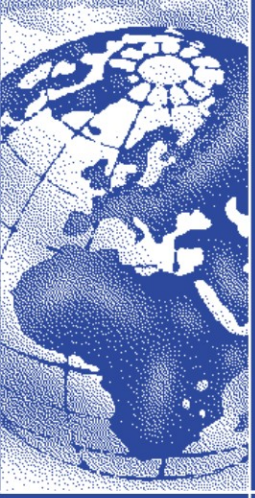

Einkauf, Logistik und
Supply Chain Management
Hrsg.: Christopher Jahns

Julia Wolf

The Nature of Supply Chain Management Research

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Einkauf, Logistik und Supply Chain Management

Herausgegeben von
Professor Dr. Christopher Jahns

Die Schriftenreihe stellt den State-of-the-art betriebswirtschaftlicher Forschung am Supply Management Institute SMI™ im Bereich Einkauf, Logistik und Supply Chain Management dar. Die Verbindung von Theorie und Praxis steht dabei ebenso im Vordergrund wie die internationale Ausrichtung und die unmittelbare Verknüpfung der Themen Einkauf, Logistik und Supply Chain Management.

Julia Wolf

The Nature of Supply Chain Management Research

Insights from a Content Analysis of International Supply Chain Management Literature from 1990 to 2006

With a foreword by Prof. Dr. Christopher Jahns

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Bibliographic information published by Die Deutsche Nationalbibliothek
Die Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data is available in the Internet at <http://dnb.d-nb.de>.

Dissertation European Business School Oestrich-Winkel, 2008

D 1540

1st Edition 2008

Editorial Office: Frauke Schindler / Nicole Schweitzer

Gabler-Verlag is a company of Springer Science+Business Media.
www.gabler.de

Cover design: Regine Zimmer, Dipl.-Designerin, Frankfurt/Main
Printed on acid-free paper
Printed in Germany

ISBN 978-3-8349-0998-5

Foreword

Among researchers in the business and management disciplines, there is some kind of a common understanding that research should provide models, concepts and solutions for practical problems. In other words: research is practice-oriented and, personally, I subscribe to this maxim. Still, sometimes, it is important to pause for a moment and reflect upon one's own activities.

The present thesis is one of those comparatively few pieces of research that do so by dealing with the scientific side of research and by asking a number of questions that target at the identification of the nature of a very recent subfield within business and management, namely Supply Chain Management. In particular, the author seeks to understand the processes that characterize the evolution of Supply Chain Management research throughout the past sixteen years and reflects upon avenues for future research - feeling that SCM research seems to have come to a crossroads.

The systematic reprocessing of Supply Chain Management literature and the methodologically sound approach are impressive and enable Julia Wolf to contribute a valuable component to scientific practice and debate in this area. Her work also illustrates that, in terms of philosophical underpinnings, research in Supply Chain Management is still at the very beginning and I hope that this thesis gives rise to more work of similar kind.

Today, I can look back with proud upon three years of inspiring work and discussions with Julia Wolf. I hope that she will demonstrate the same ambition and dedication in the future as she did throughout the time and in the scope of various different projects at the Supply Management Institute in order to further pursue and realize her personal objectives.

Prof. Dr. Christopher Jahns

Acknowledgement

The present doctoral thesis resulted from my function as research assistant at the Supply Management Institute with the focus areas Purchasing, Logistics and Supply Chain Management at the European Business School. I want to express my sincerest thanks to Prof. Dr. Christopher Jahns, my thesis supervisor, who has the particular gift to trust and thus to enable those who get engaged to outdo themselves. His entire commitment to the targets he once subscribed to encourages his scholars to believe into the realization of their own visions and aspirations. In addition, I am very much obliged to Prof. Dr. Ulrich Grimm for assuming the role of the second assessor and, in particular, for his willingness to engage into discussions about the essence of science.

Furthermore, I want thank a number of persons for their great support and encouragement:

→ Prof. Dr. Stefan Walter for exchanging ideas throughout the past three years. He was the one who claimed that giving up was not an option.

→ Prof. Dr. Richard Pibernik who shared a lot of his scientific experiences and thus strongly and unselfishly contributed to the quality of the work.

→ All my colleagues at the Supply Management Institute and in particular those whom I had the pleasure to learn to know more personally: Gernot Kaiser (thank you for many brightening scientific debates), Roger Moser (how would things have turned out without you? I owe you a lot), Martin Lockström, Handik Widiarta, Stefan Schmidberger, Gerhard Trautmann, Lars Eiermann and Anna Quitt and many others.

→ Prof. Dr. Wolfgang Winter who many years ago sowed the seeds for my aspirations. His perspective on reality and belief into the ideas of Heinz von Foerster laid the foundation for many of my later actions: "*Act always so as to increase the number of choices.*"

→ Michael who was convinced that everything would turn out all right. I hope you will make your way while maintaining you're extraordinary spirit. I still believe in you. Thanks for all.

Finally, I am indebted to thanks to my family. My mother who had to suffer most from bad temper and shortages of time and still never ceded to back me up in my doings - wherever and whenever. My father who never gets tired of philosophical or political discussions without losing his sense for practice. My brother and sister who both made their own way. I am proud of the two of you. My grand-parents for always being so supportive. You're the greatest.

Julia Wolf

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List of Abbreviations

CSCMP	Council of Supply Chain Management Professionals
EJPSM	The European Journal of Purchasing and Supply Management
IJLM	The International Journal of Logistics Management
IJOPM	International Journal of Operations & Production Management;
IJPDLM	International Journal of Physical Distribution and Logistics Management
IJPMM	The International Journal of Purchasing and Materials Management
IJPR	International Journal of Production Research
JBL	Journal of Business Logistics
JOM	Journal of Operations Management;
MS	Management Science
SCM	Supply Chain Management
SCMIJ	Supply Chain Management: An International Journal
SIC	Standard Industrial Classification

1 Introduction

This first chapter serves to introduce the problem area which is Supply Chain Management research and to specify the main research question. In addition, this chapter provides a brief validation for the investigation to be undertaken and an overview of the overall structure of the thesis. Finally, definitions of key terms are provided to acquaint the reader with the problem area.

1.1 Background to the Research

Economy in the second half of the 21st century has been characterized by a number of fundamental transformations that challenged organizations to frequently find new forms of management in order to remain competitive. Globalization has been one of the most important forces (Christopher & Ryals, 1999, p. 12; Lancioni, Forman & Smith, 2001b, p. 734). It has been facilitated by the reduction and elimination of barriers within Europe and the introduction of a joint currency, the dissolution of the command economies in the Eastern Block, the establishment of the North American Free Trade Agreement among others (La Londe & Masters, 1994, p. 35). A second force has been increased concentration on core competencies by firms and an associated trend towards outsourcing of non-core activities (Lummus & Vokurka, 1999, p. 12). Third, these two forces aggravated international competition and environmental complexity and led to a high level of uncertainty (e.g. Bandinelli, Rapaccini, Tucci & Visintin, 2006, p. 162; Peck & Jüttner, 2000a, p. 33). This effect has been aggravated by the economic rise of countires from Asia, mainly China and Japan. Fourth, the rise of new information technologies facilitated business operations and the coordination across organizations and regions (e.g. Meredith, 2001, p 399; Narasimhan & Kim, 2001, p. 51) and has probably enabled the fifth driver: spatial, organizational and functional fragmentation of production, delivery and associated services (Rodrigue, 2006, p. 510). Finally, the polarisation of markets and the necessity for many organizations to cope with the challenges of polarised high-end/low-end market profiles constitute a last major characteristic of today's international business environment (Storey, Emberson, Godsell & Harrison, 2006, p. 769).

These developments led to an increased number of management concepts such as business process re-engineering or Keiretsu that promised to provide solutions to the challenges. Among these business concepts, Supply Chain Management (SCM) has probably been one of the most important (Gripsrud, Jahre & Persson, 2006, p. 644; La Londe & Masters, 1994, p. 35) and the expectations towards SCM have been enormous. The central idea behind SCM is the generation of sustainable competitive advantage by means of integration (Cooper &

Ellram, 1993a, p. 13; Cooper, Ellram, Gardner & Hanks, 1997, p. 67; Ellram & Cooper, 1990, p. 1) of business functions either within an organization or across organizations (Mentzer et al., 2001, p. 18). Therefore, individual members of a supply chain are supposed to assist each other in order to improve competitiveness of the overall chain (Min & Mentzer, 2004, p. 63).

Evidently, SCM seems to be an appealing and promising concept for practitioners and it is a natural consequence that there has been an increasing body of literature from the scientific world that seeks to provide appropriate tools and guidelines for supply chain managers to enable them to optimally realize their tasks (e.g. Payne & Peters, 2004). The strong recognition SCM experienced within science led to the suggestion that SCM has developed into an independent business discipline (e.g. New, 1997, p. 15; New & Payne, 1995, pp. 60-68; Cousins, Lawson & Squire, 2006) whose raison d'être is the provision of valuable tools, concepts and theories to support the implementation of SCM into practice. However, despite an increasing number of research into SCM, Fawcett and Mangan found that only few companies are actually engaged in supply chain integration (Fawcett & Magnan, 2002, p. 340). This situation leads to the suggestion that there is a gap between scientific knowledge creation and the transfer of this knowledge into practice.

The reasons for this suspension can be manifold. For example, SCM research might generate theoretical models that are not or only partly applicable in practice or SCM research might pose the wrong questions. In addition, it could be that scientists in SCM have a different understanding of what SCM is than practice (e.g. Dubois, Hulthen & Pedersen, 2004, p. 4; Dubois et al., 2004; Storey et al., 2006, p. 755). Although these are only hypotheses and speculations, it seems that the legitimacy of SCM as a scientific discipline is challenged as long as the research field is not capable of providing practical solutions to managerial problems. If the discipline seeks to meet this challenge a profound understanding of the theoretical substantiation of the field, its evolution over time, the contributions that have been made by scientists from various fields and the tensions underlying SCM is a necessary precondition. As of today, this understanding has not been investigated to its full potential yet as will be described in the following chapter.

1.2 Research Problem and Main Research Question

The term Supply Chain Management was originally proposed by Oliver and Webber to designate a new form of strategic logistics management (Oliver & Webber, 1982). However, the antecedents of SCM are much older and appear to start with physical distribution and transport, based on the theory of Industrial Dynamics (Forrester, 1961). Total cost approaches to logistics and distribution have been identified as another origin of SCM (Chen & Paulraj, 2004b, p. 131). The underlying assumption in both cases is that the optimization of a single

element in a supply chain does not necessarily ensure efficiency and effectiveness of the supply chain as a whole (Croom, Romano & Giannakis, 2000, pp. 67-68).

Since then, researchers from numerous disciplines have incorporated supply chain thinking into their research programmes making it a multi-disciplinary field (e.g. Lancioni, Forman & Smith, 2001a, p. 53) as for example Strategic Management (Bechtel & Jayaram, 1997; Christopher & Ryals, 1999; Ketchen & Giunipero, 2004; Rodrigues, Stank & Lynch, 2004; Tan, Lyman & Wisner, 2002), Purchasing and Supply Management (Cavinato & Kauffmann, 1999; Jahns, 2005; Kaufmann, 2001; Leenders, Nollet & Ellram, 1994; Stuart, 1997), Marketing (Christopher, 2005; Min & Mentzer, 2004; Svensson, 2002a, 2003), Interorganizational Relationship Research (e.g. Golicic & Mentzer, 2005; Skjoett-Larsen, Thernoe & Andersen, 2003; Walter, Lechner & Kellermanns, 2007), Organization Theory (e.g. Kim, 2007) and Operations Management (Khouja, 2003b) - to name a few only.

Yet, the amount of research done to develop and map the theoretical base of SCM has been limited (Burgess, Singh & Koroglu, 2006, p. 703), leading to disintegration and fragmentation of core findings (Croom et al., 2000, p. 68; Cousins et al., 2006, p. 701; Zsidisin, Smith, McNally & Kull, 2007, p. 169). In addition, there is still no common understanding and definition of the term Supply Chain Management, although several corresponding attempts have been made (Burgess et al., 2006, pp. 708-709). Finally, each of the aforementioned disciplines emphasize a certain aspect of the overall SCM concept, leading to a diversity of problems subsumed under the SCM label and to blurred boundaries of the concept (New, 1997, p. 15; Hakansson & Persson, 2004, p. 11; Bretzke, 2005, p. 21).

The objective of this thesis is to address the problem of the insufficient theoretical base of SCM by providing insights into the theoretical substantiation of SCM as a field of research. More precisely, the following main question will be addressed:

> *"How can the processes of knowledge creation in Supply Chain Management be characterized and how did they evolve over time?"*

In other words, the main research question is about the nature of Supply Chain Management research. A number of different factors will have to be considered in order to provide a comprehensive description and characterization of research activity in SCM. For example, insights into the philosophical and theoretical underpinnings of the SCM discipline, the link between science and practice and the evolutionary processes the research field has undergone throughout a specific time period will be required. In addition, an exploration into the tensions that split different groups of researchers will be conducted. Finally, fundamental SCM research questions that have not yet been fully explored will be identified. These descriptions of the major activities in SCM knowledge creation will make it possible to generate maps of SCM research that characterize the theoretical substantiation of the field across different periods of time and as of today.

Within business disciplines, practical relevance is one of the major determinants of scientific success (Freimann, 1994, p. 12). However, an important characteristic of any discipline is its capability to reflect upon the knowledge creation processes shaping its domain (e.g. Harland et al., 2006, pp. 735-736). The objective of this research is not to produce any directly managerially relevant knowledge. Rather, the objective is to contribute to the reflections on the disciplinary status of Supply Chain Management research. As a consequence, the thesis primarily contributes substantial value for scientists in the field of SCM but, in an indirect way, it also assists practitioners involved in SCM. The following benefits can specifically be expected:

1. Mapping the paradigmatic status and its development of a research field provides an overview of the constellation of beliefs, values, and core techniques of a scientific community and is therefore capable of guiding future research in this field (Kuhn, 1996, pp. 1-26; van Gigch & le Moigne, 1989, p. 129).
2. Mapping the theoretical status and the development of Supply Chain Management research will provide an understanding of SCM that diminishes confusion and is capable of highlighting directions for research activities (Giannakis & Croom, 2004, p. 28).
3. From the perspective of the SCM scientific community, a clear understanding of what SCM actually is, contributes to its recognition as an important, substantiated discipline. This can contribute to academic professionalization and identity (Harland et al., 2006, p. 731) and lead to a power increase in scientific policy making and university funding (Baron, 2005, p. 269).
4. A profound understanding of the SCM discipline will make it easier to detect major unresolved research questions that determine future research activity (Näslund, 2002, p. 321) and, in doing so, increases its value contribution to practitioners.
5. From a practitioner view, understanding the different perspectives of SCM can assist in the identification of those concepts that are most suitable for solving their specific problems and requirements.
6. A scientific discipline is not only involved in knowledge generation processes but also in making the knowledge accessible to others by means of teaching and education. Thus, comprehensive maps of science can assist in the development of comprehensive curricula and thus to increase a common understanding of the SCM research contents and processes among SCM professionals which will further support the effective realization of SCM in practice.

In sum, although this thesis is primarily science driven, it implicitly makes an important contribution to practice and education in SCM as well. In the next chapter, the design of the thesis in terms of its structure and chapters will be outlined. In addition, a brief overview of the contents in each of the following chapters will be given.

1.3 Thesis Structure

This chapter serves to introduce the design of thesis and to briefly summarize the contents of each of its chapter. Chapter 1 lays the foundation for the thesis. It identifies the research problem, poses the central research question and describes the core objective of the thesis. Several reasons for the justification of the thesis are proposed.

Chapter 2 is dedicated to the development of a comprehensive understanding of all aspects that need to be considered for the analysis of a discipline and the characterization of its knowledge creation activities. The chapter starts with the definition of several key terms required for the understanding of thesis (chapter 2.1). A brief discussion of the central roots and origins of supply chain thinking is provided which led to the emergence of the term *Supply Chain Management* at the beginning of the 1980s (chapter 2.2.1). Furthermore, previous literature will be discussed in which similar objectives were pursued as in the present thesis. A critical discussion of the contributions that have been made in this area until today will make it easier to precise the main research question posed for this thesis and to clearly differentiate the contribution of this thesis in comparison to existing research (chapter 2.2.2). Providing a structured analysis of the evolution and status of a scientific discipline is a difficult and complex task which is aggravated by the fact that there has only been very limited research into the central components and activities that need to be considered for comprehensive discipline analyses. Thus, chapter 2.3 reviews some of the major works in theory of science and will select one of these that seems to be the most appropriate for the objective of this research. Although there are several works seeking to explore the nature of science, only few of them seek to explain the notion of science over time. Unlike most other authors, Thomas Kuhn seeks to understand the factors and processes that lead to the emergence and disappearance of scientific disciplines. Therefore, his evolutionary perspective on the structure of scientific revolutions was chosen as major frame of reference for the purposes of this thesis (chapter 2.3.1). In addition, this research draws upon the work of van Gigch who used Kuhn's notion of scientific disciplines and poured it into a more structured, hierarchical framework (chapter 2.3.2). In chapter 2.3.3, the perceptions of the two authors Kuhn and Van Gigch are integrated into a comprehensive and systematic framework for the analysis of scientific disciplines. Both the profound understanding of SCM and the specification of the frame of reference make it possible to further decompose and precise the main research question of the thesis. Therefore, chapter 2.4 provides discussions of existing

literature on SCM on the different components and elements of the frame of reference to understand whether there has already been sufficient research performed in one or more of the different sections of the framework and to decompose the major research question into a set of sub-questions.

Chapter 3 constitutes one of the two major chapters of this thesis. In this chapter, the origins and applications of the main methodologies used in the thesis are described (chapter 3.1). Due to the complex nature of the research objective, a multi-method, stepwise approach is used to answer it. This approach combines both qualitative and quantitative data collection and analysis techniques. In essence, three methodologies are applied in an intertwined way: an expert panel, a structured literature review (chapter 3.1.1) and a content analysis (chapter 3.1.2). Taken together, these three data collection techniques are realized in nine different steps that are described in detail in chapter 3.2. First, an expert study is realized to gain qualitative information on one central part of the frame of reference and to precise some sections necessary for the content analysis (chapter 3.2.1). The structured literature review comprises the two steps number two and three, the former yielding in the identification of major research outlets (chapter 3.2.2), the latter specifying the selection of articles (chapter 3.2.3) which are then submitted to content analysis. The content analysis itself comprises the steps 4 to 9. In step 4, the classification unit for the content analysis is specified (chapter 3.2.4). Step 5 serves to identify the classification categories for research activities in SCM (chapter 3.2.5). In step 6, the decision rules and coding schemes are determined (chapter 3.2.6). Step 7 describes the pilot study (chapter 3.2.7) and step 8 the actual data gathering and classification process (chapter 3.2.8). Finally, in step 9 the measures and activities are described that were implemented to ensure reliability and validity (chapter 3.2.9).

Chapter 4 constitutes the second major chapter of this thesis and is entirely dedicated to data analysis and evaluation. In chapter 4.1, the content analysis results are used to discern core periods of research activity in SCM by means of an analysis of the evolution of the overall publication activity in SCM (chapter 4.1.1). The periods are characterized in chapter 4.1.2. The data gained by means of the expert panel, the structured literature review and the content analysis then enable the portrayal the Supply Chain Management knowledge creation processes comprehensively in terms of different characteristics as differentiated by the frame of reference and across different periods of time. This characterization is realized in a stepwise process comprising chapters 4.2 to 4.6. In essence, the philosophical underpinnings of SCM are discussed in terms of ontology and epistemology (chapter 4.2.1), the object of study in Supply Chain Management is differentiated (chapter 4.3) regarding applied SCM definitions (chapter 4.3.1), major SCM constructs (chapter 4.3.2), the level of analysis (chapter 4.3.3) and the objectives pursued with SCM (chapter 4.3.4). Chapter 4.4 serves to differentiate major schools of thought in the SCM field of research. This achieved by means of a cluster analysis that is described in chapter 4.4.1. The description and characterization of

the schools of thought is provided in chapter 4.4.2. The main methodologies used in SCM to generate findings are described (chapter 4.5) in terms of research strategies pursued in the sample articles (chapter 4.5.1) and in terms of research analysis techniques (chapter 4.5.2). In addition, a discussion is provided as to the degree to which practical problems from the 'real world' are considered for theory development in SCM (chapter 4.6). This analysis focuses on two aspects, namely the industrial focus (chapter 4.6.1) and the regional scope (chapter 4.6.2) of empirical analyses. Whereas all these aspects characterize past knowledge generation processes, chapter 4.7 focuses on the identification of current major unresolved research questions (chapters 4.7.1 and 4.7.2) and anomalies (chapter 4.7.3) that provide directions for future research activity in SCM in order to ensure the long-term persistence of the discipline. Chapter 4.8 summarizes the findings in the form of maps of science for the distinct periods of SCM research activity. These maps enable the characterization and differentiation of research activity over time.

Chapter 5 constitutes the last chapter of the thesis. In this section, major findings of the thesis are summarized. Furthermore, major benefits and impacts of the thesis for both research and practice are described. In addition, this chapter provides a critical discussion of the thesis' limitations in terms of research approach, the data collection techniques and the data analysis procedures. The chapter finishes by pointing out potential other areas of future research activity by focusing on those aspects that have not been considered by the thesis.In order to facilitate the understanding of the thesis' structure, figure 1.1 summarizes the chapters and the different steps that need to be realized to answer the main research question guiding this thesis.

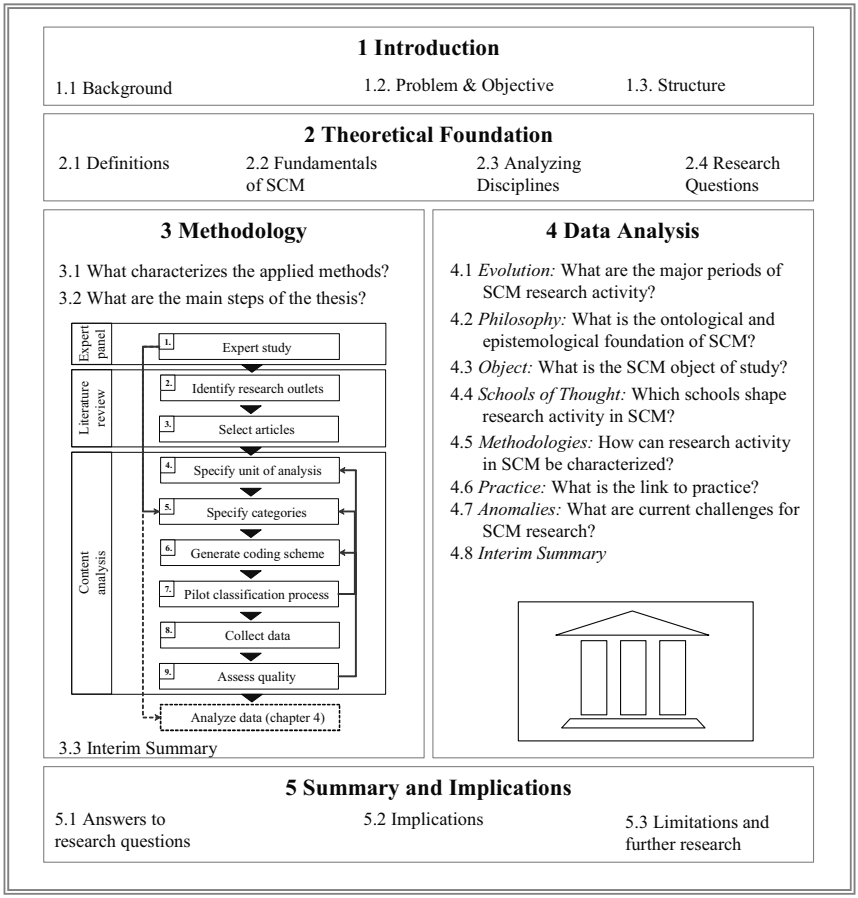


Figure 1.1: Structure of the Thesis

Source: own illustration

2 Theoretical Foundation

This chapter aims to build the theoretical foundation upon which this research is based. It includes the definition of key terms, a brief discussion of the evolution of Supply Chain Management research and an overview of the latest scientific debate in the field. In addition, the frame of reference for the subsequent analysis is developed. This is achieved by presenting, summarizing and systematizing the work of scholars who provide the necessary insights and instruments for the investigation of the knowledge creation processes in fields of science.

2.1 Definitions

In the present thesis, a bridge is built that links cognitive science to the Supply Chain Management discipline by providing insights into the theoretical foundations of SCM. As a consequence, two types of definitions need to be specified in this section. The first set of definitions is used to precise terms related to the theory of cognition. Second, the notion of Supply Chain Management used for this study needs to be defined.

1) Theory of cognition. The most important terms used in this research in relation to cognitive science are *paradigm*, *science*, *theory* and *discipline*. Each of these terms has been discussed controversially in the literature. For example, multiple meanings have been assigned to the term *paradigm* ranging from broad philosophical world views to mere metaphors (e.g. Prasad & Forray, 1993). As a consequence, this section will provide definitions of each of these terms as they will be used in the present thesis.

Regarding the term *paradigm* a major difficulty of this study needs to cope with is the fact that two types of definitions need to be used here. The frame of reference used for this study is primarily based on the work of Thomas Kuhn who concentrated huge parts of his research efforts on the exploration of scientific paradigms. Although Kuhn himself did not define the term unambiguously (e.g. Masterman, 1970), he has a very broad understanding of the term that rather corresponds to the understanding of an entire science as described in the following paragraphs. This understanding of the term *paradigm* according to Thomas Kuhn does not correspond to the understanding of the term that used in the main part of this thesis. As a consequence, a differentiation needs to be made for the use of the term in relation to Thomas Kuhn and for the remainder of the thesis. In chapter 2.2.1, *paradigm* will be defined as *"the constellation of beliefs, values and techniques, etc. shared by the members of a scientific community"* (Kuhn, 1996, p. 175). In contrast, in all other chapters the term *paradigm* will be used as a synonym to philosophy of science to designate a specific combination of ontological and epistemological beliefs shared by a group of scientists.

Still, processes of knowledge generation are not detached from specific forms and standards. Instead, researchers follow specific criteria that are generally accepted and recognized as being scientific (Seiffert, 1992, p. 391). This differentiates the processes of knowledge generation in science from other types of knowledge production. As a consequence, for the purposes of this thesis, *science* will be defined as the processes of knowledge generation by means of acknowledged criteria.

Researchers perform research in their disciplines from their individual ontological and epistemological perspectives and apply recognized criteria in order to generate theory. As a consequence, the last term from the theory of cognition field that needs to be specified in this thesis is *theory*. The label will be used to designate "*any coherent description or explanation of observed or experienced phenomena*" (Gioia & Pitre, 1990, p. 587).

In this research, "*discipline refers to the common focus of a set of researchers*" (Fabian, 2000, p. 351). Thus, what differentiates a discipline from others is the specific object of study that researchers focus their efforts on. Accordingly, scientists might perform research in a discipline from varied paradigms and philosophical assumptions and by using different sets of criteria for knowledge production. Thus, the perception of the notion discipline is broader than that of the other terms and the relations among the different terms are depicted in the subsequent figure 2.1. In sum, Supply Chain Management can be considered as a discipline as there are numerous researchers who focus on SCM as object of study from their specific perspectives and who use specific criteria for knowledge generation to develop theories about specific SCM phenomena.

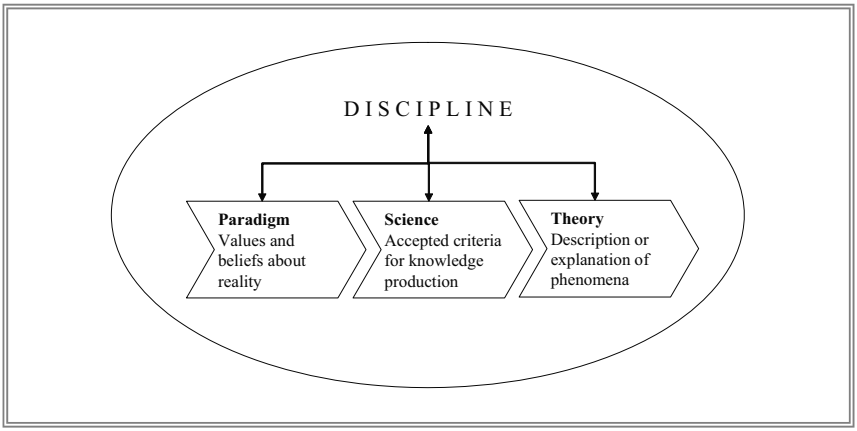


Figure 2.1: Systematization of Terms from Theory of Cognition

Source: own illustration

2) Supply Chain Management. In the following paragraphs, the focus will be on the definition of the term Supply Chain Management in order to differentiate the field of research from other disciplines. In essence, two terms need to be defined here: supply chain and Supply Chain Management.

Mentzer et al. propose that a *supply chain* comprises a set of at least three entities directly involved in the downstream and upstream flows of goods, services, information and finance from a source to the customer (Mentzer et al., 2001, p. 4). These entities can either be individuals, departments or organizations. Thus, it is not necessarily implied that a supply chain crosses organizational boundaries. What links the different elements of the chain are the flows of different objects associated with whole processes associated with the production and delivery of goods and services.

Whereas literature is comparatively clear about the notion of supply chain, the situation is different with regard to the term Supply Chain Management. Until today, there is no single, generally accepted definition of SCM. Rather, there is an ongoing discussion about the elements, activities and objectives that ought to be assigned to SCM. For example, there are definitions that focus on the strategic objective of generation of competitive advantage (e.g Bowersox, Closs & Stank, 1999, p.6), in other definitions it is perceived as a philosophy (e.g. Ellram & Cooper, 1990, p. 2) and again in others the emphasis is laid on the number of organizations involved (e.g. Christopher, 2005, p. 19). Table 2.1 summarizes some of the most frequent definitions of SCM (see also Konrad, 2005, pp. 53-57).

Author	Definition	Focus
Ellram & Cooper, 1990, p. 2	Supply Chain Management… [is] defined more broadly as an integrated philosophy to manage the total flow of a distribution channel from supplier to the ultimate user.	Philospohy Flow perspective
Christopher, 1992, p. 18	Network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer.	Network Flow perspective Value generation
Bowersox et al., 1999, p. 6	Supply Chain Management can be defined as a collaborative-based strategy to link interorganizational business operations to achieve a shared market opportunity. Supply Chain Management… is a… concept concerned with activities to plan, implement and control the efficient and effective sourcing, manufacturing and delivering process for products, services, and related information from the point of material origin to the point of ultimate consumption for the purpose of conforming to end-customer requirements.	Cooperation Strategy Activities

Author	Definition	Focus
Handfield & Nichols, 1999, p. 2	The Supply Chain encompasses all activities associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end user, as well as the associated information flows. Material and information flow both up and down the supply chain. Supply Chain Management is the integration of these activities through improved supply chain relationships, to achieve a sustainable competitive advantage.	Flow perspective Strategy Cooperation
Simchi-Levi, Kaminsky & Simchi-Levi, 2000, p. 1	Supply Chain Management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, to the right time, in order to minimize system-wide costs while satisfying service level requirements.	Cooperation Flow Perspective
Aitken in Christopher, 2005, p. 19	Network of connected and interdependent organizations mutually and co-operatively working together to control, management and improve the flow of materials and information from suppliers to end users.	Network Cooperation Flow perspective
CSCMP, 2007	Supply Chain Management (SCM) encompasses the planning and management of all activities involved in sourcing and procurement, conversion and all Logistic Management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies.	Activities Functions Cooperation

Table 2.1: Definitions of Supply Chain Management

Table 2.1 reveals that there are discrepancies among the definitions in terms of the number and constellations of organizations involved in a supply chain. For example, Ellram and Cooper suggest that the organizations involved range from the suppliers to the users, whereas Aitken and Christopher suggest that whole networks of organizations are involved in SCM. In addition, there are different perceptions as to the activities associated with SCM. For example, the definition from Christopher is rather vague by stating that SCM involves different processes and activities. In contrast, the Council of Supply Chain Management Professionals (CSCMP) clearly designates the core SCM activities. Finally, most definitions do not suggest any objective pursued with SCM whereas others consider it to be an important instrument for the generation of competitive advantage (e.g. Handfield & Nichols, 1999).

Mentzer et al. contribute to the definition debate as they differentiate *Supply Chain Management* from *Supply Chain Orientation*. According to them, Supply Chain Orientation is defined "*as the recognition by an organization of the systemic, strategic implications of the tactical activities involved in managing the various flows in a supply chain*" (Mentzer et al., 2001, p. 11). In contrast, Supply Chain Management is defined as the "*strategic coordination*

of the traditional business functions and the tactics across these business functions within a particular company and across business within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole" (Mentzer et al., 2001, p. 18). These two definitions have the potential to become standard definitions for SCM as they do not restrict SCM to certain functions or activities and consider both organization internal and external processes. Still, Mentzer suggested in 2005 that the process of definition development in SCM has not yet arrived at an end (Gibson, Mentzer & Cook, 2005, p. 23).

This leads to the conclusion that, until today, researchers do not share a common understanding of the term Supply Chain Management. Rather, they seem to subscribe to an implicit understanding of what SCM could be and, as a consequence, the perceptions can largely differ. Therefore, it does not make sense to provide a restrictive definition of SCM in this research: The objective here is to understand the theoretical substantiation of the field in its broad sense and, as a consequence, this needs to include multiple perspectives. In order to capture as many different facets of SCM as possible no artificial boundaries should be generated. Thus, in the scope of this thesis, the term *Supply Chain Management* will be used to describe the nature of international SCM research and to broadly designate all different perceptions of the term as used in international literature and with all alterations over time.

2.2 Fundamentals of Supply Chain Management

In order to develop a more profound understanding of SCM, the followings sections will provide insights into the origins of SCM. The generated knowledge goes beyond the introductory paragraphs and aims at making the reader acquainted with the field.

2.2.1 Origins of Supply Chain Management

The term SCM first appeared in the 1980's to designate a new form of strategic logistics management (Oliver & Webber, 1982). However, the fundamental assumptions upon which SCM rests are significantly older and include the systems approach (Konrad, 2005, p. 32), industrial dynamics, channel research (Cooper, Lambert & Pagh, 1997a, p. 2), and of course, logistics research (Tan, 2001, pp. 43-44). A brief overview of these origins will be provided in the following sections.

Systems Approach and Systems Integration Research. The early 20th century gave rise to the so-called systems thinking, that later evolved into several different forms of systems theories (von Bertalanffy, 1972, p. 410). A system is composed of at least two elements that entertain a relationship with each other and the environment. Each activity of an element can

have an impact upon the overall system and the system's relationship with the environment (Kneer & Nassehi, 1997, pp. 17-25). Transferring the systems notion to an organizational, context implies the recognition that all functions and activities that need to be understood in terms of how they affect, and are affected by other functions and activities of an organization. Thus, in order to ensure an efficient and effective management of the overall organizational system, it is necessary to have a holistic perspective on the elements it is composed of and to understand the relationships among these elements (Lambert, Stock & Ellram, 1998, p. 9). In contrast to the classical perspective of materials and supply management, SCM assumes a systems perspective and views the supply chain as a single entity rather than an agglomeration of independent functions. The emphasis in SCM is laid upon the integration of all these elements (Houlihan, 1987, p. 55).

Industrial Dynamics. Industrial dynamics constitutes one out of many derivatives from the previously described systems approach. The primary concern in industrial dynamics is problem solving in living systems. Living systems are characterized by dynamism and complexity. Again, a system is defined as a set of elements and their interrelationships as well as their relationship with the environment. Industrial dynamics, alternatively known as systems dynamics, is a methodology that enables the investigation of complex, dynamic feedback systems by modelling the dynamic behaviour of its elements and their interactions. *Feedback* in this context implies that one element might affect another and vice versa. These feedback loops need to be taken into consideration for holistic systems modelling (Forrester, 1961, Towill, 1996, p. 23). Jay Forrester pioneered industrial dynamics and included the model of a supply chain as one of the examples of the methodology into his work. The so-called Bullwhip-effect describes a phenomenon that occurs when several actors are involved in the materials flow in production (Forrester, 1961). It is assumed that each actor or level of the chain delays the flow because of uncertainties (e.g. demand uncertainty). 'Bullwhip' denotes oscillations in demand that amplify from those supply chain levels that are closest to the customer rather than those which are most distant (Towill, 2005, pp. 555-556). Industrial dynamics has been used in a SCM context to generate insights into system dynamic behaviour and the underlying causal relationships. The design, robustness and operating effectiveness of supply chains could therefore, be improved leading to increased performance (e.g. Berry, Towill & Wadsley, 1994). During the 1980's, the systems approach to SCM was enlarged by an integration perspective that focused on the managerial integration of key business processes and associated organizations in the supply chain to ensure increased performance (e.g. Houlihan, 1985, p. 27).

Channel Research. Researchers from this stream, in particular marketing channel researchers, conceptualize the central factors that lead to the creation and structuring of channels. Early approaches tried to find answers to questions such as *"who should be a channel member?*, *why is it necessary to coordinate activities along the channel?"* and *"how can channels be*

efficiently and effectively structured?" However, in a Supply Chain Management context, two major shortcomings of the early approaches of Channel Research had been identified. First, the primary focus of channel research was on the customer, without taking into consideration the perspective of the supplier and manufacturer. Thus, the relevance of a holistic SCM channel was neglected. Second, an emphasis was laid on marketing activities and flows across the channel, whereas the need to manage and coordinate processes across the entire chain was largely overlooked (Lambert & Cooper, 2000, p. 68). It has been only recently that authors like Andrew Cox (e.g. Cox, 2001, 2004; Cox, Watson, Lonsdale & Sanderson, 2004) started to fill this gap by addressing questions like the degree of impact one organization in a supply chain can have on associated partners.

