounded theory, Ethnography or Action research. For this dissertation, a combined strategy will be relevant: First a case study, since it is “a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence” (Saunders et al., 2003, 93 after Robson, 2002, 178), followed by a survey since this allows “the collection of a large amount of data ... in a highly economical way” and leaves a high grade of independence during the data collection process to researchers (Saunders et al., 2003, 92).

2.4 Time horizons

There are two different time horizons how studies can be carried out: longitudinal for long-time studies and cross-sectional for time-limited papers, also called “snapshots”. Due to the limited time frame of this dissertation, only a cross-sectional work has been carried out and therefore, no change in a certain time period has been regarded.

2.5 Data collection methods

There are two main ways of gathering information i.e. primary and secondary data collection processes. Primary data is data, which has been collected, revised, processed and transformed into useful information by the researchers. Secondary data is data, which already exists in a more or less processed, transformed and useful form for the researchers. For the needs of this dissertation, the authors of this dissertation have decided that primary data would be more useful, since bias coming from other researchers could

influence the way reality has been seen by us. Therefore, we have hoped that the measures, which have been obtained by us during the data collection process, would be reliable. The main part of information, which has been used in this dissertation, was collected during the period October – December 2003.

2.6 Secondary data

We should distinguish between case studies and a survey. In this dissertation, the process of collecting data from the companies is firstly done as case studies, since according to Robson's definition (2002, 178; Saunders, 2003, 93) a case study is "a strategy for doing research, which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence". We have been investigating a phenomenon of supply chain evaluation methods and we have been using three Swedish multinational companies as our sources of evidence.

After our case studies, we have conducted a survey. A survey is associated with the deductive approach and independence of researchers, which has given us the possibility to prepare our own questionnaires and obtain answers to the questions, which were interesting and useful for our research. Then, we have analysed the information obtained through the questionnaires and applied it in the process of development of a supply chain evaluation model.

2.6.1 Case studies

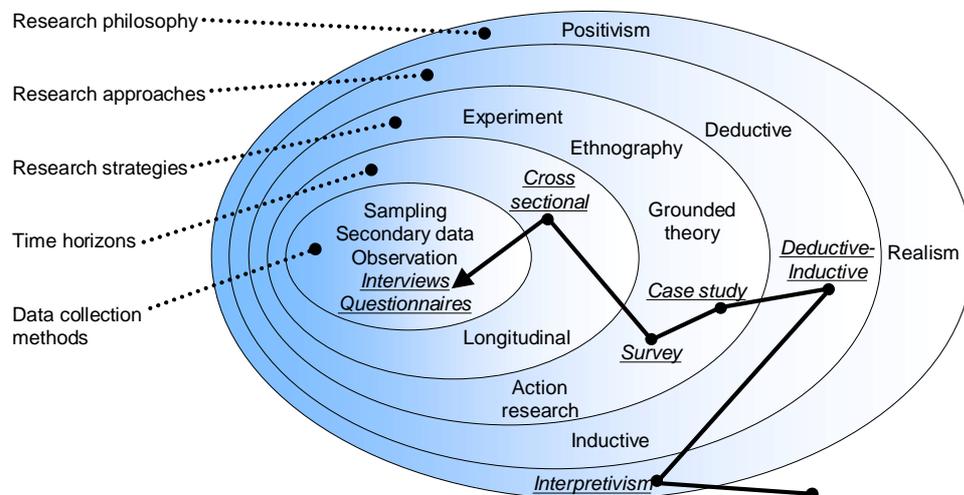
As a starting point of gathering information, face to face interviews were arranged, so help from business people, who have been dealing with supply chain evaluation, was obtained. The interviews have been made with a three-weeks-break in between, so the authors of this dissertation have had time to read through additional literature and adapt the questions for the next interview. Each single interview has given us new inside knowledge of a problem. Following the advice of our tutor Bengt Ferlenius, the companies in question had been chosen from different industries: mobile phones parts,

envelopes, packaging materials. This was made in order to face all the possible problems that different sectors of industry deal with.

2.6.2 Survey

After evaluating the interviews, there was still a lack of information and a need for a survey evolved in order to gain more information, especially how big Swedish multinational companies evaluate their supply chains. After preparing questionnaires about the evaluation of supply chains, they have been sent to 300 big Swedish multinational companies. We have picked a sample of companies operating within different industries to obtain even a greater and broader knowledge and information about the problem.

Figure 2: Research approach and strategy



Source: Saunders et. al (2003, 83), adjusted by the authors of this dissertation

Chapter 3 Theoretical framework

This chapter describes the choice of the theories that we saw as the most important ones for this dissertation. Furthermore, every theory is briefly presented.

3.1 Supply chains and investment decisions

The aims of existence of most companies are to develop and grow at the market and to bring profits for owners. Each company is involved in longer or shorter supply chains. Most of these supply chains are multinational as the twentieth century was the age of globalisation and of crossing borders and cultures. During the process of creating these supply chains, each company had to decide what kind of supply chain it should be involved in and which supply chain would bring greater profits. That is why decision-makers have been choosing among different possibilities of investing funds and money. In this dissertation, decision-makers should be understood as all people or groups of people, who make decisions on the choice of creating different supply chain possibilities i. e. choosing between different investment possibilities. Evaluation and comparison of different alternatives affected this choice. Thus the process of evaluation and comparison of multinational supply chains is inseparably connected to the investment actions.

The most important point in investing is the decision process. During this process, an investor makes a decision whether to invest his money (or the money he invests in favour of his clients) in a certain project. Such a project should be treated as any kind of supply chain. A decision-maker would choose the alternative, which brings more profits and would not be concerned of the type of a good, which would be produced. However, it is worth mentioning that the ethical issue affects this choice, as a decision-maker will choose an alternative, which converges with his ideas and conscience. Undoubtedly, an investor takes care of the money and wants to get as much profits back as possible. These needs of an investor are clear, because human psychology and behaviour of a rationale person indicate that

the choice between having less or more is already made in a person's brain – a person chooses a better position.

For the needs of this dissertation, the authors of this dissertation have decided to omit the behaviour of an irrational person. That is why this paper describes mainly a reasonable person's ways of acting. However, it cannot be forgotten that it is only the decision-maker who knows exactly which factors he has used to make his decision. Sometimes decisions are not based on strictly economic and quantitative factors. In some countries (e.g. China, Japan, etc.), personal relationships have been very important for centuries. The Chinese concept of *guanxi* (good relationships) can be a good example. Such decisions have been considered by the authors of this dissertation as partly rational decisions. On one side, these decisions are rational as the people involved expect mutual benefits from the relationship, but on the other, these decisions are not based on strictly economic factors such as profits, costs, revenues and sales. In contrast, these factors are of a qualitative nature.

There has been demand created by managers and decision-makers for finding out which project would bring more profits and which supply chain would be better. Therefore, economists, accountants and marketers have created a great range of theories and methods for evaluating ventures such as multinational supply chains.

The international business point of view, as one of the most important factors while evaluating a certain project, takes into consideration profits and costs of the venture. An enterprise may use a number of tools for valuing a production line. Some of the most known and popular are so called "dynamic methods", such as the Net Present Value (NPV) analysis, the Internal Rate of Return (IRR) analysis and the so called "static methods", such as the payback period and the Average Rate of Return. Another group of the tools is connected to financial analysis and includes such methods as the DuPont model. Sometimes, another accounting way of approaching a valuation is

used: the Cost-Volume-Profit (CVP) analysis. All of these methods are used to select among several alternative chains.

It cannot be forgotten in this context that sometimes rational decisions of a single person are irrational in the holistic approach. As an example one can state the game theory and the prisoner's dilemma, where lack of information makes the rational decision of a prisoner not rational from the point of view of an outsider, who has full information. As another example one can give the holding company in which one subsidiary makes "paper losses" (through e.g. the system of transfer prices) on purpose – so the whole company gains. Just to name a couple of advantages for the whole company, one can give such examples: reduction of tax liabilities, reduction of exposure for exchange risks, way of escaping from unfavourable countries' government policies when financial transfers are restricted or blocked, reduction of import duties when *ad-valorem* tariffs are in force (Hill, 2001, 624-625). That also makes multinational supply chains unique in the sense that sometimes parts of a supply chain may on purpose be more expensive than the other investment possibilities.

Furthermore, we have to state that the time value of money is very important in the investment process. Sometimes, high inflation rates may deteriorate the expected profits coming from supply chains. The methods like Net Present Value or Internal Rate of Return take it into consideration. These methods are described further in this chapter.

Another issue that has to be mentioned in the investment process are the political and economic risks associated with future cash flows. However, by improving the chosen methods of supply chain evaluation by probability and measurement of expected value of these cash flows, that problem might be overcome. Another way of approaching that problem is using increased discount rates for measurement of present value of these cash flows. The user may apply Euromoney's annual country risk ratings for that process (Hill, 2001, 615-619).

In this chapter, we intend to present the following methods of supply chain evaluation: the CVP analysis, the payback period, the ARR method, the NPV method, the IRR method, the DuPont model and the SCOR model.

The terms “Value Chain” and “Supply Chain” are often used interchangeably. But there is a significant difference, which is also important in this dissertation:

3.2 Differences between a supply chain and a value chain

A *supply chain* is the sum of all logistical activities (flow of goods, information and finances) along the value chain from the supplier of raw materials (Kuhn & Hellingrath, 2002, 10) to the “point of use”, such as retail stores or end-customers

(www.visionaryoasis.com/05_Value_Supply_Chain_Strategies.html) or in other terms “a network of autonomous or semi-autonomous business entities collectively responsible for procurement, manufacturing and distribution activities associated with one or more families of related products” (www.bettermanagement.com/library/Library.aspx?libraryid=658).

A *value chain* is broader in scope. It not only includes all processes within a supply chain but also all value-creating activities such as marketing activities, (Kuhn & Hellingrath, 2002, 16) customer service and disposal of packages (www.visionaryoasis.com/05_Value_Supply_Chain_Strategies.html). In other words, it is “a high-level model of how businesses receive raw materials as input, add value to the raw materials through various processes and sell finished products to customers”

(www.bettermanagement.com/library/Library.aspx?libraryid=658).

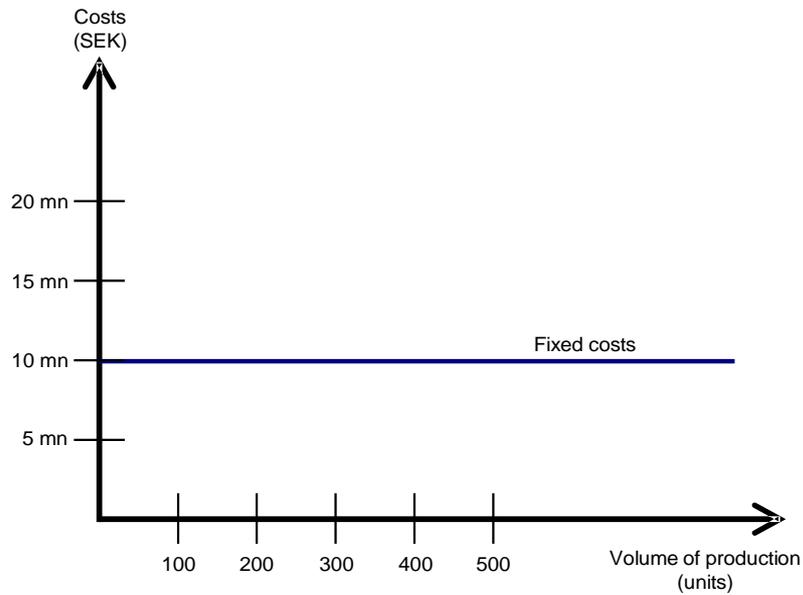
Briefly, supply chains are parts of value chains, extended with non-logistics-related activities which create value for the product.

3.3 The Cost-Volume-Profit analysis

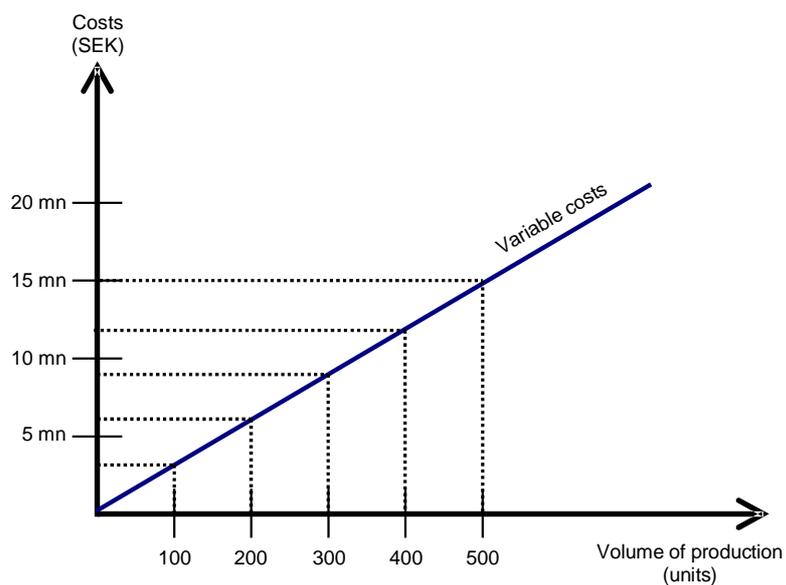
One of the most important accounting tools used for comparing supply chains is the Cost-Volume-Profit (CVP) analysis. By using this concept, a company is able to find out at what level of production (and sales) of a cer-

tain product, a venture will bring profits. This analysis also enables a company to discover which of the supply chains brings more profit or less loss at a certain production (and sales) level. Many authors have considered this analysis as one of the most important in evaluating supply chains (Scapens, 1985).

To explain and apply this accounting concept one has to distinguish between different kinds of costs which an enterprise has to bear. The managerial accounting uses many different ways of splitting the costs. However in case of the CVP analysis, the segregation of fixed and variable costs seems to be of the greatest importance. Fixed costs are defined as costs, which do not change during the production process, no matter what the volume of the production is (Figure 3).