Logistics. It has already been claimed that the term SCM was originally used to designate a new form of strategic logistics management (Oliver & Webber, 1982) that focuses on questions related to location and transportation across the entire supply chain within a single organization and across its boundaries (e.g. Rushton, Oxley & Croucher, 2004, p. 9). Physical distribution in a SCM context includes inventory management, warehousing, transportation, distribution, and delivery. Particular challenges logistics faces in a SCM context are first, the global coordination of product and service flows and second, increased expectations in terms of just-in-time delivery or kanban (Tan, 2001, pp. 43-44). Frequently, logistics and Supply Chain Management have been used synonymously (e.g. Gammelgaard & Larson, 2001, Richey, Daugherty, Genchev & Autry, 2004, Svensson, 2002a). However, SCM extends logistics as it also incorporates questions related to the transformation of goods and services (e.g. Cooper, Lambert et al., 1997a).

To summarize, scientific approaches to Supply Chain Management originate in systems theory, the industrial dynamics literature and strategic logistics research. These streams also form the basis of much of logistics research (e.g. Walter, 2003, p. 15) and channel research approaches to organizations. The main conclusion that can be drawn from previous discussions is that the fundamental principle of SCM is to holistically integrate all elements of the supply chain.

2.2.2 The Science of Supply Chain Management

Since the first appearance of the term Supply Chain Management in the early 1980's, the number of research articles in SCM gradually increased. As with many new and growing research fields, there soon appeared conceptual research that sought to improve the cognitive foundation of SCM (e.g. Ellram & Cooper, 1990, New, 1995; New & Payne, 1995, Cooper, Lambert et al., 1997a, Harland, Lamming, Zheng & Johnsen, 2001, Rogers, Lambert, Croxton & Garcìa-Dastugue, 2002, Lejeune & Yakova, 2005). In addition, a debate occurred as to whether SCM could be viewed as a new scientific paradigm (Giannakis & Croom, 2004), or

as an independent managerial discipline (e.g. Cousins et al., 2006; Gammelgaard, 2004; Harland et al., 2006). Such questions address similar topics as the main research question posed in this thesis. Therefore, this chapter provides a critical review of previous research that tried to answer the question whether SCM is a paradigm, a discipline and/or a theory.

Arlbjorn and Halldòrsson (2002) discuss diverse philosophical perspectives on the nature of reality and knowledge creation within logistics with respect to the following three elements: (1) content, i.e. the object of study in logistics; (2) context, i.e. the academic background of researchers in logistics; and (3) processes, i.e. the levels of logistics knowledge creation. This comprehensive framework provides a systematic overview of the components of logistics as a discipline. In addition, it facilitates the identification of future ways for theoretical progression. Despite these evident merits of the framework, its transferability to SCM is limited as logistics is only part of the overall SCM concept, but cannot be considered as representative for the overall body of SCM literature. In addition, the reflections made by Arlbjorn and Halldorsson are not based on any kind of empirical evidence in order to support their assumptions.

Giannakis and Croom (2004) address the question, whether it is possible to identify a potential framework or conceptual paradigm with which to support the development of SCM as a scientific discipline (Giannakis & Croom, 2004, p. 27). Based on a literature review and survey done among academics, the authors identified major streams of research with regard to their pursued objectives. In addition, they discuss how extant theories from management, economics, sociology, and engineering contribute to SCM research. As a result of these efforts, Giannakis and Croom proposed the 3S-model as a conceptual SCM framework. The *synthesis* dimension focuses on decisions relating to the strategic position of a firm within SCM structures. The *synergy* dimension draws primarily on inter-organizational relationships and the *synchronization* dimension is concerned with scheduling, coordination, information management and materials' flow analyses. To summarize, Giannakis and Croom's conceptual framework rests upon two criteria: the research objective in and the theoretical base of SCM. These two aspects are of central importance for any discipline. However, other components that also play an important role are entirely neglected in this conceptual framework. For example, Giannakis and Croom do not provide any insights into the fundamental beliefs and principles that inspire and guide SCM research. In addition, the conceptual framework provides insights into the actual state of SCM research only, whereas the evolution that this body of literature has undergone is not addressed.

Gammelgaard (2004) addresses the philosophical underpinnings of SCM research. She draws on a methodological framework by Arbnor and Bjerke, to categorize existing logistics and SCM research into three categories: analytical, systems and actors approaches (Arbnor & Bjerke, 1997). According to the analytical approach of logistics, there is an objective reality that can be discovered by hypothesis development and testing. From an integrated systems

perspective, such decompositions are meaningless. Researchers of this tradition strive for the overall understanding of systems and related elements in particular situations to provide specific solutions for cases under investigation. Finally, for advocates of the actors approach, reality is not objective but the result of social constructions. Based on this differentiation, Gammelgaard classifies existing approaches of SCM into three schools (analytical school, systems school and actor's school). The Gammelgaard framework can be merited for its analysis of the underlying ontological and epistemological approaches to SCM, whereas previous research on SCM theory mainly relied on methodological reflections (e.g. New & Payne, 1995, p. 60). Accordingly, the analysis can serve as a basis for investigations into the world views of SCM paradigm adherents. Nevertheless, other aspects such as the object of study, the constructs of SCM, and the role and value practice has for SCM are not addressed in her research. Furthermore, Gammelgaard does not provide a discussion of how the three schools evolved over time.

In 2006, the International Journal of Operations & Production dedicated a special issue to the question, whether Supply Chain Management can be considered as an emerging discipline (see guest editorial by Cousins et al., 2006). However, a closer look at this special issue reveals that the editors restrict Supply Chain Management to purchasing and Supply Management, only. For example, the contribution from Harland et al. (2006) is entitled "*Supply management: Is it a discipline?*" Thus, again, the articles in this special issue cannot be considered a representative for SCM as they only deal with a single function out of the overall functions, activities, processes and organizations involved in SCM.

Halldorsson et al. seek to develop SCM as a discipline by using theories from the non-logistics area to explain inter-organizational phenomena. The authors apply three different theories to broaden the understanding of SCM in practice: a socio-economic perspective, an economic perspective and a strategic perspective. In essence, the authors find that no single theory of SCM. Rather, several theories of SCM complement each others and the decision to the manager who needs to select a theory that is appropriate in a specific context (Halldorsson, Kotzab, Mikkola & Skjoett-Larsen, 2007). The theoretical framework provided by the authors is one of the most comprehensive ones that were proposed for SCM so far. Still, several aspects such as for examples the underlying values and principles or core methodologies are not captured in this framework. As a consequence, the framework needs to be considered as limited.

Finally, Ballou recently published an article that traces the evolution of logistics and Supply Chain Management and projects the state of this field - that he explicitly understands as a single one - with the attendant and broadened challenges for those who plan and control supply chain operations (Ballou, 2007). Ballou focuses on the practitioner perspective of SCM in his article. In addition, the observations he describes are primarily based on his own personal experience and are not based on an empirical analysis of past developments within

science and/ or practice. This differentiates the approach taken by Ballou from the comprehensive empirical data collection and assessment approach applied in this thesis.

This literature review leads to the following two conclusions. First, the academic debate on the paradigmatic, disciplinary and theoretical state of SCM research has been limited until today. Other authors suggested that the emergence of a discipline-debate is an important indicator for the development stage for this field of study, as such debate yield for independence and legitimacy of the field (Harland et al., 2006, p. 735; Pilkington & Liston-Heyes, 1999, p. 15). Although some authors touch such questions, the present review reveals that the overall discussion has only just started. Second, the research that addresses questions related to the paradigmatic, disciplinary and theoretical posture of SCM research tends to adopt a narrow perspective and limit these discussions to sub-fields within the overall body of SCM research, such as logistics or purchasing. The literature search performed for this research did not reveal a scientific contribution that comprehensively discusses the evolution of SCM in terms of its underpinning paradigms, its theoretical and scientific base and its link to practice. The limited attention these questions received so far impedes the further development of the SCM discipline. As a consequence, the aim of this thesis is to contribute to closing this gap.

2.3 Perspectives on the Analysis of Scientific Disciplines

The main purpose of this research is to understand and map the evolution of SCM research in order to gain insights into its paradigmatic and theoretical base. In order to address these questions comprehensively, an understanding of the constituent elements of SCM as a science and their progression over time is required. There have been numerous contributions from recognized scientists who dealt with similar questions before. For example, Karl Popper suggested that growth of knowledge, the ultimate goal of any kind of science, can only be achieved by means of falsification. Thus, the task of researchers is to formulate solid hypotheses on reality, submit these to empirical tests, refute falsified hypotheses and refine those ones that are maintained (Popper, 2002). Imre Lakatos differentiates between the hard core and the protection belt of science. According to him, scientific research follows specified rules that inform scholars on which paths to take and which ones to avoid thus protecting the hard core of research (Lakatos, 1970).

Where Karl Popper focuses on actual research activities and Imre Lakatos upon research programmes, Thomas Kuhn offers a broader and evolutionary explanation of the dynamics underlying growth of knowledge, which is of particular importance for this thesis. Thomas Kuhn was concerned with the factors that promote and inhibit the development of so-called scientific paradigms, i.e. the beliefs, values and techniques, etc. shared by the members of a scientific community (Kuhn, 1996, p. 175). Kuhn, therefore, provides explanations to

questions related to the paradigmatic and theoretical developments of a field of study. As a consequence, his work seems to be a suitable basis for the development of a frame of reference for this thesis. In this chapter, a theoretical framework will be proposed that is essentially based on the work of Thomas Kuhn. It is necessary to provide a profound review of Kuhn's core assumptions about the evolution and nature of *paradigm* to be able to understand the core elements this framework is composed of (an earlier version of this framework has been published by Walter & Wolf, 2007, pp. 8-13).

2.3.1 Thomas Kuhn's Characterization of Science

In his well-known book, *The Structure of Scientific Revolutions*, Kuhn suggests that the work of the adherents to a scientific discipline is guided by a set of shared beliefs that might be challenged by anomalies and unresolved questions which can become the source of the development of a new paradigm. This process is referred to as "scientific revolution". As opposed to scientific revolutions, "*normal science is firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice*" (Kuhn, 1996, p. 10). These achievements need to have the potential to attract an enduring group of scientists away from competing modes of scientific inquiry. In addition, they are open-ended and thus leave unresolved problems for the redefined group to settle. Therefore, these achievements can be called a *paradigm*. Accordingly, the paradigm assumes the function of setting the boundaries for the discipline, creating avenues for inquiry, formulating questions and determining the rules to answer them, defining relevant areas, and finally, establishing meaning to scientific research (Kuhn, 1996, pp. 10-22).

The emergence of a paradigm does not imply that it is perfect and entirely successful. Therefore, the task of *normal science* is to increase the knowledge about the areas the paradigm defines as fields of interest. These phases of normal science are characterized by either a negligence or complete ignorance of the anomalies that might occur from the paradigm. This is due to the fact that the paradigm obliges researchers to investigate a certain field of interest, in detail. If the paradigm no longer provides solutions, these anomalies provoke the search for alternatives (Kuhn, 1996, pp. 23-34).

Kuhn uses the metaphor puzzle-solving to describe the mode of scientific research within the scope of a paradigm. As with puzzle-solving, the solution is known in advance and the aim is to discover what is already known. The solution of a research question (the puzzle), however, needs to be in accordance with the rules set by the paradigm. Accordingly, the puzzle-solving analogy relates to the existence of a strong network of conceptual, theoretical, instrumental and methodological commitments setting the rules for specific world views and problem solving techniques (Kuhn, 1996pp. 35-42).

The determination of shared paradigms does not imply the determination of shared rules since scientists can disagree about the interpretation of a paradigm. These differences in interpretation are called “schools of thought” which learn differently and apply varying methodologies and instruments to their research findings (Kuhn, 1996, pp. 43-51).

Kuhn continues to examine the reasons that induce a paradigm shift. According to him, an anomaly is defined as a new or unexpected phenomenon which contradicts the anticipated results predicted by a paradigm and which cannot be solved by means of the rules established by it. The discovery of an anomaly leads to the development of a new paradigm if the old one is unable to explain and solve the anomaly. The more precise a paradigm gets, the clearer anomalies become that might otherwise have been overseen or neglected (Kuhn, 1996, pp. 52-65). Kuhn then continues to describe the structure and process of scientific revolutions which is of minor importance for this thesis, since we aim to concentrate on the elements a paradigm is composed of. The period of the ideal process from the emergence of a new paradigm to the occurrence of a scientific revolution, is illustrated in figure 2.1.

The curves in figure 2.2 describe research activity in a specific scientific field that increases as long as the paradigm is successful. In the case that an anomaly occurs that cannot be solved by the paradigm, it is replaced by another one (emergence of another curve depicted in grey in the figure). Otherwise, the curve on the middle of the figure would rise again after a short period of crisis. The latter option is not depicted in the figure.

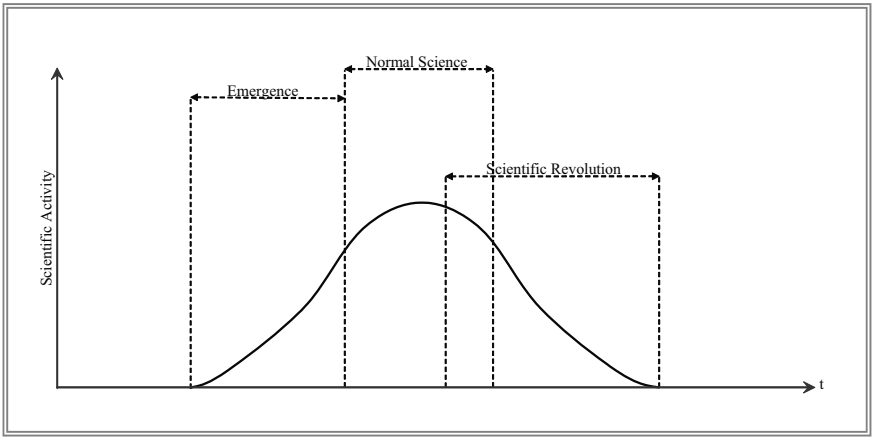


Figure 2.2: Evolution of Science According to Thomas Kuhn

Source: own illustration

In conclusion, a scientific paradigm in the sense of Thomas Kuhn is characterized by the existence of the following elements:

- ⇨ set of *shared beliefs and values*;
- ⇨ definition of relevant areas, i.e. the identification of an *object of study*;
- ⇨ specified *methodologies* and instruments for scientific discovery;
- ⇨ *schools of thought* that investigate certain parts of the problem area;
- ⇨ *anomalies* that the researchers within the paradigm must not necessarily be aware of or, if they are, are not considered fundamental enough to provoke a scientific revolution.

As Kuhn concentrates on the identification of the processes that lead to scientific revolutions, he does not provide any details about the structure, relations and hierarchy of these elements, i.e. instead they are side by side and unconnected. Therefore, another framework will be presented in the next chapter that will make it possible to systematize Kuhn's notion of science.

2.3.2 Van Gigch's Levels of Inquiring Systems

In this chapter, the characteristics of science according to Thomas Kuhn shall be further refined, completed, structured and classified. Other authors who are concerned with the components of a scientific discipline, typically structured these along three dimensions (e.g. Arbnor & Bjerke, 1997; van Gigch, 1989, 2002a, 2002b, 2003; van Gigch & le Moigne, 1989; van Gigch & Pipino, 1986). Among these, the differentiation proposed by van Gigch et al. is probably the most comprehensive one.

Van Gigch distinguishes three levels of scientific inquiry. The inquiring system at the *intervention level* is concerned with the formulation and solution of the organizational management problem, i.e. with the implementation, use and operation of the solutions provided by higher levels of inquiry in practice. Inputs at this level of inquiry come from the two higher levels. The inquiring system at the *science level* is devoted to the formulation and solution of the modelling problem, i.e. where researchers investigate certain problems by means of a set of predefined rules, instruments and methodologies. This level receives inputs both from the lower intervention level, for example problems occurring at this level that require a solution, and from the higher epistemological level, namely the paradigms that guide the work at the science level. Finally, the inquiring system at the *epistemological level* serves to formulate and to solve the metamodelling problem of a discipline. This level is characterized and influenced by the assumptions and world views of its actors and provides paradigms that guide the work at the two lower levels (van Gigch & le Moigne, 1989, p. 129;

van Gigch, 2003, pp. 499-500). Figure 2.2 displays the three layers, the activities taking place at each level and the existing links between them.

The different levels of inquiring systems provide a helpful instrument to structure the elements of science as proposed by Thomas Kuhn, as most of the elements of normal science proposed by Kuhn can be classified into a similar three level structure. In addition, van Gigch enlarges the characteristics of science by adding the perspective practice and associated questions as to how practice inspires research and vice versa. Figure 2.2 illustrates clearly that the set of shared beliefs proposed by Kuhn are positioned at the upper epistemological level, whereas methodologies are positioned at the level of scientific practice. However, other characteristics of science such as the object of study, the schools of thought and potential anomalies are not captured by the levels of inquiring systems from van Gigch.

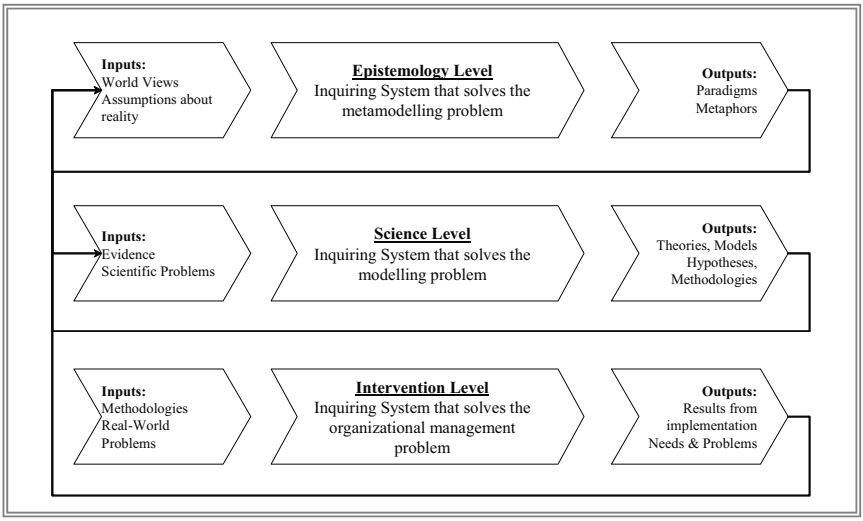


Figure 2.3: Van Gigch's Three Levels of Inquiring Systems

Source: adapted from Van Gigch & Le Moigne (1986), p. 130

For these reasons, a frame of reference will be proposed for this thesis that integrates the components of science as proposed by Thomas Kuhn and is completed by the practitioner level and structured along the three levels as proposed by van Gigch. This frame of reference will be presented and explained in the following chapter.

2.3.3 Frame of Reference

In this chapter the final frame of reference for the analysis of the paradigmatic and theoretical foundation of the Supply Chain Management discipline will be presented and explained. This

frame includes the core characteristics of science from Thomas Kuhn as described in chapter 2.2.1, adds some characteristics that were neglected by Kuhn and structures them into a hierarchical framework as proposed by van Gigch (see chapter 2.2.2). The frame of reference is depicted in figure 2.3.

According to this framework, an analysis of *science* needs to consider four elements: the philosophy of science level, the scientific practice level, the level of operational practice and potential anomalies and unresolved research questions that can occur at each of the other three levels. The components of the temple will be defined and explained in detail in the following paragraphs.

First, **Philosophy of Science** deals with the fundamental beliefs or worldviews of researchers. Such worldviews define for their holders the nature of reality, the role of the individual within this reality, and the type of relations the world has to its constituent parts. Philosophy of Science sets both the ontological and epistemological outlines of a paradigm.

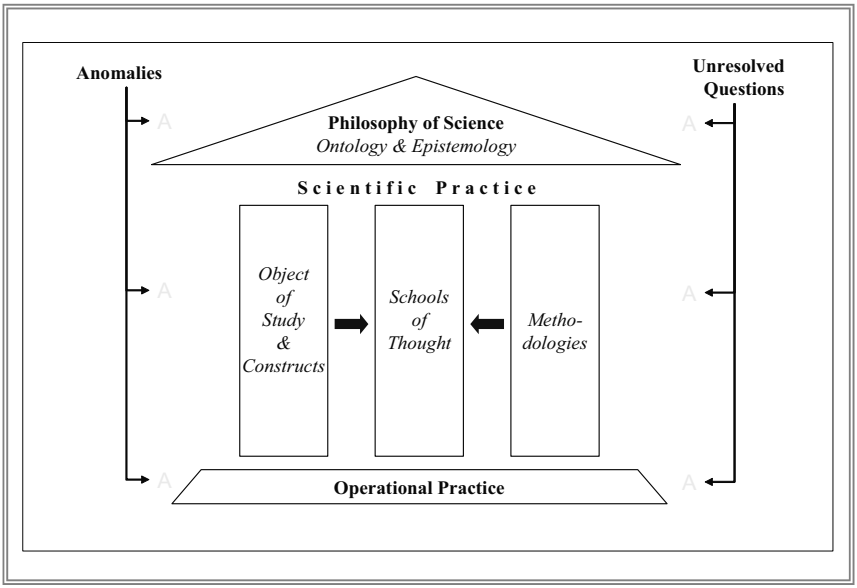


Figure 2.4: Frame of Reference

Source: own illustration

Ontology mainly deals with the basic assumptions about the nature of reality and questions like what is there that can be known about this reality. For example, if a scientist assumes that the world is 'real' this assumption implies the questions to be answered are "*How is reality shaped?*" and "*How does reality work?*" From this ontological position only those questions are admitted that relate to matters of real existence and real action, whereas other questions,

such as those relating to ethics, moral and individual learning, fall outside the realm of legitimate scientific inquiry (Guba & Lincoln, 1998, p. 108; Winter, 1999, pp. 20-21).

Epistemology is concerned with the difference between subject and object by dealing with the modes of knowing. Thus, the emphasis is to understand the relationship between the knower and what there is to know. In the previously mentioned case of an assumed real reality, the posture of the knower must be one of objective detachment from the reality under investigation in order to analyse how reality is shaped and how it works (Guba & Lincoln, 1998, p. 108; Winter, 1999, pp. 20-21).

From the perspective of several authors (e.g. Guba & Lincoln, 1998; Näslund, 2002), ontology, epistemology and methodology together, form the core components of a scientific paradigm. Methodology will be a component of the level of scientific practice for the proposed framework. Therefore, in this research a paradigm will only be defined in terms of ontology and epistemology and will not include methodology.

Since the ontological and epistemological positions of scientists vary, there have been attempts to identify, differentiate, and structure different types of scientific paradigms. One of the most frequently cited differentiation probably stems from Burrell and Morgan, who structure scientific paradigms along two dimensions. The first dimension differentiates subjective, individualistic theories and objective, structural theories. The second dimension opposes theories that emphasize regulation and stability versus those that advocate radical change. This leads to a differentiation of four different paradigms: functionalist, interpretive, radical humanist and radical structuralist (Burrell & Morgan, 1979, pp. 21-37).

Although the differentiation along the subjective-objective dimension seems to be a clear indicator of the ontological and epistemological position of a scientist, the differentiation in terms of the will to change does not have such a clear relation to ontology and epistemology. Instead, it seems to be an imperative of what should be done with the findings of research once they have been produced. The perspective assumed in the present research is that the classification proposed by Burrell and Morgan is not sufficiently appropriate to highlight paradigmatic differences. Instead, the differentiation proposed by Guba and Lincoln (1998, 2005) seem to be less contestable, as the distinction proposed by these two authors is purely based on ontological and epistemological reflections. Their classification will therefore, be used as a basis for the philosophy of the science level. Guba and Lincoln distinguish five different paradigms: positivism, postpositivism, critical theory, constructivism and participatory (Guba & Lincoln, 1998, pp. 109-111; Guba & Lincoln, 2005, pp. 195-196). In the following, the term paradigm will be used to designate these five different forms of ontological and epistemological perspectives in reality. The meaning and contents of these will be explained in detail in chapter 3.2.5.

Second, at the stratum of **Scientific Practice**, three important factors emerge. The first factor is the *object of study* including the main *constructs* it is composed of (van Gigch & Pipino, 1986, p. 76; van Gigch & le Moigne, 1989, pp. 136-137). As Kuhn noted, two factors need to come together for a new discipline to arise: (1) the emergence of problems, phenomena and unresolved questions within practice, and (2) a sufficient number of scientists who think that these problems, phenomena and unresolved questions require a distinct approach to scientific inquiry (Kuhn, 1976, 1996). Accordingly, the object of study is a core element for the justification of a discipline as it differentiates one discipline from others (Khazanchi & Munkvold, 2000, p. 30). The distinct object of study is composed of a set of phenomena (Hunt, 1991, pp. 17-18), the so-called constructs that serve to define the conceptual nature of a discipline by specifying its content domain (e.g. Ho, Au & Newton, 2002, p. 4417). In addition, a discipline can only gain legitimacy and acceptance if it delivers value-added contributions (e.g. Whetten, 1989, p. 490). Therefore, the objectives pursued by scholars in a field provide additional information on a discipline's object of study.

The second factor is the so-called *schools of thought*. Unfortunately, Thomas Kuhn remains rather vague about what he defines as a school of thought and merely states that members of a school of thought interpret a paradigm differently (Kuhn, 1996, pp. 45-46). Van Gigch perceived them as scientific disciplines (e.g. van Gigch & le Moigne, 1989, p. 137), and Gammelgaard used the notion to refer to certain research values (e.g. Gammelgaard, 2004, p. 480). Again others describe a school of thought as a combination of topical focus and used methodologies (e.g. Seuring & Müller, 2007, p. 704). McKinley, Mone and Moon provide a definition of research schools that stems from organization research, that is parallel to Mintzberg's use of the term in his analysis of strategic management (Mintzberg, 1990). According to the authors, a school of thought is defined as "*an integrated theoretical framework that provides a distinct viewpoint on organizations and that is associated with an active stream of empirical research*" (McKinley, Mone & Moon, 1999, p. 635). Despite the precision of this definition, its transferability to SCM is limited for two reasons. First, as discussed earlier, SCM is still in an early state of development. As a consequence, the number of thereotical frameworks that have been developed until today is limited and the existing ones have not been discussed extensively within literature, to enable to identify the schools of thought based on these theoretical frameworks. Instead, scientists focus on specific topical areas occurring along a supply chain. Second, McKinley et al. restrict research activity in a school to empirical reseach. According to the author of this thesis, this definition constitutes an unnecessary restriction to the identification of schools in a field as it automatically excludes other types of research that are not empirical in nature. An interesting component of the McKinley at al. definition is the notion of the *distinct viewpoint on organizations*. In fact, SCM can be considered as a particular viewpoint on organizations, as scientists in SCM seek to break open traditional thinking on disintergrated entities but try to analyze and understand the effect of integration of entities upon overall performance. Therefore, in the scope of this

thesis, a *school of thought* will be defined as the different topics scientists in SCM focus on and the specific research methodologies they apply in order to generate insights from and for their particular view on supply chains. Thus, this part of the second column of the framework is directly related to the other two, as the first column povides insights into the topical areas of SCM and the third into the methodologies.

The third factor comprises the *methodologies* applied for scientific investigations at the scientific practice level. Investigations into the methodologies and instrumentality of a discipline shed light on its main activities (van Gigch & le Moigne, 1989, p. 132; van Gigch & Pipino, 1986, pp. 72-73). Methodologies are therefore, the instruments through which research objectives are achieved (Wass & Wells, 1994, p. 4). In the following, the terms *methodology* and *method* will be used interchangeably. Typically, as a new discipline emerges, the number of papers that generate knowledge based on empirical (quantitative or qualitative) is less frequent as compared to the number of conceptual papers that try to provide theoretical frameworks of the field. As a discipline becomes more established, the number of empirical papers increases and the sophistication of methodological design advances (Harland et al., 2006, pp. 734-735). Thus, understanding the methodological developments of SCM provides insights into its status as a scientific discipline, its core activities and potential future trends.

Third, the level of **Operational Practice** is dedicated to the formulation of methodologies and applications of the findings of the superior levels into practice, i.e. it is dedicated to the scientific activity of the scientific practice level (van Gigch & le Moigne, 1989, p. 129). Although this level is not in the focus of Kuhn's analysis, it can be an important source of anomalies and unresolved questions, delivering input to operational practice, scientific practice and philosophy of science (as illustrated by the arrows between the layers of the temple). In addition, the practitioner level constitutes the main field of observation and data acquisition. Therefore, this level which corresponds to van Gigch's and Le Moigne's intervention level should be incorporated in our framework.

Fourth, **Anomalies** and **Unresolved Questions** can occur at every level of the temple. Anomalies can form the basis of scientific revolutions as they indicate that the dominant paradigm is no longer capable of providing valid answers to all relevant questions in its field. If researchers in the dominant paradigm are not able to find solutions to these anomalies without altering one of the core components of philosophy of science or of scientific practice, the dominant paradigm will be challenged by a new paradigm and, in case one is more successful, will be replaced by this new paradigm. This process represents what Kuhn labelled a scientific revolution.

The existence and identification of anomalies and unresolved questions are not a necessary precondition for a paradigm, due to the possibility of neglect. However, the awareness of such anomalies by researchers can be another indicator of the phase a discipline is in - namely the beginning of the decline - or of the activities researchers within the discipline are currently

engaged in, i.e. the trial to further refine the paradigm and to find a solution for these anomalies and unresolved questions.

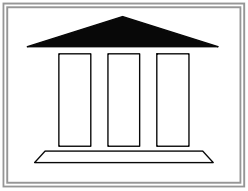
2.4 Deduction of Research Questions

In chapter 2.2.2, state-of-the-art literature on the overall perception of Supply Chain Management as a paradigm and independent scientific discipline was reviewed. The main conclusions were that discussions on the status of SCM as a scientific discipline and paradigm are scarce and, if they occurred at all, were limited to specific sub-fields of SCM. As a result, it seems to be necessary to analyze and understand the actual paradigmatic and theoretical status of SCM and to track its evolution over time in order to understand the theoretical substantiation of the discipline.

Where chapter 2.2 provided a comprehensive justification for the research objective pursued in this thesis, the previous chapter 2.3 set out the main directions of impact that need to be considered to attain the overall objective of the thesis. The proposed frame of reference is composed of numerous elements ranging from questions related to the philosophy of science, to questions related to operational practice. Overall, there has been previous research on parts of these elements that have not been covered in the overall literature review provided in chapter 2.2.2 as this literature review was dedicated to the exploration of the science of Supply Chain Management in the broader sense.

As a consequence, the objective of this chapter is to critically review literature that provided insights into questions related to the philosophy of science in Supply Chain Management, to the scientific practice in SCM and to operational practice in SCM. The detailed understanding of state-of-the-art literature in these sub-fields will make it possible to refine the main research question of this thesis and to derive detailed research questions for each part of the frame of reference.

2.4.1 Philosophy of Science



In the following paragraphs, the reviews that are dedicated to an analysis of the paradigmatic stance of SCM will be reviewed critically. Table 2.1 provides a summarized overview of the relevant scientific contributions that need to be considered here. Based on this review, it will be possible to formulate precise research questions concerning the philosophy of science of Supply Chain Management.

This review focuses on research that used a structured empirical literature review as main methodology. Therefore, the rows of the table compare the contributions in terms of the journals and research outlets where the reviewed articles were published in, in terms of the range of publication years covered in the reviews, and in terms of the main results produced. The names of the journals are abbreviated. Full names are depicted in the list of abbreviations.

Reference	Analyzed Publications	Years covered (Sample Size)	Research Focus
Samuel, 1997	IJLM, IJPMM, EJPSM	Not Available (33)	Exploration of dominating paradigms in United States and Europe
Halldórsson & Arlbjorn, 2005	IJLM, IJPDLM, JBL	1997-2004 (71)	Analysis of references to the literature on philosophy of science
Burgess et al., 2006	No restriction	No restriction - July 2003 (100)	Exploration of dominating paradigms in international publications

Table 2.2: Reviews on Scientific Paradigms in Supply Chain Management Research

Samuel compared dominating research paradigms and methods in the United States and Europe. She found that among 19 US contributions, 17 are inspired by positivist approaches. Among the 16 European contributions, 9 used naturalist approaches to the exploration of reality. With a total of 33 articles, the sample of Samuel's work is restricted. In addition, she focuses less on logistics and Supply Chain Management Journals, but rather on journals that are oriented towards purchasing and supply management. Finally, her work is already ten years old and does not capture current trends in the paradigmatic stance of SCM (Samuel 1997 based on Näslund, 2002, pp. 322-323).

Halldórson and Arlbjorn (2005) did not attempt to classify articles according to their scientific philosophical underpinning but, instead, investigated whether references to literature on philosophy science were included. This was the case for four of the sample articles. However, authors who publish articles in international scientific journals only rarely have the tendency to explain their philosophical position. A reason for this might be that the journals in which these articles are published predetermine the type of articles published. Due to rigorous predefined review processes within scientific journals, it is ensured that published articles mirror common standards and values. As such, editors, reviewers and committees function as some sort of "gatekeepers", who control the output of a scientific discipline by deciding which papers are worth publishing and which not (Benbasat & Weber, 1996; Beyer, Chanove & Vox, 1995). Therefore, authors probably do not feel the need to state the philosophical position which their work is based on as this might implicitly depend on the philosophy of the journal that an article is published in. In addition, authors might think that the type of research they perform is linked to a certain philosophy and, as a consequence, might not deem it

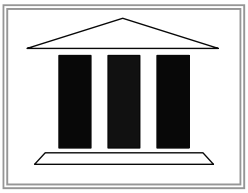
necessary to explicitly refer to the respective philosophy. For these reasons, the research strategy applied by Arlbjorn and Halldórsson does not seem to yield comprehensive results.

Burgess, Singh and Koroglu (2006) use the database ABI Inform to identify journals that deal with SCM and randomly selected 100 articles out of the results. An investigation of these lead to the result, that logistics and SCM research are dominated by the functionalist paradigm. Despite the fact that the review methodology applied by Burgess, Singh and Koroglu is not based on a systematic review strategy, their classification of articles is based on the paradigms proposed by Burrell and Morgan and not the classification structure that was considered as relevant for this research.

To the author's knowledge, there are no other scientific works that try to understand the philosophical underpinning of SCM and only one reference was found that addressed the philosophical underpinning of one of its sub-domains, namely logistics (Arlbjorn & Halldórsson, 2002a). From this, it seems to be clear that there are no recent, comprehensive analyses of the developments of scientific paradigms as identified by Guba and Lincoln. In particular, no research could be found that assessed the evolution of scientific paradigms in SCM, since there were first calls to move SCM beyond its positivistic paradigm (e.g. Mears-Young & Jackson, 1997, p. 605; Stock, 1997, p. 515; Näslund, 2002, p. 321). Regarding this gap in state-of-the-art literature on the philosophy of science of SCM, the following research question is deducted:

Research Question 1: *What are dominant research paradigms in Supply Chain Management and how did these evolve over time?*

2.4.2 Scientific Practice



In the following paragraphs, existing literature that investigates previous research on the object of study and the research methodologies applied in SCM research will be reviewed. In addition, those studies will be reviewed that differentiate schools of thought in SCM. To the author's knowledge, there have been only two contributions so far that identify different schools of thought in SCM, whereas there have been several articles and research papers investigating methodologies and the object of study. Within the logistics field of SCM, there have been several reviews on the methodologies and topic areas covered in doctoral dissertations (Gubi, Arlbjorn & Johansen, 2003; Stock, 2001; Stock & Broadus, 2006). As argued previously, doctoral dissertations are a very specific part of research on a discipline and do not necessarily mirror the general research activities in a field (Gunasekaran & Ngai, 2005, p. 428). Therefore, doctoral dissertations are not considered in the following review. Table 2.2 summarizes all pieces of research that ought to be reviewed in this section in order to draw a comprehensive

picture of the current state of research in SCM in terms of its object of study (O), its central schools of thought (S) and the main methodologies (M). The rows of the table compare the contributions in terms of the journals and research outlets where the reviewed articles were published in, in terms of the range of publication years covered in the reviews, and in terms of the main objectives pursued. The names of the journals are abbreviated. Full names are depicted in the list of abbreviations.

Reference	Part	Analyzed Publications	Years covered (Sample Size)	Research Focus
Dunn, Seaker & Waller, 1994	M	N/A	1986-1990 (N/A)	Analysis of types of research
Mentzer & Kahn, 1995	M	JBL	1978-1993 (N/A)	Analysis of research design and level of analysis
Scudder & Hill, 1998	M	13 journals from OM field	1986-1995 (477)	Analysis of operations management research in terms of types of research and data analysis techniques
Gammelgaard, 2004	S	IJPDLM, IJLM, JOM, IJOPM, JBL	1998-2003 (N/A)	Analysis of schools of thought in terms of scientific foundation
Frankel, Naslund & Bolumole, 2005	M	JBL	1999-2004 (108)	Analysis of research approaches and strategies
Sachan & Datta, 2005	M, O	IJPDLM, JBL, SCMIJ	1999-2003 (442)	Analysis of types of research, methodologies applied, and types of data analysis techniques
Kovàcs & Spens, 2005	M	IJLM, IJPDLM, JBL	1998-2002 (N/A)	Analysis of types of research approaches
Halldórsson & Arlbjorn, 2005	M, O	IJLM, IJPDLM, JBL	1997-2004 (71)	Analysis of references to the literature on philosophy of science
Reichhart & Holweg, 2006	M, S	JOM, IJPOM, MS, IJPR, JBL, IJPDLM	2004 (89)	Analysis of methodologies applied in different subfields of SCM
Spens & Kovacs, 2006	M	IJLM, IJPDLM, JBL	1998-2002 (378)	Analysis of types of research approaches
Burgess et al., 2006	M, O	No restriction	No restriction - July 2003 (100)	Analysis of object of study and methods applied
Storey et al., 2006	O	N/A	N/A	Investigation into core building blocks of SCM research
Seuring & Müller, 2007	S	N/A	N/A	Analysis of German theses dedicated to supply chain integration research

Table 2.3: Reviews on Scientific Practice in Supply Chain Management Research

Mentzer and Kahn (1995) analyze the status of logistics research. As their analysis covers articles from the period 1978-1993, they cannot provide insights into actual trends and developments. The same applies to the research performed by Dunn, Seaker and Waller (1994) who conducted their research more than ten years ago. Therefore, the results of these works are outdated and are transferable to SCM to a limited extent, only.

The most comprehensive review in terms of the amount of journals, articles and time horizon covered has been provided by Scudder and Hill (1998). They classify articles in terms of the research method and data analysis technique. The study focuses on Operations Management which is an important discipline that contributes to SCM. However, from the perspective assumed in this thesis, Operations Management is one of the sub-fields of SCM (see chapter 3.2.5). Thus, a review focussing purely on Operations Management is unable to provide a comprehensive picture of SCM.

The identification of the schools of thought in logistics proposed by Gammelgaard has already been reviewed in chapter 2.1.2 and will not be repeated here. Criticism that was brought forward regarding her work was primarily that is focused on logistics and that the type of differentiation into different schools of thought is a state-of-the-art description, only, and foes not consider the evolution the schools have experienced over time.

Frankel, Näslund and Bolumole (2005) analyze publications in the Journal of Business Logistics in order to understand how logisticians view the use of research strategies and methods. The authors specifically concentrate on logistics and one single journal in this field, but do not consider the broader scope of research in SCM.

The study realized by Sachan and Datta (2005) is much more comprehensive in terms of journals covered. The authors provide answers to a number of questions related to research strategies, methodologies and data analysis techniques. In addition, the authors examine articles in terms of the scope of supply chains covered and thus, provide some insights into the object of study of SCM. However, the authors primarily examine state-of-the-art literature in logistics rather than of the multidisciplinary field of Supply Chain Management. In addition, the literature review performed by Sachan and Datta covers four years only and is therefore, not capable of identifying long-term trends in the evolution of SCM research.

The objective of the study performed by Reichhart and Holweg (2006) was to understand the relationship between conceptual and empirical research and certain subfields of SCM research. What differentiates their study from most of the others in this review is that the two authors did not restrict their investigation to a limited number of target journals but, instead, selected articles from six journals in order to reduce bias towards particular methodologies. The disadvantage of this decision was that the time horizon covered in the analysis had to be reduced from ten years to one due to the huge amount of articles published in all these

journals. Therefore, this study has only limited potential to provide insights into the historical developments of SCM research.

In the two contributions from Spens and Kovács (2005, 2006), the authors assess the use of three different research approaches to logistics research, namely: inductive, deductive and abductive reasoning. Although this research has been unique in logistics until today, it does not systematically analyze the application of different methodologies nor does it go beyond a mere logistics focus to integrate more general SCM aspects.

Halldórsson and Arlbjorn (2005) analyze publications on SCM in terms of the purpose (to describe, to explore etc.) and research design (research strategy and data analysis technique) applied. In addition, the authors differentiate articles in terms of the supply chain level of analysis and therefore contribute insights into the object of study in SCM research. Yet, the authors do not take into consideration the long-term developments and focus primarily upon logistics research instead of SCM in a broader sense.

Burgess, Singh and Koroglu (2006) review articles in terms of the research strategy applied and the supply chain level of analysis. Again, the authors do not take into account any long-term developments but contend themselves by summarizing past achievements.

Storey, Emberson, Godsell and Harrisson (2006) study six supply chains encompassing 72 countries in Europe in order to identify the core conceptual building blocks of SCM. However, a closer investigation of their contribution reveals that the authors actually mean supply management instead of SCM as their analysis is restricted to this specific sub area of the overall SCM field of study.

Seuring and Müller (2007) identify the schools of thought in SCM by tracing major historical lines of development. Their study is restricted to an investigation of German PhD and habilitation theses and does not take into account international publications.

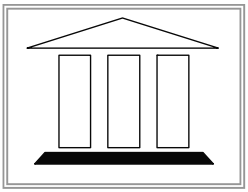
This review illustrates that there is evidently a gap in research on the theoretical development of SCM as a field of study in terms of the investigated object of study, the main underlying schools of thought and the methodologies applied. The majority of earlier research concentrates on specific sub-fields of SCM and provides snapshots instead of long-term investigations. However, if SCM is to mature as a discipline, further progress needs to be made in these fields (Storey et al., 2006, p. 755; Croom et al., 2000, pp. 67-68; Tranfield & Starkey, 1998, pp. 342-344). This leads to the formulation of the following research questions:

Research Question 2: *What is the object of study of Supply Chain Management research and how did it evolve over time?*

Research Question 3: *What are the main schools of thought underlying the SCM discipline and how did these evolve over time?*

Research Question 4: *What are the central methodologies used to gain insights into SCM and how did the use of these methodologies evolve over time?*

2.4.3 Operational Practice



Van Gigch defines the Operational Practice level as the one that applies and implements the models that are formulated at the higher level of Scientific Practice (e.g. van Gigch, 1989, p. 270). However, all analyses that van Gigch performed never took into consideration operational practice (e.g. van Gigch, 2002a, 2002b, 2003; van Gigch & Pipino, 1986). Instead, he focused on investigations of the two superior levels, and contended himself with stating that Operational Practice exists. Therefore, it is rather difficult to discern the core components Operational Practice is composed of. Still, from the perspective of the author, it might be worth understanding to which degree research in SCM considers practice.

In this sense, insights gained from existing literature might be threefold. First, it might be interesting to understand how far research on SCM remains purely theoretical, i.e. conceptual, as compared to the share of research that tries to obtain field data. Conceptual research is purely based on theoretical reflections without necessarily considering the transferability of these reflections into practice. For example, there has been a lot of conceptual research in SCM that focuses on interorganizational process integration, among supply chain partners (e.g. Bolumole, Knemeyer & Lambert, 2003; Cooper, Lambert et al., 1997a; Croxton, 2003; Croxton, García-Dastugue, Lambert & Rogers, 2001; Rogers, Lambert, Croxton & García-Dastugue, 2002; Rogers, Lambert & Knemeyer, 2004). This implies that partner organizations in a supply chain abandon part of their autonomous decision rights for the benefit of the overall supply chain (e.g. Cooper & Ellram, 1993b, p. 13; Bechtel & Jayaram, 1997, p. 21). Yet, there have been doubts whether such assumptions are realistic, particularly as it is frequently unclear whether integration leads to improved results and how these benefits are shared among supply chain partners (e.g. Bretzke, 2005, pp. 23-28).

Second, for all research that uses empirical data to generate knowledge on SCM, it might be of interest to understand which industries have been considered in these. Traditionally, SCM research tends to focus on a limited number of industries, where manufacturing and logistics are probably among the most frequently analyzed (e.g. Ellram, Tate & Billington, 2004, p. 18; Cook, DeBree & Feroleto, 2002, p. 14). However, SCM practices might not only be relevant for these industries and should take into consideration other industrial sectors as well. Thus, it might be interesting to understand whether and to what extent other industries are considered

in empirical data collection. This might generate some preliminary insights into the transferability of SCM concepts, frameworks and models to other industry sectors.

Third, there is an increasing awareness of the relevance of global supply chain integration (e.g. Albino, Izzo & Kühtz, 2002; Barry, 2004; Delfmann & Albers, 2005; Mentzer, Stank & Myers, 2007a, 2007b; Rodrigue, 2006; Williams, Maull & Ellis, 2002). This implies that empirical research on SCM should consider global supply chains rather than narrow the analysis to national contexts. Otherwise, there is a risk that solutions to practical problems have limited capacity to be transferred to other international and intercultural contexts (Whetten, 1989, p. 492). As a consequence, this section of the thesis will explore the link of SCM science in terms of the degree to which research is based on data gained from practice in relation to the industries and the degree that international supply chain contexts are considered. The most important studies on the status of research on SCM have already been identified and critically reviewed in the previous chapters. Among these, Halldórsson and Arlbjorn (2005) and Burgess, Signh and Koroglu (2006) take into consideration the industries reviewed articles focus on for empirical data collection.

Halldórsson and Arlbjorn classify articles in terms of the primary actor of analysis and mean the company type of the focal firm. As such, the focal company might be the manufacturer, carrier, wholesaler, retailer or warehouse. The pre-selection of these company types illustrates that, again, the focus here has been on logistics. Other industries, such as public administration or agriculture that may play an important role in SCM are not taken into account. Burgess, Singh and Koroglu classify articles according to the industry sector in which they were primarily based. Their findings suggest that the SCM concepts are mostly illustrated by or based on an example from the manufacturing and retail trade whereas any other industry sector might be considered in single articles but evidently do not play an important role.

To the author's knowledge, there has not yet been any review that tried to fully understand the geographic scope of SCM research. Due to the review in this section and in the previous chapters, it seems to be apparent that there have not been any comprehensive, long-term literature reviews yet, that try to understand the industrial focus and geographical scope SCM research is focused on. Therefore, the following research questions are proposed:

Research Question 5: *Which industry sectors are in the focus of empirical SCM research and how did this focus evolve over time?*

Research Question 6: *How far does empirical SCM research consider supply chains in an international as opposed to a national context?*

2.4.4 Anomalies and Unresolved Research Questions

For the purposes of this research, anomalies have been defined as the unresolved questions which run counter to the results predicted by the dominant paradigm. Anomalies can form the basis of scientific revolutions as they indicate that the dominant paradigm is no longer capable of providing valid answers to all relevant questions in its field. It is important for a discipline to understand whether and where anomalies occur in order to enable scientists to take action, to counter and remove them (van Gigch & le Moigne, 1989, p. 131).

There have not yet been any studies that tried to assess potential anomalies in SCM to the knowledge of the author. However, despite the growing recognition of SCM in research and practice, there have also been critical voices who claim that SCM risks to be a passing fad (e.g. Chandra & Kumar, 2000) that has difficulties with integrating practice appropriately in order to provide solutions to real-world problems (e.g. Cousins et al., 2006, p. 699). Others pointed out the gap that exists between the theoretical claims of what SCM ought to constitute in theory and what is possible from a practitioner's perspective. It has been stated that, unless this gap is overcome, SCM risks to remain an utopia (Bretzke, 2005). Accordingly, what seems of particular interest for SCM research is what the main open research questions and potential threats of anomalies are in this field of study. Therefore, the following research question can be formulated without further references to SCM literature:

Research Question 7: *What are the major unresolved questions and anomalies in SCM research?*

2.5 Interim Summary

This chapter set out the theoretical foundation for the main section of the thesis. Chapter 2.2 provided knowledge on the roots and historical developments of Supply Chain Management as a field of study. It became clear that the emergence of SCM has been a result of the emergence of pressures from globalization, the associated occurrence of systems thinking and industrial dynamics research that occurred in the mid of the last century and led to an awareness of the importance of both holism and integration. SCM research emerged in the 1980s and, as the field progressed, first approaches could be observed that asked whether SCM has matured enough to be considered a scientific paradigm or independent discipline. It was shown that these discussions on the theoretical status of SCM research are still in an early stage of development and, therefore, can justify an in-depth study of the developments of SCM research in terms of its paradigmatic and scientific stance.

Chapter 2.3 introduced the work of scholars whose primary concern has been to understand the factors that promote or inhibit the evolution of the field of science. In particular, Thomas Kuhn's evolutionary perspective on the development of science was presented. Thomas Kuhn's perspective was structured along a three-layer classification and amended by several additional elements proposed by van Gigch. The result was a comprehensive frame of reference for the analysis of the paradigmatic and theoretical status of a discipline that comprises four major components: philosophy of science, scientific practice, operational practice, and anomalies and unresolved questions.

Finally, chapter 2.4 provided a more fine-grained picture of the nature of the research into the paradigm and theory of SCM by discussing scientific contributions that had earlier been realized within each of the four elements. Based on the findings of this review, it was possible to further refine the major research question of this thesis and to derive an entire set of questions that are summarized in the following table 2.4.

Frame of Reference	**Research Questions**
	1: What are dominant research paradigms in SCM and how did these evolve over time?
	2: What is the object of study of Supply Chain Management research and how did it evolve over time? 3: What are the main schools of thought underlying the SCM discipline and how did these evolve over time? 4: What are the central methodologies used to gain insights into SCM and how did the use of these methodologies evolve over time?
	5: Which industry sectors are in the focus of empirical SCM research and how did this focus evolve over time? 6: How far does empirical SCM research consider supply chains in an international, as opposed to a national context?
	7: What are the major unresolved questions and anomalies in SCM research?

Table 2.4: Overview of Research Questions

To summarize, answers to each of these questions will highlight the nature of international Supply Chain Management research in a comprehensive fashion. In addition, it will be possible to understand, how the nature of SCM research evolved over time. Finally, challenges that SCM research is confronted with today can be identified and explained.

3 Research Methodology

An important decision in every research is the selection of the appropriate research methodology for the investigation of the posed research questions. In order to facilitate the selection process, Yin (1994) proposed a selection process that classifies appropriate research approaches in terms of the questions that should be answered, the required control of behavioural events and the necessary focus on contemporary events (Yin, 2003, p. 5).

In terms of the type of research questions, he differentiates five basic questions: “who”, “what”, “where”, “how”, and “why” questions. A look at the research questions identified in the previous chapter reveals that most of the questions are “what” and “how” questions. “What” questions can be further divided into exploratory and descriptive “what” questions. In this research the former type of research question dominates which justifies an exploratory methodology (Yin, 2003, pp. 5-6). “How” questions tend to be explanatory in nature and require the application of research methodologies that are able to deal with links that can be traced over time such as case studies, historical analyses, archival analyses and experiments. Case studies and experiments tend to focus on contemporary events and require a high degree of control over behavioural events. As a major interest of this research is to understand the development of SCM research over time, case studies and experiments are of minor relevance as these methodologies have only limited capacity to track historical events in an international scientific community. Therefore, historical and archival analyses remain the most appropriate research methodologies for this thesis. As historical analyses are less capable of providing answers to “what” questions, an archival analysis is chosen as an appropriate research methodology for this research.

Since this project is essentially focused on the scientific developments of SCM as a research field, a major source of knowledge are published research outcomes such as books, articles, conference contributions and so on. Therefore, the following specific types of archival research seem to be of particular interest for this study: Systematic literature review (e.g. Denyer & Tranfield, 2006; Hart, 2005; Tranfield, Denyer & Smart, 2003; Tranfield & Starkey, 1998), citation, co-citation analyses and bibliometrics (e.g. Braam, Moed & van Raan, 1991a, 1991b; Glenisson, Glänzel, Janssens & De Moor, 2005; Shapiro, 1992), and content analysis (e.g. Duriau, Reger & Pfarrer, 2007; Kassarjian, 1977; Kolbe & Burnett, 1991; Krippendorff, 2004). Citation analysis is based on direct counts of references made to or received from other documents, whereas paired citations are used as measure of association between documents in co-citation analysis (Eom, 2003, p. 8). Citation and co-citation analyses would therefore, be able to understand underlying patterns of SCM research, for example, schools of thought, but the majority of the other research questions such as the methodologies applied and the object of study could not be covered with these methodologies. Therefore, citation analysis, co-

citation analysis and other bibliometric methodologies are not used for this research. As a consequence, systematic literature reviews and content analysis will be used as core methodologies in the scope of this thesis.

Regarding the frame of reference, information on philosophy of science, scientific practice and operational practice, as well as the development of each of these elements over time can be analyzed by means of systematic literature review and content analysis. However, the section on anomalies and unresolved research questions cannot be dealt with by these two methodologies. The main reason for this is that both research techniques seek to make descriptive inferences from the text, i.e. they support the structure of information that is already known. Instead, the analysis of anomalies and unresolved research questions is exploratory in nature and seeks to uncover information that is not yet explicitly available. Therefore, an additional method of inquiry is necessary to complement the other two methodologies. According to Yin, surveys are an appropriate technique for the exploration of such type of what-questions (Yin, 2003, pp. 5-7). Due to the strong scientific orientation of the present research project, the persons who should be interrogated in the scope of the survey should be scientists in the SCM field. In addition, due to the unspecified nature of the two topics, anomalies and unresolved research questions, the questions in the survey should be open to allow for the expression of opinions, experiences and suggestions. Thus, an expert study should be the optimal methodology to complement the other two.

In the next section, the origins and principles of each of the three methodologies (systematic review, content analysis and expert study) will be described. In addition, earlier applications of the three methods in a Supply Chain Management context will be highlighted briefly.

3.1 Origins and Principles of Core Methodologies

In this chapter, the origins and fundamental principles of the three basic research methodologies adopted for this research will be described. Based on this, the major steps of the research methodology can be derived.

3.1.1 Systematic Literature Review

Fundamentals. Literature reviews are an essential part of any research as they set a research project into relation with existing knowledge (e.g. Seuring, Müller, Westhaus & Morana, 2005, p. 92). The primary objective of conducting a literature review is both to map and assess an existing intellectual territory (Tranfield et al., 2003, p. 208). Given that a literature review is conducted systematically, it cannot only be used as a starting point of research (e.g. Easterby-Smith, Thorpe & Lowe, 1991, p. 145), but can further be instrumented to develop an actionable knowledge base (Denyer & Tranfield, 2006). The major difference between

traditional and systematic literature reviews is that systematic reviews synthesize research according to an explicit and reproducible methodology (Greenhalgh, 1997, p. 672). This methodology includes a comprehensive, unbiased search for relevant research outlets and studies, a detailed quality assessment of the review methodology and rigorous data analysis (Tranfield et al., 2003, pp. 214-219).

Procedure. Due to the general objective of a literature review and under the condition that it is realized systematically, this methodology is judged as suitable for this research. However, there are problems associated with the analysis of information gathered from the rich data sources gained in literature reviews. The analysis of any kind of text would usually require qualitative data analysis techniques such as narrative synthesis, meta-ethnography, grounded-theory and so on. However, applications of these qualitative data analysis techniques in a literature review have been limited (Denyer & Tranfield, 2006, pp. 218-219) and, therefore, it is difficult to identify scientifically valid procedures. In addition, some of the previously formulated research questions such as those dealing with the evolution of SCM research are very difficult to capture by means of mere qualitative techniques.

The objective of literature reviews in management research is to understand advanced knowledge, to identify research gaps and to specify research questions (Denyer & Tranfield, 2006, p. 208). Literature reviews have been criticized for being descriptive accounts of contributions that are often selected based on implicit biases of researchers (Denyer & Tranfield, 2006, p. 208). Systematic review approaches try to remedy this criticism by applying specific review principles and making the values and assumptions underpinning a review, explicit. Tranfield, Denyer and Smart differentiate ten phases of a systematic review: (1) identification for the need of a review; (2) preparation of a proposal for a review; (3) development of a review protocol that will capture and document all decisions made during and concerning the review processes; (4) identification of research; (5) study quality assessment; (6) selection of studies; (7) data extraction and monitoring; (8) data synthesis; (9) report and recommendations; and (10) getting evidence to practice (Denyer & Tranfield, 2006, pp. 208-214). Phases one and two have already been dealt with in chapter 2 of this research. The intended result of systematic reviews is that it can be replicated by others, create consensus among scholars and focus on scientific debate in a constructive way (Cooper, 1998, p. XI).

Accordingly, systematic reviews differ from traditional narrative reviews in management research in terms of the adoption of a replicable, scientific and transparent process that minimizes bias through exhaustive literature searches and by providing proof of review decisions, procedures and conclusions (Cook, Mulrow & Haynes, 1997, p. 377; Tranfield et al., 2003, p. 209). Although, systematic reviews provide valuable conceptual foundations to the literature search process, this data collection method still faces a number of problems to synthesize and sum up the information gained from the literature (Tranfield et al., 2003, p.

217). As a consequence, systematic reviews cannot be used as a stand-alone method in this research.

Origins. In management literature, the scientific debate on systematic reviews is still at its beginning. The origins of systematic reviews reside in the so-called evidence-based movement that received significant attention from the medical sciences. Knowledge production in medicine is characterized by a need to make sense of an often-contradictory mass of evidence and a critical importance of the correctness of the conclusions drawn from previous studies. Therefore, increased attention has been paid within the medical sciences to improve the quality of the review process by synthesizing research in a systematic, transparent, reproducible manner to inform health sciences (Cook et al., 1997, p. 376).

Applications in SCM. High quality journals frequently publish literature reviews that apply similarly rigorous approaches where there have been several publications of literature reviews in SCM that account for the relevance of the methodology for the field. In addition to those reviews that were already described in chapter 2, literature reviews in SCM have been used to understand the differences and commonalities of management of different types of supply chains (e.g. Seuring et al., 2005; de Koster, Le-Duc & Roodbergen, 2007; Foster Jr., In print; Gunasekaran & Ngai, 2005; Srivastava, 2007), to understand the future of supply management (e.g. Zheng, Knight, Harland, Humby & James, 2007), the relevant SCM factors in specific industrial and cultural contexts (e.g. Gunasekaran & Ngai, 2005; Meixell & Gargeya, 2005), and to investigate theoretical linkages of SCM to other disciplines (e.g. Cheng & Grimm, 2006; Grieger, 2003; Ketikidis, Koh, Dimitriadis, Gunasekaran & Kehajova, 2008; Rungtusanatham, Choi, Hollingworth, Wu & Forza, 2003; van Hoek, 2001).

3.1.2 Content Analysis

Fundamentals. As systematic reviews focus on valid procedures for the identification and selection of relevant literature, research into the interpretation of these findings is still at its beginnings. In contrast, content analysis as a research technique is aware of the necessity of the literature search process. However, emphasis in content analysis is laid upon summarizing textual material in order to reduce it to more relevant, manageable bits of data (Weber, 1990, p. 5). Thus, the two methodologies seem to fit perfectly together, with one accounting for the weaknesses of the other. Content analysis is a research method that uses specified procedures to make valid inferences from text (Weber, 1990, p. 9). It involves the identification of specific textual characteristics yielding basic quantitative measures (Cullinane & Toy, 2000, p. 43). Thus, content analysis enables the objective, systematic, quantitative and reliable study of published information (Ellinger, Lynch, Andzulis & Smith, 2003, p. 204; Krippendorff, 2004, p. 18). Content analysis relies on a rigorously predefined coding scheme for textual data that can then be analyzed by means of basic statistical techniques (Guthrie, Petty, Yongvanich

& Ricceri, 2004, pp. 285-286). It is therefore at the intersection of qualitative and quantitative traditions (Duriau et al., 2007, p. 5). Content analysis has been used as a data analysis technique for comprehensive literature reviews in previous studies (e.g Cullinane & Toy, 2000; Pasukeviciute & Roe, 2005). Content analysis is not a very common research technique and although each scientist is acquainted with the notion *literature review* this must not necessarily be the case for systematic reviews. Therefore, the two will be explained in more detail before the methodology of this research is outlined.

Procedure. Typically, content analysis is used to reduce the content of information to a set of categories that are of research interest, to determine key ideas and topics in publications (Cullinane & Toy, 2000, p. 43) and to understand the researcher's perceptions of a topic as well as potential trends (Guthrie et al., 2004, p. 285). The central idea of content analysis is that certain text units (words, sentences or paragraphs) are classified into fewer content categories that can then be analyzed by means of basic statistical techniques (Weber, 1990, pp. 12-13). Therefore, the development and definition of central classification categories as well as the rigorousness of the classification procedure play a major role in content analysis, as they largely determine the quality of results (Weber, 1990, pp. 15-40). For this reason and due to the emergence of more sophisticated software programmes, computer-aided analysis techniques are nowadays frequently used for content analysis (Weber, 1990, pp. 80-82).

According to Duriau, Reger and Pfarrer, content analysis offers a range of advantages. First, it provides a replicable methodology to access both individual and collective structures such as values, intentions, attitudes, and cognitions. It can therefore, be applied to a broad range of phenomena including those that are usually difficult to study using traditional quantitative measures. Second, content analysis allows for analytical flexibility. Scientists can capture manifested content in a number of statistical procedures, at a more abstract level. Scientists can decide to refer to single units of text to interpret more latent content, at a more detailed level. Third, longitudinal research deigns can be implemented due to the long-term availability of information in textual form. Fourth, if applied to existing text and not to interviews or open-ended responses to surveys, content analysis can be non-obtrusive, and therefore, does not suffer from researcher demand bias. For all these reasons and particularly the last aspect, content analysis seems to be an appropriate instrument for data analysis for the present study (Duriau et al., 2007, pp. 6-7).

Origins. Content analysis is an established technique in social science research, with applications dating back to the early twentieth century (Diefenbach, 2001, p. 13). According to Krippendorff, the systematic analysis of texts can be traced back to inquisitorial pursuits by the Church in the 17th century. The first well-documented case of quantitative analysis of printed documentation occurred in the 18th century in Sweden, as a result of the publication of the Songs of Zion, a collection of 90 hymns from an unknown author. These were blamed for undermining the orthodox clergy and supporting the work of a dissenting group. This led

to a discussion of how the texts and symbols were to be interpreted and a number of revisions of interpretations in response to criticism of earlier versions until the phenomenon could be explained (2004, pp. 3-11, for a brief summary see Insch, Moore & Murphy, 1997, pp. 2-3). The beginning of the 20th century brought a large increase in the mass production of newsprint. The strong influence that newspapers had on the formation of public opinion led to a greater demand for ethical standards and empirical investigations into the power of newspapers and journalism. These challenges were met by what was then called quantitative newspaper analysis and was later extended to the measurement of occurrences and keywords on radio, in textbooks, comic strips, speeches, advertising, movies, and television (Krippendorff, 2004, pp. 5-6; Insch et al., 1997, p. 3). The emergence of both electronic media and empirical research methods in the social sciences resulted in an increase in the use of content analysis and further refinements of the methodology. It is therefore not surprising that content analysis was used in World War II to extract information from propaganda to reveal unwished journalistic practices. Due to the large amount of textual information to be analyzed and the repetitiveness of the task, computers came to an early use of content analysis, already 50 years ago. Due to these developments, content analysis is applied today in a wide range of social science questions (Krippendorff, 2004, pp. 8-11; Insch et al., 1997, p. 3).

Applications in SCM. Despite these developments of the method, content analyses have only been used sparingly by researchers in SCM. Yet, during the last three to four years, there has been a strong increase of SCM research that applied content analysis as a data collection technique. For example, Spens and Kovács, use content analysis to assess different theory building approaches in SCM (Kovàcs & Spens, 2005; Spens & Kovacs, 2006). Chen et al. applied content analysis to understand key issues in quality and communication management in fashion supply chains between the UK and China (Chen, Murray & Jones, 2007). Seuring and Müller investigated papers, books and theses from the perspective of content analysis to understand major lines of development (Seuring & Müller, 2007). Fawcett at al. examined the nature and extent of commitment to supply chain collaboration by analyzing the contents of in-depth interviews conducted with Supply Chain Management professionals (Fawcett, Ogden, Magnan & Cooper, 2006). With the exception of the work from Spens and Kovàcs, all these applications have in common that they do not make explicit how categorizations to operationalize contents came about. In addition, questions related to reliability and validity are barely discussed. Thus, the quality of studies using content analytical approaches to SCM research can still be increased. In addition, content analysis has not yet been used to explore similar questions as those asked in this thesis.

3.1.3 Expert Study

Fundamentals. An expert study relies on the knowledge of persons who are recognized for their experience in a certain field in order to generate insights that, otherwise, would have been obtained only with difficulty or not at all (Bogner & Menz, 2005b, p. 7). Within science, peer information from experts is used in numerous ways. For example, in early exploration of complex phenomena, experts are asked to provide information to enable the scientist to gain access to the field (*exploratory objective*) and to support structuring of this domain (*systematization objective*). Furthermore, specific and comprehensive forms of expert studies such as Delphi (e.g. Linstone & Turoff, 1975b) or Focus Group (e.g. Kamberelis & Dimitriadis, 2005) can be used as stand alone methodologies for the qualitative exploration of phenomena to generate new theory (*theory building objective*, Bogner & Menz, 2005a, p. 37).

Procedure. In the scope of an expert study, particular accuracy is required for the precise and comprehensive definition and characterization of who an expert is in a certain field. In essence, criteria need to be defined in order to decide whether a certain person is an expert or not. These criteria might take into consideration the theoretical background of a person, his or her practical experience, the relations this person entertains and so on (Bogner & Menz, 2005a, pp. 39-40). In a second step, the type of interaction the researcher has with the expert(s) needs to be specified. For example, it needs to be decided whether information from an expert shall be gathered personally, orally or in written form. Finally, the type of questions to be asked need to be determined (Bogner & Menz, 2005a, pp. 47-64).

Origins. Relying on expert knowledge to capture their experience in a field is nothing new. However, within scientific applications of the method, attempts have been made to the increase objectivity, reliability and validity of expert studies (e.g. Bogner, Littig & Menz, 2005, p. 94). For example, during the 1950's the Rand Corporation conducted a series interviews to obtain reliable consensus of opinion among experts and thus laid the foundation for the professionalization of the Delphi technique (Linstone & Turoff, 1975a, p. 10).

Applications in SCM. Several forms of expert studies have been applied to SCM research. The Delphi technique has been used for theory generation on several aspects of SCM (e.g. Lummus, Vokurka & Duclos, 2005). Furthermore, studies among experts were frequently used to identify appropriate performance measures in SCM (e.g. Ngai, Cheng & Ho, 2004, Bichou & Gray, 2004). However, to the author's knowledge, there have not yet been any applications to determine anomalies and major unresolved research questions in SCM.

3.2 Steps in the Research Methodology

The research methodology assumed for this research is a stepwise, iterative process that applies an expert study (Bogner et al., 2005) and captures elements from systematic reviews (Tranfield et al., 2003; Tranfield & Starkey, 1998) and content analysis (Weber, 1990, pp. 21-28; Insch et al., 1997, pp. 9-18; Mayring, 2002, p. 120). Figure 3.1 summarizes the different elements of the research methodology, and their relations will be described step-by-step in the following chapters.

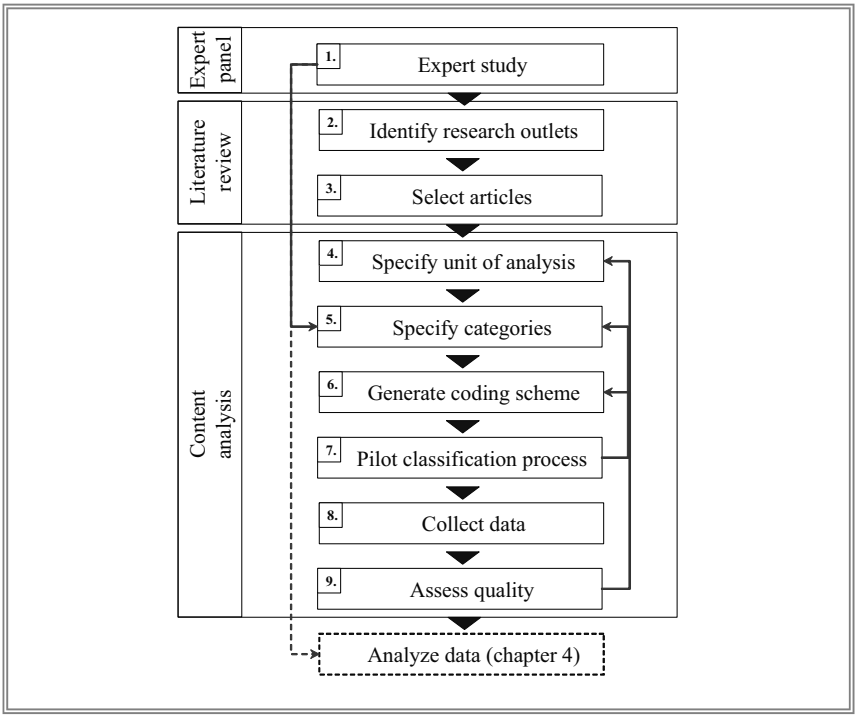


Figure 3.1: Steps of the Research Methodology
Source: own illustration

3.2.1 Step 1: Expert Study

The major methodology of this research is a content analysis on the development and the state-of-the-art SCM research. However, content analysis is an insufficient research methodology for some parts of the theoretical framework and will therefore be supplemented with insights gained from an expert study. Typically, studies among experts adopt a face-to-

face form, i.e. they are frequently conducted as oral interview (e.g. Bogner & Menz, 2005b, p. 7). As illustrated in the following, this has not been possible in the scope of the present project. Therefore, instead of applying the common term *expert interview*, we decided to label this step of the research design *expert study,* to account for the fact that no oral conversation took place between the experts and the author of this thesis.

Sample. An expert is defined as a person who has the potential to structure a specified area of interest with his or her interpretations and in a reasonable way to direct future activities. It is therefore, necessary that the expert has sufficient experience in the defined area of interest (Bogner & Menz, 2005a, p. 45). For the purposes of the present project, an expert has been defined as all university professors, associate professors, and assistant professors who are concerned with the theoretical aspects of SCM and who have already published at least one scientific article in this sense in an international academic journal. The latter condition has been applied to ensure the acquaintance of SCM scientists with questions that are similar to those posed in this thesis. The restriction to professors and senior lecturers has been made in order to ensure a high degree of scientific experience. From a literature review on major theoretical contributions to SCM research, twenty-eight experts were identified. Those experts that provided answers to the questionnaire are listed in appendix 1..

Questionnaire. The questionnaire used for the expert study comprised open questions on different topics. Two of these topics concerned the anomalies and open research questions in SCM. In terms of open research questions, the experts were provided with a list of three fundamental open research questions and were asked whether these questions were formulated correctly and whether they would like to add any further fundamental open research questions. In terms of anomalies, the experts were asked whether they were aware of any anomalies in SCM and if they could describe these (the entire expert study questionnaire is attached in appendix 2).

Procedure and responses. The expert questionnaire was sent to all experts in November 2006. In March 2007, a first reminder was sent to non-respondents and a second reminder was issued in June 2007. The long response time that was accorded to the experts seemed appropriate as the questions referred to issues related to theory of cognition and, therefore, it was rather difficult to reply to them. Thus, the experts were supposed to have enough time to reflect on the more complex questions. From the 28 experts, 15 (54%) sent a reply. Among these, 6 (21%) indicated that they did not have the time to provide comprehensive answers to the questions. In addition, two experts (7%) claimed that their knowledge in these rather specific topics was not sufficient in order to provide reliable information. Finally, 13 experts (46%) did not reply. Thus, 7 (25%) usable questionnaires were obtained. Their names and affiliations are provided in appendix 1.

The insights gained from the expert study are incorporated in two different sections of the thesis. First, in terms of research methodology, the expert study supported the development of

a coding scheme for core Supply Chain Management constructs. The results of this part of the study are described in chapter 3.5. Second, in terms of data analysis, the expert study provided a contribution to the analysis of anomalies and unresolved research questions in SCM research. The responses to this section of the questionnaire are described in chapters 4.7.2 and 4.7.3.

3.2.2 Step 2: Identification of Relevant Research Outlets

The first major decision to be taken at this stage was on the research outlets from which relevant studies could be identified. Tranfield, Denyer and Smart (2003, p. 215) recommend to include numerous information sources for the comprehensive investigation of a research question such as unpublished studies, conference proceedings or the internet. This is certainly a valid criterion as the objective of a review is to gather knowledge about the *content* of research in a field. However, the objective of this research is to understand the current nature of *research* in Supply Chain Management by considering the underlying philosophy of science, major schools of thought, research methodologies etc. It would therefore be problematic to include textbooks, the internet, and conference proceedings in this review, as this type of publications are frequently not scientific in nature, i.e. they do not entirely respect and fulfil scientific standards. Textbooks usually do not present a methodology but summarize knowledge gained in previous studies. Sources in the Internet are usually not scientific. The quality of conference proceedings is frequently not as high as those publications that have undergone a strict review process before publication in a scientific journal. Accordingly, for the sake of rigorousness, textbooks, working papers, conference papers, and the internet were excluded as information sources for this review. Instead, the focus has been on scientific journals, only. This decision has also been made by other authors earlier and, hence, seems to be a valid restriction (e.g. Gunasekaran & Ngai, 2005, p. 428 or Machuca, González-Zamora & Aguilar-Escobar, 2007, p. 588).

The next question to be addressed was deciding on the specific journals that ought to be included in the review. There is a wide range of very different journals that publish studies on SCM-related topics and a preliminary search via EBSCO by means of the search term “Supply Chain Management” yielded more than 3,000 articles spread in 64 journals in which at least one article had been published with the keyword “Supply Chain Management” figuring in the title. However, a closer look at this preliminary list revealed that the number of articles specifically dedicated to SCM and the type of journal strongly differed. Therefore, another selection strategy had to be applied.