Figure 3: Fixed costs

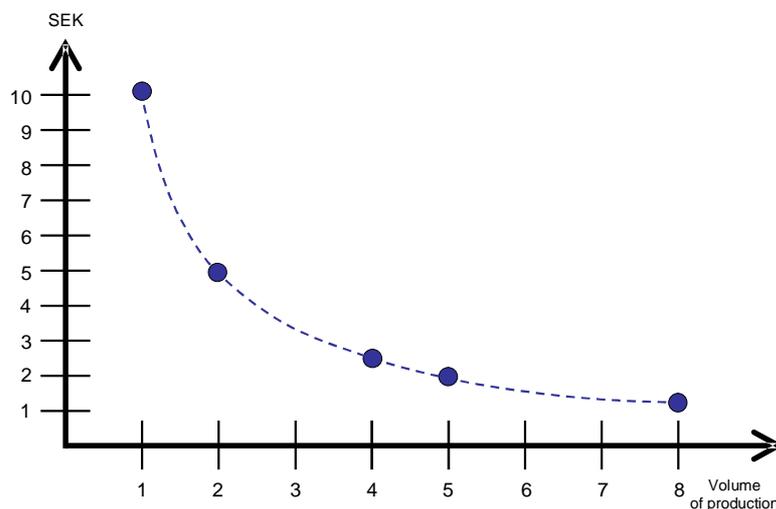
These are for example such costs as amortisation of the machines used for the production or remuneration of managers. Variable costs – on the other hand – are costs, which depend on the volume of the production. These are such costs as direct materials costs, direct labour costs and other direct costs of the product (Figure 4).

Figure 4: Proportional variable costs

These costs increase when an enterprise produces more units of a product and decrease while an enterprise is producing fewer units.

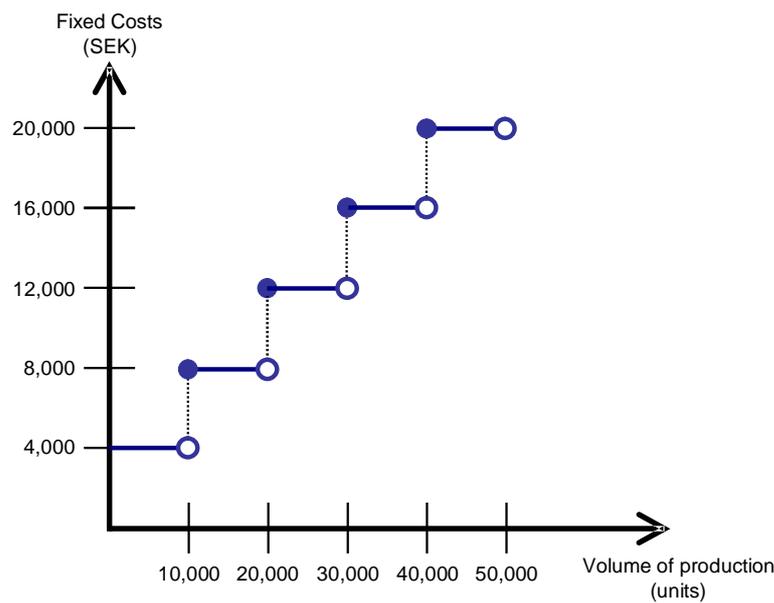
However, it must not be forgotten that in reality fixed costs of a production line should be treated as semi-fixed costs. This means that the costs are fixed but only within a certain level of production. This seems to be quite obvious. If the machine is designed to produce 10,000 units within a period of its life (which can be e.g. one year), it means that the costs of buying and installing the machine are the same no matter how many units this machine produces during the period of its life (this one year). The only difference, which occurs, is that, the costs of the purchase and installation of the machine are divided into a different number of units. Thus the part of fixed costs which is applied to the products varies according to the number of units produced. It results in various amounts of costs, which are applied to one unit of a product. As a result the more units are produced, the cheaper every single unit is (Figure 5).

Figure 5: Dependence between the amount of fixed costs applied to each unit of a product and the volume of production

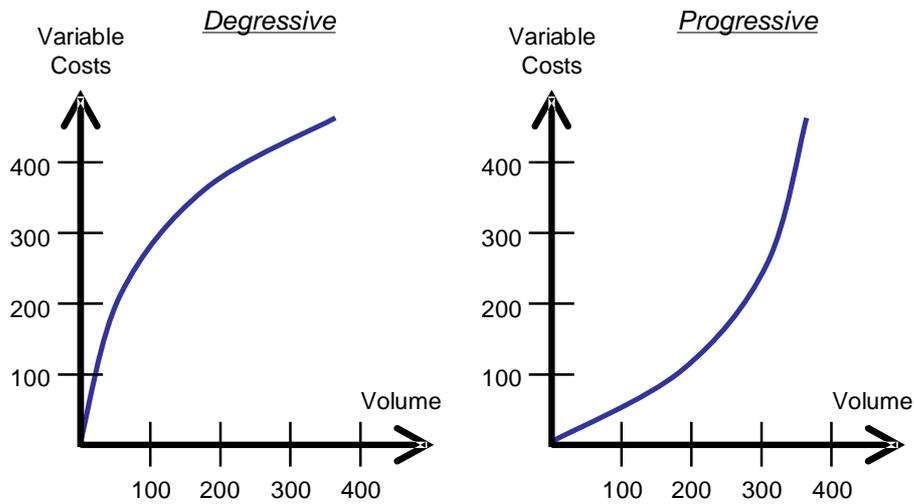


However, if an enterprise has decided to produce two times more products than the machinery park is able to create, then the additional devices must be bought. These additional machines are extra fixed costs (Figure 6).

Figure 6: Dependence between fixed costs and production volume



Moreover, if a company takes variable costs into consideration, it should bare in mind that sometimes these costs do not increase proportionally, that is by the same amount of money. Depending on the product and production process, variable costs may increase progressively or degressively (Figure 7). Progressive growth occurs when the next unit of a product requires higher amount of variable costs, whilst degressive growth occurs when every single next unit of a product requires less variable costs.

Figure 7: Degressive and progressive variable costs

Source:

www.crrif.ckl.com.pl/Expert/analiza_progu_rentownosci_i_symulacja.htm,
adjusted by the authors of this dissertation.

All costs a company has to take into consideration, while deciding on which supply chain to choose, can be written by means of a simple linear equation

$$C(V) = C_F + C_V$$

$$C(V) = C_F + c_V * V$$

where:

$C(V)$ = all total costs which a company has to bear during certain production level

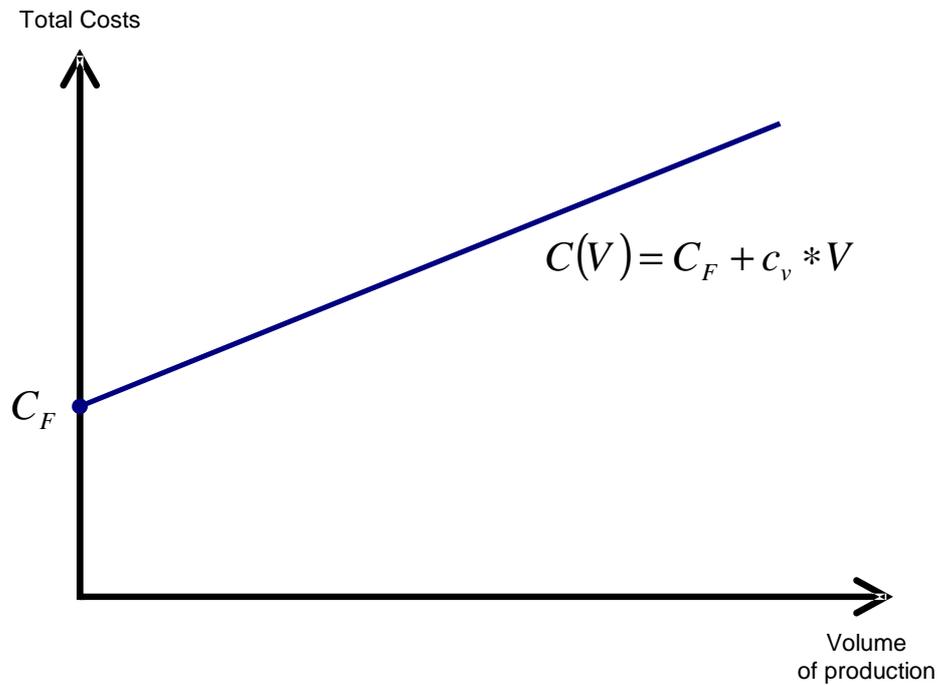
C_F = total fixed costs

C_V = total variable costs

c_V = variable costs of production of 1 unit of a product.

V = volume of production

All costs of a production line are represented in the Figure 8.

Figure 8: Total costs

An enterprise earns a profit when income from the sales of products exceeds the costs of production, which is represented in Figure 9. The point at which the project's revenues equal the costs of the project is called *Break Even Point* and is calculated according to the following equation:

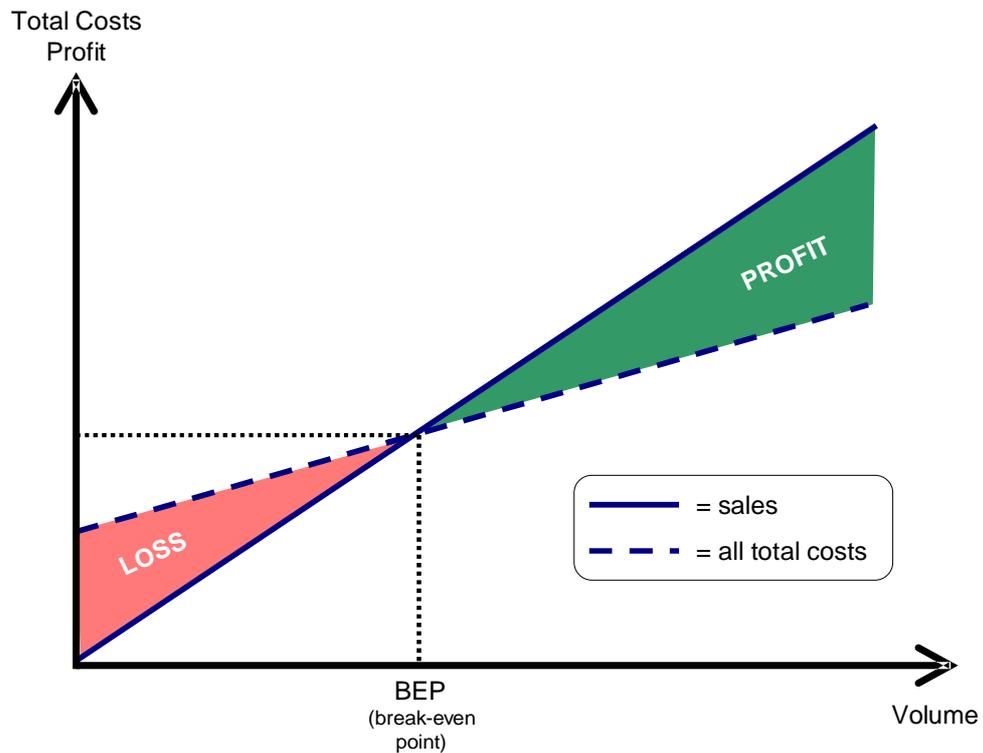
$$BEP = \frac{C_F}{(p - c_v)}$$

where:

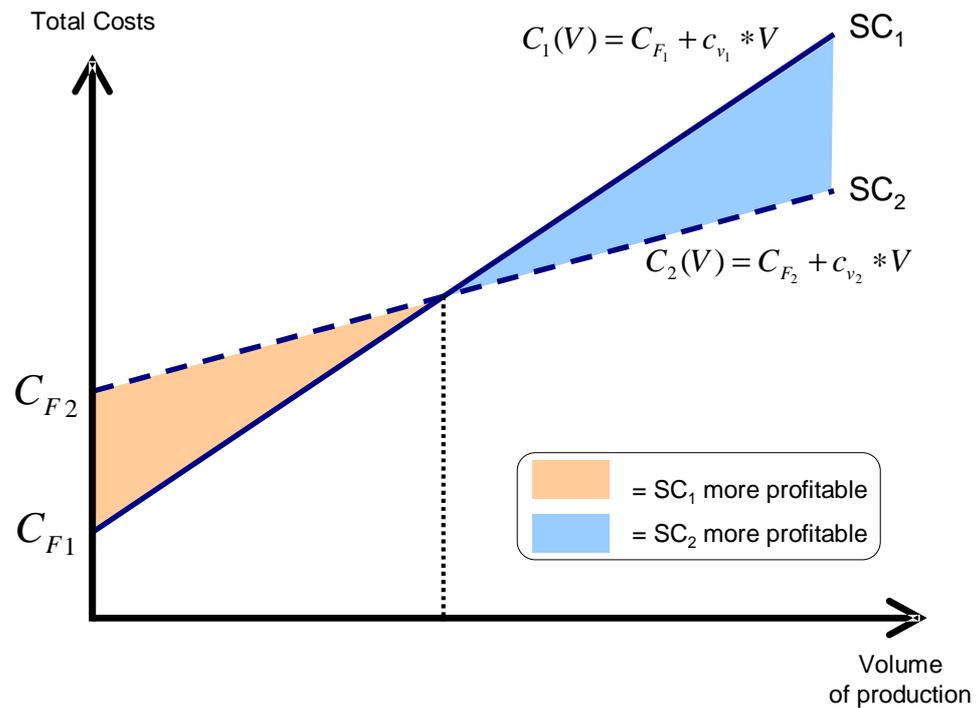
BEP = Break Even Point

p = price of a product

c_v = variable costs of production of 1 unit of a product.