Previous research that applied similar methodologies, focused on an analysis of the quality and relevance of journals (e.g. Barman, Hanna & LaForge, 2001; Barman, Tersine & Buckley, 1991; Soteriou, Hadjinicola & Patsia, 1999; Young, Baird & Pullman, 1996; see also the

recommendation made by Zsidisin et al., 2007, p. 165) and therefore, these two criteria were applied for journal identification in this research. The *impact* of a journal upon SCM research was determined in terms of the number of papers featuring SCM topics. Journals were included in the short-list only if they had published at least ten articles specifically dedicated to SCM in the last ten years. This led to a reduced list of fourteen target journals.

The second criterion, *quality* of journals, was determined by means of journal rankings as done earlier by other authors (e.g. Fawcett, Vellenga & Truitt, 1995). For the present research, a journal was only considered if it had been ranked "B" or above in the ranking of the Association of University Professors of Management in German speaking countries (Verband der Hochschullehrer für Betriebswirtschaft). The journal ranking criterion also considered rankings of journals that did not yield sufficient responses in the VHB ranking (Hennig-Thurau, Walsh & Schrader, 2003). This led to a further reduction of the target journal list, to eight journals. One of these, the *European Journal of Operational Research*, is specifically dedicated to mathematical modelling and, therefore, might substantially bias the results of the methodological analysis. For this reason, the journal was excluded from the target list as done in other studies (e.g. Reichhart & Holweg, 2006, p. 383). Table 3.1 provides an overview of the remaining target journals, their rank according to VHB and the abbreviations that will be used for their designation in the following chapters.

Journal Name	**VHB-Rank**	**Abbreviation**
International Journal of Logistics Management	B	IJLM
International Journal of Physical Distribution & Logistics Management	B	IJPDLM
International Journal of Production Economics	B	IJPE
International Journal of Production Research	B	IJPR
Journal of Business Logistics	(B)	JBL
Journal of Operations Management	A	JOM
Production Planning & Control	(B)	PPC

Table 3.1: Final Target Journal List

In 1991, the journal *Engineering Costs & Production Research (ECPR)* was renamed to *International Journal of Production Economics.* Thus, IJPE will be used as a synonym for ECPR in the following sections.

3.2.3 Step 3: Selection of Articles

The next major step was the selection of relevant articles from the target journals. In this context, two decisions had to be made. The first referred to the time horizon to be covered. One objective of this research was to understand the evolution of SCM research over time.

This implies that a large time-span of published articles ought to be covered. The term *Supply Chain Management* first appeared in 1982 and the first conceptual papers on Supply Chain Management were published in the mid 1980's (e.g. Houlihan, 1985, 1987; Stevens, 1989). This suggests including articles from 1985 onwards in the analysis. However, one of the major target journals, The Journal of Logistics Management, first appeared in 1990. In order to reduce the risk of bias in the analysis, the time horizon of the analysis was therefore restricted to publications appearing in the time period from 1990 until 2006. This seems to be a sufficiently large time horizon in order to trace the development of SCM research.

The second decision referred to the inclusion or exclusion of studies into the sample. The objective of the research is to understand the development and actual status of SCM research. In this context, one decision criterion could be to use a standard definition of SCM and include only those articles that meet the definition as frequently done in similar studies (e.g. Cheng & Grimm, 2006). However, this strategy has a major disadvantage as it excludes a number of articles that offer different perceptions of what SCM actually is. This would substantially bias the analysis, in particular since the definitions of SCM varied over time and the perception of SCM in 1990 might differ from the one that dominates in 2006. Instead, all those articles were selected in which the term *Supply Chain Management* featured either in the title, in the abstract or both. This search strategy was supposed to ensure that a broad range of different articles were included in the sample and that SCM was among the central topics a study dealt with. Such reflections led to similar search strategies in previous literature reviews (e.g. Reichhart & Holweg, 2006, p. 388).

In total, the search strategy yielded 340 relevant articles. Out of these, 58 were book reviews, editorials to journal issues or calls for papers. These were excluded from the analysis as these types of papers do not provide any direct contribution to SCM research. Thus, the overall sample of this research comprises a total of 282 articles (the complete list of sample articles including the references is depicted in appendix 3).

3.2.4 Step 4: Specification of Unit of Analysis

The unit of analysis, or recording unit, defines the basic unit of text to be classified. Within content analysis, there are five commonly used options:

1. *Word:* Coding of each word.
2. *Word sense*: Coding of different sense of words with multiple meanings and coding of phrases that constitute a semantic unit (for example idioms or proper nouns).
3. *Sentence*: An entire sentence may be used as coding unit in order to investigate words or phrases that occur closely together.
4. *Paragraph*: Coding of whole paragraphs typically as positive, negative or neutral.

5. *Document*: Assignment of the whole text to a category (Holsti, 1969, p. 116; Weber, 1990, pp. 21-22; Insch et al., 1997, p. 10).

The decision concerning the appropriate recording unit should take into account and be consistent with the nature of the research question (Harris, 2001, p. 198). For example, within marketing and public relations research, word-frequency counts are frequently applied in order to understand how often a particular word is used (e.g. Dowling & Kabanoff, 1996). Broader research questions, however, frequently necessitate the use of larger recording units in order to capture all relevant aspects. As an example, Kabanoff et al. used content analysis to investigate the value structures of organizations and whether change issues are mirrored differently in organizations with different value structures. For the purposes of their study, the authors used the sentences in annual reports, newsletters and magazines as unit of analysis (Kabanoff, Waldersee & Cohen, 1995).

The research questions to be addressed in this study include the identification of dominating scientific paradigms, disciplines and methodologies applied in a specific study and the relation a piece of research has with practice. Such topics are difficult to capture by word or word sense recordings. Whereas methodologies might be described in a sentence or a small number of paragraphs, this is not possible for understanding the scientific paradigm that underlies a specific study. The latter can only be understood by means of a profound understanding of the whole text document. As a consequence, the unit of analysis chosen for this research is the document.

An implication that follows from the selection of the document as unit of analysis is that data collection must be done manually by human coders, rather than relying on computer-aided tools for coding, as computers are still unable to handle large amounts of text correctly (Franzosi, 1995, p. 157, Harris, 2001, p. 199). Thus, the coding process might be more time-consuming but, at least for complex recording units, reliability is increased when human coders are used (Insch et al., 1997, p. 14).

3.2.5 Step 5: Specification of Categories

After the identification of relevant journals, the selection of sample articles and the identification of the recording unit, the next step in the research methodology is to specify the categories. Content analysis is able to capture explicit textual elements such as certain keywords or more implicit (latent) content such as values (e.g. Spens & Kovacs, 2006, p. 379). In either case, the concepts and variables of interest in a research project need to be determined, structured and defined in so-called *content categories* or simply *categories* (Weber, 1990, p. 23). Content categories specify the characteristics a text must have in order

to be classified into it, and thus ensure that those texts that have similar meanings are classified into the same category (Weber, 1990, p. 12).

In specifying the content categories, two decisions need to be made. The first is whether categories are to be mutually exclusive. In *single classification*, only one category can be assigned to the unit of analysis. In *multiple classification*, more than one category can be assigned to the unit of analysis. The second choice refers to the origins of the categories. Thus, a deductively *assumed category* is defined prior to the examination of the text and, normally, based on pre-existing theoretical concepts. This way of category development increases reliability but, at the same time, might restrict the results so that unknown phenomena are neglected that would have been uncovered otherwise. In contrast, relying on inferred categories means to let categories emerge from the text in an inductive way. This approach may yield new results but risks to generate a multitude of categories (Weber, 1990, p. 23; Insch et al., 1997, p. 11).

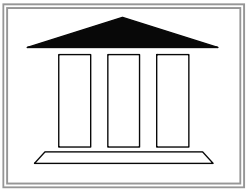
For the purposes of this study, a mixture of single and multiple categorization schemes was used. In addition, the majority of the categories are assumed categories. However, in order to ensure a high degree of validity and in order to be able to draw as much new information from the texts as possible, the coding process allowed for the integration of new, inferred categories, when the coder considered these as appropriate.

Finally, in order to ensure a high degree of comprehensiveness, validity and reliability of the assumed categories, a number of different actions were taken that can be split in the following three types of sources of certainty: (1) previous success or failure of pre-defined categories; (2) the use of established theories; (3) embodied practices, sampled from a context, to argue for the representative nature of the inferences obtained from these practices (Krippendorff, 2004, pp. 173-185; Sonpar & Golden-Biddle, 2007, pp. 7-8). All three actions were used in this thesis.

The task in this section of the thesis is to develop appropriate categories for all elements of the frame of reference developed in the previous chapter. Wherever possible, the content categories are what have been used successfully in earlier studies. This has been the case for research methodologies and operational practice. Nevertheless, the frame of reference comprises some parts that have not been investigated in a similar way in content analysis before. In these cases, reference was made to existing theories, models and frameworks in SCM. This was the case for philosophy of science and parts of the SCM object of study. Furthermore, where existing theories were not precise enough, experts were asked to backup and validate the content categories. Therefore, insights from the expert study were applied to identify disciplines and SCM constructs. Embodied practices refer to recurring individuals who embody the required categories because of their familiarity with the subject matter (Krippendorff, 2004, p. 179).

In the following paragraphs, the processes of category development for each part of the frame of reference will be described and definitions for all categories will be provided that are used in this study. This description will be very detailed to ensure that the categories and processes that led to their identification can be understood by other researchers who will then be able to repeat the study and increase the reliability of the content categories. In addition, due to the high number of categories and the different levels of the frame of reference these pertain to, the coding instructions for these categories will be highlighted in the respective sections.

A) Categories for Philosophy of Science



The Philosophy of Science level is probably one of the most difficult in terms of the identification of clear categories and categorization rules. The reason for this is that researchers usually do not state which paradigm their work is embedded in. Thus, the ontological and epistemological position assumed by the author(s) of an article can only be derived from an implicit understanding of the values and beliefs underlying the scientific article in question.

The definitions of the five paradigms positivism, post positivism, critical theory, constructivism and participatory are based on the definitions provided by Guba and Lincoln (1994, 2005) as described in chapter two. In addition, the methodology applied in an empirical article can provide additional supportive information on the paradigmatic perspective assumed by the authors (e.g. Guba & Lincoln, 1998, 2005; Näslund, 2002; Ramsay, 1998).

Positivism. From an ontological perspective, positivist researchers assume that there is an apprehendable reality driven by immutable laws and mechanisms. Knowledge is described in the form of context- and time-free generalizations that frequently take the form of cause-effect laws. Research can succeed to understand the 'true' state of affairs. In terms of epistemology, the investigator and the analyzed object are supposed to be independent entities. This enables the researcher to study the object without influencing it or being influenced by it. If threats to validity are recognized or suspected, i.e. risks of influence in either direction, strategies are implemented to reduce these risks. Values and biases are prevented as far as possible from influencing outcomes. Replicable findings are considered to reflect the true state of reality (Guba & Lincoln, 1998, pp. 109-110).

Postpositivism. The ontological assumption of postpositivist scientists is that reality exists but is only imperfectly apprehendable because of flawed human intellectual capacity and the fundamentally intractable nature of phenomena. It therefore, is only possible to approach reality as closely as possible but never to fully understand it. From an epistemological

perspective, objectivity remains a regulatory ideal despite awareness that it is almost impossible to maintain pure objectivity. Replicated findings are considered as probably true as long as they could not be falsified. The most important representative of the postpositivist paradigm has probably been Karl Popper (e.g. Popper, 2002; Guba & Lincoln, 1998, p. 110).

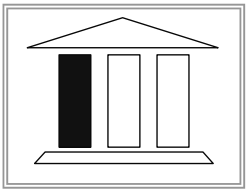
Critical Theory. Ontology of *critical theory* or *historical realism* as the paradigm might synonymously be labelled is that reality was once plastic, but was shaped over time by a number of cultural, social, political, economic, ethnic, and gender factors. These reified into a series of structures that are now inappropriately taken as 'real', natural and immutable, although they are 'only' historical reality. In terms of epistemology, the investigator and the investigated object are assumed to be interlinked. This means that the values of the investigator inevitably influence the inquiry which leads to value mediated results (Guba & Lincoln, 1998, p. 110).

Constructivism. The ontological base of constructivism is that realities are apprehendable in the form of multiple, intangible mental constructions, experientially and socially based, local and specific in nature and totally dependent on the individual persons or groups holding these constructions. These constructions are not considered as true in an absolute sense, but simply as more or less sophisticated. They can be altered as their associated realities. The epistemology in constructivism assumes that the investigator and the investigated object are interactively linked so that 'findings' are literally created as the investigation proceeds. This leads to the disappearance of the conventional distinction between ontology and epistemology (Guba & Lincoln, 1998, pp. 110-111).

Participatory. The ontological assumption of participatory inquiry is that of a given cosmos whose objectivity is relative to how it is shaped by the investigator and how it is inter subjectively shaped, as knowing presupposes mutual participative awareness. This implies the need for an extended epistemology: The investigator participates in the inquiry in experiential, presentational, propositional and practical ways. Like in constructivism, it is not possible to distinguish ontology and epistemology, as both are totally intertwined (Guba & Lincoln, 2005, pp. 191-195; Heron & Reason, 1997, pp. 289-290).

In essence, these five paradigms formed the basic categories for the article classification in the philosophy of science dimension. The applicability of the classification categories has been tested by means of a pre-study which comprised of the classification of a subset of articles from the overall sample. This pre-study revealed that the differences between the positivist and post positivist paradigms were too marginal to be able to clearly differentiate between them. Therefore, these two paradigms were subsumed under the label *positivist approaches* for the main classification process.

B) Categories for Scientific Practice - Object of Study



In this section, the classification classes for the determination of the SCM object of study are presented and described. In addition, the respective codes and their definitions are developed. Several aspects should be considered in order to understand the SCM object of study. The first and easiest way of determining the SCM object of study would be to understand its definition. However, SCM research has not yet arrived at a common understanding of the notion. Therefore, additional factors should be taken into account. As the object of study is composed of a set of constructs, an analysis of the core SCM constructs might provide valuable information about the object of study. In addition, the level of analysis of SCM research provides important insights into different perceptions of the SCM object of study. Finally, management disciplines such as SCM increases its legitimacy and acceptance if it generates value-added contributions (e.g. Whetten, 1989, p. 490). Thus, a final classification class for understanding the SCM object of study comprises the practical objectives pursued by SCM research. In this chapter, these four components of the SCM object of study will be elaborated in detail. In addition, the steps and reflections that have been made in order to generate valid codes for classifying articles in this dimension will be explained.

Definition. As noted in chapter 2, the object of study of a discipline serves to differentiate it from other disciplines. Definitions are an essential part of the object of study as they explain why and how the relationships of constructs are logically linked (Wacker, 1998, pp. 363-364). Thus, understanding the definition of SCM provides substantial information on the object of study of the discipline. However, as pointed out in chapter 2.1, SCM lacks a consensus definition and the many definitions provided strongly vary in terms of their focus (e.g. Bechtel & Jayaram, 1997, pp. 16-19), interest (e.g. Lummus & Vokurka, 1999, pp. 12-13), and the activities involved (e.g. Gibson et al., 2005, p. 21). Accordingly, the object of study might substantially vary depending on the perspective of individual authors. A major source of information on this perspective is in particular the definition of Supply Chain Management adopted by the authors of an article. Thus, although the definitions used in an article provide valuable information on the SCM object of study, this classification dimension needs to be supplemented by other classification classes.

In order to understand the definition of SCM, articles were classified in terms of the SCM definition they were based on. Four different categories were used to track, whether an article was not based on a definition or whether it was based on an own, existing or modified definition as done earlier (e.g. Burgess et al., 2006, pp. 707-708):

- *None*: No definition explicitly stated.
- *Modified*: Indirect citation of a definition with reference; take record of the reference.

- *Existing*: Direct citation (e.g. quotation marks) of a definition with reference or another hint to existing literature; take record of the reference.
- *Own:* Explicit definition stated without reference or any other hint to existing literature.

An article was only classified into one of the categories *own*, *existing* or *modified*, if a definition had explicitly been stated and not merely implied, in order to be taken into account. Articles were classified as having not used a definition if there was no clear statement. If there were definitions apparent they were further classified into existing, modified or own definitions. In case that an existing, own or modified definition was used, the reference was documented in order to understand the most frequent definitions used, the evolution of these references over time, and in order to permit a qualitative analysis of these definitions which should provide more precise information into the SCM object of study.

Constructs. The object of study of a discipline is composed of a set of constructs that specify its content domain. Accordingly, the topics that SCM focuses on researching should be a central source of information on the central constructs of SCM research, their role, importance and evolution over time. A classification of articles in terms of their contents requires a precise and comprehensive pre-definition of the main constructs that play a role in SCM research and this process evolved around several steps that will be explained in the following.

Frequently, content analysis relies on coding schemes that are developed on the basis of existing literature and frameworks (e.g. Spens & Kovacs, 2006, p. 379). Thus, the first step for the development of the SCM construct categories and coding scheme has been a literature review on existing research into the central SCM constructs. The results of this review are depicted in table 3.2.

Reference	Proposed Constructs	Reference	Proposed Constructs
Burgess et al., 2006, p. 710	Leadership Intra-organizational relationships Inter-organizational relationships Logistics Process improvement orientation Information systems Business results and outcomes	Tracey, Fite & Sutton, 2004, p. 55	Technology Internal relationships External relationships Product development Transportation Inventory management Production efficiency Product delivery Response to demand Product quality Competitive pricing Performance

Reference	Proposed Constructs	Reference	Proposed Constructs
Cooper, Ellram et al., 1997, p. 69; Cooper & Ellram, 1993b, p. 16	Inventory Management Total Cost Time Horizon Information Sharing Joint Planning Corporate Philosophy Supplier Base Leadership Risk Sharing Information Systems	Houlihan, 1985, pp. 23-38	Planning and control structure Product flow facility structure Information flow Values and attitudes Organizational culture Management methods
Cooper, Lambert et al., 1997a, p. 6	Management components Business Processes Supply chain structure	Min & Mentzer, 2004, p. 67	Supply chain orientation Supply Chain Management Performance
Tan & Kannan, 1999, pp. 1035-1039	Environment Quality management Supply base management Customer relations Performance		

Table 3.2: Supply Chain Management Constructs

This overview reveals that the perceptions of the core SCM constructs strongly differ. Some authors assume the perspective strategic management and leadership (e.g. Cooper, Lambert et al., 1997a; Min & Mentzer, 2004), whereas others emphasize the activities by means of how these management components are implemented into practice (e.g. Cooper, Ellram et al., 1997; Cooper & Ellram, 1993b). Furthermore, some sets of constructs focus on the organization of internal SCM activities (e.g. Houlihan, 1985), whereas others emphasize the relationships with other partners in the supply chain (e.g. Burgess et al., 2006; Tracey et al., 2004). Furthermore, the constructs are frequently not entirely distinct. For example, the distinctions between the planning and control structure and information flow (Houlihan, 1985, pp. 23-38) or leadership and organizational relationships are not entirely clear (Burgess et al., 2006, p. 710). Due to these strong disagreements, it seemed impossible to provide a valid and comprehensive list of the core constructs of SCM based on a mere literature review that could be used for classification purposes.

As a consequence, a comprehensive list of more than 50 potential SCM constructs was developed. This list was integrated into the expert study described in chapter 3.2.1. The experts were asked whether the proposed constructs were exhaustive, appropriate and internally consistent. Unfortunately, among the seven responses yielded from experts, only two provided comments on this part of the questionnaire. The reason for this was probably that the list was too long and required too much time and effort for the experts to provide comprehensive information. In any case, the results from this part of the questionnaire were

deemed inappropriate to generate a valid, mutually exclusive and comprehensive list of core SCM constructs.

Hence, in a third step, the list of potential SCM constructs was critically examined in order to understand whether there were constructs that could be grouped together. As an example, the original list comprised of the constructs Electronic Data Interchange, Electronic Commerce, Business-to-Business Relationships and Internet. These constructs were merged to form the new construct labelled Information Technology. In order to facilitate the classification of articles during the review process, all of the original constructs that the new classes were composed of were maintained in the so-called extensional lists (see codebook in appendix 4). Such extensional lists help to specify the conceptions of complex classification schemes by enumerating instances that define a code (Krippendorff, 2004, pp. 133-134).

Finally, a test was performed on the proposed list of core SCM constructs in order to examine its degree of exhaustiveness. A list of all keywords was therefore, generated that were indicated in the sample articles. In the test, it was checked whether all keywords that related to emphasized SCM parts could be grouped into the proposed list of constructs. In case it was not possible to find a suitable group, a keyword became a new construct. In case it could be grouped into the existing list of constructs but did not yet feature in the extensional list, the keyword was added to the respective extensional list. In case a keyword did not refer to a part of SCM, as was for example the case for keywords that specified a certain industry focus or a methodology applied in the research, the keyword was neglected.

This process lead to a total of twenty-one core SCM constructs and an additional category "*others*" for those articles that could not be classified into any of these. For example, literature reviews typically do not consider the components of SCM, but rather research methodologies or similar questions that could not be classified into one of the other codes. The list of core SCM constructs and the definitions these are based on in the scope of this research is as follows:

- *Closed-Loop Supply Chain & Environmental Protection*: Activities, processes, methodologies and tools related to returns management and remanufacturing (e.g. Guide & Van Wassenhove, 2006, p. 345; Srivastava, 2007, pp. 53-54).
- *Demand Chain Management*: Activities, processes, methodologies and tools that recognize customer needs and customer value and respond to these expectations for the benefit of the supply chain (e.g. Flint & Gammelgaard, 2007, pp. 51-62).
- *Human Resource Management*: Activities, processes, methodologies and tools related to personnel recruitment, development retention with a specific emphasis on particular requirements in a Supply Chain Management context (e.g. Keller, 2007, p. 273, 275-278). This includes measures for the generation and development of skills, competences and capabilities at the level of the individual (e.g. Gammelgaard & Larson, 2001, p. 27).

- *Information Technology & E-Business*: Activities, concepts and procedures related to the design of information technology and technology infrastructure in a supply chain context (e.g. Bagchi & Skjoett-Larsen, 2003, pp. 91-92) as well as internet-based tools and communication procedures to execute front-end and back-end business processes (e.g. Lee & Whang, 2001, p. 1).
- *Inventory Management*: All policies and procedures that monitor inventory levels and determine the timing and quantities of replenishment (e.g. Sahin & Robinson, 2007, p. 186).
- *Knowledge Management*: Climate, processes and infrastructure targeted at the generation of knowledge and (inter-) organizational learning at the level of the organization and the supply chain as a whole (e.g. Davis & Chenneveau, 2007, pp. 87-89; Narasimhan & Kim, 2001; Elliman & Orange, 2000; Lancioni, Schau & Smith, 2003; Lancioni, Smith & Oliva, 2000; Lancioni, Smith & Schau, 2003; Hill & Scudder, 2002; Wang, Heng & Ho, 2005; Dussauge, Garrette & Mitchell, 2000; Jayaram, Vickery & Droge, 2000; Hult, Ketchen Jr. & Slater, 2004; Premkumar, Ramamurthy & Saunders, 2005).
- *Lean Supply Chain Management & Integration*: Activities, processes, methodologies and tools targeted at synchronizing, smoothening and balancing the flow of products in the supply chain (e.g. Srinivasan & Reeve, 2007, pp. 288-290).
- *Legal Affairs*: Topics related to the impact of laws and legal regulations upon Supply Chain Management (e.g. Sanderson, 2001, pp. 16-18).
- *Marketing & Sales*: Activities, processes, methodologies and tools related to the development, implementation and execution of a marketing strategy in a supply chain context and to selling the respective products and services (Jüttner, Christopher & Baker, 2007, p. 377; Svensson, 2002a, 2002b; Lambert & Cooper, 2000 p. 68; De Carlo & Cron, 2007, pp. 119-134).
- *Organization Structure & Processes*: Activities and procedures related to the organization of the internal design of processes and structures (e.g. Larsson & Ljungberg, 2007, p. 103; Johannessen & Solem, 2002, pp. 34-33; Monczka, Trent & Handfield, 2005, pp. 139-146).
- *Performance Measurement & Reward Systems*: Concepts, tools and methodologies used to determine the financial impact of Supply Chain Management and to develop systems for reward sharing among supply chain partners (e.g. Timme, 2007, pp. 305-307).
- *Power, Reach, Interdependence*: Topics related to the degree of influence and impact one partner in a supply chain has upon associates (e.g. Cox, 2004; Cox et al., 2004).
- *Product Management*: Activities related to conceptualization, development and testing of existing and new products (e.g. Bruce, Daly & Kahn, 2007, p. 135).

- *Production Management*: Design and management of the transformation processes of goods and services (e.g. Robinson & Sahin, 2007, p. 149).
- *Quality Management*: Methodologies and techniques related to quality assurance and quality improvement (e.g. Hines, 2006, pp. 296-305).
- *Relationships, Alliances & Collaboration*: Activities, tools and procedures related to the design and implementation of alliances with external partner organizations (e.g. Sheth & Sharma, 2007, p. 361). This includes all activities related to the identification of suppliers, supplier selection, supplier base management and supplier development (e.g. Hines, 2006, pp. 150-158).
- *Risk Management*: Activities and procedures related to the identification, evaluation and mitigation of risks (e.g. Manuj, Dittmann & Gaudenzi, 2007, p. 320).
- *Strategy & Leadership:*: All questions related to the development of Supply Chain Strategies, the achievement of strategic fit of a company's strategy and its Supply Chain Strategy and the generation of competitive advantage with Supply Chain Management (Mentzer et al., 2007a, pp. 22-25; Christopher & Ryals, 1999; Defee & Stank, 2005; Vickery, Jayaram, Calantone & Dröge, 2003; Mentzer et al., 2007a, pp. 20-22).
- *Supply Chain Design*: Decisions and activities related to the optimal configuration of supply chains in terms of plant locations, warehouse locations, supply chain partner locations etc. This category differs from the "organization and process" category in terms of its long-term orientation and the difficulty to revise a realized decision (e.g. Speh, 2007, p. 323; Chopra & Meindl, 2004, pp. 100-109).
- *Supply Management & Purchasing*: Activities related to the procurement of goods and services including supply management and category sourcing strategies, gathering of market information, handling RFx processes, negotiating and supply contract management (e.g. Jahns, 2005, pp. 22-30; Monzcka, Trent & Handfield, 2005, pp. 7-8; Handfield & Nichols Jr., 2004; Lemke, Goffin, Szwejczewski, Pfeiffer & Lohmuller, 2000; Scannell, Vickery & Dröge, 2000; Narasimhan & Kim, 2001; Wynstra & Weggemann, 2001; Zsidisin & Smith, 2005; Cooper & Ellram, 1993b). Supplier Management is not included into this category but considered as part of the relationships and alliances construct.
- *Transportation & Logistics*: Activities related to planning, implementing and controlling the efficient and effective forward and reverse flow of goods, services and related information (CSCMP, 2007; Ho et al., 2002; Copacino, 1997)
- *Others:* All articles that do not directly address one of the previously identified parts but contribute purely to the theoretical base of SCM research (e.g. definitions or reviews of PhD-theses).

A complete overview of the keywords in the extensional lists is provided in the appendix (see appendix 4).

Articles were classified according to these codes if one or more of these constructs were discussed in at least one section of the main part or if it was a major part of a proposed model, theory or framework. Hence, codes in this part of the classification were not mutually exclusive. Depending on the type of statistical analysis performed, this has to be respected in the analysis phase as recording one unit simultaneously into different codes violates basic statistical assumptions of some techniques (Weber, 1990, p. 23).

Level of Analysis. Regarding the changing role of the logistics manager facing Supply Chain Management, one of the first contributions to the theoretical underpinning of SCM stems from Houlihan (1987), who states:

> "Marketing,[…], may boost its forecasts in order to secure large allocations from manufacturing so as not to be caught short in a potential upswing. In response, the manufacturing and distribution functions may develop their own independent forecasts or try to second-guess actual sales of inventories. Functions all along the supply chain tend to exhibit certain possessiveness…" (Houlihan, 1987, p. 53).

This citation illustrates that Houlihan, when talking about Supply Chain Management, considers an internal supply chain that is able to penetrate functional silos within a particular firm. A recent contribution to SCM stems from Barker and Naim (2004) who investigate a construction supply chain. The following citation is taken from their article and reveals an entirely different perception of what SCM is:

> "This supply chain representation is realistic and is a hybrid encompassing a combination of dyadic, raw material to the final customer and network types. It includes information from between the site and regional/national headquarters and the interface with suppliers, manufacturers, merchants and contractors" (Barker & Naim, 2004, pp. 57-58).

Unlike Houlihan, Barker and Naim consider a whole network of organizations as belonging to a supply chain. Evidently, there is a fundamental difference in the understanding of the number of organizations incorporated in a supply chain. This difference might have substantial impact on the perceived object of study. Therefore, the level of analysis in SCM research will be introduced as an additional class to analyze the SCM object of study. Consequently, this research analyzes the object of study in terms of a third criterion, namely the supply chain level of analysis. Previous literature differentiates four different levels for SCM analysis: internal supply chain relationships, dyadic relationships, chain relationships and network relationships. The differences between these four types of supply relations are depicted in the following figure 3.2.

For coding purposes, these have been defined as follows:

- *Internal*: Integration of business functions involved in the flow of materials and information from inbound to outbound ends of the business.

- *Dyadic*: The management of two party relationships with immediate suppliers or customers.
- *Chain*: The management of a chain of businesses including a supplier, a supplier's suppliers, a customer, a customer's customer, etc.
- *Network*: The management of a network of interconnected businesses that must not be directly linked to the process of production and delivery of goods or services, as for example a consultancy agency (Harland, 1996, p. S64; Lambert & Cooper, 2000, p. 65).

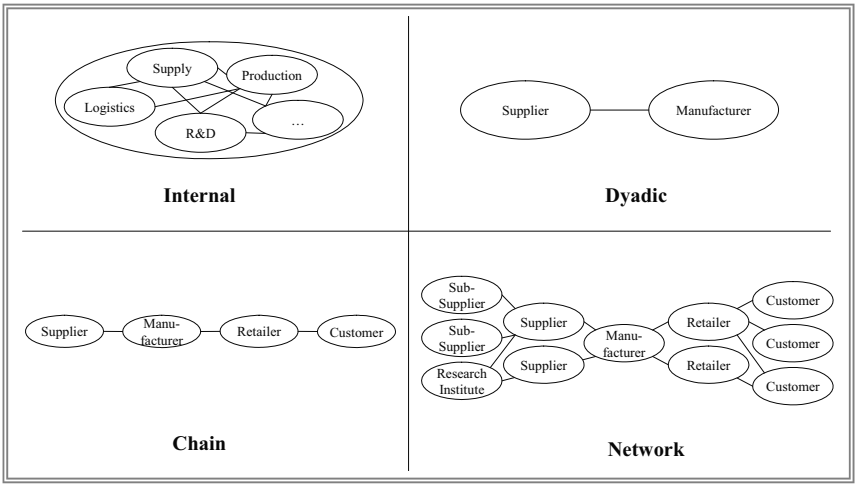


Figure 3.2: Four Levels of Analysis in Supply Chain Management Research
Source: adapted from Harland (1996), p. S72

Coding patterns in this section of the classification scheme were mutually exclusive, i.e. an article had to be classified into one of the four levels, only. However, many scientific articles analyze supply chains at different levels. For example, research into the integration of suppliers in the product development process considers organizing internal supply chains in terms of the integration of functions such as R&D and purchasing and it considers dyadic relationships of an organization and its suppliers. In such cases, articles were classified into the broadest level of analysis as done in previous research (Burgess et al., 2006; Halldórsson & Arlbjorn, 2005). In the example, the article would have been classified as "*dyadic*".

Objectives. The delimitation of distinct objects of study differentiates a discipline from other fields of research. Legitimacy of this discipline is, however, dependent on the valuable contribution research that the discipline can make (Whetten, 1989, p. 490). As a consequence,

understanding the practical objectives that are pursued with SCM research is a final component of analysis in order to draw a comprehensive picture of the SCM object of study.

Again, developing a classification scheme for the SCM objectives of SCM research will rely on existing literature. As stated in chapter 1, the underlying idea of SCM is to integrate business partners in order to remain competitive in complex global and highly dynamic markets (Cooper & Ellram, 1993a, p. 13; Cooper, Ellram et al., 1997, p. 67; Ellram & Cooper, 1990, p. 1). Thus, a major objective of SCM research is to operationalize the notion of *competitive advantage* in a specific SCM context. In this context, a review of earlier research into the operationalization of SCM objectives yielded the following list of *core* objectives (see table 3.3):

Objectives	**References (selected examples)**
Cost reduction	Li, Ragu-Nathan, Ragu-Nathan & Subba Rao, 2006, p. 109 Ward, McCreery, Ritzman & Sharma, 1998, p. 1036 Ho et al., 2002, p. 4422 Scannell et al., 2000, p. 26
Quality improvement	Li et al., 2006, p. 109 Ward et al., 1998, pp. 1036-1037 Ho et al., 2002, p. 4422 Scannell et al., 2000, p. 26
Delivery and reliability	Li et al., 2006, p. 109 Ward et al., 1998, p. 1037 Korpela & Lehmusvaara, 1999, p. 141
Flexibility	Li et al., 2006, p. 109 Ward et al., 1998, p. 1037 Korpela & Lehmusvaara, 1999, p. 141 Scannell et al., 2000, p. 26

Table 3.3: Objectives of Supply Chain Management

These traditional SCM objectives have been supplemented in order to increase the value contribution for the customer (Lummus & Vokurka, 1999, p. 11; Ho et al., 2002, p. 4422). Among the additional targets, the generation of innovations (e.g. Li et al., 2006, p. 109; Scannell et al., 2000p. 26) and organizational learning to facilitate continuous improvement (e.g. Al-Mudimigh, Zairi & Ahmed, 2004, p. 313) seem to be the most important. Therefore, the classification scheme for SCM objectives have been defined as follows:

- *Cost:* All activities targeted at and related to the reduction of costs and prices.
- *Quality:* All activities related to improve the features and characteristics of product- or service-related quality that bear the ability to satisfy stated or implied needs.
- *Delivery & Reliability:* All activities that enable the delivery according to a promised schedule and the reduction of the time required for delivery.
- *Flexibility & Responsiveness*: All activities targeted at improving the capability to adapt or vary.

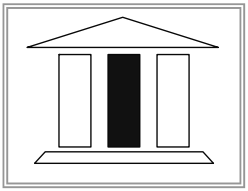
- *Organizational Learning*: All activities related to the development of skills and competencies.
- *Innovation*: All activities related to the generation of value by means of new products, services or features that are valuable from the perspective of the customer.

During the coding process, it became clear that this list of SCM objectives was not yet exhaustive, as recent developments in the political environment led to an enlargement of the objectives pursued in SCM. As an example, an increased awareness of the impact modern life has upon the environment led to more research into means and possibilities to improve environmental protection (e.g. Barker & Naim, 2004). In addition, global supply chains are susceptible to unplanned and unanticipated disruptions as illustrated by recent events such as the 11th September 2001 or the deluge of New Orleans in 2005 that provoked the collapse of supply in many industries (Zsidisin, Melnyk & Ragatz, 2005, pp. 3401-3402). As a result, there has been an increasing number of research on possibilities to secure supply in such situations of supply chain disruptions (e.g. Prokop, 2004). For these reasons, the review panel (see chapter 3.2.8) decided to supplement the classification scheme for SCM objectives by the following two objectives:

- *Environmental protection*: All activities related to the protection of the environment.
- *Security*: All activities related to the prevention and minimization of risks of supply disruption.

The coding instructions for this category allowed for multiple coding of articles in this section.

C) Categories for Scientific Practice - Schools of Thought



In chapter 2, schools of thought have been defined as the different topics scientists in SCM focus on and the specific research methodologies they apply in order to generate insights from and for their particular view on supply chains. In essence, there are two possibilities to uncover major schools of thought in SCM by means of content analysis. The first is to seek to identify potential schools before data collection and to classify the articles into the specific schools. In fact, one question of the expert panel questionnaire was targeted at the identification of central SCM schools. However, the expert's responses suggested that this procedure was inappropriate as it might unnecessarily restrict the outcomes, as this method would either lead to the confirmation or rejection of predefined schools and at the same time restrict the identification of specific other schools that might not have been clearly visible in advance.

Instead, the second method allows for the emergence of schools of thought in the scope of data analysis techniques that allow for the identification of groups that share certain characteristics. This method seems to provide more viable data and information on schools of thought in Supply Chain Management. As a consequence, it is not required to predefine specific categories for SCM schools of thought. Instead, it is necessary to identify those categories that mirror the proposed definition of a school of thought as defined in chapter 2 and either use those categories that serve to generate insights into other parts of the theoretical framework or generate new categories for those elements of the definition that are not yet captured by other categories.

The first major element of the school of thought definition is the specific topics scientists in SCM focus on. In the previous chapter, a number of categories have been defined for the exploration of major SCM constructs. For example, strategy, purchasing, information technology and production occur as core SCM constructs in this section. These constructs can also be interpreted as the specific topics addressed in the SCM articles. Thus, the categories in this section can be used for the identification of SCM schools of thought. Another aspect scientists might focus on is the particular benefit that might result from the appropriate realization of SCM in practice. As a consequence, SCM objectives are a second variable that ought to be considered for the identification of SCM schools.

A third major element of the school definition concerns the research methodologies applied to generate insights on SCM. This aspect is dealt with in the third column of the theoretical framework used for the present thesis, as this third element of the scientific practice level seeks to provide a clear picture of the research activity and fact finding procedures of a discipline. As described in the following chapter 3.2.5, a number of different categories are defined in order to explore methodologies in SCM. Among these, the different research strategies (conceptual exploratory, conceptual structured, empirical quantitative, empirical qualitative and triangulation of the latter two) seem to be appropriate for the description of the major research activities of different schools of thought in SCM.

The fourth and last major component of the school of thought definition concerns the specific viewpoints on supply chains. In chapter 3.2.5, the level of analysis of supply chains have been differentiated into internal, dyadic, chain and network relationships. Thus, this category seems to provide an appropriate differentiation into different viewpoints on supply chains.

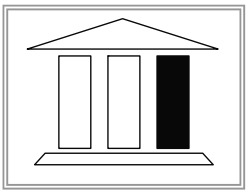
To summarize, it is not necessary to generate additional categories for the exploration of key schools of thought in SCM. Instead, categories from the two other columns of the theoretical framework can be applied and operationalized for the identification schools in SCM. The corresponding categories are the following:

- *Constructs*
- *Objectives*

- *Methodologies*
- *Level of analysis*

The interconnected nature of the three columns is reflected in the arrows that relate columns one and three to column two in the frame of reference (see figure 2.4).

D) Categories for Scientific Practice - Methodologies



Methodologies have been defined as the activities and instruments by which research objectives are achieved (see chapter 2.4.2). The methodological component of the scientific practice level is composed of two parts: research strategy and research analysis. Figure 3.3 provides an overview of how these two parts are structured in the scope of this thesis.

Research Strategy. In this study, *research strategy* refers to the nature of an article. Depending on whether field data is gathered for the generation of theory or not, an article can be either conceptual or empirical (Mehmetoglu, 2004, p. 179). According to Bowen and Sparks (Bowen & Sparks, 1998, p. 126) *conceptual research* encourages theoretical debate, and does not rely on data from the 'real world' and stimulates empirical research. On the one hand, although conceptual research usually does not rely on empirical field data, there are several *structured* tools and concepts in place to increase reliability and validity. For example, for study designs such as mathematical modelling, simulation and experiments, artificial laboratory data is generated to refine and precise theoretical models. On the other hand, another stream of research seeks to maintain a very high degree of freedom and flexibility in order to seek out innovative insights for complex phenomena that are very difficult to understand. Typically, the latter research approach does not rely on specified research designs but appreciates unfamiliar, intellectually challenging forms of inquiry. This type of research has been labelled *exploratory*. The term *exploratory* designates a type of research whose primary purpose is to seek out new insights, ask questions and assess phenomena in a different perspective (Adams & Schavaneveldt, 1991, pp. 103-104). Therefore, the perspective adopted for this thesis is that conceptual research can be differentiated into structured and exploratory designs.

Empirical research might be either quantitative, qualitative or a combination of the two (Creswell, 2002, p. 4). The major difference between conceptual and empirical research is, that empirical research relies on field data whereas conceptual research does not (Mehmetoglu, 2004, pp. 179-180). *Qualitative empirical research* emphasizes the qualities of entities, processes and meanings that are not measured in terms of quantity, amount, intensity or frequency. Qualitative research is aware of the value-laden nature of an inquiry and seeks to

understand how social experience is created and given meaning. In contrast, *quantitative research* emphasizes the measurement and analysis of causal relationships between variables, not processes, and seeks to establish cause effect laws (Denzin & Lincoln, 2005, p. 16; Guba & Lincoln, 1998, pp. 105-106).

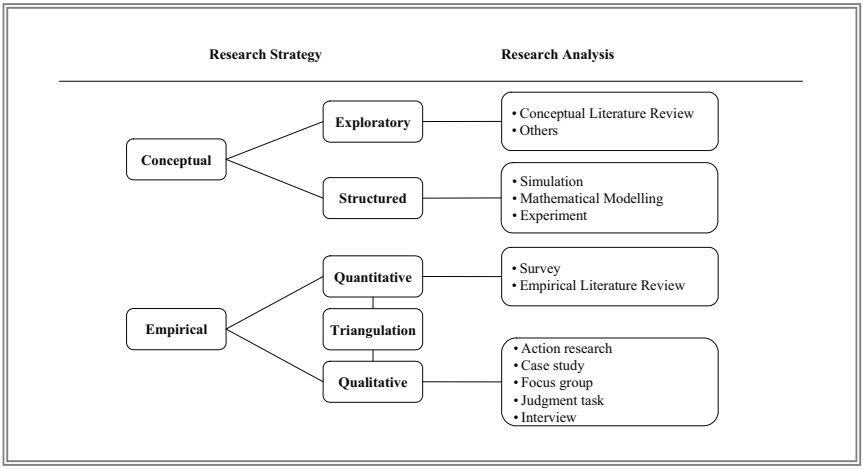


Figure 3.3: Hierarchy in Research Methodologies

Source: own illustration

Research Analysis. In this thesis, *research analysis* refers to the specific fact-finding procedures that yield information about the research phenomenon (Frankel et al., 2005, p. 188). The perspective used in this thesis suggests that no pre-defined and specified research strategy is frequently employed for conceptual exploratory research. In this case, an article is classified into the category "not applicable". Still, conceptual exploratory research might apply existing theories such as the resource-based view (e.g. Barnay, 1991; Prahalad & Hamel, 1990), principal agent theory (e.g. Jensen & Meckling, 1976), or transaction cost theory (e.g. Williamson, 1985) and transfer these established theories to other contexts in order to generate hypotheses (for an example of such an approach see Choi & Krause, 2006; Grover & Malhotra, 2003). Often, no specific research analysis techniques can be discerned for such types of theory generation, as this type of research seeks to maintain a high degree of freedom in the inquiring process. However, some research that is conceptual and exploratory in nature uses reviews of existing literature and theory to provide propositions and hypotheses. As a consequence, one of the most important research analysis techniques employed by this type of research is conceptual literature reviews.

Conceptual research that uses structured approaches for theory development and refinement frequently relies on strategies that yield in the generation of artificial data. For the purposes of this thesis, artificial data are defined as data that were not obtained from the real world but, instead, are created in the laboratory or by means of computer programs. In essence, three major types of data generation techniques can be differentiated: simulations, mathematical modelling, and experimental simulation.

Due to the different nature of inquiry in qualitative and quantitative empirical research, the types of research analysis techniques in these two approaches strongly differ. However, in previous studies on research analyses in SCM, often no differentiation was made in terms of the empirical study design for quantitative and qualitative strategies (e.g. Mentzer & Kahn, 1995, Sachan & Datta, 2005) with the exemption of the contribution from Reichhart and Holweg (2006). The research analysis techniques that will be analyzed in this study are mainly derived from previous similar studies from other fields than SCM (Scandura & Williams, 2000, pp. 1250-1252; Flynn, Sakakibara, Schroeder, Bates & Flynn, 1990, pp. 256-257; Scudder & Hill, 1998, p. 95). The classification into qualitative and quantitative research is based on the differentiation proposed by Richart and Holweg (2006, p. 385). To summarize, the following types of research strategies will be differentiated for the purposes of this thesis:

Conceptual, exploratory research analysis techniques:

- *Conceptual literature review*: In a literature review, literature is summarized to gain insights into an area (Scandura & Williams, 2000, p. 1250). There are two different types of literature reviews: conceptual literature reviews and empirical literature reviews. The objective of the first one is to critically review existing literature and to map knowledge in an area in order to conceptualize models for empirical testing (Denyer & Tranfield, 2006). As an example, Chen and Paulraj reviewed more than 400 contributions on Supply Chain Management in order to develop a theoretical framework for Supply Chain Management research (Chen & Paulraj, 2004b, pp. 132-133). The second type will be explained in the section on quantitative research strategies. Only those articles were classified as literature reviewed (either conceptual or empirical) that used a literature review as methodology in the main body of the text. Thus, articles that provided literature reviews as a mere foundation for the main part were excluded.
- *Others*: Any other research analysis techniques employed in the scope of conceptual exploratory research to allow for a high degree of flexibility in the inquiring process.

Conceptual, structured research analysis techniques:

- *Simulation*: Simulations refer to experiments on the reactions of a model through targeted manipulation of variables in an artificial environment. Simulations are frequently realized with the assistance of computers (*computer simulation*) that

involve the artificial creation of data and the realization of the simulation by means of specialized software programmes and techniques (Scandura & Williams, 2000, pp. 1250-1251).

- *Experiment*: As in simulation, the researcher uses an experiment to manipulate some variable(s) in order to observe the resulting changes. What differentiates an experiment from a simulation is that they take place in natural settings (Flynn et al., 1990, p. 257).
- Mathematical Modelling: Mathematical modelling is a research analysis technique that uses abstract mathematical language to describe the behaviour of a system (Rutherford, 1994, p. 12).

Empirical quantitative research analysis techniques:

- *Survey*: A survey uses an instrument (usually a questionnaire) for the collection of factual-data on a certain topic in order to enable statistical data analyses (Flynn et al., 1990, pp. 257-258; Scudder & Hill, 1998, p. 95; Scandura & Williams, 2000, p. 1250)
- *Empirical literature review*: The objective of this second type of literature review is to empirically summarize knowledge in an area without necessarily developing models for empirical testing. The major difference between a conceptual literature review and an empirical one is that the former relies on statistical techniques to map knowledge whereas the latter relies on narrative summarizing techniques.

Empirical qualitative research analysis techniques:

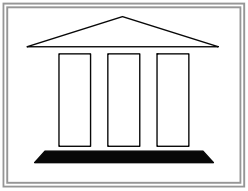
- *Action research*: Action research is a social change process of a phenomenon that requires the direct involvement and participation of the researcher in the object of study (Näslund, 2002, p. 333; Kamberelis & Dimitriadis, 2005, pp. 566-568; Müller, 2005, p. 353). What differentiates action research from most other methods of inquiry is the direct involvement of the researcher. In addition, due to the process orientation of action research, the object of study might vary in the course of investigation.
- *Case study:* A case study is a method of inquiry that investigates a phenomenon within its real-life context (Yin, 2003, p. 13) in order to understand the dynamics present in single settings (Eisenhardt, 1989, p. 534). What differentiates case study research from action research is that the researcher is not directly involved in the modification process. Case study research can either build on a singular case or multiple cases to ensure an increased degree of generality of findings (Eisenhardt & Graebner, 2007, p. 27; Stake, 2005, p. 444; Flynn et al., 1990, pp. 256-266)
- *Focus group:* Focus groups are collective conversations or group interviews (Kamberelis & Dimitriadis, 2005, p. 887). Unlike panel studies (see below), the group is physically assembled on the invitation of a facilitator who asks questions.

Each member has the opportunity to give his opinion on the question to the entire group. The overall goal is to reach consensus on the topic of discussion (Flynn et al., 1990, p. 257).

- *Judgement tasks (Delphi, expert panel)*: The primary objective of a panel study is to obtain consensus on a certain question, e.g. on the definition of a term or identification of future trends (e.g. Hill & Fowles, 1975). One of the most important types of panel study is the Delphi technique. A panel study requires the identification of experts in the field of investigation. These experts are invited to respond to questions in written form. Anonymous responses are distributed randomly to the members of the panel who are asked to give further comments and to revise their own responses. This procedure is repeated until consensus is reached (Rowe, Wright & Bogler, 1991, pp. 236-237; Flynn et al., 1990, p. 257). In this research, the terms judgement task, expert panel and panel study are used as synonyms.
- *Interview*: An interview study is one where the data and findings are based on researcher-to-respondent conversations (Daniels & Cannice, 2004, p. 185) by means of a questionnaire (Flynn et al., 1990, p. 259). What differentiates interviews from survey research is that the questions asked are open questions that ensure conversation.

Sample articles are classified into the corresponding research analysis techniques. Those studies that employed more than one research analysis technique were classified into the category *methodological triangulation* (Scandura & Williams, 2000, p. 1249).

E) Categories for Operational Practice



In this final section on codebook development, categories for two elements are developed: industrial sectors and geographic focus. The idea underlying the investigation of these two elements was to understand the degree to which empirical data collection considers the importance of cross-sector and international research, i.e. how far practical challenges are mirrored in theory building from empirical data. Accordingly, in both cases, only those articles can be classified into the respective categories that are empirical and not conceptual in nature.

Industrial sectors. Articles were classified into those industrial sectors from which empirical data were gathered. Those articles that did not use empirical data for theory development and those that did not make any reference to the origin of the data, were classified as *not applicable* (N/A) in this category. Articles using empirical data from multiple industries could be classified in more than one industrial sector.

As done in previous, similar research (e.g. Burgess et al., 2006, p. 707), this study relied on a standard industrial classification code. Since SCM research is still dominated by contributions from North American authors (Sachan & Datta, 2005, p. 673), it seemed to be appropriate to select a classification code from the United States since the majority of empirical data collection would presumably be from US-based organizations. Still, in order to ensure that European, Asian and other region's industries could be easily classified into the industrial sector classification scheme, the decision was made to remain at a high and abstract level of classification. This seemed to be the case for the Standard Industrial Classification (SIC) System provided by the United States Department of Labour that differentiates ten major industry divisions depicted in table 3.5 (United States Department of Labour, 2007).

Industrial Sector	**Definition**
Agriculture, Forestry, Fishing	Establishments primarily engaged in agricultural production, forestry, commercial fishing, hunting and trapping, and related services
Mining	Establishments primarily engaged in mining. The term mining is used in the broad sense to include the extraction of minerals occurring naturally: solids, such as coal and ores; liquids, such as crude petroleum; and gases such as natural gas
Construction	Establishments primarily engaged in construction. The term construction includes new work, additions, alterations, reconstruction, installations, and repairs
Manufacturing	Establishments engaged in the mechanical or chemical transformation of materials or substances into new products. These establishments are usually described as plants, factories, or mills and characteristically use power driven machines and materials handling equipment
Transportation, Communications, Electric, Gas, Sanitary Services	Establishments providing, to the general public or to other business enterprises, passenger and freight transportation, communications services, or electricity, gas, steam, water or sanitary services
Wholesale Trade	Establishments or places of business primarily engaged in selling merchandise to retailers; to industrial, commercial, institutional, farm, construction contractors, or professional business users; or to other wholesalers; or acting as agents or brokers in buying merchandise for or selling merchandise to such persons or companies
Retails Trade	Establishments engaged in selling merchandise for personal or household consumption and rendering services incidental to the sale of the goods
Finance, Insurance, Real Estate	Establishments operating primarily in the fields of finance, insurance, and real estate. Finance includes depository institutions, non-depository credit institutions, holding (but not predominantly operating) companies, other investment companies, brokers and dealers in securities and commodity contracts, and security and commodity exchanges. Insurance covers carriers of all types of insurance, and insurance agents and brokers. Real estate includes owners, lessors, lessees, buyers, sellers, agents, and developers of real estate

Industrial Sector	Definition
Services	Establishments primarily engaged in providing a wide variety of services for individuals, business and government establishments, and other organizations. Hotels and other lodging places; establishments providing personal, business, repair, and amusement services; health, legal, engineering, and other professional services; educational institutions; membership organizations, and other miscellaneous services, are included
Public Administration	The executive, legislative, judicial, administrative and regulatory activities of Federal, State, local, and international governments

Table 3.4: Classification Scheme for Industrial Sectors

Geographic focus. In order to understand the degree to which SCM research responds to the challenges of internationalization. The original idea was to classify articles according to the countries that empirical data were gathered from. However, the pre-test revealed that this classification was too fine-grained (see chapter 3.2.7). Often, authors remain rather vague in terms of the countries that empirical data have been gathered from. As an example, Abrahmsson and Brege provide in-depth analyses of supply chain structures of selected organizations with plants spread all across the European continent without clearly indicating which countries these were (Abrahamsson & Brege, 1997). In addition, several researchers only indicated that empirical data was gathered from American and European organizations without specifying which countries these European organizations were based in.

Therefore, after the pre-test, the decision has been made to classify articles only according to the continent that empirical data was gathered from. However, this strongly reduces the possibility to understand the degree of internationalization of SCM research. Therefore, an additional classification criterion was introduced and supposed to cope with this limitation. This criterion classifies articles based on either single or multiple countries, as data sources. Thus, articles that gathered empirical data from American and European countries would be classified as *Europe*, *America* and *Multiple*. Articles that used data from, for example, Spain were classified as *Europe* and *Single*, and articles that gathered data from, for example, eastern European countries were classified as *Europe* and *Multiple*. Table 3.6 summarizes the classifications for the element *geographic focus* of the operational practice level.

Continent	Country coverage
Africa	Single country
Asia-Pacific	Multiple countries
Australia	
Europe	
North America	
South America	

Table 3.5: Classification Scheme for Geographic Focus

Those articles that did not use empirical data for theory development and those that did not make any reference to the origin of those data were classified as *not applicable* (N/A) in this category.

F) Conclusions

The previous paragraphs provided a comprehensive description of the processes and steps undertaken to develop valid and comprehensive analytical constructs for the following elements of the frame of reference: philosophy of science, object of study and main constructs, schools of thought, methodologies, and operational practice. In order to ensure a high degree of quality and comprehensiveness of these analytical constructs, a variety of sources of certainty has been applied for their formulation. Among these, previous successful analytical constructs, expert knowledge and established SCM models and theories were the most important. Table 3.7 summarizes the proposed categories and their characteristics.

Anomalies and unresolved research questions are the only parts of the frame of reference that will not be analyzed by means of content analysis. In essence, the characterization of the evolution of a discipline takes into consideration its underlying philosophy, the object of study, schools of thought, research methodology and the link to operational practice. All these aspects can be investigated by an analysis of existing literature. Instead, from the perspective assumed in this thesis, anomalies and unresolved research are those central problems that shape the actual state of a discipline in order to derive directions for future research activity. As a consequence, no analytical constructs were proposed for these. Instead, insights into these sections will be gained from the expert study.

Element	Categories	Type
Paradigm	Positivism Critical theory, constructivism, participatory	single - inferred single - assumed
Definition	None, existing, modified, own	single - assumed
SCM constructs	Closed-loop supply chain & environmental protection; demand chain management; human resource management; information technology & e-business; inventory management; knowledge management; lean supply chain management & integration; legal affairs; marketing & sales; organization structure & processes; performance measurement & reward systems; power, reach, interdependence; product management; production management; quality management; relationships, alliances & cooperation; risk management; strategy & leadership; supply chain design; supply management & purchasing; transportation & logistics; others	multiple - assumed / inferred

Element	Categories	Type
Level of analysis	Internal, dyadic, chain, network	single - assumed
Objectives	Cost, quality, delivery & reliability, flexibility & responsibility, organizational learning, innovation environmental protection, security	multiple - assumed multiple - inferred
Disciplines	Logistics; purchasing &supply management; marketing; network management & relationship analysis; human resource management; strategic management; organization sciences; information technology & knowledge management; financial management & controlling; operations management & operations research	single - assumed
Research strategy	Conceptual exploratory, conceptual structured, empirical quantitative, empirical qualitative	multiple - assumed
Research analysis	Conceptual literature review, simulation, mathematical modelling, experiment, survey, empirical literature review, action research, case study, focus group, judgement task, interview, not applicable	multiple - assumed
Industrial sector	Agriculture, mining, construction, manufacturing, transportation, wholesale trade, retail trade, finance, services, public administration, not applicable	multiple - assumed
Geographic focus	Africa, Asia-Pacific, Australia, Europe, North America, South America, not applicable Single, multiple	multiple - assumed/ inferred single - assumed

Table 3.6: Overview of Content Categories

3.2.6 Step 6: Generation of Coding Scheme

This step entails the definition of classification rules (Insch et al., 1997, p. 12). In the previous chapter, the main classification rules for categorizing articles have already been explained. These rules were summarized in a codebook that supported the work of the coder. Next to the categories, their definitions and characteristics (i.e. a statement whether multiple coding was possible or not), the codebook also provided specifics of the (1) data language or codes, (2) extensional lists, and (3) decision schemes.

During the classification process, the coder had to assign values to categorize each article in order to determine whether they thought that an article belongs to the category or not. For this reason, the data language was reduced to the two expressions “0” and “1”. Coding an article with “0” into a certain category meant that the article was not classified in this category. In contrast, coding an article with “1” in a certain category meant that the article was classified into the category.

According to Krippendorff (2004, pp. 133-134), extensional lists become important, when content categories are complex and difficult to communicate. In such cases, extensional lists

enumerate instances or keywords that define the categories and thus, assist coders in doing their work. In the scope of this study, supportive extensional lists were provided for categories of scientific paradigms and for categories determining the SCM constructs.

Decision schemes are an additional instrument to support the classification process and to ensure that categorizations into complex and difficult categories are the outcome of a reliable, predefined sequence of decisions. Such decision schemes organize complex judgements in terms of what needs to be decided first, second, third, and so on. In addition, they help to provide consistent classifications into categories that are defined at different levels of generality or that overlap in meaning (Krippendorff, 2004. p.135). In the present study, the categories for both scientific paradigms and schools of thought were considered very complex and difficult to determine. Therefore, decision schemes were provided for these two sections of the codebook. As an example, the decision scheme for a scientific paradigm is depicted in the following figure 3.4.

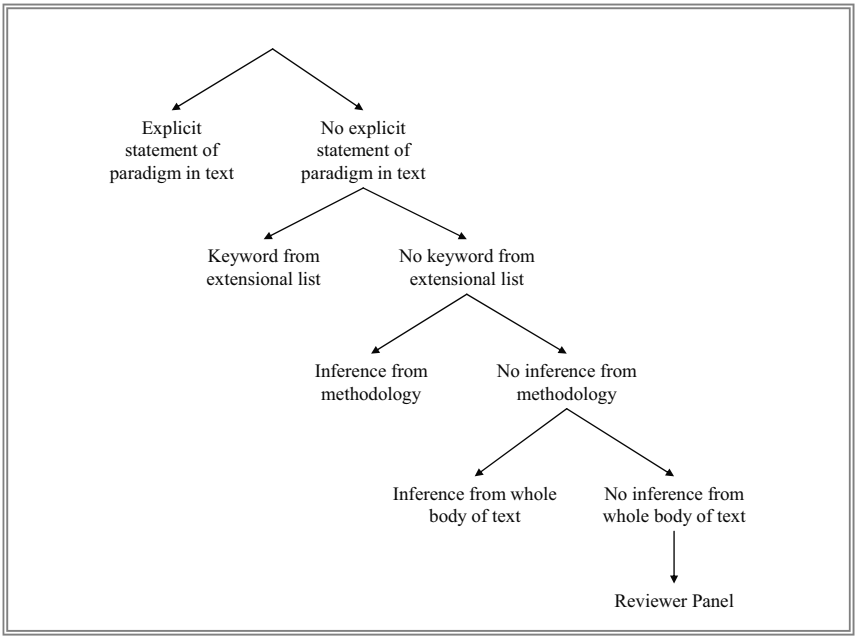


Figure 3.4: Example of a Decision Scheme

Source: own illustration

3.2.7 Step 7: Pilot Classification Process

This step serves to pre-test the coding scheme, i.e. the categories and coding instructions, in order to understand whether categories are appropriate, exhaustive and clear, and whether the coding instructions fulfil the same criteria. Therefore, the researcher should identify a sample of texts and code them (Insch et al., 1997, p. 199). The pilot study of this research involved coding twenty articles and entering the data into a pre-designed excel-spreadsheet. As a result of this process, some category definitions were revised and refined. In addition, several instructions for classification were revised, made precise and amended to provide additional clarity.

3.2.8 Step 8: Data Collection

The actual coding can take place once the categories and coding instructions have been made accurate, the sample drawn and the units of analysis specified (Insch et al., 1997, p. 14).

For the purposes of this study, all 282 articles were classified into all categories proposed by assigning them the values “1” (for applicable) or “0” (for not applicable). These values were inserted into a data collection form created in Microsoft Excel. The data collection form supported the data collection process, as it calculated sums for all categories belonging to the same construct. Thus, in particular for exclusive categories that allowed only for one entry of the value “1”, it was easy to see whether an article had already been assigned to a category or not. In addition, the data collection form collected general information on each article. Each article therefore, received a unique identification number, the names of the authors were collected, the journal in which an article was published and, finally, the year of publication was tracked. The latter should enable a differentiated analysis of the obtained data according to different periods of time. This main coding process took place in July and August 2007. Whenever the coder was unsure about the correct classification of an article, he consulted the assistant professor of the thesis. In such cases, the two scientists had to come to an agreement on the final classification of the article in question.

3.2.9 Step 9: Quality Assessment

Content analysis has been defined as a research technique used to make replicable and valid inferences from texts. As a consequence, measures to ensure validity and reliability play an important role in content analysis (Spens & Kovacs, 2006, p. 379). *Reliability* implies that a research procedure should respond to the same phenomena in the same way regardless of the circumstances of its implementation (Krippendorff, 2004, p. 211). *Validity* is achieved if measuring instruments measure what their user claims to measure (Krippendorff, 2004, p. 313, Kassarjian, 1977, p. 9). This section describes the measures used in this thesis to ensure a high degree of reliability and validity.

A) Reliability

Krippendorff distinguishes three types of reliability: stability, reproducibility and accuracy (2004, pp. 214-216). *Stability* refers to the degree to which a process is unchanging over time. *Reproducibility* describes the degree to which a process can be replicated by different analysts working under varying conditions (Weber, 1990, pp. 17-18). *Accuracy* is the degree to which a process conforms to its specifications and yields what it is designed to yield. Table 3.7 provides an overview of the actions that were used successfully in similar, earlier content analysis studies.

Reliability type	Proposed Measure	Reference
Stability	R1) Specify clear analytical constructs, categorization schemes and decision rules for coding	Cullinane & Toy, 2000, p. 45 Kassarjian, 1977, p. 9 Kolbe & Burnett, 1991, p. 245 Spens & Kovacs, 2006, p. 380
	R2) Provide clear description of required coder qualifications; ensure availability of potential coders	Krippendorff, 2004, pp. 127-128 Milne & Adler, 1999, p. 238
	R3) Reread, recategorize and reanalyze the same text after some time	Krippendorff, 2004, p. 215 Spens & Kovacs, 2006, p. 381
Reproducibility	R4) Ensure that coders are capable of understanding these rules and applying them consistently	Krippendorff, 2004, p. 127 Milne & Adler, 1999, p. 238
	R5) Ensure reliability of coding instrument	Krippendorff, 2004, pp. 171-179 Milne & Adler, 1999, pp. 238-239 Spens & Kovacs, 2006, p. 381
Accuracy	R6) Ensure reliability of coded data set through the use of multiple coders	Krippendorff, 2004, p. 215 Spens & Kovacs, 2006, p. 381 Cullinane & Toy, 2000, pp. 45-46 Cheng & Grimm, 2006, p. 3
	R7) Report and analyze discrepancies between coders	Cullinane & Toy, 2000, p. 46 Ellinger et al., 2003, p. 204 Guthrie et al., 2004, p. 287 Kassarjian, 1977, p. 9
	R8) Assess coding consistency and stability	Guthrie et al., 2004, p. 287 Krippendorff, 2004, pp. 215-216 Spens & Kovacs, 2006, p. 381

Table 3.7: Measures to Ensure Reliability

In the following paragraphs, the activities that have been realized will be described in order to address reliability of the methodology applied in the scope of this section of the thesis.

R1 - Specification of coding instructions To ensure reliability of the review process, a codebook has been developed in order to ensure consistency during the review process and to facilitate the replication of the review. The codebook provides definitions of all analytical constructs as developed in chapter 3.2.5. These definitions ensure a common understanding of the respective codes. In addition, the codebook specifies the data language used for the classification articles into the respective codes. Since this research used two different kinds of classes of codes and analytical constructs, namely those where codes were mutually exclusive and those where this was not the case, the codebook specified which category each pertained to. Complex categories that required a set of several decisions in order to judge on the classification of an article were amended by a decision scheme to ensure that the outcome follows a strictly predefined sequence of decisions.

R2 - Coder specifications. A clear specification of the qualification needed by the coders engaged in a content analysis, is necessary to ensure that the content analysis can be replicated elsewhere (Krippendorff, 2004, p. 127). The nature of the main research question of this study requires coders to have a strong scientific background with knowledge on the ontology and epistemology of science and the main methodologies used in the social sciences. Therefore, coders need to have obtained at least a master's degree or equivalent in a field of research belonging to social sciences. In addition, familiarity with Supply Chain Management is required, i.e. coders should have at least two years of practical and/or scientific experience in SCM to ensure that they have sufficient background to understand the analytical constructs and to apply the coding instructions consistently.

Specifically, this research relied on one coder and a research partner: The research partner obtained a diploma in business administration with one major in logistics. In addition, the supervisor gained approximately ten years scientific and practical experience in logistics and supply chain management. The primary coder obtained a master's degree in strategic management and disposes of one year practical experience in supply management and additional three years scientific experience in logistics and supply chain management. In addition, both reviewers provided proof of their capacity to cope with this research as they investigated similar topics previously (e.g. Walter & Wolf, 2007).

R3) Recoding. The main coding process took place in July and August 2007. Two months after the end of the main coding process, a random sample of articles was cross-coded. Such test-retest reliability measures provide information on intra-observer inconsistencies as they measure variations in the performance of an observer (Krippendorff, 2004, p. 215). In order to perform the re-test, a random sample of thirty articles was drawn from the original sample. The primary coder recoded all these and compared them to the original classification.

Deviations from the original classification were measured by means of two different values, the first being the rate of agreement, the second referring to Krippendorff's α. The present study relied on binary data, i.e. during the review process one of two available values were

assigned to each code. Thus, each article received "0" for an absent code and "1" for a present one. The rate of agreement provides the percentage of agreements on the codes that the analyzed articles received for one analytical construct under investigation. For the purposes of this research, the rate of agreement had to be at least 80% to be accepted.

Krippendorff's α is the most general coefficient measure in content analysis. In this context, α describes the extent to which the proportion of the differences that are in error deviates from absolute agreement that is obtained if α assumes the value "1". In order to do so, α puts into relation the actual observed disagreement with the disagreement that can be expected when chance prevails (for a complete description of the calculation of Krippendorff's α see Krippendorff, 2004, pp. 221-227). Coding differences between the test-retest conditions were considered as severe if the coefficient α fell below the threshold of 0.6. A complete overview of the results for the rate of agreement and Krippendorff's α calculation is provided in the appendix (see appendix 5). The test-retest did not reveal any substantial differences and thus, confirms reliability of the coding process.

R4) Coder qualification. Ensuring coder qualification implies to ensure that coders are capable of understanding the coding instructions and of applying them consistently. In essence, three actions contribute to coder qualification. The first entails setting clear and comprehensive coding instructions for the coding process (see R1). The second is to ensure that coders have sufficient cognitive abilities and background to understand these and to apply them consistently. In R2, a description of necessary coder characteristics for this study was provided. From this it becomes clear that emphasis have been laid on the establishment of certain barriers in terms of educational background and, practical and scientific experience for coders to be accepted. Thus, a sufficient level of coders' cognitive abilities is ensured. Krippendorff proposes coder training as a final activity to ensure coder qualification (Krippendorff, 2004, pp. 129-131). As both the coder and the assistant professor who were involved in the review process for this study were engaged in similar research previously, there seemed to be no need for comprehensive additional training. Nevertheless, a two-hour workshop was organized where the two coders discussed each item of the codebook, clarified their perceptions of these and, in case these perceptions differed, established an agreement and precision of the respective code.

R5) Reliability of coding instrument. Ensuring the reliability of the coding instrument implies that the coding instructions must be designed in a way to enable the replication of the content analysis elsewhere and under different circumstances. Accordingly, the syntax and semantics of data language and the decision rules and procedures coders must apply in order to classify articles need to be specified (Krippendorff, 2004, p. 127). As described in R1, all this information is bundled comprehensively and exhaustively in the codebook. The complete codebook is attached in appendix 4 and, therefore, is made available to researchers who intend to replicate the content analysis.

R6) Multiple coders. Content analyses typically rely on more than one coder to ensure inter-rater reliability (Krippendorff, 2004, p. 215). However, within literature, there is no agreement as to the optimal number of coders that should be used for specific types of content analyses. Kolbe and Burnett (1991, p. 246) reviewed 128 applications of content analysis and found that most frequently, two coders were used in the review process. Furthermore, Milne and Adler (1999, pp. 238-239) state that the number of coders can be reduced if there are procedures in place that ensure the reliability of the coding instrument itself. In this research, a number of actions have been implemented to ensure a high level of reliability of the coding instruments as described in the previous paragraphs. In contrast, due to constraints in terms of financial and time resources, it was not possible to use more than one coder. However, in order to ensure a high degree of reliability of the coding process, an research partner from the same research institute as the author of the thesis was involved in the formulation of the codebook and functioned as key consultant in cases where the main coder was unsure about the appropriate classification of an article.

R7) Discrepancies between coders. Since the research partner did not function as secondary coder, it is not possible to report any discrepancies between coders in terms of calculations of agreement rates and Krippendorff's alpha. Still, differences are probably to be rather small as both the author of thesis and the research partner frequently interacted and discussed the categories in order to generate a common understanding of these.

R8) Coding consistency and stability Ensuring coding consistency and stability ensures that the coding process conforms to its specifications and yields what it is designed to yield (Krippendorff, 2004, p. 215). In this study, coding consistency has been ensured by means of four actions. First, the clear and precise definition of categorization rules ensured the consistent classification of articles in all sections (see R1, R4, and R5). Second, the applicability of the codebook has been tested in a pre-study of twenty articles that led to the precision and reformulation of some of the category definitions and classification rules. Third, consistency and stability was ensured by performing a test-test-analysis (see R7) and, fourth, by performing a test-retest-analysis (see R3).

To summarize, a number of actions have been taken in order to ensure a high degree of reliability of the present content analysis. It should still be noted that - as in almost any type of research - content analysis is susceptible to a number of intentional (e.g. the applied sampling strategy) or accidental pollutants, distortions, and biases (Krippendorff, 2004, p. 211). Thus, it is almost impossible to obtain perfect reliability and all the results of this analysis should be considered and discussed with respective precaution. The next chapter turns the discussion to issues and questions related to validity. Some of the actions are to ensure reliability and also support the validity of this research. Therefore, where appropriate, references will be made to the corresponding sections of this chapter.

B) Validity

An analysis technique is considered valid if it measures what its user claims to measure (Krippendorff, 2004, p. 313). In this sense, two distinctions can be made. The first concerns the distinction between the validity of the correspondence between two sets of things, for example analytical constructs, methods and data, validity as generality of results, and references and theory. The second distinction concerns that between the validity of the classification scheme and the validity of the interpretation. To ensure that a category or analytical construct is valid is to ensure that there is a correspondence between the construct and the concept that it represents. To ensure that a research result is valid is to ensure that the finding does not depend upon specific data, methods or measurements (Weber, 1990, p. 18). Frequently, the following core types of validity are differentiated:

- *Face validity* refers to the correspondence between an investigator's definition of concepts and the analytical constructs supposed to measure them.
- *Empirical validity* is the degree to which available evidence and established theory supports various stages of the investigation process.
- *Content validity* is the extent to which all features that define the concept are measured.
- *Construct validity* refers to the extent to which a measure is correlated with other measures of the same construct (Weber, 1990, pp. 18-21; Krippendorff, 2004, pp. 313-315).

The concepts that have been analyzed in this research were measured by means of nominal scales and mutually exclusive constructs, i.e. an analytical construct would either be applicable or not applicable. Therefore, assessing construct validity does not make sense in this research. The following table 3.8 reports on the measures that have been applied in earlier research to ensure the remaining three types of validity.

Validity type	Proposed Measure	Reference
Face validity	V1) Fine-tuning of category development during the coding process	Cullinane & Toy, 2000, p. 45 Harris, 2001, p. 199 Kolbe & Burnett, 1991, p. 245 Spens & Kovacs, 2006, p. 380
	V2) Use human coders instead of computerized programs	Krippendorff, 2004, pp. 313-314 Sonpar & Golden-Biddle, 2005, p. C2
Empirical	V3) Follow theoretical framework for the development and definition of analytical constructs	Cullinane & Toy, 2000, p. 45 Guthrie et al., 2004, p. 289 Pasukeviciute & Roe, 2005, p. 860 Spens & Kovacs, 2006, p. 380

Validity type	Proposed Measure	Reference
Content	V4) Ensure exhaustiveness of analytical constructs	Sonpar & Golden-Biddle, 2007, pp. 7-8 Spens & Kovacs, 2006, p. 380 Krippendorff, 2004, pp. 173-185

Table 3.8: Measures to Ensure Validity

V1) Category fine-tuning. The objective of category fine-tuning is to ensure that categories are both exhaustive and precise enough to account for all events that might occur during the review process. Three actions contributed to category fine-tuning. First, the applicability of the codebook has been tested in a pre-study on a small sample of the overall sample units. This study did not reveal any necessity to adapt the codebook (see R8). Second, as the review process continued and the whole sample was comprised, it became evident that the number of pre-set categories was not exhaustive. In these cases, the review panel jointly came to the conclusion to include additional categories (see R8 and R3). Third, the calculation of agreement coefficients allowed revealing categories where coders systematically disagreed. In such cases the review panel had to come to a solution for these discrepancies (see R8).

V2) Type of coders. As Krippendorff (2004, p. 257) suggests, the emergence of information technology and the development of specific software programs have revolutionized content analysis. Whereas performing content analyses "by hand" is often time-consuming and unreliable, computers are used to circumvent the tedium involved in manual data handling. However, programming software in a way to ensure unambiguous results is also a very difficult and time consuming task. For example, an investigation into human rights and a corresponding search for the word "right" might yield results for "right" in the sense of left-right. Human coders are usually less susceptible to such kinds of errors. In addition, many of the categories used for the purposes of this study cannot be investigated by means of information technology (see for example the case of scientific paradigm). As a consequence, relying on human coders seemed to produce more valid results for this study.