Figure 9: Costs and revenues of a production line

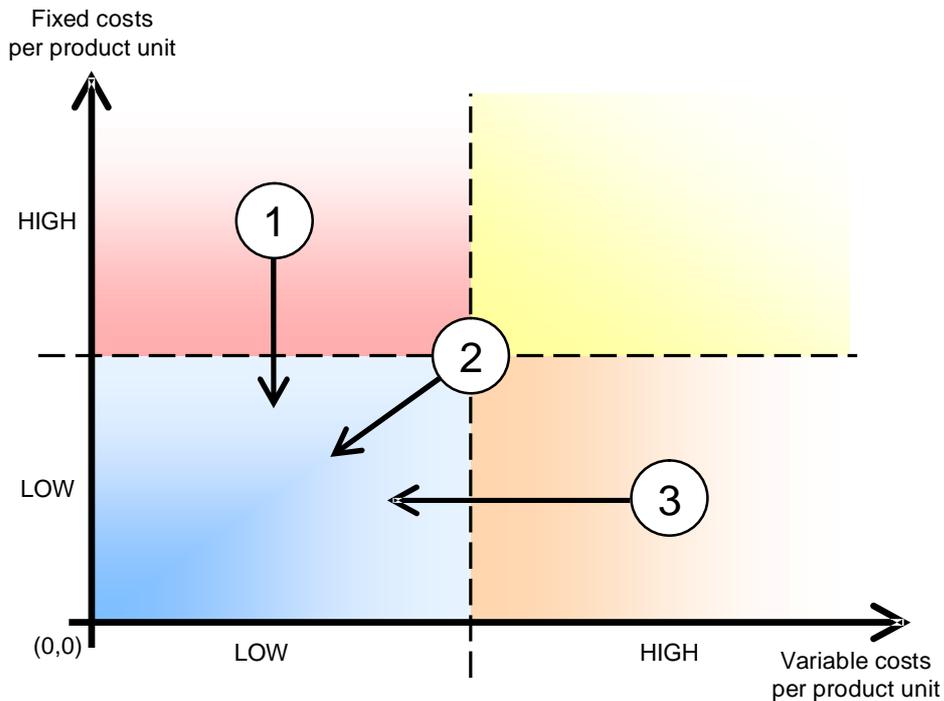
If an enterprise makes a decision on choosing one of the two possible supply chains, then it should take into consideration all total costs of each supply chain. Additionally, the volume of the production must be taken into consideration. Furthermore, not only the production level is important, but also the capacity of the market, as the products must be sold to earn a profit on them. Different levels of fixed costs and different variable costs of production indicate that one of the supply chains will be more profitable than the other only until a certain point of production. This can be easily seen in Figure 10.

Figure 10: Costs of two possible supply chains

One of the disadvantages of this method, which is worth mentioning, is the difficulty in applying the CVP analysis in multi-product operations (e. g. restaurant operations)

(jan.ucc.nau.edu/~ha355-c/ha355/class/statement/cvp/lesson2-3-1.html).

According to the authors of this dissertation, in business life, companies usually undertake one of the three possible strategies, while considering a choice between fixed and variable costs. These strategies are displayed in Figure 11.

Figure 11: Strategies for fixed and variable costs

According to the authors of this dissertation, in business life, companies usually undertake one of the three possible strategies, while considering a choice between variable and fixed costs per product unit. Our knowledge concerning this matter is based on our studies at home universities and a number of cases which were solved by us at seminars.

The horizontal axe represents variable costs per unit of a product. These costs are counted in currency units. The vertical axe represents fixed costs per unit of a product, also counted in currency units. This graph could be used for comparing strategies for fixed and variable costs that different companies apply. These companies must be representatives of the same industry (e.g. bookstore), so the products, which companies deal with are the same. Additionally, the comparison must be made for one specific product (e.g. books).

A company applying the first strategy minimises variable costs of e.g. production, supply or materials purchase. At the same time, the company builds up a big stock of products (increased fixed costs per unit), since the pur-

chase of large quantities usually lowers the price for the product (minimised variable costs).

A company applying the third strategy minimises fixed costs per product unit (e.g. by minimising the stock). At the same time it keeps variable costs per product unit at a high level (e.g. by buying small quantities exactly at the time when the product is needed).

The second strategy is a mixture of the first and the third strategy.

As an example, one can give bookstore: the company Amazon.com as one part of its product range, sells books. In 1997, the company kept no stock to minimise fixed costs. Therefore, the fixed costs of e.g. the warehouse purchase, the insurance of the stock, the insurance of the warehouse, the salary of warehouse workers were minimised to the great extent. When the company got an order from the customer, Amazon.com send an order to a wholesaler for this specific book. The price paid to the wholesaler was much bigger than the price which Amazon.com would have to pay to the publisher. However, publishers sell books in bigger quantities so Amazon.com would have to keep stock of the books in the warehouse. (Horngren, Datar & Foster, 2003, 73).

The contradiction for Amazon.com is an ordinary bookstore. The owner of an ordinary bookstore tries to purchase books in large quantities from publishers and to minimise therefore the price paid for the single book (minimising of variable costs per unit). However, the owner has to keep a high stock of the books and has to pay for the warehouse and insurance, etc (increased fixed costs per product unit).

In our opinion, every company should focus on moving its strategy closer into point (0,0), so it would result in minimising the total costs per product unit (and not only variable or fixed costs per product unit).

The authors of this dissertation would also like to present the newest concept of the Break Even Point developed by Andrzej Iwasiewicz (Prof. Dr. hab. Iwasiewicz is the head of the Institute of Statistical Methods of Quality Control at Cracow University of Economics). The new concept takes into account the quality of a product. Iwasiewicz identifies three notions: “the quantitative breakeven point at a given level of quantity, qualitative breakeven point at a given scale of operations and a two-dimensional quantitative – qualitative breakeven point” (Iwasiewicz, 2003, 345). It is stated that the profitability of company operations (and thus the profitability of a supply chain) can be guaranteed only together with two factors: sufficient volume of sales and sufficiently high quality. The qualitative breakeven point is therefore, the lowest possible level of quality at which the company is not suffering loss. The qualitative breakeven point is calculated by the equation:

$$p = \frac{(m - ck - cs)}{(m + cd)}$$

(Iwasiewicz, 2003, 355)

where:

p = product defectiveness rate

m = unit coverage margin = price - variable cost per unit

ck = unit cost related to maintaining the present quality of manufacture

cs = fixed unit cost

cd = defectiveness loss unit

The concept of a qualitative breakeven point may also be useful in evaluating supply chains. Usually, there is a choice between quality and price and a lower price quite often is connected to lower quality and vice versa. However, the authors of this dissertation would like to mention here that the rivalry at the market has been very tight during the last years and the quality of a product cannot be substituted any longer by the cheap price of this good. That is why managers should concentrate not only on the quantitative Break Even Points but also the qualitative ones, as only the low price com-

bined with the very good quality of the product may lead to the market success.

3.4 Static methods

Managers are also equipped with such tools as the payback period and the Average Rate of Return (unjustified rate of return). The payback period is the time, which is needed to recover the initial cost of the investment. According to this method, the best investment is that, which repays the initial cost within the shortest time. In this method, cash flows without inflation and without interest rate are taken into consideration. Another limitation for applying this method is that it ignores cash flows after the payback, which may be of significant importance for the project.

The average rate of return (ARR) method considers average profits from each year of the project as the most important factor in evaluating multinational supply chains. The best project is the one with the highest ARR ratio.

$$\text{ARR} = \frac{\text{Average Annual Profit Before Interest and Taxation}}{\text{Initial Capital Investment}}$$

(Jones, 2002, 458-459)

Some authors – instead of average annual profits – apply average annual cash flows, which may cause confusion in interpretation of results. Then, the equation takes the below form

$$\text{ARR} = \frac{\text{Average Annual Cash Flows}}{\text{Initial Capital Investment}}$$

(Chadwick, 1991, 133-134)

The problem which may occur when applying this method is that profits may significantly fluctuate from one year to another. Furthermore, this method uses the nominal and not the real value of money. Moreover, there are many different definitions of profits which may also cause difficulties in interpretation of this ratio.

In our opinion, these methods can be applied only to a certain extent while evaluating supply chains. The payback period method would be applicable only in the early years of the venture. Managers could compare the costs of a certain supply chain (such as transport, direct materials, insurance and storage costs) with the profits it brings. However, as it has been mentioned before, this method has a great range of disadvantages and should not be used as a mean of evaluating supply chains. The ARR method is neither the full nor sufficient means of evaluating supply chains. It could be useful if there were two different supply chains in two companies and one end product. Then this ratio would indicate, which of these supply chains brings more return to the company.

3.5 Dynamic methods

Managerial accounting provides decision-makers also with other – more complicated – methods of evaluating different investment ventures such as multinational supply chains. In these methods, the time value of money is taken into consideration. One of these methods is the Net Present Value (NPV) method, which is very similar to Capital Budgeting (Hill, 2001, 613-614). The other one is the Internal Rate of Return (IRR) method, also known as the yield method.

The NPV analysis enables managers to discover whether the initial cost of an investment (such as building a new production line, searching for a supplier or building a new supply chain) and costs incurred during the life time of a project (such as some expensive licenses, utilisation of dangerous materials, necessary spare parts) are lower than the positive cash flows created by this project during its life-time.

$$NPV = PV - C$$

(Dobija, 2002, 183)

where:

NPV = Net Present Value of a certain project (supply chain)

- PV = Present Value of future cash flows calculated according to the presumption that the discount rate's level is equal to "r"
- C = initial cost of an investment

Each project with a positive NPV is worth consideration. (Chadwick, 1991, 134; Wilimowska & Wilimowski, 2001, 827-831; Dobija, 2002, 183; Coulthurst, Feb. 1985, 84-88; Coulthurst (May 1985, 230-234). This method is very complicated since it takes into consideration the time value of money and cash flows from the whole life time of a project, which may be very difficult to assess. Managers, who decide on the choice between various supply chains, could apply this method while comparing the profitability of two possible products.

The NPV method also can handle the political and economic risks connected to a particular country. Then the probabilities and expected value of cash flows should be included in the calculation of NPV.

The Net Present Value method would be especially useful if the amounts of capital were the same and the time of each amount invested was the same. However, if the amounts of capital are different, the Internal Rate of Return method could bring better results. The IRR method would show the rate of return from the certain supply chain investment project.

The IRR method shows the discount rate which will produce an NPV equal to zero, i.e. the cash flows discounted less the initial cost of a project (e.g. the creation of a supply chain) are nil. The Internal Rate of Return is calculated in accordance with the following equation

$$IRR = r_+ + D * \left(\frac{NPV_+}{NPV_+ - NPV_-} \right)$$

(Dobija, 2002, 79)

where:

r_+ = the highest discount rate for which the NPV is still positive, but close to zero

D = difference in discount rates; $D = r_- - r_+$

r_- = the lowest discount rate for which the NPV is still negative, but close to zero

NPV_+ = the value of NPV for r_+

NPV_- = the value of NPV for r_-

Only when the IRR is greater than the cost of capital, the project should be considered as profitable (Chadwick, 1991, 134; Dobija, 2002, 79; Dobija, 1994, 60-62; Wilimowska & Wilimowski, 2001, 833-838). Usually during the creation of a supply chain, there is a need for obtaining certain amount of capital. That is why it is also good to look at the IRR as the maximum rate of interest that a company can pay without suffering a loss on the project (Jones, 2002, 463). The price for lending the capital is the interest rate. Also, when a company has capital it can place it at the bank account rather than creating a new supply chain. The profits from the supply chain should be greater than the price paid for the capital. Thus a supply chain that generates a greater IRR ratio should be treated as a better one. This method may be considered as a very useful one, although it is very difficult to apply.

Hornngren et al. give a couple of advantages and disadvantages of both methods (Hornngren, Datar & Foster, 2003, 723). Advantages of the NPV method are at the same time disadvantages of the IRR method and vice versa. The most important advantages of the NPV method are: expressing computations in terms of currency and not in percentage, additiveness (the NPV of one supply chain can be added to the NPV of another supply chain) and it can be used when required rate of return varies over the life of a project. The IRR ratio does not express computations in terms of currency but in terms of percentage. It is not additive and thus it can neither be used when the required rate of return varies over the life of a project. However, according to Hornngren, managers find the IRR method easier to understand. Jones gives more disadvantages of the IRR method. It is difficult to understand, is complex (needing computers), gives misleading results in certain

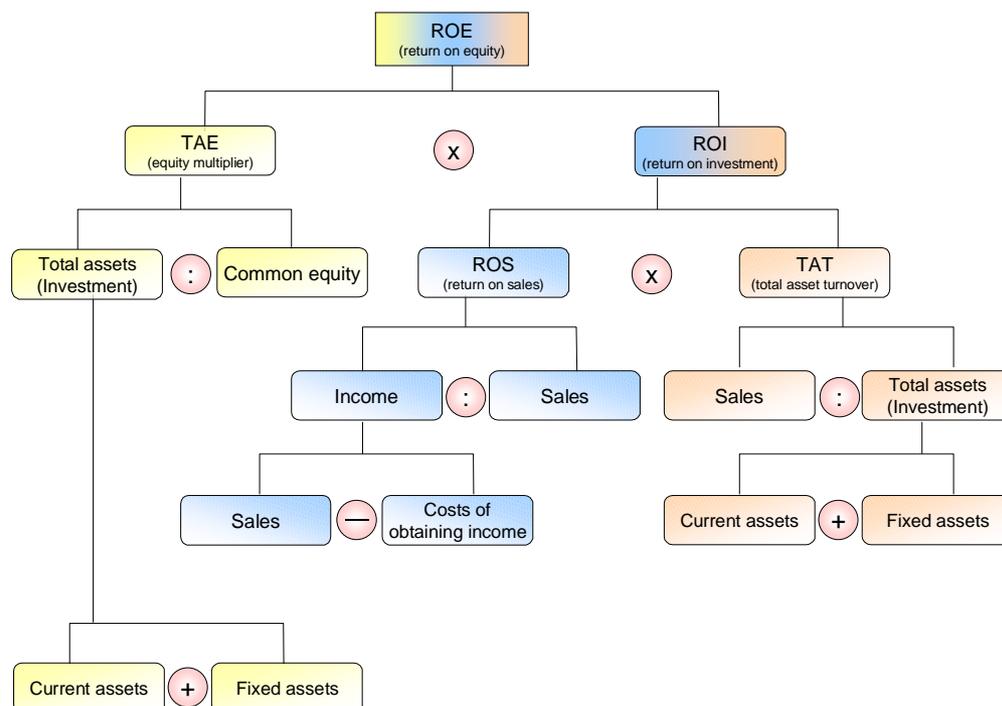
situations (if there are unconventional cash flows) and contains no need for selecting a specific discount rate (Jones, 2002, 463). All in all, according to the authors of this dissertation the IRR and NPV methods are very useful and helpful in evaluating supply chains, although they contain certain disadvantages.