V3) Follow theoretical framework. Using existing theoretical frameworks for the development of classification categories, accounts for both exhaustiveness and a high degree of potential success of the categories and codes (Krippendorff, 2004, p. 173). As illustrated in chapter 3.2.3, great emphasis has been laid upon the use of existing theory and models for the proposition of the analysis constructs. Thus, the constructs for the following categories are based on existing theory: paradigms, definitions of SCM, level of analysis, objectives of SCM, research strategy, research analysis, industry sectors and geographical focus.

V4) Exhaustiveness. Due to the strong reliance on existing theory and successful applications of the constructs in earlier studies, exhaustiveness of categories was supported, if applicable. In addition, where only insufficient data from existing theory was available, information obtained from the expert study (see chapter 3.2.1) provided for additional sources of certainty

for exhaustiveness of the categories. Finally, the review process allowed for the ex-post integration and refinement of categories in case that these were deemed insufficient by the review panel (see R3, R7 and R8).

3.3 Interim Summary

This chapter provided a profound and comprehensive description of the methodology applied in this research. Those aspects of the frame of reference developed in chapter 2 are analyzed by means of a content analysis from existing literature on Supply Chain Management. In essence this concerned the philosophy of science, scientific practice and operational practice elements of the frame of reference. The results of the eight core steps of the content analysis involved in the study are summarized in the table 3.9.

In addition, an expert study was described that seeks to gain information on those elements of the frame of reference that can be assessed only with difficulty from a mere content analysis approach. Primarily, this concerns anomalies and unresolved research questions. In this chapter, the characteristics defining an expert in the theory of SCM were laid out, the questions these experts were asked were described and the methodology of response collection was set out.

Steps	Core Results
Research outlets	International Journal of Logistics Management, International Journal of Physical Distribution & Logistics Management, International Journal of Production Economics, International Journal of Production Research, Journal of Business Logistics, Journal of Operations Management, Production Planning and Control
Studies	282 scientific articles
Unit of analysis	Article
Categories	76 categories for 19 constructs
Coding scheme	Codebook: categories, instructions, data language, extensional lists, decision schemes
Pilot study	20 sample articles, refinements
Data collection	Primary coder, review panel
Quality Assessment	Reliability: pilot study, test-test, test-retest, coder qualification Validity: inferred categories, review panel, theoretical frameworks

Table 3.9: Overview of Methodology

In the following chapter, the results of these two data collection techniques are presented and analyzed step-by-step.

4 Data Analysis and Evaluation

The classification of articles into the categories defined in the previous chapter led to the generation of quantitative data from the qualitative article contents. These data were entered into both an Excel-database and a SPSS file, to enable and facilitate data analysis. In this chapter, the results of the empirical data analysis process will be described. In addition, the experts' answers from the expert study will be provided and analyzed. The insights gained from these data analysis procedures will make it possible to answer the research questions formulated in chapter 2.

This chapter is structured as follows. A major objective of this research has been to understand the nature of international SCM research and its evolution over time. As a consequence, an important first step was to differentiate appropriate phases of evolutionary SCM periods (chapter 4.1). These phases will be the basis for the empirical data analysis in the second step. Here, the different parts of the frame of reference will be analyzed step-by-step in a structured way. Therefore, in each section, quantitative data on a certain element of the framework will be provided, and its evolution over time will be discussed in order to discern the characteristics of the elements in the differentiated periods (chapters 4.2 to 4.6).

The final element of the frame of reference has been potential anomalies and major unresolved research questions in SCM that might challenge SCM research in the near future. Information on this part of the framework was gained by means of an expert study and not through content analysis. Therefore, the third step consists of a qualitative analysis and evaluation of the experts' answers to the respective questions (chapter 4.7). The information gained from these comprehensive data analysis processes will make it possible to characterize the evolution and nature of international SCM research (chapter 4.8).

4.1 Evolution of Supply Chain Management Research Activity

In this section, several general descriptive features of articles, their publication outlet and the years of publication will be analyzed in order to understand which degree of emphasis has been laid on SCM over time. Moreover, an attempt will be made to differentiate between the major phases of the development of SCM research by means of an analysis of the overall publication activity in Supply Chain Management.

4.1.1 Description of Publication Activity

This chapter does not discuss the results of the content analysis per se, but provides an overview of the overall distribution of the 282 sample articles across time and journals. This

process sheds light on the overall evolution of research and publication activity within SCM and the role the different journals play as SCM research outlets. These insights can be used to segment the overall analysis period ranging from 1990 to 2006 into different periods or phases in order to make the results of the content analysis process rather easily comparable over time.

	90	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**Σ**
IJPE	0	0	0	0	0	0	1	0	0	2	1	5	6	7	8	7	9	**46**
IJPR	0	0	0	0	0	1	0	0	0	0	1	0	7	5	4	10	3	**31**
IJLM	2	0	0	2	1	2	4	7	5	5	5	5	4	4	6	4	2	**58**
IJPDLM	0	0	0	0	3	0	2	2	2	1	9	4	8	5	5	10	5	**56**
JBL	0	0	1	0	0	3	1	1	0	4	4	6	1	2	6	5	4	**38**
JOM	0	0	0	0	0	0	0	0	1	1	1	2	4	3	4	3	2	**21**
PPC	0	0	0	0	0	3	0	0	2	0	2	3	5	4	6	3	4	**32**
Total	**2**	**0**	**1**	**2**	**4**	**9**	**8**	**10**	**10**	**13**	**23**	**25**	**35**	**30**	**39**	**42**	**29**	**282**

Table 4.1: Total Distribution of Articles in Journals and Years

Table 4.1 highlights the distribution of the selected articles per journal and publication year. Among the seven journals, the *International Journal of Logistics Management* (IJLM) is the most influential in terms of the publications of SCM articles, with 58 articles (20.6%). Interestingly, IJLM has also been the only journal that published SCM related articles in 1990. In addition, IJLM has been a constant source of SCM related articles with only one interruption in 1991, when no article on SCM was published. These three aspects indicate that IJLM has been one of the most important research outlets for SCM research from an early stage. However, in recent years as the table reveals, other journals such as the *International Journal of Production Economics* (IJPE), the *International Journal of Production Research* (IJPR) and the *International Journal of Physical Distribution & Logistics Management* (IJPDLM), have gained in importance with high numbers of articles in 2005 and 2006.

In terms of the frequency of SCM related articles, IJLM is followed by the IJPDLM (56 articles, 19.9%), another logistics-oriented journal. IJPDLM has been an outlet for SCM research since 1996 with the overall number of published SCM articles strongly increasing since 2000. The attention of IJPE was drawn rather late to SCM and, with the exception of 1999, it is only since 1999 that IJPE regularly publishes SCM articles. To summarize, IJPE takes the third place for overall SCM contributions with 46 articles accounting for 16.3%. Although the *Journal of Business Logistics* (JBL) is a regular source of SCM articles for several years now, it only accounts for 13.5% of all publications. JBL is followed by Production Planning & Control (PPC, 32 articles, 11.3%) and the International Journal of Production Research (IJPR, 31 articles, 10.9%).

Among all journals, the *Journal of Operations Management* (JOM) received the highest rank by VHB and is the only A-journal in the sample. The first SCM articles were published in

JOM from 1998 onwards and the overall number of SCM articles was the weakest with only 21 articles (7.5%). Although this result seems to be disappointing at a first glance, it could be an important indicator of the status of SCM as a discipline. Harland et al. suggest that the quality of publications where research appears points to the role the discipline plays. Thus, respected and established disciplines yield publications in top management journals which is, however, not the case for an emerging discipline (Harland et al., 2006, pp. 733-734, 736). As a consequence, these insights suggest that SCM has become an accepted discipline since the turn of the century.

Figures in the last row of table 4.1 display the total numbers of SCM-related publications per year and across all journals. It becomes apparent that SCM did not play an important role at the beginning of the 1990s. Since 1995, the figures gradually increased and reached a peak in 2005 (42 articles, 14.9%) whereas 2006 saw a strong decline in comparison to the previous years (29 articles, 10.3%). These numbers suggest that there has been a certain evolution in SCM research and the question is whether it is possible to distinguish specific phases of this evolution that could help to answer those research questions posed in this thesis that deal with the development of SCM as a science over time.

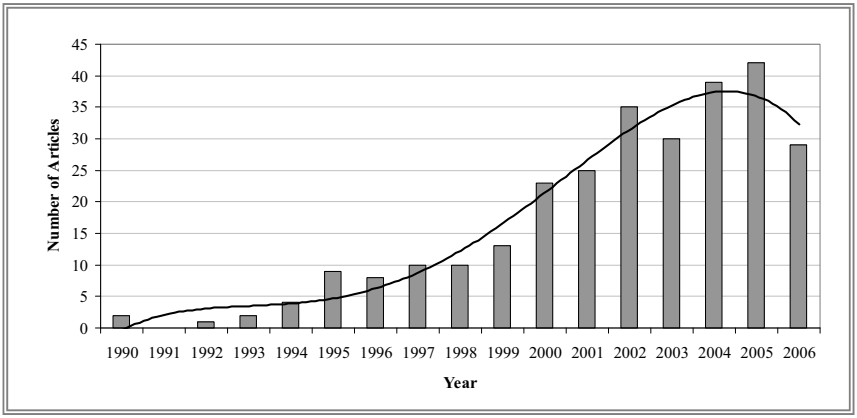


Figure 4.1: Absolute Distribution of SCM Articles over Years
Source: own illustration

Figure 4.1 represents a bar chart of the overall distribution of articles from 1990 to 2006. The curve represents a function of fourth degree which illustrates that research activity can be differentiated into at least three phases: the emergence of discipline from 1990 to 1994, an immense *growth* phase from 1995 to 2004 and a phase of decline from 2005 onwards. However, the number of articles published on SCM does not seem to provide valid information on the overall evolution of the research field, as they do not provide information

on the attention that has been paid to SCM in comparison to other topics. Instead, the absolute number of articles should be put in relation to the total number of articles published in journals in order to understand how much weight SCM has in comparison to other research topics. Table 4.2 provides the percentages of the articles listed in table 4.1 representing in relation the total number of articles published in each journal and year. Information on the total of articles in a journal has been drawn from the databases EBSCO and Science Direct.

	90	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**Σ**
IJPE	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	1.1	0.7	3.0	4.1	4.6	4.8	4.3	4.1	**1.8**
IJPR	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.3	0.0	2.5	2.1	1.3	4.1	1.2	**0.8**
IJLM	8.7	0.0	0.0	11.1	5.0	10.0	22.2	38.9	26.3	27.8	27.8	33.3	23.5	23.5	35.3	25.0	9.1	**18.4**
IJPDLM	0.0	0.0	0.0	0.0	7.9	0.0	3.0	5.9	3.3	2.8	17.0	9.8	16.0	9.6	7.1	21.7	10.2	**6.9**
JBL	0.0	0.0	4.0	0.0	0.0	12.0	4.0	4.5	0.0	20.0	18.2	30.0	6.3	8.7	31.6	25.0	10.0	**9.7**
JOM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	2.9	3.3	5.4	7.4	7.3	5.6	5.1	3.2	**3.3**
PPC	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	1.8	0.0	2.0	3.4	6.0	12.5	7.1	3.8	5.0	**2.6**
Total	**0.5**	**0.0**	**0.2**	**0.5**	**0.7**	**1.5**	**1.4**	**1.8**	**1.8**	**2.1**	**3.5**	**4.1**	**5.4**	**5.4**	**5.3**	**6.7**	**4.1**	**2.9**

Table 4.2: Relative Distribution of Articles in Journals and Years

The IJLM (18.4%) is still the most important source for SCM research and it is now followed directly by the other two logistics related journals of the sample, with JBL 9.7% and IJPDLM 6.9% in terms of the relative attention paid to SCM. The remaining four journals focus on operations and production. In all of these journals, the role SCM research plays in relation to other topics is rather weak and only ranges from 0.8% (IJPR) to 3.3% (JOM). In addition, where JOM continuously offers contributions to SCM, the relative importance of these slowly started decreasing from 2003. This finding suggests that SCM is better associated with logistics rather than with Operations Management. The information gained from table 4.2 makes it possible to generate another bar chart that displays the evolution of the relative importance of SCM articles in the overall period from 1990 to 2006 (figure 4.2).

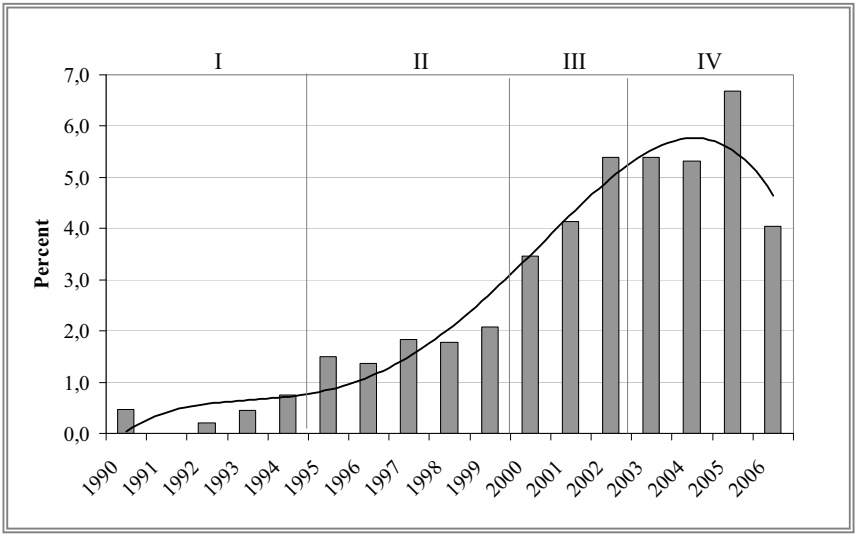


Figure 4.2: Relative Distributions of SCM Articles over Years

Source: own illustration

Figure 4.2 offers a similar picture of the developments of SCM research as figure 4.1. In both representations, SCM research plays a subordinate role in the first half of the 1990s where the highest values of both absolute and relative numbers of SCM research are reached since the turn of the century. In 2005, a maximum is obtained with a total of 42 publications on SCM that equal 6.7% of all publications in the target journals in this year that might be a result of a number of special issues on SCM. Furthermore, where there has almost been uninterrupted growth of SCM research in all preceding years, the role of SCM research declined in absolute (29 articles) and relative terms (4.1%) in 2006. At this stage, only speculations can be made regarding the decline of SCM related publications in 2006. Regarding the frame of reference and Kuhn's perception of scientific evolution, the decrease in 2006 could be the result of an increasing number of anomalies and unresolved research questions that induce scientists to turn to other, more promising scientific concepts. Even if this is just speculation, figures 4.1 and 4.2 confirm the importance of analysing potential anomalies and unresolved questions.

4.1.2 Characterization of Major Research Periods

Figure 4.2 shows the share of SCM related articles in the target journals is less than 1% in the period from 1990 to 1994. In 1995, the share of SCM publications transgresses the 1% hurdle. Nevertheless, growth of SCM related articles has been rather weak until 1999. In the years 2000 to 2002, SCM research increased by more than 0.5% annually and therefore, marks a

period of strong growth that ends in 2003 when this strong growth phase suddenly stagnates. Therefore, the author proposes to differentiate four phases in the evolution of SCM research, and with regard to Kuhn's perception of scientific progress, the following designations of the four phases are suggested as follows: (I) *emergence* from 1990 to 1994, (II) *acceptance* from 1995 to 1999, (III) *growth* from 2000 to 2002, and (IV) *normal science* from 2003 to 2006. These phases will be described and roughly characterized in the next sections.

I Emergence. This first phase of SCM as a field of study comprises the years 1990 to 1994. In total, only nine SCM related articles have been published in this period in IJLM (five), IJPDLM (three, all in 1994), and in JBL (one in 1992). None of the more operations management related journals contributed to SCM research in this period. In addition, sample articles occurred in the years 1990, 1992, 1993 and 1994, whereas no article on SCM was published in any of the target journals in 1991. Furthermore, the relative importance of SCM research has been very weak and does not even reach the value of 1%: 0.5% in 1990, 0.0% in 1991, 0.2% in 1992, 0.5% in 1993, and finally, 0.7% in 1994. As a consequence, it seems that SCM research played only a subordinate role in this period with a limited number of contributions. Therefore, this period seems to be close to what Thomas Kuhn called the *emergence* of a new scientific paradigm. As a consequence, the author proposes to call this period the *emergence* of SCM research.

II Acceptance. The second phase covers a total of five years ranging from 1995 to 1999. Thus, in terms of the number of years covered, this period is the largest one among all four phases. As shown in figures 4.1 and 4.2, the annual number of SCM contributions in these years is substantially higher than in the *emergence* period, both in absolute and relative terms. However, annual growth is almost stagnating in the *emergence* phase which differentiates it from the *acceptance* phase. The overall number of SCM related publications in the second period is substantially higher than in the previous phase. To summarize, this period covers 17.7% of the overall sample. The distribution of articles gradually increased over time with nine articles in 1995, eight in 1996, ten in 1997 and 1998, and thirteen in 1999. In addition, the relative importance of SCM slowly increases in this period. For the first time in 1995, it yielded a value higher than 1%, with 1.5%. From 1996 onwards, the relative importance continuously increased with 1.4% in 1996, 1.8% in 1997 and 1998, and 2.1% in 1999. However, both the absolute and relative growth rates are rather moderate. In the *emergence* phase, only the logistics oriented journals contributed to the growth of knowledge in SCM. With a total of 78% of the sample articles, the logistics oriented journals still account for the vast majority of SCM articles in the second period (IJLM 23 articles, JBL 9 articles, IJPDLM 7 articles). Yet, all other journals contributed at least one article to SCM research in this period (PPC 5 articles, IJPE 3 articles, JOM 2 articles, and IJPR 1 article) thus, accounting for the remaining 22%. Thomas Kuhn suggests that, if a scientific paradigm is successful, an emerging science is gradually accepted by more and more scientists who practice research in

the field. This second period has been characterized by an increase in the absolute and relative number of SCM research. In addition, all journals that have been identified as relevant SCM research outlets, contributed to SCM in this period. Therefore, *acceptance* seems to be an appropriate label for this second phase.

III Growth. Figure 4.2 illustrates that the third differentiated phase covers the years 2000 to 2002, and is as a consequence the shortest phase of the four. Nevertheless, it is the second largest in terms of total number of sample articles falling into the period with 83 articles accounting for 29.4%. Unlike the previous phase, where almost no growth could be observed between the different years, this period is characterized by strong annual increases. For example, from 1999 to 2000, there has been an increase of 77%, 9% from 2000 to 2001, and 40% from 2001 to 2002 in the absolute number of SCM related articles. Similar developments can be observed for the relative importance of SCM research that gradually increased in this period (3.5% in 2000, 4.1% in 2001, and 5.4% in 2002). In this period IJLM is for the first time, not the main contributing journal. Instead, this position is taken by IJPDLM. However, the logistics oriented journals still dominate the SCM debate with 21 SCM articles in IJPDLM, 14 in IJLM and 11 in JBL. To summarize, articles published in the logistics related journals represent 55% of the sample articles in the third period. Although this is still the majority, the operations oriented target journals strongly increased their contributions to SCM research and account for almost half of the sample articles (45%). Thus, in comparison to the previous two phases, the third phase is characterized by an institutionalized recognition of SCM among the operations oriented research outlets with 12 articles in IJPE, 10 in PPC, 8 in IJPR, and 7 in JOM. Although Thomas Kuhn stipulates that a successful science paradigm is marked by an increasing number of scientists adhering to it, he does not differentiate different phases of this acceptance. Still, figures 4.1 and 4.2 suggest that the evolution of SCM and the corresponding concern of researchers with the field did not evolve continuously but moderately from 1995 to 1999 and significantly from 2000 to 2002. As a consequence, the author proposes to differentiate two phases in the establishment of SCM research, namely the *acceptance* phase II and the phase of substantial growth described in this section.

IV Normal Science. The last phase of the proposed four that characterize the evolution of SCM research comprises a four year period from 2003 to 2006. While the previous phase was characterized by continuous and high growth rates, a major disruption of this growth occurred in 2003, when the absolute number of SCM related publications decreased by 15% in comparison to 2002. Thus, this year marks the entry into a new period after strong and continuous increase that characterized the *acceptance* and *growth* periods. Whereas the years 2004 (39 articles) and 2005 (42 articles) experienced another increase in the research and publication activity of SCM, 2006 faced the strongest decline with only 29 SCM related articles. This corresponds to a reduction of 31% in comparison to the year before. The relative importance of SCM research in comparison to other topics demonstrates similar

developments. In 2003, the relative amount of SCM related publications equals the figure of 5.4% in 2002. In 2004, the amount decreased slightly and attained 5.3%, but there has been another strong increase in 2005 with 6.7% in comparison to the year before. This was the highest proportion SCM related research yielded in the overall sample period. In 2006, the relative importance of SCM decreased to 4.1%. Although this fourth period is not the largest in terms of the years covered, it is the largest in terms of the overall number of articles that have been published in the target journals in the period. This amounts to 140 articles, accounting for 49.6% of all 282 articles in the sample. Thus, despite the decrease in 2006, this period is characterized by the highest proportion of research and corresponding publication activity in SCM. For the first time in this period, contributions stemming from the operations oriented journals dominate those coming from the logistics oriented journals, with absolute numbers of contributions amounting to 82 and 58. In addition, for the first time, the largest share of publications comes from an operations oriented journal, namely IJPE with a total of 31 contributions followed by IJPDLM (25 articles), IJPR (22 articles), JBL and PPC (17 articles each), IJLM (16 articles), and JOM (12 articles). As a consequence, although the overall research activity in phase four is the highest in comparison to the previous three phases, SCM research seems to have overcome the *growth* phase in this last period. Phase four is characterized by vital scientific activity at a high level. However, as the developments under consideration in the last year suggests, SCM research risks to decline. From the perspective of the author, the designation *normal science* corresponds to the established research activity that characterizes phase four. As a result, this phase in the evolution of SCM research will be labelled *normal science*. The distribution of the 282 articles in absolute and relative terms across these four periods is depicted in the following table 4.3.

	1990-1994 (I)		**1995-1999 (II)**		**2000-2002 (III)**		**2003-2006 (IV)**		**Total**		**% difference between periods**		
	Art	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**1-2**	**2-3**	**3-4**
IJPE	0	0.0	3	6.0	12	14.5	31	22.1	**46**	**16.3**	*6.0*	*8.5*	*7.7*
IJPR	0	0.0	1	2.0	8	9.6	22	15.7	**31**	**11.0**	*2.0*	*7.6*	*6.1*
IJLM	5	55.6	23	46.0	14	16.9	16	11.4	**58**	**20.6**	*-9.6*	*-29.1*	*-5.4*
IJPDLM	3	33.3	7	14.0	21	25.3	25	17.9	**56**	**19.9**	*-19.3*	*11.3*	*-7.4*
JBL	1	11.1	9	18.0	11	13.3	17	12.1	**38**	**13.5**	*6.9*	*-4.7*	*-1.1*
JOM	0	0.0	2	4.0	7	8.4	12	8.6	**21**	**7.4**	*4.0*	*4.4*	*0.1*
PPC	0	0.0	5	10.0	10	12.0	17	12.1	**32**	**11.3**	*10.0*	*2.0*	*0.1*
Total	**9**	**100.0**	**50**	**100.0**	**83**	**100.0**	**140**	**100.0**	**282**	**100.0**			

Table 4.3: Distribution of Articles across Periods

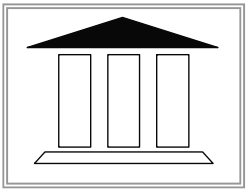
The last three columns of table 4.3 indicate the differences between the different periods in terms of share of articles in the different journals which illustrates that the major alterations

between periods occurred in IJLM and IJPDLM. However, so far, there is no indication as to the reason for these alterations.

4.1.2 Interim Summary

This chapter provided an overview of the evolution science in SCM has experienced during the last 16 years in terms of the publication activity of scientists in SCM and in relation to other research topics. Based on these insights, it was possible to discern four major stages of development of the scientific fields. These are called *emergence*, *acceptance*, *growth* and *normal science*. This differentiation will make it easier to understand the evolution and progress SCM research has made in the past years in the three main building blocks of the frame of reference: philosophy of science, scientific practice and operational practice. In the following chapters, these sections of the frame of reference will be dealt with separately in order to provide answers to the research questions posed in chapter two.

4.2 Philosophy of Science in Supply Chain Management



This chapter seeks to recognize the major philosophical underpinnings of SCM research and to provide an answer to the first research question as stipulated in chapter 2.3.1. In order to address this question, the 282 sample articles were classified according to the main scientific paradigm underlying their specific research approach. These could have been positivist (POS, a combination of classical *positivism* and *post positivism*, see chapter 3.2.5), critical theory (CRIT), participatory (PART) or constructivist (CON).

4.2.1 Ontology and Epistemology in Supply Chain Management

Table 4.4 illustrates how the occurrence of different scientific paradigms varied over time. As shown in the following table, there is a clear preponderance of *positivist* and *post positivist* approaches to SCM research with 81.2% (229 articles) in total. A second important paradigm is *critical theory* although it only represents 18.1% (51 articles). *Participatory* approaches to SCM research have been used in only 0.7% of the cases, i.e. two articles. Finally, no article was found in the sample that investigated SCM under a *constructivist* lens. Thus, this research confirms findings from earlier studies stipulating that Supply Chain Management research is dominated by the positivist paradigm (e.g. Mentzer & Kahn, 1995, p. 232; Burgess et al., 2006, p. 714). However, the percentage of research engrained in *critical theory* has not been found in earlier research. For example, Mentzer and Kahn did not find a single article belonging to this stream of research (Mentzer & Kahn, 1995, p. 232). Furthermore, in their

empirical literature review, Burgess, Singh and Koroglu found only one article, accounting for 1% that can be attributed to the *critical theory* paradigm (Burgess et al., 2006, p. 714). In the following, the emphasis of description will be on those less typical paradigms.

Furthermore, table 4.4 illustrates how the occurrence of different scientific paradigms varied over time. As shown in the table, *positivist* approaches dominated SCM research since the beginning of the analysis phase. However, as opposed to the suggestion of Mentzer and Kahn (1995, p. 232), *critical theory* constantly influenced SCM research as well. In order to understand the impact of *critical theory* and *participatory* research that have not been recognized earlier and the topics investigated from the perspective of these two paradigms, brief overviews of these will be provided in the following paragraphs.

	1990-1994 (I)		**1995-1999 (II)**		**2000-2002 (III)**		**2003-2006 (IV)**		**Total**		**% difference between periods**		
	Art	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**1-2**	**2-3**	**3-4**
POS	8	88.9	40	80.0	65	78.3	116	82.9	**229**	**81.2**	*-8.9*	*-1.7*	*4.5*
CRIT	1	11.1	9	18.0	17	20.5	24	17.1	**51**	**18.1**	*6.9*	*2.5*	*-3.3*
PART	0	0.0	1	2.0	1	1.2	0	0.0	**2**	**0.7**	*2.0*	*-0.8*	*-1.2*
CON	0	0.0	0	0.0	0	0.0	0	0.0	**0**	**0.0**	*0*	*0*	*0*
Total	**9**	**100.0**	**50**	**100.0**	**83**	**100.0**	**140**	**100.0**	**282**	**100.0**			

Table 4.4: Evolution of Scientific Paradigms across Periods

Emergence Phase. In the *emergence* phase, approximately 90% of SCM related research was rooted in the positivist tradition, whereas more than 11% could be attributed to *critical theory*. Due to the small sample size in the period, one article accounts for 11%. This article provides a critical discussion of changes in the business environment in the nineteen nineties and how the purchasing function of organizations will change in order to remain or meet new requirements (Leenders et al., 1994). *Participatory* research has not yet occurred in this phase.

Acceptance. In the second period, where SCM gradually became a recognized field within academia, research inspired by *critical theory* almost doubled and attained 18%. Scientists who are embedded in the *critical theory* paradigm assume that there is a reality which was shaped over time by cultural developments. These developments are now inappropriately taken as real (see chapter 3.2.5). As a consequence, researchers who adhere to this paradigm try to understand a phenomenon in its particular setting. They tend to focus on the developments that lead to the emergence of the phenomenon and provide less general, but rather specific propositions for dealing with the phenomenon. Therefore, it is not surprising that many of the articles in the sample address questions such as, how changes in the institutional, legal, political and competitive environment affect Supply Chain Management (Angell & Klassen, 1999; Bhattacharya, Coleman, Brace & Kelly, 1996; Carlsson & Sarv,

1997; Fernie & Rees, 1995; Hoek & Weken, 1998; Sabath, 1998). A second, more conceptual and theoretical stream of research assumes critical perspectives in order to understand the concept of SCM (Lambert, Cooper & Pagh, 1998; Skjoett-Larsen, 1999) or the behaviour of SCM as a system (Wilding, 1998).

Only one article in the second period investigated SCM from a *participatory* perspective. In this research, a mixed team of scientists and practitioners was set up to design and realize a reengineering process in an organization in order to integrate the supply chain and improve the material flows (Lewis, Naim & Towill, 1997). Thus, there was a direct involvement of the researchers into the improvement project that led to the classification of the articles into the *participatory* paradigm. Mainly, the increase of the *critical theory* paradigm, but also the emergence of the *participatory* paradigm in the second phase happened at the detriment of the positivist paradigm that decreased to 80% in the respective period.

Growth. As in the previous phase, the *growth* period of SCM research was characterized by a further decline of *positivism* that reduced to 78% and a corresponding increase of *critical theory* that yielded a value of 20.5%. As in the precedent phase, a lot of research assumed a *critical theory* perspective to understand how specific constellations and developments impact upon SCM from an internal, functional perspective (e.g. Garver & Mentzer, 2000; Paik & Bagchi, 2000; Robertson, Gibson & Flanagan, 2002; Schiefer, 2002) or by analyzing the impact of developments in the external environment upon SCM (e.g. Heikkila, 2002; Peck & Jüttner, 2000b; Sheffi, 2001; Rahman, 2002; Sohal, Power & Terziovski, 2002; Vorst & Beulens, 2002) by discussing models threatening to replace SCM (Hewitt, 2000). Another stream of research engrained in *critical theory* provides critical discussions on the conceptual basis of SCM (e.g. Arlbjorn & Halldórsson, 2002b; Skjoett-Larsen, 2000; Spens & Bask, 2002; Trienekens & Hvolby, 2001; Vokurka & Lummus, 2000; Svensson, 2002b). One additional article has been published during the growth phase of SCM research that assumes a *participatory* lens in order to understand critical factors shaping a reengineering process (Mohanty & Deshmukh, 2000). The two authors are both researchers bringing theoretical knowledge to this project and practitioners who were charged with the realization of the reengineering project. They were therefore, directly involved in the improvement project and documented their experiences.

Normal Science. In the *normal science* period, 161 articles were published that were primarily based in the positivist and post positivist paradigms (83%). Although the amount of research assuming a *critical theory* perspective has been increasing (24 articles), the overall percentage of *critical theory* in comparison to positivist research decreased and attained only 17% in the growth period. As explained in the two previous phases, *critical theory* plays an important role for theory and framework development in SCM (e.g. Gripsrud et al., 2006; Gubi et al., 2003; Hakansson & Persson, 2004; Lambert, Garcia-Dastugue & Croxton, 2005; Min & Mentzer, 2004; Robinson & Malhotra, 2005; Surana, Kumara, Greaves & Raghavan,

2005; Zineldin, 2004). In addition, *critical theory* has been used to understand and improve issues associated to organizing internal SCM practices in specific functions, industries or countries (e.g. Hyland, Soosay & Sloan, 2003; Demeter, Gelei & Jenei, 2006; DeWitt, Giunipero & Melton, 2006; Kemppainen & Vepsäläinen, 2003; Mangan & Christopher, 2005; Mello & Stank, 2005; Sabath & Whipple, 2004; Singh, Smith & Sohal, 2005; Williams, 2006), and also across organizations (Dowlatshahi, 2005; Fugate, Sahin & Mentzer, 2006; Ojala & Hallikas, 2006; Sheffi, 2004; Tan, Smith & Saad, 2006; Treville, Shapiro & Hameri, 2004). In this period, no contribution was found that investigated SCM from a *participatory* perspective.

To summarize, as illustrated in table 4.4, SCM research has been dominated by positivist and postpositivist research with an average of about 83%. Still, *critical theory* has already been an established second paradigm in SCM research for more than ten years. In earlier studies, it was frequently claimed that the preponderance of positivist research is an American tradition, whereas European research is much more oriented towards alternative research paradigms (e.g. Benbasat & Weber, 1996, p. 391; Näslund, 2002, p. 326). However, a closer look at the articles analyzed in this research reveals that this argument does not really hold in a SCM context. In order to test this suggestion, the university affiliations of all the authors of the 282 sample articles were tracked. These affiliations were assigned to the respective continents where the university was located. In total, 283 authors from United States based universities participated in the generation of the sample articles. Among these, 84% contributed to articles classified as positivist and 16% to articles classified into the *critical theory* paradigm. The 241 authors from European universities are split into 79% positivist, 20% critical and 1% *participatory*. Although there is a slight difference between the contributions from authors affiliated to United States universities and European universities, this difference is not significant. In addition, the proportions mirror the overall distribution of articles in the sample.

An explanation for the dominance of positivist research in SCM might be related to the target journals where the article sample was drawn from. Frequently, high quality journals favour positivist research and the corresponding empirical quantitative techniques and it is the task of the reviewers to check that published articles respect the philosophy and publication strategy of the journals (e.g. Beyer et al., 1995, p. 1219). In fact, table 4.5 reveals that articles from the *critical theory* paradigm are most frequently published in IJLM (29%) and IJPDLM (29%) and are least frequently published in PPC (6.3%). Overall, the operations oriented journals seem to favour positivist research approaches, whereas the more logistics oriented journals also support research from alternative paradigms. As a consequence, the preponderance of the positivist paradigm might be due to the journal selection strategy.

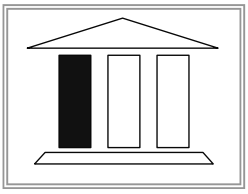
	IJPE		IJPR		IJLM		IJPDLM		JBL		JOM		PPC		Σ
	Art	%	Art	%	Art	%	Art	%	Art	%	Art	%	Art	%	n
Positivism	42	91.0	26	84.0	41	71.0	39	70.0	34	89.0	18	86.0	29	91.0	229
Critical	4	8.7	5	16.0	17	29.0	16	29.0	4	11.0	3	14.0	2	6.3	51
Participatory	0	0.0	0	0.0	0	0.0	1	1.8	0	0.0	0	0.0	1	3.1	2
Total	**46**	**100**	**31**	**100**	**58**	**100**	**56**	**100**	**38**	**100**	**21**	**100**	**32**	**100**	**282**

Table 4.5: Distribution of Paradigms in Journals

4.2.2 Interim Summary

Chapter 4.2 sought to provide a response to the first research question of this thesis: What are the dominant research paradigms in Supply Chain Management and how did these evolve over time? The findings suggest that SCM research is dominated by positivist research and, to a minor extent, continuously by *critical theory*. The role of other paradigms such as *participatory* or *constructivism* can be neglected as they do not occur at all or only sporadically. In addition, research question one sought to comprehend how the dominating paradigms evolved over time. The findings suggest that, scientific paradigms were not subjacent to major changes, over time, i.e. that the contributions the *positivist* and *critical theory* paradigms made to SCM research have almost been the same throughout the examined time period and the distinguished phases. The only exception to this observation was the phase of *emergence* of SCM, when the positivist paradigm still accounted for ca. 90% of SCM research, whereas this share gradually fell to an average of 80% in the following periods. Although no major differences could be observed in terms of evolution of SCM research, the findings reveal that the logistics oriented journals are more open to the publication of research stemming from other paradigms than the traditional positivist ones. The stability that characterizes the philosophical foundation of SCM research suggests that there will not be any major changes in the coming years despite calls from several scientists to increase the share of research from other paradigms (e.g. Näslund, 2002).

4.3 The Supply Chain Management Object of Study



The scientific practice level of the frame of reference comprises three major elements: the object of study, the schools of thought and the methodologies. The latter two components will be dealt with in chapters 4.4 and 4.5. This section deals with an analysis of the object of study of SCM in terms of its definition, the constructs that SCM is composed of, the objectives that SCM

promises to attain and, finally, the different levels of analysis that can be distinguished in SCM research.

4.3.1 Definitions

Definitions play a central role in the differentiation of one field of study from that of other disciplines (see chapter 3.2.5). As a consequence, the definitions that researchers use for SCM delimit the borders of SCM research and justify its existence as a separate discipline in business and management. In order to understand whether research in SCM is concerned with the clear demarcation of its boundaries to other fields, the use of SCM definitions in the sample articles was tracked. Therefore, publications were classified in terms of the definitions that were used for research. There were four possibilities:

1) no obvious definition was used for SCM,
2) the authors used a modified definition of one that had been proposed earlier,
3) the authors used an existing definition, and
4) the authors proposed an own definition.

Figure 4.4 depicts the results of this part of the analysis and the distribution of the values over time.

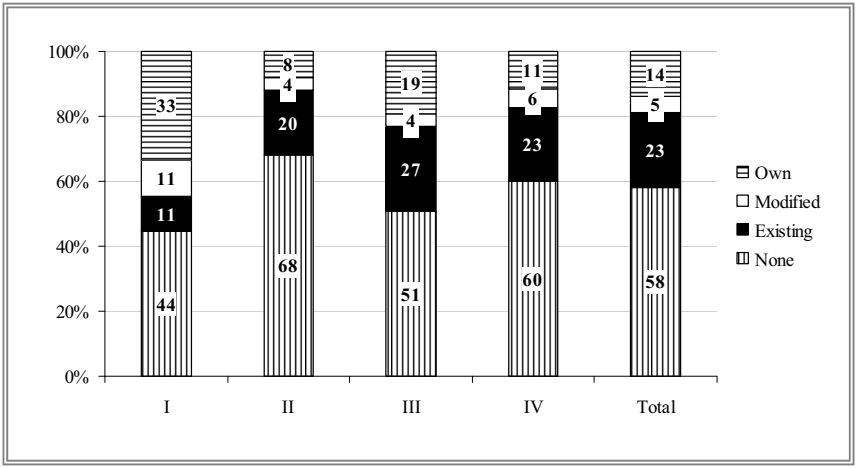


Figure 4.3: The Use of Supply Chain Management Definitions
Source: own illustration

A result of the article classification process was that the majority of the sample articles did not specifically state a definition of SCM that a particular research was based on (59%). This level is surprisingly high and is astonishing as it does not correspond to scientific standards.

One major criterion for selecting an article into the sample was that the term *Supply Chain Management* should either figure in its title or abstract to ensure that SCM is one of the main topics an article deals with. Usually, one would expect that the central topics of an article are defined in order to ensure that readers of an article share the same understanding of the object of study. Evidently, this has frequently not been the case for SCM research. There might be several reasons for this. First, some authors might concentrate on a specific problem of a rather broad field in SCM and concentrate on a definition of the terms directly associated with this problem. Second, SCM is still a very young field of research that lacks a common definition (see chapter 2.1). In particular, early phases of a new field of study are characterized by unclear perceptions of what the field covers. However, this suggestion is not confirmed in this analysis as the proportion of articles that do not use a definition remains substantial in all periods. Thus, a comparison of the use of definitions in the first periods and the later ones should make it clear whether this has been the case for SCM. Third, researchers might simply not see the necessity to define their object of study either by neglect or assuming that this needlessly restricts their scope of study.

The second largest group is formed by those articles that refer to an existing definition of SCM (23%). In 38 articles accounting for 13%, the authors of the sample articles developed and proposed their own perspectives of what SCM constitutes. Finally, in 5% of the sample articles, the authors used a modified version of an existing SCM definition as a basis for their work. Table 4.6 shows how the different forms of handling SCM definitions evolved over time.

	1990-1994 (I)		**1995-1999 (II)**		**2000-2002 (III)**		**2003-2006 (IV)**		**Total**		**% difference between periods**		
	Art	%	Art	%	Art	%	Art	%	**Art**	**%**	1-2	2-3	3-4
None	4	44	34	68	42	51	84	60	**164**	**58**	*23.6*	*-17.4*	*9.4*
Existing	1	11	10	20	22	27	32	23	**65**	**23**	*8.9*	*6.5*	*-3.6*
Modified	1	11	2	4	3	4	8	6	**14**	**5**	*-7.1*	*-0.4*	*2.1*
Own	3	33	4	8	16	19	16	11	**39**	**14**	*-25.3*	*11.3*	*-7.8*
Total	**9**	**100.0**	**50**	**100.0**	**83**	**100.0**	**140**	**100.0**	**282**	**100.0**			

Table 4.6: Evolution of the Use of Definitions

On average, 56% of articles did not use a definition in the first two phases and 55.5% in the second two phases. Thus, the hypothesis that the percentage should have been higher in the first two phases is not confirmed. However, the percentage of articles that relied on existing definitions increased from an average of 15.5% in the first two phases to an average of 25% in the second two periods. This increase has been significant with $\chi^2 = 5.8$. The proportion of own definitions does not demonstrate a structured development with 33% in the *emergence* phase, 8% in the *acceptance* phase, 18% in the *growth* phase and 11% in the *normal science* phase. The same applies to the use of modified definitions that evolved from 11% in the first

period over 4% in the *acceptance* on *growth* phases and, finally, to 6% in the *normal science* period.

An analysis of the frequency of the types of definitions used is informative but not sufficient to understand the object of study of SCM and its evolution over time. As a consequence, it is important to deep-dive into the contents of the SCM definitions as referenced in the sample articles. Although it would be possible to analyze all types of used definitions in more detail (i.e. own, existing and modified), the author decided to focus on the existing ones only. The rationale lying behind this decision is that authors usually cite more established scientists of a field to justify their own perception. Therefore, concentrating on these types of definitions promises to mirror more generally accepted views of what SCM is. According to Wacker, a definition is comprehensive if it defines the content and domain (*what*), the relationships between elements (*how and why*) and if it makes predictions (*what could happen*, Wacker, 2004, p. 630). As a consequence, the definitions of SCM will be compared according to these criteria in the next sections.

Emergence. The sample of articles falling into the *emergence* phase is only n = 9. Out of these nine articles, only one refers to an existing definition. In this case, it was an article written by Cooper and Ellram who refer to a definition of SCM they proposed earlier. In fact, this definition reappears as reference by other authors in the same period. The following table 4.7 comprises four columns. In the first column, the sample article is cited where a SCM definition has been drawn from, which is followed by the replication of the definition. The brackets after the definition indicate the reference the definition has been based on. The author of this thesis did not refer to the original definitions and, therefore, the original documents are not listed in the bibliography. Table 4.7 illustrates that the definition Cooper and Ellram cite, views SCM as an integrative philosophy. The domain that SCM covers from this perspective is that of a chain of organizations. No prediction is made in terms of what can be achieved by SCM. In addition, there is no clear indication of the functions and tasks that SCM should cover. Furthermore, the definition states that SCM is about "flow management". However, there is no specification of what this "flow" covers. As a consequence, the perception of SCM can be considered as incomplete in this early stage of development.

SCM definition used	What?	How & Why	Prediction
Cooper & Ellram, 1993a, p. 13: *"SCM is an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user"*(Cooper & Ellram 1990)	Philosophy Chain	Management of flow	N/A

Table 4.7: References to Existing SCM Definitions in the Emergence Phase

Acceptance. In this phase, the definitions of SCM used in the articles become much more precise. As illustrated in table 4.8, the vague notion of "philosophy" is increasingly replaced by the perception that SCM concerns the management and integration of a chain of

organizations and processes. In addition, several of the definitions proposed comprise an objective or a prediction of what will happen if SCM is implemented successfully. The most important objective is the generation of *value* for customers, although it is not frequently specified what *value* actually means. Another interesting result is that, evidently, the most accepted definition of SCM in this phase with five articles using it as base stems from Jones and Hines (recited by Ellram in 1991).

SCM definition used	What?	How & Why	Prediction
Carter & Ferrin, 1995, p. 189 / Rich & Hines, 1997, p. 212 / Stank, Crum & Arango, 1999, p. 27 / Cooper, Ellram et al., 1997 /Verwijmeren & van der Vlist, 1996, p. 16: *"SCM is an integrative approach for planning and controlling the flow of materials from suppliers to end users."* (Ellram 1991, Jones & Riley 1987)	Approach Chain	Management of materials flow	N/A
Cooper, Lambert & Pagh, 1997b, p. 1 *"The process of planning, implementing and controlling the efficient, cost effective flow and storage of raw materials, in-process inventory, finished goods, and related information from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements."* (LaLonde 1994)	Process Chain	Management of materials and information flow	Value
Lambert, Cooper et al., 1998, pp. 2-3: *"Integrating and managing key business processes across the supply chain"* (Global Supply Chain Forum)	Process Chain	Integration and management	N/A
Closs & Stank, 1999, p. 59 *"Extending logistical integration to include management of logistics networks both within and across company boundaries to generate cost savings and/or better customer service over the total chain of organizations involved in supply, production, and delivery of final goods for consumption is termed SCM."* (Bowersox & Closs 1996)	Logistics chain	Integration and management of logistics	Cost savings, service
Skjoett-Larsen, 1999, p. 41 / Burgess, 1998, p. 15 *"SCM is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders."* (Lambert, Cooper & Pagh 1998 & 1997)	Process chain	Integration	Value

Table 4.8: References to Existing SCM Definitions in the Acceptance Phase

Growth. In comparison to the *acceptance* period of SCM, no substantial differences occur in the *growth* phase of SCM research. Thus, the conceptual boundaries of SCM correspond to the definition of a chain of organizations as proposed in chapter 3.2.5. In essence, SCM is realized by means of integrating and managing processes and functions among supply chain partners. Yet, a very interesting result is that in this phase, there has been an extraordinary preponderance of references to the definition proposed by Lambert, Cooper and Pagh. 13

articles out of the 22, i.e. 59%, use this definition as a basis for their work. Thus, this definition can be seen as a characteristic for the *growth* phase of SCM research.

SCM definition used	What?	How & Why	Prediction
Peck & Jüttner, 2000b, p. 33 *"SCM [...is marked by; note from the author] a departure from a one-firm perspective to the recognition that value is more often than not created and delivered through horizontally as well as vertically connected 'value'."* (Normann & Ramírez 1993)	N/A	Integration	Value
Angeles & Nath, 2001, p. 109 / Sundaram & Mehta, 2002, p. 532 *"SCM encompasses efficiently integrating suppliers, manufacturers, warehouses, and retailers in order to produce and distribute pre-established products that meet pre-established criteria."* (Simchi-Levi, Kaminsky & Simchi-Levi 2000)	Chain	Integration Production Distribution	N/A
Chan, Humphreys & Lu, 2001, p. 124: *"SCM is the process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods and related information from point-of-origin to point-of-final-consumption for the purpose of conforming to customer requirements."* (Taylor 1997)	Process Chain	Management of materials flow and information	Value
Croxton, 2003, p. 20 / Croxton et al., 2001, p. 13 / Jayaram et al., 2000, p. 134 / Korpela, Lehmusvaara & Tuominen, 2001, p. 145 / McAfee, Glassman & Honeycutt, 2002, p. 4 / Mejza & Wisner, 2001, p. 37 / Paik & Bagchi, 2000, p. 59 Robertson et al., 2002, p. 4022 / Rogers, Lambert, Croxton & Garcia-Dastugue, 2002, p. 2 / Skjoett-Larsen, 2000, p. 377 / Spens & Bask, 2002, p. 73 / Trienekens & Beulens, 2001, p. 469 / Vokurka & Lummus, 2000, p. 89. *"SCM is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders."* (Lambert, Cooper & Pagh 1998 & 1997; Lambert & Cooper 2000)	Process Chain	Integration and management of material, service and information flows	Value
Stank, Keller & Daugherty, 2001, p. 30 *"The new vision of SCM links all the players and activities involved in converting raw materials into products and delivering those products to consumers at the right time and at the right place in the most efficient manner."* (Copacino 1997)	Linkage Chain	Production, delivery	Efficiency
Brewer & Speh, 2000, p. 76 / Shin, Collier & Wilson, 2000, p. 318 *"SCM is an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user."* (Cooper & Ellram 1990, 1991, 1993)	Philosophy Chain	Management of flow	N/A

Table 4.9: References to Existing SCM Definitions in the Growth Phase

Normal Science. The definitions of SCM used by researchers in the *normal science* phase are depicted in table 4.10. However, there is consensus among scientists that SCM comprises

chains of organizations and is realized by means of integration of functions and activities for the sake of creation of customer value. However, the overall number of different definitions used has substantially increased in comparison to the previous phases. Some definitions used in the *normal science* period exhibit characteristics that did not occur in the previous phases and contribute to an increase of complexity in this period. For example, in addition to the traditional chain perspective, there is one definition that considers the supply chain as a network of organizations including intermediary parties. Furthermore, the traditional value creation objective has been enlarged to include cost savings, performance increase, and competitiveness improvement objectives. Finally, although the definition from Cooper, Lambert and Pagh is still the most frequently cited (6 references out of 32), there are other definitions occurring repeatedly: CSCMP (4 references), the Cooper and Ellram definition (3 references), and the definition proposed by Mentzer in 2001 (3 references).

SCM definition used	**What?**	**How & Why**	**Prediction**
Kainuma & Tawara, 2006, p. 99 *"Extending logistical integration to include management of logistics networks both within and across company boundaries to generate cost savings and/or better customer service over the total chain of organizations involved in supply, production, and delivery of final goods for consumption is termed SCM."* (Bowersox & Closs 1996)	Chain	Integration and management of logistics	Cost savings, service
Lu, Chang & Yih, 2005, p. 4220 *"SCM encompasses efficiently integrating suppliers, manufacturers, warehouses, and retailers in order to produce and distribute pre-established products that meet pre-established criteria."* (Simchi-Levi, Kaminsky & Simchi-Levi 2000)	Chain	Integration Production Distribution	N/A
Bandinelli et al., 2006, p. 167: *"Integrated SCM can be defined as the task of integrating organisational units along a supply chain, thus co-ordinating materials, information and financial flows in order to fulfil customer demands, with the aim of improving competitiveness of the supply chain as a whole."* (Stadtler & Kilger 2000)	Chain	Integration of materials, finance and information flow	Value Compe-titiveness
DeWitt et al., 2006, p. 292 / Gimenez, 2006, p. 232 / Hakansson & Persson, 2004, p. 12 / Treville et al., 2004, p. 615 / Bolumole et al., 2003, p. 16 / Hyland et al., 2003, p. 317: *"SCM is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders."* (Lambert, Cooper & Pagh 1998 & 1997; Lambert & Cooper 2000, Lambert 2004)	Process Chain	Integration and management of materials, service and information flows	Value
Bhatnagar, Jayaram & Phua, 2003, p. 147 *"[…] a network of production and distribution facilities that link material, information, and money*	Chain	Link of material, finance and	N/A

SCM definition used	What?	How & Why	Prediction
flows, from material supply to customer delivery in order to deliver a product to the final customer." (Jones & Riley 1985)		information flow	
Gimenez & Ventura, 2003, p. 77 / Lemke et al., 2000, p. 25 *"SCM is the management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole."* (Christopher 1998)	Chain	Management of relationships	Value Cost
Hieber & Hartel, 2003, p. 123 *"SCM is concerned with the strategic approach of dealing with logistics planning and operation on an integrated basis."* (Lau & Lee 2000)	Approach	Logistics Integration	N/A
Kemppainen & Vepsäläinen, 2003, p. 701 / Lejeune & Yakova, 2005, p. 83 / Mello & Stank, 2005, p. 543: *"Supply Chain comprises a set of at least three entities directly involved in the downstream and upstream flows of goods, services, information and finance from a source to the customer."* (Mentzer et al. 2001)	Chain	Flow of materials, service, information, finance	N/A
Barker & Naim, 2004, p. 53 / Kotzab, Grant & Friis, 2006, p. 273 / Lambert et al., 2005, p. 25 *"SCM is an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user."* (Cooper & Ellram 1990, 1991, 1993)	Philosophy Chain	Management of flow	N/A
Chin, Tummala, Leung & Tang, 2004, p. 506 *"SCM involves the flow of materials, information, and finance in a network consisting of customers, suppliers, manufacturers, and distributors."* (Lee 2000)	Chain	Management of materials, information, finance flow	N/A
Gunasekaran, Patel & McGaughey, 2004, p. 333 *"SCM represents the most advanced state in the evolutionary development of purchasing, procurement and other supply chain activities."* (Thomas & Griffin 1996)	State	N/A	N/A
Ngai et al., 2004, p. 623 / Williams, 2006, p. 3832 *"SCM is the integration of all activities associated with the flow and transformation of goods from the raw materials stage through to the end user, as well as associated information flows."* (Handfield & Nichols 1999)	Chain	Integration of activities	N/A
Li, Rao, Ragu-Nathan & Ragu-Nathan, 2005, p. 618: *"SCM is the systemic, strategic coordination of the traditional business functions and tactics across these business functions within a particular organization and across business within the supply chain for the purposes of improving the long-term performance of the individual organizations and the supply chain as a whole."* (CLM 2000)	Chain	Coordi-nation of functions and tactics	Perfor-mance
Singh et al., 2005, p. 3376 *"SCM is a philosophy of management that involves the management and integration of a set of selected key business processes from end user through original suppliers, that provides products, services, and*	Philosophy Chain	Process integration	Value

SCM definition used	What?	How & Why	Prediction
information that add value for customers and other stakeholders through the collaborative efforts of supply chain members." (Ho, Au & Newton 2002)			
Cheng & Grimm, 2006, p. 2 / Defee & Stank, 2005, p. 29 / Moberg, Whipple, Cutler & Spech, 2004, p. 16 / Stank, Davis & Fugate, 2005, p. 27 *"SCM encompasses the planning and management of all activities involved in sourcing and procurement, conversion and all Logistics Management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, SCM integrates supply and demand management within and across companies."* (CSCMP 2005)	Network	Integration Management Cooperation Production Delivery	N/A
Demeter et al., 2006, p. 557 *"Supply chain refers to all those activities associated with the transformation and flow of goods and services, including their attendant information flows, from the sources of raw materials to end users. Management refers to the integration of all these activities, both internal and external to the firm."* (Ballou, Gilbert & Mukherjee 2000)	Chain	Integration Production Delivery	N/A

Table 4.10: References to Existing SCM Definitions in the Normal Science Phase

Summary. The period of *normal science* seems to be characterized by a high degree of fragmentation and diversity in the perception of what SCM is. Thus, although there has been some kind of implicit consensus of what SCM is in the first three periods, this is less clear in the *normal science phase*. However, these developments might be problematic as they soften the borders of SCM and thus expose the discipline to the risk of being integrated into other disciplines. This finding might constitute a potential anomaly in SCM research. In fact, the curve presented in figure 4.2 at the beginning of this chapter is slightly declining in the last period. Although it is unknown how the curve will develop from 2007 onwards, this already indicates that SCM research will have to surmount to several challenges and problems, and the problem of the fragmented definitions will certainly be one of them.

4.3.2 Constructs

Besides definitions, another means for the specification of the content domain of a discipline is the identification of the constructs that it is composed of. Therefore, a comprehensive list of 22 SCM constructs has been developed and articles were classified into the respective categories if they substantially dealt with one or more of them. Table 4.11 shows the number of articles in which each construct is dealt with. The investigation of more than one construct in a single article means that the figure for the total in the table (1,467) exceeds the number of articles that were analyzed (282).

	1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		Total		% difference between periods		
	Art	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**1-2**	**2-3**	**3-4**
Closed loop	0	0.0	4	1.4	7	1.6	13	1.9	**24**	**1.6**	*1.4*	*0.2*	*0.2*
Demand Chain	4	6.7	21	7.5	28	6.5	59	8.5	**112**	**7.6**	*0.9*	*-1.0*	*2.0*
Design	1	1.7	8	2.9	18	4.2	18	2.6	**45**	**3.1**	*1.2*	*1.3*	*-1.6*
HRM	0	0.0	6	2.2	10	2.3	22	3.2	**38**	**2.6**	*2.2*	*0.2*	*0.8*
Inventory	5	8.3	24	8.6	22	5.1	37	5.3	**88**	**6.0**	*0.3*	*-3.5*	*0.2*
IT	3	5.0	24	8.6	30	6.9	44	6.3	**101**	**6.9**	*3.6*	*-1.7*	*-0.6*
Knowledge	0	0.0	2	0.7	4	0.9	7	1.0	**13**	**0.9**	*0.7*	*0.2*	*0.1*
Lean SCM	7	11.7	31	11.1	49	11.3	85	12.2	**172**	**11.7**	*-0.6*	*0.2*	*0.9*
Legal	1	1.7	3	1.1	3	0.7	5	0.7	**12**	**0.8**	*-0.6*	*-0.4*	*0.0*
Marketing	2	3.3	6	2.2	8	1.9	14	2.0	**30**	**2.0**	*-1.2*	*-0.3*	*0.2*
Organization	1	1.7	15	5.4	31	7.2	33	4.7	**80**	**5.5**	*3.7*	*1.8*	*-2.4*
Performance	4	6.7	17	6.1	24	5.6	44	6.3	**89**	**6.1**	*-0.6*	*-0.5*	*0.8*
Power & Reach	0	0.0	5	1.8	5	1.2	9	1.3	**19**	**1.3**	*1.8*	*-0.6*	*0.1*
Product	2	3.3	13	4.7	18	4.2	23	3.3	**56**	**3.8**	*1.3*	*-0.5*	*-0.9*
Production	4	6.7	20	7.2	40	9.3	48	6.9	**112**	**7.6**	*0.5*	*2.1*	*-2.4*
Purchasing	2	3.3	15	5.4	22	5.1	44	6.3	**83**	**5.7**	*2.0*	*-0.3*	*1.2*
Quality	3	5.0	9	3.2	10	2.3	26	3.7	**48**	**3.3**	*-1.8*	*-0.9*	*1.4*
Relationships	7	11.7	26	9.3	39	9.0	70	10.1	**142**	**9.7**	*-2.3*	*-0.3*	*1.0*
Risk	4	6.7	3	1.1	5	1.2	14	2.0	**26**	**1.8**	*-5.6*	*0.1*	*0.9*
Strategy	6	10.0	13	4.7	32	7.4	44	6.3	**95**	**6.5**	*-5.3*	*2.7*	*-1.1*
Transportation	4	6.7	10	3.6	21	4.9	28	4.0	**63**	**4.3**	*-3.1*	*1.3*	*-0.8*
Others	0	0.0	4	1.4	6	1.4	9	1.3	**19**	**1.3**	*1.4*	*0.0*	*-0.1*
Total	**60**	**100**	**279**	**100**	**432**	**100**	**696**	**100**	**1467**	**100**			

Table 4.11: Breakdown of SCM Constructs across Periods

Table 4.11 shows the distribution of SCM constructs in articles across periods in absolute figures and relative percentages. In addition, the last three columns depict the differences between periods which are the percentages in terms of occurrence of a construct during the more recent period less the percentage of the anterior period. As seen from the results, the profile of SCM in terms of its constructs did not alter significantly over time, with deviations varying between 1.0% and 2.3%. The largest share of differences occurs between the *emergence* phase and the *acceptance* period. This is, however, not surprising given that the number of articles in the first period has been limited (9) in comparison to the number of articles falling into the second period (50) which might distort the results.

Nevertheless, the table also reveals that there are evidently several SCM constructs that are less important than others and occur less frequently. In some cases, for example *knowledge management*, the overall percentage of occurrence is comparatively weak with 0.9%. In contrast, other constructs such as *Lean Supply Chain Management* seem to be of central importance for SCM in all periods as these constantly yield high values (for example *Lean*

Supply Chain Management 11.7%, *Relationships, Alliances & Collaboration* 9.7% or *Demand Chain Management* 7.6%). In order to be able to differentiate those SCM constructs which are core to SCM from those that only play a minor role, an artificial threshold of 80% was established, meaning that only those constructs will be considered that account for 80% of all SCM constructs under investigation in the specific periods and in total. This threshold should therefore, enable the differentiation into major and minor SCM constructs and make it possible to get a less complex and fragmented overview of core SCM constructs. The result of this procedure is depicted in table 4.12 that provides an overview of major SCM constructs in order of decreasing relevance for each period and in total.

1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		Total	
%	Construct	%	Construct	%	Construct	%	Construct	%	Construct
12	Lean SCM	11	Lean SCM	11	Lean SCM	12	Lean SCM	12	Lean SCM
12	Relations	9	Relations	9	Production	10	Relations	10	Relations
10	Strategy	9	Inventory	9	Relations	8	Demand	8	Demand
8	Inventory	9	IT	7	Strategy	7	Production	8	Production
7	Demand	8	Demand	7	Organization	6	Strategy	7	IT
7	Performance	7	Production	7	IT	6	IT	6	Strategy
7	Production	6	Performance	6	Demand	6	Performance	6	Performance
7	Risk	5	Purchasing	6	Performance	6	Purchasing	6	Inventory
7	Logistics	5	Organization	5	Inventory	5	Inventory	6	Purchasing
5	Quality	5	Strategy	5	Purchasing	5	Organization	5	Organization
		5	Product	5	Logistics	4	Logistics	4	Logistics
		4	Logistics	4	Product	4	Quality	4	Product

Table 4.12: Breakdown of Major SCM Constructs across Periods

Overall, the table illustrates that only twelve SCM constructs out of the original 22 are central to SCM. As already illustrated in the definitions section, the integration of functions, activities and organizations is central to SCM and maybe, the differentiating characteristics of SCM in comparison to other management disciplines. Consequently, it is not surprising that *Lean Supply Chain Management* (11.7%) assumes rank one in the overall hierarchy of core SCM constructs. Integration and alignment of business functions and activities within an organization and across its boundaries requires the establishment of successful relationships with associated partners. Considerable attention has been paid to this aspect of SCM in research (9.7%). The third major construct in SCM is *Demand Chain Management* (7.6%) that provides the customer perspective to SCM.

The construct *Logistics & Transportation* assumes rank 11 among all constructs in total and has been one of the less relevant constructs in all periods. This is counterintuitive, as SCM is rooted in logistics management as illustrated in chapter 2.2.1. Thus, one might expect that a lot of attention from SCM scientists is attributed to the exploration of logistics-oriented topics. However, the findings from the sample articles do not support this overall importance. An

explanation for this finding could be that SCM researchers associate a certain meaning to the notion SCM and explore it in terms of this particular meaning. For example, *integration* is frequently seen as one of the key tasks of logistics (e.g. Walter, 2003, p. 26, Lambert, Stock et al., 1998, pp. 7-10). The definitions of the SCM constructs proposed in chapter 3.2.5 suggest that integration is part of the *Lean Supply Chain Management*. This construct has been explored extensively. Thus, the contribution traditional logistics make to SCM might also be covered by the *Lean Supply Chain Management* constructs whereas the pure operative, transportation related questions are not seen as key component of SCM by many scientists.

Concerning the evolution of the core SCM constructs over time, a major observation in the *emergence* phase is that SCM is shaped by fewer core constructs than in the following phases: Only ten constructs account for 80%, whereas all following periods are characterized by twelve constructs. The three most important constructs in this period are *Lean Supply Chain Management* (12%), *Relationships, Alliances and Collaboration* (12%) and *Strategic Management and Leadership* (10%). As the first two of these constructs remain important in the consecutive periods, the constructs Strategic Management and Leadership is gradually overcome in importance by other constructs. Interestingly, Risk Management occurs in the core construct list in the *emergence* period whereas this construct does not reappear in any of the later periods. As a consequence, scientists in the *emergence* period seem to have had a higher level of awareness of the risks that might arise from SCM than researchers in later periods. Other constructs that are of central importance in the following three periods do not yet occur in the *emergence* period, for example *Information Technology*, *Purchasing and Supply Management* and *Product Management*.

In the *acceptance* period, the most important SCM constructs are *Lean Supply Chain Management* (11%), *Relationships, Alliances and Collaboration* (9%), *Inventory Management* that replaced *Strategic Management and Leadership* (9%) and *Information Technology* (9%). The latter construct did not yet occur in the *emergence* period. In addition, *Purchasing & Supply Management* (5%), *Product Management* (5%) and *Organization Structure and Processes* (5%) appear for the first time in this phase of development. In essence, the picture that characterizes SCM constructs in the *acceptance* period is already very similar to that of the *growth* and *normal science* periods and differs only in terms of the order that the core SCM constructs assume.

Transportation and *risk* do not reappear in later periods. However, *strategy* becomes again a core construct during the *growth* phase and remains in this position until the end of the overall analysis period. Furthermore, this period is the only one in which *integration* does not hold the top position but is replaced by *production*. All other core constructs relevant in the *growth* phase remain important in the *normal science* period and it is only the ranking position they assume that slightly changes. Thus, it seems that these constructs will be relevant for SCM research in the coming years as well.

4.3.3 Level of Analysis

The analysis of SCM definitions revealed that SCM is frequently seen as a chain of organizations involved in the production and delivery of a product or service from the original supplier through to the end user. Yet, along this chain, various activities and functions need to be considered. Thus, research on SCM tends to decompose the overall chain in order to analyze parts of it. This can be a profound analysis of the role a single organization plays in SCM or an investigation into dyadic relationships between one organization and its suppliers, or its customers, or the analysis of all three partners: supplier - focal company - customer. In addition, other researchers might broaden the traditional supply chain perspective to integrate the impact that government and other institutions that are not directly involved in the production and delivery process can have upon SCM. As a consequence, the SCM level of analysis varies from internal, dyadic, chain, to network relationships. So as to understand what level of analysis research in SCM focuses on, sample articles were classified into the respective categories. The result of this process is depicted in table 4.13.

	1990-1994 (I)		**1995-1999 (II)**		**2000-2002 (III)**		**2003-2006 (IV)**		**Total**		**% difference between periods**		
	Art	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**1-2**	**2-3**	**3-4**
Internal	0	0.0	7	14.0	21	25.3	30	21.4	**58**	**20.6**	*14.0*	*11.3*	*-3.9*
Dyadic	1	11.1	10	20.0	20	24.1	42	30.0	**73**	**25.9**	*8.9*	*4.1*	*5.9*
Chain	8	88.9	30	60.0	34	41.0	59	42.1	**131**	**46.5**	*-28.9*	*-19.0*	*1.2*
Network	0	0.0	3	6.0	8	9.6	9	6.4	**20**	**7.1**	*6.0*	*3.6*	*-3.2*
Total	**9**	**100**	**50**	**100**	**83**	**100**	**140**	**100**	**282**	**100**			

Table 4.13: Breakdown of SCM Levels of Analysis across Periods

In sum, the majority of articles (46.5%) analyze SCM problems across a chain of organizations as suggested by the analysis of SCM definitions. Yet, in an important share of articles (25.9%), scientists concentrate on the investigation of a cut-out of SCM, namely dyadic relationships. In addition, 20.6% of the classified articles study SCM topics from an internal organization perspective. The number of articles taking into consideration whole networks of organizations is significantly lower than the other three categories and comprises only 6.4% of the sample articles. Taken together, these results are not surprising. Studying supply chains from a chain perspective and deep-diving into some parts is reasonable. In addition, exploring whole networks of organizations is a complex and difficult task and the results of such investigations will probably remain superficial. As a consequence, it is not surprising that the share of articles assuming a network perspective on SCM is not very high. Still, what is interesting is the evolution the SCM level of analysis made across the four periods. Figure 4.5 visualizes this evolution.

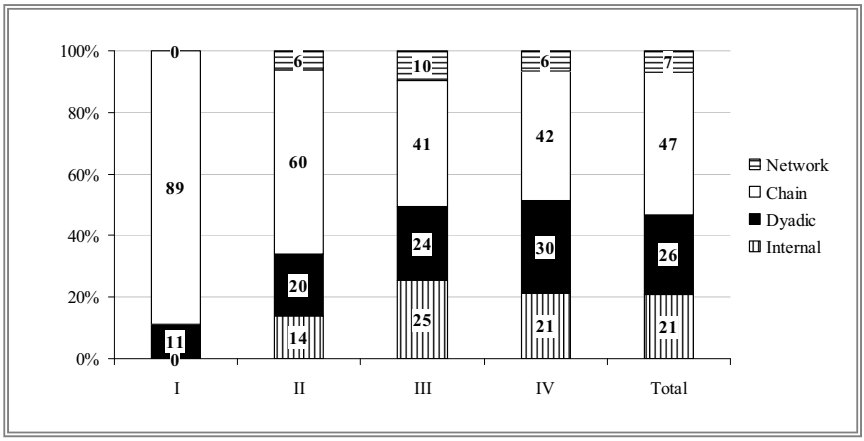


Figure 4.4: Evolution of SCM Levels of Analysis
Source: own illustration

As the analysis of chain relationships dominated in the *emergence* phase, the importance of this type of supply chain analysis gradually decreased in the *acceptance* and *growth* phases to the advantage of dyadic relationships and analyses of internal supply chains. The two columns representing the *growth* period and the phase of *normal science* do not exhibit any significant alterations. Thus, it seems that this sort of distribution in terms of types of investigated supply chains has become established.

A recollection of the findings from chapter *4.1 Evolution of Supply Chain Management* reminds us that the *acceptance*, *growth* and *normal science* phases have been characterized by increased recognition of SCM among the operations oriented journals, whereas logistics journals were the only ones that published SCM related articles in the *emergence* phases. Operations management is a sub-field of business and management that frequently assumes an organization's internal perspective to the examination of production processes and inventory management. Thus, the question arises whether there is a correlation between the increased attention that has been paid to SCM by researchers publishing in the operations management journals and the growing relevance of internal SCM levels of analysis. A positive response to this question would imply that operations and logistics have different perspectives on what SCM actually is. In order to answer this question, a contingency analysis was performed in SPSS. The results of the contingency analysis are depicted in the following cross tabulation 4.14.

	Level of Analysis (%)				
Journals (%)	Internal	Dyadic	Chain	Network	Total
Operations	9.9	15.5	19.1	1.4	46.1
Logistics	10.6	10.3	27.3	5.7	53.9
Total	20.6	25.9	46.5	7.1	100
$\chi^2 = 12.75; \alpha < 0.01; df = 3; \varphi = 0.213$					

Table 4.14: Cross Tabulation of Journal Type and Level of Analysis

The results suggest that there is a relationship between the logistics oriented journals and a research focus on the level of analysis "chain" (27.3% in comparison to only 19.1% of the operations oriented journals). Nevertheless, the hypothesis that operations-oriented journals tend to focus on the level of analysis "internal", is not supported as the percentage in this cell (9.9%) is lower than that of the logistics oriented journals (10.6%). Instead, the operations related journals publish more articles on the investigation of dyadic relationships (15.5%) than the logistics related journals (10.35%). The chi-square test reveals that these correlations are significant ($\chi^2 = 12.75$, $\alpha < 0.01$). The φ-coefficient is a measure for the calculation of the strength of a relationship between variables. If φ is higher than 0.3, it is assumed that a correlation is not trivial but strong (Backhaus, Erichson, Plinke & Weiber, 2003, p. 244). In this analysis, the phi-correlation reveals that the correlation is not strong ($\varphi = 0.213$). Still, it can be concluded that the contribution operations oriented journals have made to SCM since the *acceptance* phase have had a significant impact upon the investigation of dyadic chain relationships.

Taken together, the level of analysis in SCM has evolved from almost pure chain relationship investigations to a more balanced picture that, today, takes into consideration other types of SCM levels of analysis as well. The columns representing the *growth* and *normal science* periods of SCM research illustrate an almost equal share among the four different types of SCM level of analysis and also seem to be represented for the coming years,. Table 4.15 displays the most important levels of analysis accounting for 80% of the investigations in each period and in total.

1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		Total	
%	**Construct**	**%**	**Construct**	**%**	**Construct**	**%**	**Construct**	**%**	**Construct**
89	Chain	60	Chain	41	Chain	42	Chain	47	Chain
		20	Dyad	24	Internal	30	Dyad	26	Dyad
				25	Dyad	21	Internal	21	Internal

Table 4.15: Breakdown of Major Levels of Analysis across Periods

4.3.4 Objectives

A field of research is considered legitimate, if it delivers a valuable contribution (Whetten, 1989, p. 490). Therefore, a final objective in analyzing the object of SCM research was to understand the value that SCM contributes to practice. The value of research was measured in terms of the objectives that were pursued in a specific piece of research. In this sense, a proposed SCM model or concept would usually assist practice in the achievement of specific goals that could be the reduction of costs, increase in quality, flexibility, reliability, and security and improvements of organizational learning and environmental protection. Table 4.16 shows the number of articles in terms of the objectives to which these made a contribution. The investigation of more than one objective in a single article means that the figure for the total in the table (646) exceeds the number of articles that were analyzed (282).

	1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		Total		%difference between periods		
	Art	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**1-2**	**2-3**	**3-4**
Cost	6	25.0	41	31.5	60	29.9	91	31.3	**198**	**30.7**	*6.5*	*-1.7*	*1.4*
Quality	3	12.5	13	10.0	19	9.5	32	11.0	**67**	**10.4**	*-2.5*	*-0.5*	*1.5*
Del	5	20.8	23	17.7	35	17.4	47	16.2	**110**	**17.0**	*-3.1*	*-0.3*	*-1.3*
Flex	4	16.7	20	15.4	27	13.4	35	12.0	**86**	**13.3**	*-1.3*	*-2.0*	*-1.4*
Inno	0	0.0	3	2.3	6	3.0	6	2.1	**15**	**2.3**	*2.3*	*0.7*	*-0.9*
Sec	0	0.0	1	0.8	2	1.0	4	1.4	**7**	**1.1**	*0.8*	*0.2*	*0.4*
Env	0	0.0	1	0.8	5	2.5	5	1.7	**11**	**1.7**	*0.8*	*1.7*	*-0.8*
Capa	0	0.0	3	2.3	6	3.0	11	3.8	**20**	**3.1**	*2.3*	*0.7*	*0.8*
Int	6	25.0	25	19.2	41	20.4	60	20.6	**132**	**20.4**	*-5.8*	*1.2*	*0.2*
Total	**24**	**100.0**	**130**	**100.0**	**201**	**100.0**	**291**	**100.0**	**646**	**100.0**			

Table 4.16: Breakdown of Objectives across Periods[1]

Overall, the most important value that SCM research creates is to provide tools and models for cost reduction (30.7%). Another important objective in SCM research is to provide means for the successful realization of supply chain integration (20.4%). This result mirrors the importance that has been attributed to the role of integration in the definitions of SCM. Taken together, these two SCM objectives account for more than 50% of all potential SCM objectives. As a consequence, the main value that SCM delivers to practice is to assist with the realization of cost reductions and integration. In addition, the importance of several other targets in a SCM context has been confirmed by the data gained from the sample. Still, these are less frequently considered in SCM research than the two mentioned above. Among these,

[1] Del = delivery; Flex = flexibility; Inno = innovation; Sec = security; Env = environmental protection; Capa = capability; Int = integration.

improvements of delivery and reliability performance (17.0%) are the most important objective, followed by an increase in flexibility (13.3%) and quality improvement (10.4%).