3.6 DuPont model

Another popular approach of measuring the performance of a supply chain is represented by a so-called methods of pyramid analysis. The essence of these methods is the complex evaluation of the financial situation of an enterprise through the system of a ratios' pyramid (Chartered Institute of Management Accounting, 1989, 100). It must be stated that there is a tight "reasons and effects" relationship between the ratios. Some of the examples that can be found in this group of methods are: the American DuPont model (see Figure 12), the English Pyramid Structure of Ratios or the German ZVEL – Kennzahlensystem (Ross, Westerfield & Jordan, 1998, 65; Urbańczyk, 1998, 197; Waśniewski, 1993, 209; Myddelton, 2002; Walczak, 2002; Bednarski, 1989). For the needs of this dissertation, the authors have decided to look deeper at the Return on the Investment ratio (ROI), which is a part of the DuPont model:

$$ROI = \frac{Income}{Investment}$$

(Horngren, Datar & Foster, 2003, 778)

Figure 12: DuPont model

Source: Micherda, 1992; Sierpińska & Jachna, 2003, 107; Siemińska, 2002, 130; Jaruga, Sobańska, Kopczyńska, Szycha & Walińska, 1995, 48-54; Czekał & Dresler, 1995, 218; adjusted by the authors of this dissertation.

According to Horngren et al. (2003, 788), ROI is the most popular measurement technique since “it blends all the ingredients of profitability – revenues, costs and investment – into a single percentage; and it can be compared with the rate of return on opportunities elsewhere inside or outside the company”. Furthermore, Dearden (1988, 485) states that ROI compares the financial performance of dissimilar businesses or types of investment and is a universal measure of financial effectiveness. Additionally, this measure is affected by changes both in the balance sheet and in the income statement (profit and loss account). Moreover it combines operating performance and investment performance in one ratio (Dearden, 1988, 485).

Usually, the ROI ratio is represented by two other ratios: Return on Sales and Investment (Capital) Turnover (Horngren et al., 2003, 778).

$$ROI = ROS * Investment\ Turnover$$

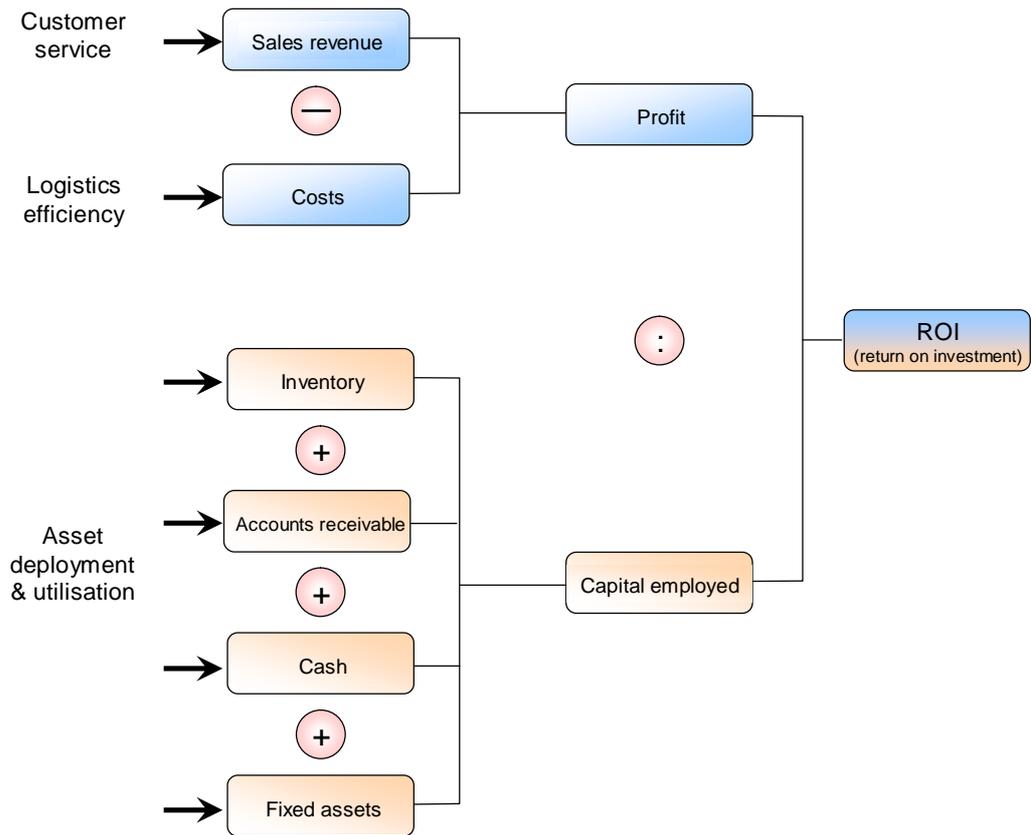
$$ROS = \frac{Profit}{Sales}$$

$$Investment\ Turnover = \frac{Sales}{Investment\ (Capital\ Employed)}$$

In the DuPont model, usually the term Total Asset Turnover is used instead of Investment (Capital) Turnover.

Since – according to the definition – a supply chain is a set of all logistical activities, it is useful to look at the ROI ratio from the point of view of Martin Christopher (1998, 79).

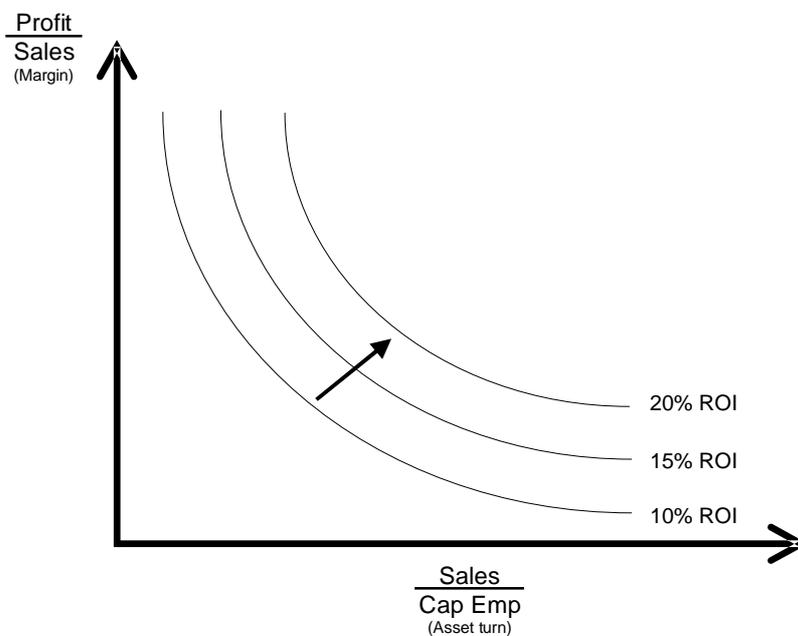
Figure 13: Logistics impact on ROI



Source: Christopher, 1998, 79.

The major elements determining ROI can be improved through a more effective logistics management. This will improve the productivity of capital and make the assets sweat. The ROI ratio is a product of two other ratios: ROS and Investment Turnover, so if one of these ratios increases, it results in ROI growth. Figure 14 illustrates the “iso-curves” of the different levels of ROI. By that figure it can be easily understood that the same level of ROI can be achieved by either a high ROS and low Investment Turnover or a high Investment Turnover and a low ROS. The logistics management should therefore be focused on moving the curve to the right and up.

Figure 14: The impact of margin and asset turn on ROI



Source: Christopher, 1998, 79.

According to Christopher, in the retail business often small net margins lead to excellent ROI ratio if the productivity of capital is high. In order to improve the productivity of capital, retailers may limit their inventory, try to achieve high sales per square foot, lease premises rather than purchase them. To improve sales a company may implement superior customer service.

It should not be forgotten here that the ROI ratio besides its advantages also has some disadvantages. As Dearden (1988, 485-486) describes, ROI: “can discourage managers of divisions with rates of return from making new investments”. Additionally, “new investments that will eventually yield satisfactory returns earn a low return at the outset”. Moreover, results obtained from the ROI measurement system may be inconsistent since capitalisation policies within a company may be different. Furthermore “maximizing divisional ROI will not assure maximization of comparing financial performance” (Dearden, 1988, 485) since the important thing is the long run cash flow from the resources and a true financial rate of return higher than the company’s cost of capital. Some of the divisional managers may also put their self-interest and self-motivation above the interest of the whole company. It may result in proposing new supply chains that will improve or, at least, not harm the measures by which their performance is evaluated. In the end, a board of directors may reject a new supply chain, which would bring profits to the whole company, but at the same time lower the performance of some divisions (Emmanuel, Otley & Merchant, 1993, 346).

3.7 The Supply Chain Operations Reference (SCOR) model

The SCOR model is – also according to our definition – a framework. However, we have regarded it here as a method, which can be used within our own evaluation model. It is normally a benchmarking tool, however, for this dissertation it will be used as a method to compare two supply chains.

3.7.1 Description of the SCOR model

A possibility to evaluate the performance of a Supply Chain is to compare it with other units in the same company. This, however, is not always advisable since comparisons with the “outside” can show better ideas and promote the adoption of those methods (Tucker, Zivan & Camp, 2001).

The Supply Chain Council (SCC) was founded in 1996 by the management consulting company *Pittiglio Rabin Todd & McGrath (PRTM)* and *Advanced Market Research (AMR)* and included 69 voluntary member companies, such as Bayer, Compaq, Procter & Gamble, Texas Instruments and

3M. The SCC now has about 1,000 members around the world and has established subdivisions on almost all continents. The SCC's members are active in a broad cross section of industries, including manufacturers, services, distributors and retailers (www.supply-chain.org/about_us.htm). It is a global, "not-for-profit trade association open to all types of organizations. It sponsors and supports educational programs including conferences, retreats, benchmarking studies and development of the Supply-Chain Operations Reference-model (SCOR)".

SCC's main goals include e. g. to expand knowledge about the SCOR-model around the globe, to sponsor events that provide supply chain management education and networking and also to promote research and good leadership in the supply chain management area (www.supply-chain.org).

The SCC developed the Supply Chain Operations Reference (SCOR) model as a standardised model for the communication among partners in a Supply Chain with the purpose to define common supply chain management processes, to match them against "best practices". The model enables companies to communicate, compare and learn from competitors both within and outside of their sector of industry.

(projects.bus.lsu.edu/independent_study/vdHING1/othertopics/scor.htm)

Often, the comparison does not take place in the same sector (www.supply-chain.org). This, seen as such, sounds a bit like "comparing apples with pears", but it is not necessarily so. Benchmarking (not necessarily with SCOR) within the same sector (which means comparing with the competitors) can pose problems. For one thing, the competitors might use practices that are not worth adopting, for another, a company cannot probably reveal practices to beat the competitors (although it will be an aid to meet the competitor's performance). The most important point in not comparing oneself with the competitor is simply that it is obviously difficult to get information from direct competitors (Tucker et al., 2001). For example, Tetra Pak Packaging Material AB compares its practices to those of the car industry (Lindmark & Klein, 2003). To find the right partners for comparison,

Tucker et al. (2001) suggest to check annual reports and other easily available publications and to use universally recognised measures like return on assets, revenue per employee etc. Despite the benefits mentioned above, a company has to carefully select the companies it compares itself with; some are just not comparable for example due to a different size (Lapide, 2000).

The SCOR model is a powerful tool for companies when it comes to improving supply chain operations. It presents a framework for manufacturers, suppliers, distributors and retailers with the goal to evaluate the effectiveness of their supply chain operations and to target and measure particular process operations

(projects.bus.lsu.edu/independent_study/vdHING1/othertopics/scor.htm).

It is designed to improve the users' efficiency and productivity
(www.supply-chain.org).

It is designed as a process reference model, which means it integrates the concepts of business process reengineering, benchmarking and process measurement into one cross-functional framework. Furthermore, it helps organisations to capture the actual state ("as-is") of a process with the objective to achieve the desired target ("to-be") state. It also allows organisations to quantify the operational performance, establish internal targets based on "best-in-class" results in similar companies. It describes standard management processes and relationships among different processes (Supply Chain Council, 2003).

To measure process performance and management practices that produce the best-in-class performance, standard metrics are defined. Finally it exemplifies the management practices and software solutions that result in "best-in-class" performance.

3.7.2 SCOR's 4 levels

The main part of the SCOR model is a “pyramid of four levels” that represents the path, which a company takes on the road to improve its supply-chain(s)

(projects.bus.lsu.edu/independent_study/vdhing1/othertopics/scor.htm).

3.7.2.1 SCOR Level 1

Strategic decisions are made on this level regarding a company's operation in the following areas

(www.icognitive.com/scorbenchmarkstudy/what.html) (see also Table 1):

- Delivery performance,
- Order fulfilment performance,
- Fill rate (Make-to-stock),
- Order fulfilment lead time,
- Perfect order fulfilment,
- Supply-chain response time,
- Production flexibility,
- Total supply-chain management cost,
- Value-added productivity,
- Warranty cost or returns processing cost,
- Cash-to-cash cycle time,
- Inventory days of supply,
- Asset turns.

Since a company cannot focus on all those areas, it needs to decide which of them to focus on to improve supply-chain efficiencies. This provides definition of the Plan, Source, Make and Deliver process types since these are the four key processes (See also Appendix 1: Example of a SCORcard) (projects.bus.lsu.edu/independent_study/vdhing1/othertopics/scor.htm).

- “Plan” is the process in which a company should assess supply resources, aggregate and prioritize demand requirements, plan inventory, distribution requirements, production, material and rough-cut

capacity of all products and all channels. Decision related to long term capacity and resource planning, product phase-in / phase-out are undertaken in this phase.

- “Source” manages sourcing infrastructure. Various activities like vendor certification and feedback, sourcing quality monitoring or vendor contracts are conducted.
- “Make” is concerned with production, execution and managing the production’s infrastructure.
- “Deliver” consists of order management, warehouse management and transportation management.

3.7.2.2 SCOR Level 2

Level 2 defines 26 core process categories, which can be present in a supply chain. Using these processes, organisations can configure their ideal or actual operations.

3.7.2.3 SCOR Level 3

Level 3 provides the information required for a successful planning and setting of goals for supply-chain improvements. It also defines a company’s ability to compete successfully in its chosen markets and consists of:

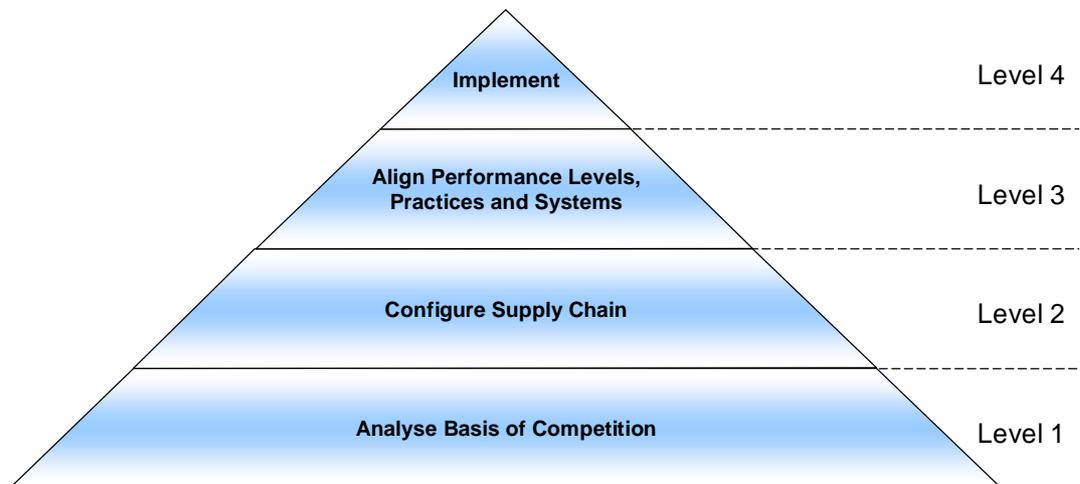
- Process element definitions
- Process element information inputs and outputs
- Process performance metrics
- Best practices where applicable
- System capabilities required to support best practices
- Systems/tools

3.7.2.4 SCOR Level 4

Level 4 focuses on putting specific supply-chain improvements into action. These improvements are not defined within an industry standard model as

the implementation can be unique to each company since every company has its own needs, routines and rules.

Figure 15: The 4 levels of SCOR



Source: Supply Chain Council, 2003; adjusted by the authors of this dissertation

3.7.3 Performance Measurement and Benchmarking using the SCOR model

As the saying “if you can’t measure it, you can’t manage it” suggests, measures have to be taken to evaluate Supply Chains; the SCOR model takes that saying into account and accordingly comprises performance attributes for each process in the model where suitable. There are five performance metrics on which process analysis rely; these are:

- Supply Chain reliability,
- Supply Chain responsiveness,
- Supply Chain flexibility,
- Supply Chain costs and
- Supply Chain asset management.

Asset and cost attributes are mainly faced by internal actors whereas reliability, responsiveness and flexibility affect the customer’s satisfaction.

Table 1 shows the *Level 1 metrics* used by SCOR to measure supply chain performance (see also Appendix 1 for a practical example).

Table 1: Definitions of SCOR performance

	Performance attribute	Performance attribute definition	Level 1 metric
Customer-facing	Supply Chain reliability	The performance of the supply chain in delivering: <ul style="list-style-type: none"> • the correct product • to the correct place • at the correct time • in the correct condition and packaging, • in the correct quantity • with the correct documentation, • to the correct customer. 	Delivery performance
			Fill rates
			Perfect order fulfilment
	Responsiveness	Speed at which a supply chain provides services to a customer.	Order fulfilment lead times
Internal-facing	Flexibility	The Supply Chain's agility in responding to market changes to gain or maintain competitive advantage.	Supply chain response time
			Production flexibility
Internal-facing	Costs	Costs associated with operating the supply chain.	Cost of goods sold
			Total Supply chain management costs
			Value-added productivity
	Asset management efficiency	An organisation's effectiveness in managing assets to support demand satisfaction. This includes the management of all assets, such as fixed and working capital.	Warranty / Returns processing costs
			Cash-to-cash cycle time
			Inventory Days of supply
		Asset turns	

Source: Supply Chain Council, 2003

3.7.4 Boundaries of the SCOR model

The SCOR model includes the following factors:

- All interactions towards suppliers and customers,
- all physical material transactions (from the supplier's supplier via the own production itself up to the customer's customer),
- all market interactions (from the understanding of the market to fulfilling each order) and
- returns.

The model does not include the processes' functional units, which brings to focus activities' related outcomes instead of the person or organizational element that are carrying the task. Additionally, it does not attempt to describe every business process or activity. Specifically, the model does not address sales administration, technology development, product and process design and development processes and some of the after-sales technical support processes (Supply Chain Council, 2003).

By having in mind that SCOR is used to benchmark supply chains, it is obvious that this is done with data from other companies, so it cannot be used by a company alone to evaluate its supply chain(s). However, the data obtained can be used to identify problems in a company's supply chain and can therefore be used to apply modifications to improve its performance, so in this dissertation, SCOR will be used as an evaluation method (as stated above).

3.8 Choice of a method

In the end it should be stated that all the methods described in this chapter may (but not necessary have to) give different results. If a company tries to evaluate a certain supply chain by using two different methods, such a company might end up with two different results. The first method may evaluate one supply chain as a better one whilst the other method may evaluate a second supply chain as a better one. However, there is no simple solution to discover which method is more important, since the choice depends on the decisions made by the management group in the company and on what the management group considers as the most important factor. Furthermore, some factors may be of different importance if one takes existing limitations into consideration. These limitations can be divided into two groups (Kiziukiewicz, 2003, 328):

- External – such as: demand for certain products, substitutability of products, competitors, market stability, availability of production factors;

- Internal – such as: production abilities, inventory and applied technology of production, knowledge and skills of staff.

Chapter 4 Empirical Part

This chapter describes the empirical background of this dissertation to explain our way of gaining more knowledge.

4.1 Research limitations

For this dissertation, only five people in three companies have been interviewed face to face as it has been quite difficult to arrange such meetings with competent managers in the companies we have been interested in.

Another limitation has been that the companies visited have their operating facilities in the neighbourhood of Kristianstad due to our limited financial resources.

The last but not least research limitation has been the selected sample of companies to which questionnaires have been sent, as it would be almost impossible to ask all big companies in Sweden to fill in the questionnaires, since there have been restrictions of time and money in our work.

4.2 Data collection

In order to find out which methods of supply chain evaluation are used in practice, the authors of this dissertation have conducted field studies. These included case studies followed by questionnaire surveys.

The case studies have been made in three companies: Nolato Alpha AB, Bong Ljungdahl Sverige AB and Tetra Pak Packaging Material AB. Each of the interview partners had been chosen carefully, since we wanted to obtain information by the person, who deals on a daily basis with the problems described in this dissertation. Therefore, we interviewed only persons having extensive knowledge and experience in the field of supply chain evaluation.

Before our first meeting (with Nolato Alpha AB), we prepared a number of questions, which we wanted to ask. These questions have been sent in ad-

vance before each of the meetings. During the meetings, we made notes simultaneously in order to prevent the loss of any type of useful information due to a researcher's potentially short memory. After each meeting, we have prepared a report from the meeting and adapted our questionnaire (Appendix 2). We have made our interviews in two-three weeks time breaks in order to have enough time to read through additional literature and to analyse the material, which we obtained from the previous interview.

As a result of those meetings, we have gained knowledge about the practical evaluation of supply chains. However, we did not get enough information throughout the case studies to obtain enough data to create our model, so it was necessary to create the questionnaires, which should be sent to a number of companies.

However, the questionnaire survey has not been as easy as the authors of this dissertation had thought in the beginning, since it has contained quite a few problems. Also, the questionnaire has not been as successful as it had been expected in the beginning of the research work. One of the problems has been the process of selecting and deciding which companies should receive the questionnaires. It has been obvious that – due to limited time and lack of financial resources – it would have been impossible to obtain these particular – interesting from the research point of view – pieces of information from all companies. That is why the research work was limited only to big Swedish companies. Furthermore, as it has already been stated in the research limitations, the questionnaires have been sent to multinational enterprises operating within different industries. However, the authors of this dissertation have decided that the questionnaires should be sent to companies operating within the production or manufacturing industry. All of these companies have supply chains. However, our first thought was that only huge companies have got big and multinational supply chains. For these companies, the evaluation process may become a crucial factor in deciding on new and existing investments. Additionally, big companies have knowledge (know-how) and human resources to evaluate and compare investment possibilities. Therefore, only big companies have been taken into considera-

tion while doing research on methods of evaluating supply chains. However, we are aware of the fact and do not deny that other – smaller – companies may also have big experience in the supply chain evaluation processes.

Big companies have been defined in this study as companies, which had been included in the list of 500 Swedish biggest companies. The list not only contained manufacturing and production companies, therefore some of the companies – from other industries – have been taken out of the list. That is how the population for the survey was created.

We have decided to make a census research in the form of a questionnaire survey. In the beginning, we had made the assumption that a great range of companies would not answer our questionnaire but at the same time we wanted to obtain as much information as it would be possible. Additionally, we wanted to minimise the margin of error, therefore we abandoned the sampling technique since this technique is never 100% accurate.

Chapter 5 Case studies

In this chapter, information gathered from our three case studies is presented.

Three case studies have been carried out in three big and well-known process-based manufacturing companies, which operate in different business sectors: Nolato Alpha AB (Nolato), Bong Ljungdahl Sverige AB (Bong) and Tetra Pak Packaging Materials AB (Tetra Pak). Nolato is a first tier supplier within the telecom sector and other areas, producing for example mobile phone parts. Bong produces and supplies envelopes and Tetra Pak produces packaging materials for Tetra Pak packaging machines used for liquid food and beverages.

The case studies are presented in the same order as they have been carried out, each one starting with a short presentation of the company, the person interviewed and the reasons for which the company has been chosen for the case study. The following step demonstrates the supply chains that have been selected and describe the methods of their evaluation.

5.1 Case Study: Nolato Alpha AB

The interview has been made with the head of the logistics department Mr. Gert Larsson and his colleague Mr. Kent Nordstrand. They have provided us with detailed information about products, the company's supply chains and also the ways of their evaluation. Two reasons made us choose Nolato for this case study: firstly because of earlier established contacts (one of the group members has work experience in their logistics department) and secondly the company is suitable for studying supply chains with complex, high-end products.

5.1.1 Presentation of the company

Nolato is part of a group of companies working in various sectors, including telecommunications, household, automotive, consumer electronics, medical

products and others. The company itself is a producer/supplier within the telecom sector. It develops and manufactures systems and components, primarily for mobile telephones. They also offer solutions from product development to the delivery of finished products. Furthermore, the company is a supplier for most of the mobile telephone giants, delivering both simple injection moulded parts and complex mobile telephone fronts. Nolato employs approximately 500 people in its plant in Kristianstad, which produces a revenue of approximately SEK 1 billion.

5.1.2 Supply chain studied in Nolato Alpha AB

We have concentrated on one supply chain and only one product within this chain, representing the high-end/complex product in our case studies.

The actual product chosen is a fully assembled mobile telephone front. It includes the display and the keypad, which is ready to be attached to the other parts of the phone. It is important to note that in the case study the end product is only the mobile phone front.

The requirements for the product are extremely high on all areas, e.g. quality, delivery precision, lead time, flexibility and costs. The supply chain is also very capital intensive and requires equipment, such as press moulds and other machinery for a number of millions SEK. Furthermore, the supply chain is highly integrated with companies involved. The products are therefore developed in close co-operation with both suppliers and customers.

5.1.3 Evaluation methods

Nolato has developed its own evaluation system, called Logistic Preparation. It has been designed to meet all kinds of specific requirements from all parties involved. The evaluation method is therefore unique in each case and depends on the required information. However, some generalisation is possible by dividing the system into different stages. It is a simplified version of the system, so the reader can grasp the evaluation process with ease, without being confused with details.

The first stage is called “*Site Flow*” and describes the complete flow of the products including the location of all suppliers and customers, the description of the logistic flow in- and outside the factory. This is used to receive a general view of the process and to provide a quotation for each product. Additionally it is used as a foundation for the next stage in the evaluation.

The following stage is called “*Supply Chain*” and is a detailed description of each step within the supply chain, e.g. moulding, assembly, painting, packaging and transportation. This is used to calculate costs and lead time for each step of the process from raw material prices to transportation costs.

The next stage, the “*Customer flow*”, is an even more detailed description of the process, mainly measuring quality, by providing yield loss rates in each stage. In this stage the flow is reversed, starting from the end customer, and is calculated backwards. For example, if an end customer requires 7000 pieces of one article and the aggregated yield loss is 30% along the whole supply chain, the raw material personnel has to order material for 10000 pieces.

The final and most detailed stage in the system is “*Varieties*” in each product e.g. different colours and types. This is used to evaluate the most detailed functions in the system – for example the time it takes to change one colour to another – and is measuring flexibility or reaction time in each process.

5.1.4 Varying importance of different evaluation methods

There are four major evaluation measures mentioned in the section above: cost, quality, lead time and flexibility. A significant part was to determine if there is any important difference between these evaluation stages. Our findings were very interesting in this area:

It turned out that in deciding which method is the most important, we firstly need to determine the area or the intention of the evaluation itself. There are

basically three different perspectives to choose from in each company within the supply chain:

The first perspective is to evaluate the incoming material such as parts or raw materials coming from suppliers. This could be referred to as the incoming perspective, since in this case all parts are delivered to the company. For Nolato, the most important measure is cost. When choosing a supplier, usually the one offering the lowest total landed cost is selected. This means that all incoming activities within the supply chain – purchase, stock keeping, transports etc. – have to be carried out as efficiently as possible, to provide customers with the lowest possible landed cost. Another increasingly important factor is accessibility, meaning to be as close to the customer as possible to be able to meet increasing requirements on flexibility and shorter lead times.

The second perspective is about evaluating the activities taking place within the company itself, called the domestic perspective. It contains all processes that take place inside the company until the products are shipped out, e.g. production, in house logistics / transports and supporting activities such as machine maintenance. All these are important functions to evaluate, since the information gathered here is used jointly to increase the total efficiency of the company. In the domestic area, there are a couple of factors more significant than the rest, namely lead time and flexibility. To produce and transport the products inside the company as fast as possible with the highest flexibility and quality is priority number one.

Finally, the third dimension is called the outgoing perspective, and contains the delivery issues towards the customer, e.g. outgoing stock levels, cost of transportation to customers, sale prices, delivery precision and flexibility. From this point of view, Nolato acts as supplier to any customer. The most important factors in this area are to deliver the right products, at the right price but most importantly at the right time. Any delays are not just affecting the customer's production but can result in the stop of the entire supply chain causing major delays. This is not just a question of losing time and

money, but more importantly the loss of reputation and reliability in the business. Even if quality has not been mentioned in this section, it is still very important through all three areas. If a product is received or shipped out at the right time but is not useful because of poor quality, the performance of the entire supply chain is diminished increasing the price of the end product.

5.2 Case Study: Bong Ljungdahl Sverige AB

One of the main objectives of our dissertation was to investigate the difference between the evaluation of supply chains of simple and complex products. In this chapter, Bong represents the supply chain of a simple product, namely envelopes. An envelope usually consists of 4-5 different basic materials, and forms a low-end product.

The person interviewed was Lars Danielsson, who is responsible for all production units in Scandinavia, all together four factories. He has only been working in Bong for one year, but has already broad knowledge of Bong's supply chain activities. He has been very kind to share a large amount of information with us in this area, which was very useful for us.

5.2.1 Presentation of Bong Ljungdahl Sverige AB

Bong is a multinational company, producing envelopes for the European market and has 13% of the European market share. The company produces in 12 different factories in nine countries all around Europe and is involved in numerous international supply chains. There are two factories in Sweden. We have visited the plant in Kristianstad, which is responsible for the production of approximately 50 different types of envelopes. The actual structure of the product is usually the same. The differences are size, strength, material or the text printed on the envelopes.

5.2.2 Supply chain studied in Bong Ljungdahl Sverige AB

An envelope contains 4-5 different raw materials: paper, ink, glue, plastic film, etc. Each one is usually shipped from different suppliers. The supply chain starts with the production of these different raw materials. Bong is

connected to 75 different suppliers but for one particular envelope, only 4-5 of these suppliers are of importance. Most of the raw materials are purchased in large quantities to gain economies of scale both in purchase and production.

The printed envelope is actually the finished product – ready to be used by the end customer – placing Bong at the very end of the supply chain.

The supply chains are not as integrated as they are in Nolato. The customer places orders with specific product requirements such as quantity, type of product and lead time. Decisions of where and how to produce are made by Bong and then the finished products are delivered according to the specific requirements.

5.2.3 Evaluating different supply chain options

When evaluating different supply chain options in Bong, there are three main factors taken into consideration, which are: location, cost and capacity.

Location is about being as close as possible to the customer minimizing freight cost and lead time. Even though the envelope business is fairly stable, the increasing competition has resulted in increased emphasis on being as close as possible to the customer. While 15 years ago accepted lead time was 3 months, today it is down to 4-6 weeks, sometimes even less. Being local is not just about shortening lead times but to also increase flexibility, giving room for order changes in quantity, volumes, colours etc.

Cost functions are used to evaluate most of the activities within the supply chain. Complete supply chains are never evaluated or compared with each other instead each process is divided into minor quotas such as: Cost per unit (CVP analysis), cost per employee, ROCE (return on capital employed) index, the DuPont model and the Balanced Scorecard. Basically the whole company is cost centred and performance is evaluated in a similar way.

The final factor is capacity and is basically only applied when a plant is running at full capacity and cannot confirm any new orders because of the lack of production abilities. In this case, production has to be transferred to another plant – usually the closest or the one with the cheapest labour cost – for support. At the time of our interview, a similar situation occurred in one factory. The plant in Belgium needed some support to meet the customer's deadlines and therefore some orders from Belgium were transferred to the Norwegian factory in order to add capacity and meet the required lead times.

5.2.4 Varying importance of different evaluation methods

The importance of different evaluation methods is in the same order as described above: location, cost and capacity.

The most important factor is availability or being close to the customer, for the shortest lead time and transports possible. When a customer places a new order, it is in most cases sent to the closest factory according to earlier agreements. Most of the incoming orders are based on routine and each customer knows which plant to contact. If an order should come from a new customer, again the nearest situated plant is selected as the supplier.

Applying cost related methods comes in second place when evaluating supply chains or choosing production facilities. Obtaining cost advantages has become increasingly important for Bong, and explains why Poland is the only country with three different factories. It is a clear objective in lowering production costs by using cheap labour force. When asked why there is not any production established in Asia – with even lower production costs – to supply the entire European market, we were told that the distance was unacceptable in today's requirements on availability and being local to the customer. Furthermore, since envelopes are low-end products and the value/weight ratio is very small, combined with the distance between Europe and China, production in China and the related transport costs would not bring higher profit than production in Europe.

Least important is the capacity of the factory. This factor is only valid when one factory is out of capacity at that moment and some part of the orders have to be shifted to some other factory in order to produce in the time requested.

5.3 Case Study: Tetra Pak Packaging Materials AB

Tetra Pak Packaging Materials AB is a part of a whole set of companies, which are managed from Lausanne (Switzerland) by the holding company. Therefore, the company's independence is highly limited, which also influences the decision-making process on the choice among possible supply chains. Our interview partners were Anders Lindmark and Johnny Klein, both working in Tetra Pak's plant in Lund.

5.3.1 Presentation of Tetra Pak Packaging Materials AB

The company produces packaging materials for Tetra Pak packaging machines used for liquid food and beverages, such as milk, juices, cream, soup. However, it must be stated that the production is very capital intensive and requires around 500 million SEK to start a production line. The company produces about 4.2 billion packs yearly and employs about 340 people in its plant in Lund. The company has no serious competitors and is market leader in the production of packaging materials.

5.3.2 Supply chain studied in Tetra Pak Packaging Materials AB

The products are considered as low end products, which require very simple supply chains. There are only around 16 suppliers for one factory.

5.3.3 Evaluation methods

The company itself does not evaluate their supply chains. This is done by the headquarters in Lausanne. Additionally, it is up to the headquarters to choose the factors of greatest importance for the evaluation process. These factors include service, quality and cost. However, cost becomes more and more important for the owners of the company. Furthermore, the Lausanne office sets the importance of these factors.

The holding company owns about 50 factories all over the world, which allow to profit from economies of scale to place orders of e.g. paper. Therefore, such purchases are centralised. Usually, if the quality is the same, the paper is bought from the cheaper supplier.

Managers of each factory are allowed only to buy such ingredients as ink, according to their own specifications. Therefore, the company evaluates some of its direct suppliers. It looks at the claims, which have been made by the mother company, and compares them to the quality of the service. The quality of the service means the way of how a supplier reacts to a claim and the time for getting money back from the supplier in case of a claim. Additionally, Tetra Pak looks at the suppliers' environmental systems (if a supplier has environment friendly production process), speed of transportation, etc.

The very new concept applied in the TetraPak Packaging AB is the benchmarking process. The company compares itself with car manufacturers rather than with print-workshops.

5.3.4 Varying importance of different evaluation methods

This information could not be obtained, since the holding company makes all the decisions. However, the decision to include this case study was because it gives a deeper understanding of the subject.

5.4 Summary of Case Studies

Our intention with the case studies was to obtain an understanding and knowledge of how the selected companies evaluate their own supply chains. However, the more questions asked and the more information gained, the more complex each case turned out to be. For example in the Tetrapak case no relevant answers could be given, because general supply chain decisions are made a lot higher up in the company's hierarchy.

After all three case studies have been carried out, we decided to design a general questionnaire that could be sent out to a large amount of companies.

These general questions have been more relevant in answering our research questions.

Chapter 6 Survey

During the case studies, we have gained detailed understanding about supply chains. However, not all our questions could be answered to our satisfaction and therefore, during follow-up discussions, more questions in the research process evolved. This chapter describes the survey that was used to answer these questions.

6.1 Method of the survey

To make a survey, the authors of this dissertation decided to look at Sweden's top 500 companies (www.top500.de/g0039500.htm). Some of those companies are not engaged in any type of supply chain (for example mail distribution centres, pharmacies or energy production companies), therefore the population was set to 300 companies that act in Sweden, which have supply chains in Sweden and/or abroad. Since those 300 companies shall be representative for all big Swedish companies with supply chains, it is not only the population but also a sample. The decision to test a sample, was made since a subgroup should be tested, rather than all possible cases, when it is impracticable to survey the entire population and if time or money are limited (Saunders et al., 2003, 150-151). It would have been rather impossible to contact all companies in Sweden.

The questionnaire was developed in English. To avoid the language barrier, we translated it into Swedish and let a third person translate the Swedish version back into English (back-translation). With this approach, we made sure, that the translation into Swedish still expressed what we meant in the English version.

After sorting out the not eligible companies, we decided to go the – in our eyes – easiest way. We have used the internet to find out the companies' web addresses. Then, we have sent the Swedish version of our questionnaire (see also Appendix 4) as an email to the companies' Information department. Usually, the address was similar to *info@company.se*. Within the next

days, the first responses were sent back to us. After about one week, we decided to send a follow-up questionnaire. This time we only wrote a short mail to the addresses that had not responded yet and added the questionnaire as a form in Microsoft Word format. After this second wave, we received more answers.

The reason for choosing this way of contacting companies, was to not influence the respondent, which means that the questionnaire was self-administered. Furthermore, we wanted to combine the advantages of the *online* and the *postal* option, such as short response times and low costs.

The total active response rate is calculated as:

$$\text{total response rate} = \frac{\text{total number of responses}}{\text{total number in sample} - (\text{ineligible} + \text{unreachable})}$$

(Saunders et al., 2003, 157)

In total figures, that means for this dissertation:

$$\frac{37}{300 - (106)} = 19,07 \%$$

This number is a rather normal response rate for this type of survey, so we assume that the data is useful for our analysis.

Some reasons for this response rate are for example so-called spam filters, so some of our mails probably were falsely recognised as spam mails and just deleted. Some companies of course just refused to answer, probably also due to the time of the year, when many important answers consume all time in companies. Those mails that got through to companies that basically wanted to answer, might have been deleted in the information department when a responsible person for answering our questions could not be located within the company. A researcher can hardly prevent being filtered by spam filters, nor can researchers influence the company's will to respond. What

we could have done, is to mention the responsible department (logistics, controlling, etc.) to which the email recipient could have forwarded the mail.

6.2 Analysis of the survey

This section will give a short overview of the answers of the returned questionnaires.

Table 2: Analysis of the survey

Question	Answers
Type of product	11 simple, 21 complicated, 3 other
Internationality of supply chain	10x international, 2x Swedish, 23x Swedish and international
Evaluation (yes/no)	21 yes, 14 no
Method of evaluation	A big variety of answers made the analysis of this question rather inaccurate: SCOR was used in 2 companies, NPV: 5, DuPont: 2, CVP: 5, Payback: 4, ARR: 0, IRR: 3, other: 16 (these included “manual calculations” etc.)
Differences in evaluation (national/international)	17x same, 6x different evaluation

As can be seen in the table above, the answers in how companies evaluate their supply chains vary too much, so no pattern was visible. The answer for the research question

- “Do different companies use the same methods to make investment decisions?”

is “no”. However, the evaluation has shown that the theories used in this dissertation are the usual methods in evaluating supply chains within the

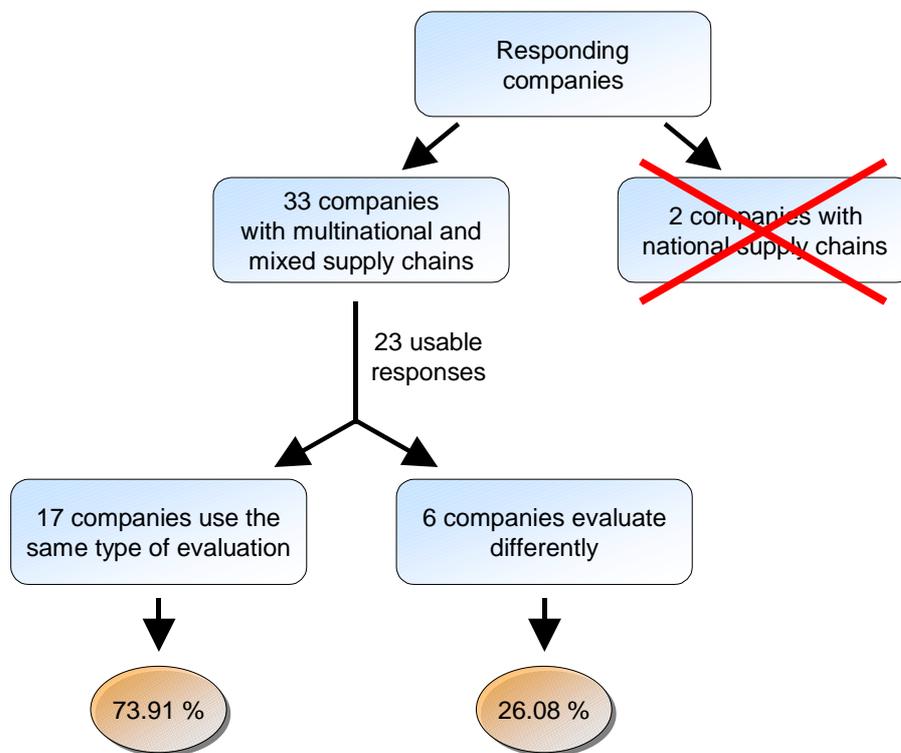
manufacturing and production companies within Sweden's big 500 companies. Only the ARR method was not used by any of them.

Luckily, the answers to the second research question

- “Are there any differences in the evaluation of multinational and national supply chains within big companies in Sweden?”

were easier to evaluate. The figure below demonstrates details about the reliability of the answers to this question.

Figure 16: Differences in the evaluation of multinational and national supply chains in Sweden



Since almost 74 % of the usable responses of the companies with multinational and mixed supply chains use the same type of evaluation for their supply chains, we assume that we can create one model to evaluate and compare multinational and national supply chains. However, we are not completely satisfied with this outcome, since we had the impression that

companies do not change data into information so our model will go further (as described below during the creation of the model).

6.3 Criticism of the survey

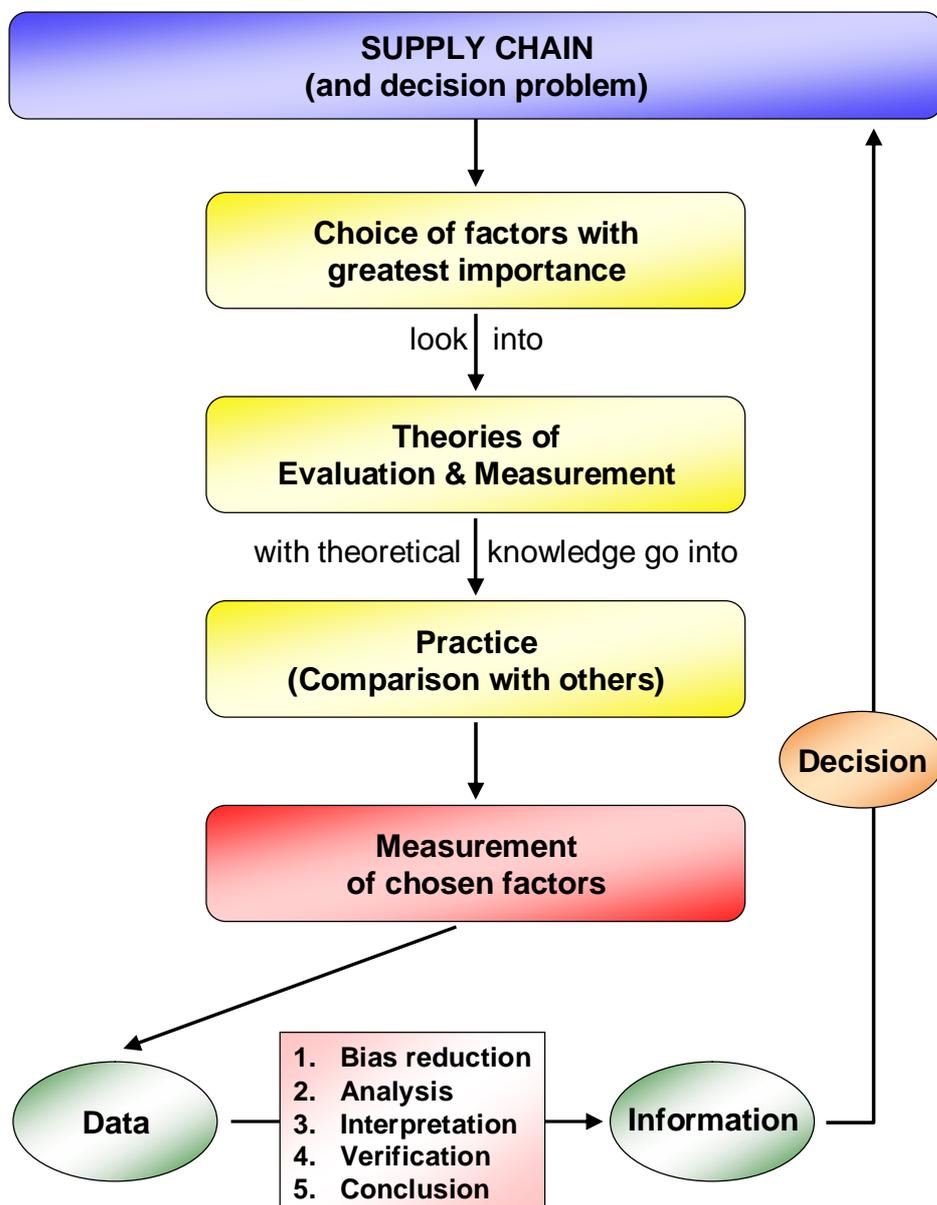
As with all self-administered surveys, we have to have in mind that the researchers did not have any influence on the responding partner. Therefore, it cannot be guaranteed that the right person responded or that the person, who has sent the response was the one, who answered. However, we assume that the responding partner was the right person and had the right knowledge for answering our questions.

Chapter 7 Development of the model

This chapter presents the creation of a model to evaluate supply chains. Furthermore, a description and a test help to explain the model to the reader.

7.1 Developing a general model

Figure 17: General model



The model describes the way of approaching the problem of supply chain evaluation. This problem relates to the choice among different possible supply chains during the process of financial long-term investments by a company. Therefore, the model's starting point is "Supply chain (and decision problem)". A person responsible for evaluating certain supply chains defines the possible supply chains and the problems related to them.

The empirical part of this dissertation influenced the development of a model to a great extent. During our field studies, we found out that big Swedish multinational manufacturing companies use different methods for supply chain evaluation and there was no pattern for these methods. This was also the answer for our first research question. We are also aware of the fact that each company is different and unique. Thus, there is always a need for tailoring and adjusting the model. Therefore, to meet specific requirements coming from decision-makers, we designed the second step in the model. This step includes the choice among factors which are of the greatest importance for the decision-maker.

For this second step, the responsible person for comparing supply chains (who is also the decision-maker), chooses the factors, which are of the greatest importance for the company. This step was specially designed to meet specific needs of a decision-maker. It may include not only quantitative factors but also qualitative ones. As an example of quantitative factors, one can state the relationship between profits coming from a particular supply chain and the amount of money invested in this particular supply chain, the time for the payback of the initial investment, the rate of return of the supply chain or cost per unit of a product. The qualitative factors may include for example the sustaining of a good relationship among people involved in certain parts of a supply chain.

The next step includes looking into the theories of evaluation and measurement, which may include such examples as:

- the CVP analysis,
- the payback period,
- the ARR method,
- the NPV method,
- the IRR method,
- the DuPont model and
- the SCOR model.

The factors chosen by the company should be identified in the theories. These theories should be studied carefully.

The following step includes the comparison with other companies in regard of the chosen factors and theories, followed by the step “Measurement of chosen factors”. This step ends with obtaining particular data.

It is worth mentioning that during our field studies, we gained the impression that the evaluation process in the companies ended after obtaining data. During the creation of our model we moved one step further – we added the part of transforming data into information.

This part can be used for dealing with the problems of high inflation rates or different risks engaged in the supply chains. The inflation problems can be solved by verifying quantitative factors, such as the Return On Investment index. Furthermore, different risks can be included in the model by using for example the probability and expected value of quantitative factors, such as cash flows.

The data gained during the measurement of the chosen factors should be transformed into information. The transformation (and correction) process includes:

- bias reduction,
- analysis,
- interpretation,

- verification and
- conclusion.

After having gained information, the next step in the model is “Decision”, which has great influence on the first step “Supply chain (and decision problem)”, since it is the solution to the problem of supply chain evaluation.

7.2 Simplified tests of the model

After creating the model, we have conducted purely theoretical tests, since tests based on the practical background would be almost impossible to conduct, due to the limited time for this work. Another barrier for basing the test on real data has been a lack of the companies’ interest in revealing any secret and confidential information concerning their supply chains.

The model has been developed for the evaluation of multinational supply chains in order to make long-term investment decisions.

7.2.1 First test

To make it easier for the reader to understand the main concept of the model, we will consider only one year in the life of possible supply chains. The following years can be evaluated in the same manner.

This test shows only one of the many possible problems that might occur in the economic environment of supply chains.

The test presented below follows the model’s outline, therefore it is presented in the following manner (a short overview is presented in table 3):

7.2.1.1 “Supply chain (and decision problem)”

Let us consider two possible supply chains. The first one is located in country A, where the inflation rate is $i(A) = 0\%$. The second one is located in country B, where the inflation rate is $i(B) = 35\%$. A company has to evaluate these two supply chains and decide on, where to invest its financial resources $FR = 100$ c.u. (currency units).

7.2.1.2 “Choice of factors with greatest importance”

It has been decided that the most important factor while evaluating the two supply chains, is the relationship between profits from the supply chain and the amount invested in this supply chain.

7.2.1.3 “Theories of evaluation and measurement”

The DuPont model includes the Return on Investment (ROI) index, which is one of the possible ratios often used for performance measurement. This index could be used for the purpose of the measurement in the test of the developed model, since it represents the relationship between profits from the supply chain and the amount invested in this supply chain.

7.2.1.4 “Practice (comparison with others)”

By looking into practice, one can learn that companies operating in this particular industry usually achieve an ROI ratio of 25%.

7.2.1.5 “Measurement of chosen factors”

The measurement of ROI in the two possible supply chains has been conducted according to the following equation.

$$\text{ROI} = \frac{\text{Profit}}{\text{Investment}}$$

The following accounting data has been taken into consideration while evaluating the supply chain in country A:

1.01.200X – purchase of materials – investment of 100 c.u. (currency units) in the supply chain in country A.

31.12.200X – sales of materials for 130 c.u. – income from the supply chain in country A.

Profit = Sales - Costs

Profit = 130 - 100 = 30 c.u.

As a result:

$$\text{ROI (A)} = \left(\frac{30 \text{ c.u.}}{100 \text{ c.u.}} \right) = 30\%$$

ROI (A) = the nominal return on investment from the supply chain located in country A.

The following accounting data has been taken into consideration while evaluating the supply chain in country B:

1.01.200X – purchase of materials – investment of 100 c.u. (currency units) in the supply chain in country B.

31.12.200X – sales of materials for 140 c.u. – income from the supply chain in country B.

$$\text{Profit} = \text{Sales} - \text{Costs}$$

$$\text{Profit} = 140 - 100 = 40 \text{ c.u.}$$

As a result:

$$\text{ROI (B)} = \left(\frac{40 \text{ c.u.}}{100 \text{ c.u.}} \right) = 40\%$$

ROI (B) = the nominal return on investment from the supply chain located in country B.

7.2.1.6 Data

As the result of the measurement, we can see that $\text{ROI (B)} > \text{ROI(A)}$. This would indicate that the company should invest its financial resources in supply chain B.

The process of transformation data into information includes five possible steps: reduction of bias, analysis, interpretation, verification and conclusion. Since the two possible supply chains are located in two countries with two different inflation rates, there is a need for the verification and correction of the ROI ratios.

The reason is, that in the equation for ROI, the amounts of money, which are compared, come from different periods of time. Therefore the time value of money must be taken into consideration. In order to achieve the real ROI,

profits should be corrected by the inflation rate. Additionally, the amount of money invested in the project has to be also corrected by the inflation rate.

If the inflation rate in country A is 0% ($i(A) = 0\%$), there is no need for correction, since the currency unit from the time it was invested, has the same real value at the time when profits are made.

Therefore:

$$\text{ROI}(A') = \left(\frac{30 \text{ c.u.}}{100 \text{ c.u.}} \right) = 30\%$$

$\text{ROI}(A')$ = the real return on investment from the supply chain located in country A.

However, in country B, there is an inflation rate of 35% ($i(B) = 35\%$). Therefore, there is a need for costs correction in order to be able to count the real profits coming from the supply chain in country B. In this case, part of the profit is created by the inflation.

The cost of the purchase on 31.12.200X is:

$$100 \text{ c.u.} * 1,35 = 135 \text{ c.u.}$$

Therefore, the real profit (counted according to the matching principle and accrual concept)

(www.develop.emacmillan.com/iitd/material/DirectFreeAccessHPage/FNFE/ch1_accountingp.html) equals to:

$$140 \text{ c.u.} - 135 \text{ c.u.} = 5 \text{ c.u.}$$

Additionally, there is a need for investment correction in order to count the real (and not nominal) ROI ratio:

$$\text{Investment} * 1,35 = 100 \text{ c.u.} * 1,35 = 135 \text{ c.u.}$$

Therefore:

$$\text{ROI (B')} = \left(\frac{5 \text{ c.u.}}{135 \text{ c.u.}} \right) = 3.70\%$$

ROI (B') = the real return on investment from the supply chain located in country B.

7.2.1.7 Information

As a result, we obtain the following information on the ROI ratios of the two possible supply chains.

$$\text{ROI (A')} = 30 \%$$

$$\text{ROI (B')} = 3.70 \%$$

$$\text{ROI (A')} > \text{ROI (B')}$$

7.2.1.8 Decision

The company should decide to invest in the supply chain in country A, since the real return on investment is greater than in country B. Additionally, the ROI ratio in the supply chain A is greater than the usual ROI in this type of industry.

Table 3: Overview of the first model's test

		A	B
<i>Before correction</i>	Investment	100 c.u.	100 c.u.
	Sales	130 c.u.	140 c.u.
	Profit	30 c.u.	40 c.u.
	ROI	30 %	40 %
<i>After correction</i>	Inflation Rate	0 %	35 %
	Cost of purchase (corrected)	100 c.u.	135 c.u.
	Sales (corrected)	130 c.u.	140 c.u.
	Profit (corrected)	30 c.u.	5 c.u.
	ROI (corrected)	30 %	3.70 %

7.2.2 *Second test*

7.2.2.1 “Supply chain (and decision problem)”

Let us consider two possible supply chains. The first one is located in country A. The second is located in country B. A company has to evaluate these two supply chains and to decide on where to invest its financial resources of 100 c.u. (currency units). The inflation rates in both countries are equal to 0%. Therefore, the time value of money is not taken into consideration.

7.2.2.2 “Choice of factors with greatest importance”

It has been decided that the most important factor, while evaluating the two supply chains, is the time of getting back the invested financial resources.

7.2.2.3 “Theories of evaluation and measurement”

The payback period method deals with these problems, since it shows the time during which the initial amount of money invested will be paid back. Therefore, it could be used for the purpose of the measurement in this test.

7.2.2.4 “Practice (comparison with others)”

By looking into practice, one can learn that companies operating in this particular industry usually achieve 5 years of payback period.

7.2.2.5 “Measurement of chosen factors”

The measurement is conducted according to the following table, which represents the whole life of both supply chains and their cash flows together with probabilities of achieving these specific cash flows. Since the probabilities of achieving these cash flows are different than the expected value of these, cash flows must be computed.

Table 4: Payback period measurement

Years	Supply Chains			
	A		B	
	Predicted probability of cash flows	Predicted cash flows	Predicted probability of cash flows	Predicted cash flows
0	1	-100	1	-100
1	$\frac{1}{4}$	40	25	1
	$\frac{3}{4}$	20		
2	$\frac{1}{4}$	40	25	1
	$\frac{3}{4}$	20		
3	$\frac{1}{4}$	80	50	1
	$\frac{3}{4}$	40		
4	$\frac{1}{4}$	40	25	1
	$\frac{3}{4}$	20		
5			1	25
Sum of cash flows		125		125

The predicted cash flow in country A in year 1 is calculated as follows:

$$(\frac{1}{4} * 40) + (\frac{3}{4} * 20) = 25$$

The other figures are calculated in the same way.

From the table it can be seen that the payback period of supply chain A is 3 years since

$$-100 + 25 + 25 + 50 = 0$$

and the payback period of supply chain B is 4 years since

$$-100 + 20 + 20 + 30 + 30 = 0.$$

Since the assumption is that inflation rates are equal to 0% in both countries, the time value of money is not taken into consideration. That also comes explicit from the theory of payback period since it is a static accounting method, which does not take time value of money into consideration.

7.2.2.6 “Data”

Payback period of supply chain A: 3 years.

Payback period of supply chain B: 4 years.

In this example, data and information are conform because there is no need to take e. g. time value of money into consideration.. Although our model is especially useful because of the possibility to change data into information, there is not always a need to do so.

7.2.2.7 “Information”

Payback period of supply chain A: 3 years.

Payback period of supply chain B: 4 years.

7.2.2.8 Decision

The company should decide to invest in the supply chain in country A, since the payback period is shorter than in country B. Additionally, the payback period in the supply chain A is shorter than the usual payback period in this type of industry.

There were three criteria, which our model should fulfil:

- Consideration of different inflation rates,
- Consideration of different risks of cash flows because of the political and economic environment
- Consideration of qualitative and quantitative factors.

The first criterion is fulfilled since the model may include the methods of supply chain evaluation which take into consideration the time value of money (e.g. Net Present Value or Return On Investment corrected by inflation rate). However, it is only the user of the model who decides if these methods will be included in the evaluation process.

The second criterion is fulfilled since the model may include the methods of evaluation with risks associated to future cash flows (e.g. payback period with probability and expected value of cash flows).

The third criterion is fulfilled since the second step in the model includes the choice of factors which are of a greatest importance for the user of the model. These factors may include quantitative (e.g. the relationship between profits coming from a particular supply chain and the amount of money invested in this particular supply chain, the time for the payback of the initial investment, the rate of return of the supply chain or cost per unit of a product) and the qualitative ones (e.g. the sustaining of a good relationship among people involved in certain parts of a supply chain). However, it is only the decision-maker who decides on these factors.

As a result, we can see that the model has been developed to meet specific requirements from its users. Therefore, it fulfils the criteria stated above but only if users want them to be included in the model. Thus, we have to bare in mind that the user of the model cannot be forced to use specific factors – the user chooses the factors which are important for him.

Chapter 8 Conclusions and Recommendations

This chapter concludes the research process and shows our own conclusions, gained during our work.

8.1 Conclusions

The purpose of this dissertation was to develop a general model for the evaluation of multinational supply chains. This problem was supported by two research questions. The first research question was to check whether the companies in Sweden evaluate their supply chains using the same methods. As a result of our empirical survey, we found out that the companies in question do not use similar means of evaluation and measurement. The methods used by them include the Cost Volume Profit analysis, the Net Present Value analysis, the Supply Chain Operations Reference model, the DuPont model, the payback period method and the Internal Rate of Return analysis. Some of the companies also use other (own) methods of measurement and evaluation. However, the companies have not specified these additional methods.

The second research question was also inseparably connected to the purpose of the research. The question included the problem of finding out if the companies make a difference between the evaluation of national and multinational supply chains. We assumed that there are different evaluation methods for national and multinational supply chains. Therefore, we have taken a look into the theories describing the methods of supply chain evaluation (Supply Chain Operations Reference model, Cost-Volume-Profit analysis, payback period, Average Rate of Return, Net Present Value analysis, Internal Rate of Return analysis, DuPont model, etc.). The next step in discovering the uniqueness of multinational supply chain has been to conduct two types of field studies: case studies (in the form of interviews) followed by a questionnaire survey on a number of big Swedish companies. To our surprise, it has occurred that there was no significant difference in the methods of supply chain evaluation, no matter whether they have national or

multinational character. From the sample of the companies in question, 73.91% use the same methods of supply chain evaluation. Therefore, we have decided to develop a general model of supply chain evaluation. However, during our research, we had the impression that companies do not take the correction of data into consideration. This is where – in our opinion – the model contributes new knowledge to decision-making within supply chains.

The purpose of this dissertation had been to develop a general model for evaluating multinational supply chains. This model could provide guidelines for process-based manufacturing companies when comparing or choosing between different supply chains in order to make long-term investment decisions. The model is suitable in a high grade for evaluating multinational supply chains because it includes adjustment possibilities and correction factors in order to take different political and economic environments into consideration. Such adjustment possibilities could include the choice of factors with greatest importance and qualitative and quantitative factors, where as the correction factors include risks and the time value of money.

Our model could be used for the purposes of national and multinational supply chain measurement and comparison. The model has been tested on two theoretical examples. The outcome was positive – the model worked properly. Additionally, the model fulfils the criteria, which we stated in the beginning of our research. Therefore, the authors of this dissertation highly recommend the usage this model for the purposes of supply chain evaluation.

8.2 Recommendations

This dissertation has been written on a general level, attempting to embrace as many business sectors as possible. Our intention with this direction was to provide a model applicable to as many companies and business sectors as possible.

First of all, a research of this type could be carried out in a more specialised manner, concentrating on only one type of business (e.g. supply chains only within the packaging industry). This would allow the researcher to enter more deeply into and gain more specific knowledge about the selected business sector.

It would also be interesting to devote detailed research into several business areas and to make a direct comparison between these selected sectors. This could increase the knowledge within the supply chain research area but: the more detailed the research, the more difficult it is to present a general model.

With a broader time limit, we would have carried out more case studies with even more companies and different products, which can be recommended to someone else interested in continuing the research topic. The same is applicable on the surveys.

It could also be interesting to find out interdependencies of evaluation methods, e.g. if the company size or the business sector influence the evaluation of supply chains.

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Appendix 1: Example of a SCORcard

				Performance vs. competitive population			
	Overview Metrics	SCOR Level 1 Metrics	Actual	Parity	Advantage	Superior	Value from Improvements
External	Supply Chain Reliability	Delivery Performance to Commit Date	50 %	85 %	90 %	95 %	\$30M Revenue
		Fill Rates	63 %	94 %	96 %	98 %	
		Perfect Order Fulfilment	0 %	80 %	85 %	90 %	
	Responsiveness	Order Fulfilment Lead Times	35 days	7 days	5 days	3 days	\$30M Revenue
	Flexibility	Supply Chain Response Time	97 days	82 days	55 days	13 days	Key enabler to cost and asset improvements
		Production Flexibility	45 days	30 days	25 days	20 days	
Internal	Cost	Total SCM Management Cost	19 %	13%	8 %	3 %	\$30M Indirect Cost
		Warranty Cost	NA	NA	NA	NA	NA
		Value Added Employee Productivity	NA	\$156K	\$306K	\$460K	NA
	Assets	Inventory Days of Supply	119 days	55 days	38 days	22 days	NA
		Cash-to-Cash Cycle Time	196 days	80 days	46 days	28 days	\$7M Capital Charge
		Net Asset Turns (Working Capital)	2.2 turns	8 turns	12 turns	19 turns	NA

Source: Supply Chain Council, 2003

Appendix 2: Questionnaire for interviews (final version)

1. What do you produce? What is the structure of your product?
2. Are your products high- or low-end products? (complex or simple)
3. When planning a different type of product or production, do you plan together with a supplier or a customer? (integrated supply chain?)
4. Do you only produce in Sweden or also in other countries?
5. Did your company make any choices on where to produce? If yes, on which bases were these decisions made?
6. What is your company's operating sector?
7. Is your company involved in different supply chains? If yes, how many?
8. How do these supply chains look like?
9. In which part of the supply chain is your company's process situated in?
10. Does your company use any means or factors of evaluating different supply chain options?
11. What is the importance of these factors used for evaluating supply chains? Are they of equal importance? How are these factors measured?
12. When there is a possibility to choose between different supply chains, who makes the decision to produce in a particular supply chain?
13. How does the ordering process look like?
14. How does the production process look like?
15. Are there different suppliers for different supply chains?
16. How are you evaluating different factors such as quality, production costs, stock, lead time, transport costs and flexibility?
17. Is inventory important in your decision?
18. Do you have direct contact with the end customer?

Appendix 3: Questionnaire (Swedish text)

Hej!

Vi är tre studenter som studerar Internationell ekonomi vid Högskolan Kristianstad och skriver just nu vårt examensarbete.

Detta går ut på att jämföra företags sätt att utvärdera olika värdekedjor (sk. supply chains). Vi skulle vara väldigt tacksamma om Ni kunde kryssa i några snabba frågor ang. detta. (svar är naturligtvis anonymt om så önskas). Tack på förhand!

Sätt kryss om möjligt, vid behov var vänlig specificera:

1) Tar eran verksamhet hand om *enkla* eller *komplicerade* produkter?

Enkel *Komplicerad* *Annat?* _____

2) Är produkt kedjorna ni är del av: *internationella* (utländska leverantörer eller kunder) *eller enbart nationella*?

Del av internationell produktkedja
 Del av produktkedja enbart inom Sverige
 Både och

3a) Har ni någon form av utvärdering mellan eran produktkedjor?

Ja Nej

3b) Om ja, vilken?

Exempel på några ni kan tänkas använda:

SCOR model (Supply Chain Operations Reference model),
 NPV analysis (Net Present Value),
 DuPont model,
 CVP analysis (Cost-Volume-Profit),
 Payback period,
 ARR ratio (Average Rate of Return),
 IRR ratio (Internal Rate of Return),
 Om annat, var vänlig specificera: _____

4) Varför valdes just den här utvärderingsmodellen?

5a) Om företaget är del av *både nationella och internationella produktkedjor*, utvärderar ni dessa *likadant eller på olika sätt*?

Likadant Olika sätt

5b) Om ni använder olika sätt, vilka är dessa?

6) Namn och position inom företaget?

Namn: _____

Position: _____

Önskar vara anonym.

Ni får gärna ta del av vår undersökning, när vi är färdiga med den i januari om ni anser det vara intressant.

Med vänliga hälsningar

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Appendix 4: Questionnaire (English text)

Hello!

We are three students, who study International Business at Kristianstad University and are about to write our final dissertation.

The paper is about comparing the companies' mode of evaluating supply chains. We would be grateful if you could answer a few short questions. Your answers will of course be treated anonymously if you wish.

Thank you in advance!

Please tick where possible, if necessary motivate your answer:

- 1) Do you produce simple (low-end) or complicated (high-end) products?

Simple *Complicated* *Other?* _____

- 2) Are your supply chains *international* or *only national*?

international
 only within Sweden
 both

- 3a) Do you have any type of evaluation of your supply chains?

Yes No

- 3b) If yes, which?

SCOR model (Supply Chain Operations Reference model),
 NPV analysis (Net Present Value),
 DuPont model,
 CVP analysis (Cost-Volume-Profit),
 Payback period,
 ARR ratio (Average Rate of Return),
 IRR ratio (Internal Rate of Return),
 Other, please specify: _____

- 4) Why do use that kind of evaluation?

5a) If you have *national and international supply chains*, do you evaluate them the *same way or differently*?

Same Differently

5b) If you use different methods, which are these?

6) Name and position in your company?

Name: _____

Position: _____

Want to stay anonymous.

After finishing our work in January, we can send you our results, if you wish.

Best regards

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