During the category identification and definition process described in chapter 3.2.5, several other targets have been identified that can be achieved by means of SCM. However, the coding process revealed that these are not as important as the ones previously described. This is the case for the development of capabilities by means of (inter-)organizational learning (3.1%), for the generation of innovations in association with supply chain partners (2.3%), for the use of effective SCM practices to save the environment (1.7%), and for the provision of tools and techniques to prevent supply disruption (1.1%).

In terms of the varying importance these different objectives played over time, only a small number of alterations can be observed with average deviations ranging from 1.1% to 3.6%. To summarize, the strongest differences occur between the *emergence* phase of SCM and the *acceptance* period. In addition, no significant changes can be observed in terms of the most important targets per period. In all four phases, the three most important SCM objectives are cost reduction (*emergence* 25.0%, *acceptance* 31.5%, *growth* 29.9%, *normal science* 31.3%), integration (*emergence* 25.0%, *acceptance* 19.2%, *growth* 20.4%, *normal science* 20.6%), and finally, delivery (*emergence* 20.8%, *acceptance* 17.7%, *growth* 17.4%, *normal science* 16.2%, see table 4.17 for an overview of those targets that account for 80% in each period).

1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		Total	
%	**Objective**	**%**	**Objective**	**%**	**Objective**	**%**	**Objective**	**%**	**Objective**
25	Cost	32	Cost	30	Cost	31	Cost	31	Cost
25	Integration	19	Integration	20	Integration	21	Integration	20	Integration
21	Delivery	18	Delivery	17	Delivery	16	Delivery	17	Delivery
17	Flexibility	15	Flexibility	13	Flexibility	12	Flexibility	13	Flexibility

Table 4.17: Breakdown of Major SCM Objectives across Periods

Except for the objective *integration*, the SCM objectives that dominate in all periods do not differ significantly from the 'traditional' operations and logistics objectives. As a consequence, SCM seems to have only limited potential to provide specific means for the generation of competitive advantage. Still, the less traditional SCM objectives such as learning, security of supply, innovation and environmental protection gradually increased in importance over time. These less traditional SCM objectives have the potential to provide real competitive advantage to organizations engaged in SCM. Thus, future investigations into these objectives would be beneficial and, as it seems, the trend goes into this direction.

4.3.5 Interim Summary

Data analysis in this chapter dealt with the object of Supply Chain Management that differentiates the research field from other business and management disciplines. Four different elements were analyzed in order to provide a comprehensive understanding of the SCM object of study: SCM definitions, core constructs, levels of analysis, and objectives. This chapter sought to provide an answer to research question two, which was to understand what the object of SCM is. In sum, it was found that researchers implicitly share loose agreement on the SCM object of study that is supposed to integrate among chains of organizations ranging from suppliers to customers.

Despite the slack agreement that SCM is concerned with the analysis of *chains* of organizations, there has been a substantial amount of research that analyzed SCM from different perspectives regarding the number of organizations taken into consideration. In fact, it was found that investigations strongly differ in terms of the SCM levels of analysis considered. Taken together, investigations into *chains* of organizations do not even account for half of the publications, although this would have been expected as a result of the definition analysis. Instead, researchers frequently analyze supply chains from an organization internal or dyadic relationship perspective and it is doubtful whether the findings from such studies can be generalized and applied to whole chains of organizations.

In terms of alterations of the SCM object of study over time it was found that, although the integration perception of SCM characterized supply chain management research from the beginning of the analysis period, there have been some alterations over time. Throughout time, SCM research experienced a continuous growth in terms of the definitions used to describe it, the constructs attributed to it, the levels of analysis taken into consideration, and the objectives pursued. Even though SCM research is targeted at integration, research activity is marked by disintegration and increasing fragmentation. Overall, these developments might constitute a serious threat to the discipline, as the object of study gets blurred and the differentiation from other disciplines might get increasingly difficult. As a consequence, future research in SCM should try to regain clear focus of the field of study. Table 4.18 summarizes the findings of this section of the analysis.

Element	Emergence	Acceptance	Growth	Normal Science
Definition	Integration of chain of processes	Integration and management of chain of activities	Integration and management of chain of activities for value generation	Not clearly discernable

Element	Emergence	Acceptance	Growth	Normal Science
Constructs	Lean SCM, Relationships, Strategy, Inventory, Demand Chain, Performance, Production, Risk, Logistics, Quality	Lean SCM, Relationships, Inventory, IT, Demand Chain, Production, Perfomance, Purchasing, Organization, Strategy, Product, Logistics	Lean SCM, Production, Relationships, Strategy, Organization, IT, Demand Chain, Performance, Inventory, Purchasing, Logistics, Product	Lean SCM, Relationships, Demand Chain, Production, Strategy, IT, Performance, Purchasing, Inventory, Organization, Logistics, Quality
Level	Chain, Dyad	Chain, Dyad, Internal	Chain, Dyad, Internal	Chain, Dyad, Internal
Objectives	Cost, integration, delivery, flexibility	Cost, integration, delivery, flexibility	Cost, integration, delivery, flexibility	Cost, integration, delivery, flexibility

Table 4.18: Summary of Findings on the SCM Object of Study

4.4 Scientific Practice - Schools of Thought in Supply Chain Management

The identification of key schools of thought serves to reveal the main disciplines that contribute to the growth of knowledge in a field of study. In chapter 2, a school of thought has been defined as the different topics scientists in SCM focus on, the specific research methodologies they apply in order to generate knowledge from and for their particular view on supply chains. Whereas classification categories have been predefined for the investigation of the majority of the other sections of the frame of reference, this has not been the case for the identification of key schools of thought in Supply Chain Management. The most important reason for this was that a predefinition of categories for schools of thought might hamper the discovery of schools that were not known in advance. In contrast, the analysis structures and groups from the data set seemed to allow for the discovery of schools that might not have been found otherwise.

Due to the provision of a large number of data from the classification of articles into the numerous categories defined for the remaining sections of the frame of reference, it is possible to use the results of these other sections in order to analyze potential structures in the data set. By means of statistical analyses it is possible to analyze the degree to which certain articles resemble each others or not, and how far it is possible to group certain articles together and thus, to designate them as a school of thought. In chapter 3.2.5, four classification categories have been identified that ought to be considered to be operationalized for investigations into central schools of thought in SCM. These were constructs, objectives, methodologies and the SCM level of analysis.

The statistical data analysis techniques required for such analyses go beyond mere descriptive statistics as applied for data analysis in the other sections of the frame of reference and enters the field of multivariate analysis. There are numerous different multivariate data analysis techniques that can be differentiated into those techniques that seek to test particular hypothesis about the data to understand the correlation of certain variables within a given data set (Landau & Everitt, 2004). In order to apply these techniques, it is necessary to have a certain understanding and knowledge of these correlations among variables before data analysis starts (Backhaus et al., 2003, p. 7). Since the objective of data analysis in this section is to uncover relations among variables that are unknown at this point, these techniques are of minor importance here. The second type of multivariate data analysis technique is the so-called exploratory data analysis technique. The primary purpose of exploratory data analysis techniques is to maximize insights into data, to uncover potential underlying structures, to extract important variables, to detect outliers and anomalies and to develop parsimonious models (NIST, 2003). As a consequence, exploratory data analysis techniques seem to be appropriate for data analysis in this section of the thesis.

According to Backhaus, five major data analysis techniques can be differentiated among the exploratory data analysis techniques: factor analysis, cluster analysis, multidimensional scaling, correspondence analysis and finally, neuronal nets (Backhaus et al., 2003, pp. 12-15). The type of data that has been generated in the scope of the classification process is nominal, i.e. articles were only classified into one of the two categories “0” or “1” with “0” meaning that a certain category does not apply for an article and “1” that a category does apply. Thus, the variables generated are *nominal* in nature. As a consequence, all those data analysis techniques that require a higher level of variable scaling such as ordinal, interval or ratio cannot be applied in the scope of this thesis. Out of the five exploratory data analysis techniques, three require a higher degree of variable scaling than mere nominal ones. These are factor analysis, multidimensional scaling and neural networks. Among the remaining two, correspondence analysis serves to visualize complex data, i.e. the primary purpose of this technique is to provide graphical representations of combined frequencies (Backhaus et al., 2003, p. 13). From the perspective of the author, the graphical representation is not sufficient for the identification and description of the variables that characterize certain schools of thought in SCM. As a consequence, only cluster analysis remains as a data analysis technique. Cluster analysis seeks to identify *“the “natural” structure of groups based on a multivariate profile, if it exists, which both minimises the within-group variation and maximises the between-group variation”* (Chan, 2005, p. 153). Thus, this technique seems to provide the necessary insights into schools of thought in SCM and will therefore be applied as data analysis technique in this section of the thesis.

In the following chapters, the cluster analysis procedure that has been conducted in the scope of this thesis will be described in detail. Furthermore, the clusters and, as a consequence, the

resulting schools of thought from cluster analysis will be described. In addition, those variables that are the most important to separate one cluster from another one will be identified. In this sense, a cluster is a group of data that is rather homogeneous in terms of the certain variables and can thus be separated from other groups and outliers. Thus, the terms *cluster* and *group* provide the structural representation of the schools of thought whereas the *schools of thought* are the descriptive characterizations of the different clusters.

4.4.1 Cluster Analysis

In this chapter, the cluster analysis that was performed in order to identify groups of articles that share similar characteristics and therefore, form different schools of thought in Supply Chain Management will be described. The software used for cluster analysis in the scope of this thesis is SPSS, version 13.0. SPSS offers three different possibilities for cluster analysis:

- *K-Means Cluster Analysis*: This method attempts to identify relatively homogeneous groups of cases based on selected characteristics, using an algorithm that can handle large numbers of cases. The algorithm requires to specify the number of clusters and can therefore be applied if the initial number of clusters is known (Chan, 2005, p. 157).
- *TwoStep Cluster Analysis*: This procedure is an exploratory tool designed to reveal natural groupings within a data set that would otherwise not be apparent. Unlike the two other cluster techniques, TwoStep cluster analysis allows for the simultaneous handling of variables with different types of scales, namely categorical and continuous. As the present data set specifies categorical variables, only, the degree of suitability of this technique needs to be considered as limited (Chan, 2005, p. 159).
- *Hierarchical Cluster Analysis*: This procedure attempts to identify relatively homogeneous groups of cases based on selected characteristics, using an algorithm that starts with each case (or variable) in a separate cluster and combines clusters until only one is left. Thus, this technique allows for an iterative process in order to determine the optimal number of clusters in terms of the degree of homogeneity desired. As a result, this latter cluster analysis technique will be used in the scope of this thesis.

Within hierarchical cluster analysis, two basic cluster hierarchical clustering procedures can be differentiated: agglomerative and divisive. Agglomerative starts by defining each object (or article) as a single cluster and combines these to new clusters until eventually all objects are grouped into one large cluster. Divisive proceeds in the opposite direction and seeks to divide one large cluster into smaller groups (Chan, 2005, p. 153). According to Backhaus et al.

the agglomerative approach is more generally accepted and explored within research (Backhaus et al., 2003, p. 481), and will therefore be used for the present cluster analysis.

Backaus et al. propose a three-step process for the realization of cluster analysis that starts with the identification of an appropriate distance similarity measure. Next, an algorithm is selected for the formation of the clusters, and finally, the number of optimal clusters is defined (Backhaus et al., 2003, p. 481). This approach has been followed in this thesis. The different steps will be described in more detail in the next sections.

A) Determination of Similarity Measure

In order to determine the similarity or distance of two articles in the data set, the characteristics of these articles in terms of the classification that have been made are compared. The similarity or distance between the two articles is then measured by means of a similarity measure. While similarity measures determine the similarity of two articles, distance measures determine the degree of their difference.

The determination of the appropriate similarity or distance measure is dependent on the scale level of data. As the present data set is composed of nominal data (i.e. either “0” for a characteristic that is not applicable or “1” for a characteristic that is applicable), only similarity measures for binary data can be considered. In addition, appropriate similarity measures need to correspond to a second criterion in the scope of this thesis. Most of the similarity measures suggest that every couple of equal values of two articles in terms of the same variable is considered as a common characteristic. Due to the large number of variables (more than 100 in total) that characterize the sample articles, there are many couples of equal values where a variable does not occur in either of the articles. This would falsify the results as the similarity of two articles is higher in cases where one variable is applicable in two articles, rather than where this is not the case. As a consequence, all those similarity measures are excluded that consider the absolute number of variables as weighting factors. This is the case for example for the Rogers and Tanimoto coefficient that gives double weight to non matches. According to Backhaus et al., there are three similarity measures that are applicable to binary data and that focus on the comparison of the applicability of a variable for the calculation of the similarity:

- *Jaccard*: This index is a measure in which joint absences are excluded from consideration and which gives equal weight to matches and non matches.
- *Dice*: This index is an extension to the Jaccard index. It also excludes joint absences from consideration but gives double weight to matches and non matches.

- *Kulzynski:* This index calculates the ratio of joint presences to all non matches. The index has a lower bound of zero and is unbound above (Backhaus et al., 2003, pp. 484-485).

The Kulzynski measure cannot be computed for the present data set, as it contains too many missing distances. As a consequence, only the *Jaccard* and *Dice* measures can be applied to determine the degree of similarity between the articles in the dataset. In order to obtain a high degree of stability of the clusters, the results for both of these measures will be calculated. Only those articles belonging to a certain cluster that have been classified into the same cluster by both similarity measures will be considered. In contrast, all articles that are classified into different clusters by the two measures increase the instability of a cluster and will therefore be excluded.

B) Amalgamation Rules

The hierarchical cluster analysis applied in this thesis is agglomerative in nature, i.e. each article is considered as a separate cluster at the beginning of the analysis. These clusters are then grouped together according to their similarity until only one cluster remains. The similarity measures Jaccard and Dice serve to determine the similarity between articles. In a second step, the point needs to be determined where the two articles are sufficiently similar to be grouped together. This is done by the so-called amalgamation or linkage rules which are algorithms targeted at the combination of objects in a data set.

Again, there are different algorithms that can be applied as an amalgamation rule for hierarchical cluster analysis. Among these, there are several ones which require metrical scaling of data such as Ward's method or centroid that cannot be used for the present type of binary data. The most important remaining algorithms are:

- *Single linkage or nearest neighbour*: This algorithm determines the distance between two clusters by using the distance of the two closest articles (nearest neighbour) in the different clusters. In essence, the result constitutes clusters that tend to represent long chains and the clusters at the two ends of the chain are those that are least likely to the others.
- *Complete linkage or furthest neighbour:* This algorithm determines the distance between two clusters by means of the greatest distance (furthest neighbour) between any two articles in the different clusters.

In order to determine schools of thought in Supply Chain Management that are characterized by a high level of stability, both of these algorithms were computed. In a first step, the nearest neighbour algorithm was used to determine outliers at the two ends of the chain of clusters

which will then be excluded from further analysis. Table 4.19 provides an overview of the outliers that have been excluded after calculation of the nearest neighbour algorithm:

Outlier	Jaccard	Dice	Outlier	Jaccard	Dice
Angell & Klassen, 1999	X		Kia, Shayan & Ghotb, 2000		X
Arlbjorn & Halldórsson, 2002b	X	X	Krause, Handfield & Scannell, 1998	X	
Bandinelli et al., 2006		X	Kumar & Kwon, 2004	X	X
Barker & Naim, 2004	X	X	Lancioni et al., 2001b	X	X
Bechtel & Jayaram, 1997	X	X	Mangan & Christopher, 2005	X	X
Brewer & Speh, 2000	X	X	McAfee et al., 2002	X	X
Burcher, Lee & Sohal, 2005	X	X	Ngai et al., 2004	X	X
Carlsson & Sarv, 1997	X	X	Prokop, 2004	X	X
Carr & Crum, 1995	X	X	Rungtusanatham et al., 2003	X	X
Cheng & Grimm, 2006	X		Sachan & Datta, 2005	X	X
Choudhury, Tiwari & Mukhopadhyay, 2004	X	X	Schiefer, 2002	X	X
Cigolini & Grillo, 2003	X	X	Shen, Kremer, Ulieru & Norrie, 2003	X	X
Closs & Stank, 1999	X	X	Skjoett-Larsen, 1999	X	X
Dominguez & Lashkari, 2004		X	Stevenson, Hendry & Kingsman, 2005	X	X
Ellinger, Ellinger & Keller, 2005	X	X	Stock & Broadus, 2006	X	X
Filbeck, Gorman, Greenlee & Speh, 2005	X	X	Stock & Lambert, 2001	X	X
Gammelgaard & Larson, 2001	X	X	Svensson, 2002b	X	X
Gibson et al., 2005	X	X	Taylor, Fawcett & Jackson, 2004	X	X
Griffis, Cooper, Goldsby & Closs, 2004	X	X	Voss, Calantone & Keller, 2005	X	X
Gubi et al., 2003	X	X	Warren & Hutchinson, 2000	X	X
Holweg & Miemczyk, 2002	X	X	Xie, Tu, Fung & Zhou, 2003	X	X
Johnson, Klassen, Leenders & Fearon, 2002	X	X	Zineldin, 2004	X	X

Table 4.19: Outliers from Nearest Neighbour Analysis

As a result, 44 articles (15.6%) of all sample articles were identified as outliers. Among these, 38 were identified as nearest neighbour calculations for both Jaccard and Dice, three were identified by Jaccard only, and three by Dice only. Nearest neighbour analysis results in clusters that represent long chains and these outliers are located at the two ends of this chain.

They are the least likely to each other and to the remaining articles. Therefore, they ought to be excluded from further analysis as they would decrease the degree of homogeneity of the different clusters.

Thus, all outliers as identified in table 4.19 were eliminated from the data set for further analyses. As these count for approximately 15% of all sample articles, it would have been possible that their elimination led to the drop-out of one variable considered in the cluster analysis. For example, in chapter 4.3.2 it was found that only 12 articles deal with the marketing construct. The exclusion of 44 articles might lead to the complete drop-out of the marketing construct. However, the algorithms in cluster analysis require that there is at least one object in a sample that a certain characteristic applies to. Therefore, frequency counts were performed after elimination of outliers to ensure that each of the variables is still represented by at least one article. Otherwise, a certain variable would have to be excluded from further analysis. The frequency counts revealed that each variable was represented in at least one article. As a consequence, no variable had to be eliminated for further analysis.

In a next step, the remaining 238 sample articles were submitted to the furthest neighbour analysis in order to identify clusters in terms of the greatest distance between any two articles. Furthest neighbour analysis was performed with both Jaccard and Dice measures. Thus, it is possible to differentiate those articles that were classified into the same cluster by each of the two algorithms from those that were classified into a certain cluster by only one analysis technique. The identification of key schools of thought in Supply Chain Management will only be based on those articles that have been classified into the same cluster by both similarity measures. Thus, the degree of stability in each cluster is increased.

In contrast, those articles that were classified into different clusters by the similarity measures Jaccard and Dice are located at the ends of the clusters and can be attributed to one or another depending on a particular emphasis that is placed on a certain criterion. These articles increase the degree of instability of the clusters. For that reason, these articles will also be removed from further analyses after determining the optimal number of clusters in the next chapter.

C) Determination of the Number of Clusters

The algorithms for hierarchical clustering described in the previous chapters are agglomerative in nature, i.e. they start with the assumption that each article forms a separate cluster and then forms groups in a stepwise process until all articles are placed into a single cluster. As a consequence, a decision needs to be taken regarding the optimal number of clusters in the third step, i.e. when to stop the grouping process.

A statistical indicator for the optimal number of clusters is the heterogeneity coefficient that is an index for the distance between clusters. The higher this index, the higher is the distance

and thus the heterogeneity of two clusters. From a statistical perspective, the optimal number of clusters is obtained when the next step in the clustering process is characterized by the highest increase of the heterogeneity coefficient across all clustering steps. The agglomeration schedules resulting from furthest-neighbour analyses illustrate that there is no clear demarcation between the various coefficients. Instead, the degree of heterogeneity slowly increases between the various iterations.

For this reason, the optimal number of clusters was determined in terms of the manageability of clusters, instead of statistical indicators. The dendograms using both Jaccard and Dice suggest that a manageable number of clusters are obtained from the second last iteration, which results in six clusters for the Jaccard similarity measure and six clusters for the Dice similarity measure. In the next iteration, the number of clusters, and schools of thought would increase to thirteen for Jaccard and fourteen for Dice. To summarize, thirteen or more schools of thought seem to be many for a single research field. The characterization of Supply Chain Management seems to be more efficient if only six schools are considered.

In order to increase the stability within the six different clusters, only those articles that have been classified into the same cluster by both the Jaccard and Dice similarity measures are supposed to form the "core" of a certain school of thought. In contrast, all those articles that have been attributed into different clusters by the algorithms, lead to a higher degree of instability within the groups. As a result, these articles will not be referred to when characterizing the different clusters. Table 4.20 displays the articles and different clusters they have been placed into and which are therefore subject to exclusion.

Article	Jaccard	Dice	Article	Jaccard	Dice
Abrahamsson & Brege, 1997	4	2	La Londe & Masters, 1994	4	2
Berglund, van Laarhoven, Sharman & Wandel, 1999	3	4	La Londe & Pohlen, 1996	4	3
Bhattacharya et al., 1996	6	5	Lambert & Pohlem, 2001	4	3
Bottani & Rizzi, 2006	5	3	Lambert et al., 2005	4	2
Carter & Ferrin, 1995	3	1	Landeghem & Vanmaele, 2002	2	6
Chan, 2003	5	3	Lasch & Janker, 2005	1	3
Chan et al., 2001	3	1	Lee, Lee & Jeong, 2003	1	3
Chandrashekar & Schary, 1999	4	2	Lemke et al., 2000	5	3
Chen & Huang, 2006	3	2	Lin & Lin, 2006	3	1
Chen, Lin & Huang, 2006	1	3	Mason-Jones, Naim & Towill, 1997	3	1
Chin et al., 2004	4	2	Mejza & Wisner, 2001	4	2
Christopher & Ryals, 1999	4	3	Mello & Stank, 2005	6	5
Cooper, Lambert et al., 1997a	4	2	Min & Mentzer, 2004	2	4

Article	Jaccard	Dice	Article	Jaccard	Dice
Davies & Brito, 1996	4	3	Minner, 2001	3	1
Defee & Stank, 2005	4	3	Minner, 2003	1	3
Demeter et al., 2006	6	5	Mohanty & Deshmukh, 2000	2	6
Dimitriadis & Koh, 2005	6	5	Narasimhan & Kim, 2001	2	6
Doran, 2005	4	3	Nguyen & Harrison, 2004	4	2
Dowlatshahi, 2005	3	2	Ojala & Hallikas, 2006	6	5
Ellram & Cooper, 1993	4	2	Olhager, 2002	4	2
Fandel & Stammen, 2004	3	1	Ovalle & Marquez, 2003	4	2
Fernie & Rees, 1995	5	3	Peck & Jüttner, 2000b	6	5
Flynn & Flynn, 2005	5	3	Persson & Olhager, 2002	1	2
Fugate et al., 2006	5	3	Rahman, 2002	2	6
Fürst & Schmidt, 2001	5	3	Rau, Wu & Wee, 2003	3	1
Goldsby & Garcia-Dastugue, 2003	4	2	Richey et al., 2004	3	4
Goutsos & Karacapilidis, 2004	4	2	Robertson et al., 2002	2	6
Gunasekaran & Ngai, 2004	2	6	Ryu, Son & Jung, 2003	3	2
Gunasekaran & Ngai, 2005	4	2	Scannell et al., 2000	5	3
Handfield & Pannesi, 1995	5	3	Schneeweiss, 2003	6	5
Hieber & Hartel, 2003	3	1	Shin et al., 2000	5	3
Hill & Scudder, 2002	4	2	Spens & Bask, 2002	2	6
Hoek & Weken, 1998	4	2	Stank et al., 2001	4	2
Humphreys, Lai & Sculli, 2001	4	3	Talluri & Silberman, 2000	3	2
Hyland et al., 2003	6	5	Talluri & Sarkis, 2002	1	3
Ignacio Sanchez Chiappe & Herrero, 1997	4	2	Tan et al., 2006	5	3
Kaihara, 2001	3	1	Trienekens & Beulens, 2001	4	3
Kaihara, 2003	3	1	Turowski, 2002	4	2
Kainuma & Tawara, 2006	3	1	Umeda & Zhang, 2006	3	1
Kemppainen & Vepsäläinen, 2003	4	2	Walton & Miller, 1995	4	3
Khouja, 2003a	3	1	Wang, Jia & Takahashi, 2005	3	1
Kim & Narasimhan, 2002	4	2	Williams, 2006	5	3
Koh, Saad & Arunachalam, 2006	6	5	Wu & O'Grady, 2005	3	2
Kotzab et al., 2006	4	2	Zhu & Sarkis, 2004	3	2
Krause, Pagell & Curkovic, 2001	5	3			

Table 4.20: Articles Changing-Over Clusters by Jaccard and Dice Calculations

The remaining 148 articles were classified into the same clusters by both Jaccard and Dice analyses. These are considered to form the centre of each of the six clusters or schools of thought in Supply Chain Management. They will be characterized in the following chapter.

4.4.2 Characterization of Schools of Thought

The cluster analysis described in the previous chapter revealed that the sample articles can be classified into six rather homogeneous clusters according to a number of common characteristics. Thus, each cluster represents a school of thought in Supply Chain Management. The next question to be answered is which classification categories characterize each of the six schools and make it distinct from the other ones. A contingency analysis was performed in order to understand which variables from the classification grid occur in which cluster and to reveal how far these co-occurrences are significant. The results of this contingency analysis are summarized in table 4.21 which displays the percentages of articles that have been classified as applicable into a certain category for each cluster. For example, 41.2% of the articles in cluster 1 have been classified at the internal supply chain level of analysis. The remaining 58.8% have been classified into other levels of analysis.

Variables	**1**	**2**	**3**	**4**	**5**	**6**	χ^2	φ
LoA: Internal	41.2	24.0	14.3	5.6	0.0	100.0	*30.9	0.331
LoA: Dyad	55.9	22.0	0.0	0.0	89.5	0.0	*75.2	0.517
LoA: Chain	2.9	46.0	85.7	88.9	10.5	0.0	*69.6	0.497
LoA: Network	0.0	8.0	0.0	5.6	0.0	0.0	7.4	0.162
Obj: Cost Reduction	94.1	90.0	85.7	50.0	63.2	33.3	*32.0	0.337
Obj: Quality Improvement	8.8	44.0	14.3	22.2	15.8	0.0	17.6	0.250
Obj: Delivery	38.2	86.0	42.9	19.4	31.6	0.0	*60.7	0.464
Obj: Flexibility	23.5	90.0	14.3	11.1	5.3	0.0	*105.1	0.610
Obj: Innovation	2.9	14.0	0.0	2.8	0.0	0.0	10.1	0.189
Obj: Security	5.9	0.0	0.0	8.3	0.0	0.0	9.3	0.181
Obj: Environmental Protection	0.0	2.0	0.0	2.8	0.0	0.0	6.1	0.147
Obj: Capabilities	0.0	6.0	0.0	0.0	10.5	0.0	10.1	0.189
Obj: Integration	2.9	42.0	42.9	77.8	57.9	100.0	*45.2	0.400
Con: Closed-loop Supply Chain	2.9	16.0	0.0	2.8	0.0	0.0	9.9	0.187
Con: Demand Chain Mgt	52.9	64.0	0.0	52.8	21.1	0.0	*32.7	0.341
Con: Lean SCM	47.1	80.0	57.1	88.9	73.7	66.7	*32.8	0.341
Con: Inventory Management	67.6	30.0	42.9	27.8	36.8	0.0	*28.0	0.315
Con: Knowledge Management	0.0	2.0	0.0	2.8	10.5	0.0	6.0	0.147
Con: Law & Legal Affairs	2.9	6.0	14.3	5.6	0.0	0.0	3.5	0.111
Con: Marketing & Sales	2.9	18.0	0.0	13.9	10.5	33.3	8.2	0.170
Con: Organization	5.9	52.0	14.3	19.4	31.6	100.0	*32.2	0.338
Con: Performance	5.9	52.0	85.7	27.8	15.8	0.0	*33.4	0.344

Variables	1	2	3	4	5	6	χ^2	φ
Con: Power & Reach	0.0	8.0	14.3	5.6	0.0	0.0	6.0	0.146
Con: Product Management	8.8	38.0	0.0	22.2	21.1	0.0	12.5	0.242
Con: Production Management	58.8	56.0	71.7	22.2	63.2	66.7	*41.4	0.334
Con: Quality Management	8.8	24.0	0.0	22.2	15.8	0.0	6.2	0.147
Con: Risk Management	11.8	8.0	14.3	22.2	5.3	0.0	10.2	0.190
Con: Human Resource Mgt	8.8	20.0	0.0	8.3	21.1	33.3	6.4	0.150
Con: Relationships	26.5	76.0	57.1	47.2	94.7	0.0	*42.8	0.390
Con: Strategic Management	8.8	42.0	0.0	69.4	10.5	0.0	*41.2	0.382
Con: Supply Chain Design	20.6	18.0	85.7	11.1	0.0	0.0	*31.2	0.333
Con: Purchasing & Supply	29.4	34.0	0.0	13.9	52.6	0.0	13.9	0.222
Con: Information Technology	5.9	58.0	14.3	41.7	36.8	66.7	*27.4	0.312
Con: Transportation & Logistics	26.5	18.0	42.9	44.4	15.8	33.3	16.0	0.238
Con: Others	0.0	4.0	0.0	2.8	0.0	0.0	12.0	0.206
RS: Conceptual Exploratory	0.0	32.0	14.3	75.0	21.1	0.0	*54.3	0.439
RS: Conceptual Structured	97.1	4.0	85.7	0.0	0.0	0.0	*142.1	0.710
RS: Empirical Qualitative	0.0	18.0	0.0	5.6	42.1	66.7	*26.9	0.309
RS: Empirical Quantitative	2.9	42.0	0.0	11.1	36.8	33.3	*25.6	0.301
RS: Triangulation	0.0	4.0	0.0	8.3	0.0	0.0	4.8	0.130

** Significant at a level of 0,001*

Table 4.21: Characterizing Variables for Six Schools of Thought in SCM

The second last column of table 4.21 displays the Chi-Square results which are an indicator for the significance of a relationship. In most of the cases, very high levels of significance of less than 5% or even 0.1% of probability of error are obtained. The φ-coefficient displayed in the last column is a measure for the calculation of the strength of a relationship between variables. If φ is higher than 0.3, it is assumed that a correlation is not trivial but strong. This is the case for all variables and clusters that are marked with "*" in the Chi-Square-column of table 4.21.

In the next sections, the different clusters will be characterized in terms of all variables that yield levels of significance of more than 0.1% and φ-coefficients of more than 0.3. Furthermore, a certain variable or category will be considered as key characteristic of research activity in a certain Supply Chain Management school of thought, if it applies to circa 50% of all articles in the respective cluster. These characterizations will be described in the next sections. In addition, the core articles of each cluster and their occurrence over time in terms the four different periods will be enumerated.

A) The Operations Research School (Cluster 1)

Regarding the level of analysis, most of the articles grouped into the first cluster are concerned with dyadic or internal supply chain relationships. This clearly differentiates cluster one from clusters three and four, where most attention is paid to chain relationships.

As illustrated in table 4.21, the objectives that can be obtained by the successful implementation of Supply Chain Management practices as investigated in the different articles play only a subordinate role in the differentiation of the clusters. With the exemption of cluster six, all other clusters are characterized by a strong focus on cost reduction targets. The objectives quality improvement, capabilities, security and environmental protection do not contribute to the differentiation of the clusters and are of minor importance for all six clusters. Thus, the high share of articles contributing to cost reduction in SCM in cluster one cannot be considered as a differentiation to other clusters. In the following, flexibility, delivery and integration are key SCM objectives that sharpen the profile of some other clusters.

The central topics concentrated on by research in cluster 1 are demand chain management, inventory management and production management. Production management is a theme that reoccurs in four of the remaining other clusters as well and has therefore only limited potential to clearly separate this cluster from the remaining ones. Clusters one, two and four share similar degrees of interest in topics related to demand chain management. However, unique for cluster one is the strong focus on inventory management.

Finally, the variable research strategy is a clear differentiation of the articles grouped into cluster one in comparison to the other clusters. 97.1% of the articles classified into this cluster used a conceptual structured research design, whereas no conceptual exploratory or empirical qualitative article belongs to this particular group. Conceptual structured research designs most frequently rely on the formulation of mathematical models to provide formula for the optimization of production processes or to investigate optimal fill-rates for inventories. Models for the latter usually imply the integration of the customer or supplier, as these two parties have central impact on the capacity utilization of inventories. This contributes to the explanation of the frequent occurrence of dyadic relationships in this cluster. Furthermore, conceptual structured research approaches are central for production optimization of the supply chain in a single organization.

Operations Research focuses on an effective and efficient management of the processes related to the production and transformation of goods and services (Robinson & Sahin, 2007, p. 149). Frequently, topics such as production planning (e.g. Erenguc, Simpson & Vakharia, 1999), forecasting (e.g. Zhao & Xie, 2002), capacity management and inventory management (e.g. Jammernegg & Reiner, 2007; Tyan & Wee, 2003), or Kanban and Just-in-Time (e.g. Claycomb, Dröge & Germain, 1999; Kannan & Tan, 2005; Vokurka & Lummus, 2000) are

dealt with by scientists in operations research. In addition, a central methodology used in operations research is mathematical modelling. From the perspective of the author the characteristics of cluster one correspond to that of operations research in many respects. Therefore, the label "**Operations Research School**" seems to be an appropriate designation for this Supply Chain Management school of thought.

Table 4.22 depicts the different articles grouped into the Operations Research School. Evidently, this school came about in the acceptance period and enfolded its full capacity in the growth and normal science period with a strongly increasing number of contributions in these two periods.

Period	Articles
Emergence (1990 - 1994)	- none -
Acceptance (1995 - 1999)	Beier, 1995; Korpela & Lehmusvaara, 1999; Li & O'Brien, 1999; Waller, Johnson & Davis, 1999
Growth (2000 - 2002)	Cheung & Leung, 2000; Lee, Kim & Moon, 2002; Li & O'Brien, 2001; Pontrandolfo, Gosavi, Okogbaa & Das, 2002; Rota, Thierry & Bel, 2002; Silva, Lisboa & Huang, 2000; Teulings & Van der Vlist, 2001; Waller, Dabholkar & Gentry, 2000; Zhao & Xie, 2002; Zimmer, 2002
Normal Science (2003 - 2006)	Abad & Aggarwal, 2005; Bhatnagar et al., 2003; Braglia & Zavanella, 2003; Brun, Caridi, Fahmy Salama & Ravelli, 2006; Damodaran & Wilhelm, 2005; Garavelli, 2003; Kim & Ha, 2003; Lu et al., 2005; Park, 2005; Persona, Grassi & Catena, 2005; Ruiz-Torres & Mahmoodi, 2006; Sirias & Mehra, 2005; Sucky, 2005; Takahashi, Myreshka & Hirotani, 2005; Talluri, Cetin & Gardner, 2004; Venkatadri, Srinivasan, Montreuil & Saraswat, 2006; Wang, Fung & Chai, 2004; Wu, 2006; Yang & Pan, 2004; Zhang, 2006

Table 4.22: Articles from the Operations Research School of Thought

B) The Customer Orientation School (Cluster 2)

Unlike most of the other clusters, cluster two is not clearly marked by a specific focus on a certain level of analysis in SCM. Instead, analyses focusing on internal, dyadic and chain supply chains occur in this cluster with the latter assuming the dominant position. In similar vein, research strategy does not contribute to the profile of this second cluster as there is no certain research strategy dominating. Therefore, this cluster seems to be characterized primarily in terms of SCM objectives and constructs.

Like in all other clusters, cost reduction targets are an important objective in cluster two. However, interestingly, there is a strong focus on the improvement of delivery performance and on an increase in flexibility as a result to the successful implementation of SCM practices in this cluster. In fact, this is a unique characteristic of the articles classified into this group.

In terms of the SCM constructs or topics that research in this cluster focuses on, there are many different themes occurring frequently. First, there is a strong emphasis on demand chain management and lean supply chain management. This is not surprising, as the two objectives flexibility and delivery that also characterize this cluster are frequently sought after by both demand chain management and lean supply chain management. Other central topics are the establishment of strategic alliances and cooperations with other partners in a supply chain, questions related to the organizational design of supply chain structures and processes, the optimization of production, the use of information technology in a supply chain context, and finally, the impact that SCM has upon performance. Taken together, these topics suggest that a central concern of research activity in this cluster is the organization of processes and structures of a supply chain in order to respond to customer requirements in a flexible and quick fashion. For this reason, this cluster will be designated the "**Customer Orientation School**." Unlike the previous Operations Research School, the Customer Orientation School has been active from the very beginning of the analysis period and therefore, seems to mirror a continuing emphasis that is placed on the fulfilment of customer needs in a supply chain context. Table 4.23 summarizes the contributions that have been made by this school in the four differentiated periods.

Period	**Articles**
Emergence (1990 - 1994)	Amstel & Farmer, 1990
Acceptance (1995 - 1999)	Burgess, 1998; Cooper, Lambert et al., 1997a; Ellram, La Londe & Weber, 1999; Evans, Towill & Naim, 1995; Giunipero & Brand, 1996; Groves & Valsamakis, 1998; Higginson & Alam, 1997; Lambert, Cooper et al., 1998; Lee & Sasser, 1995; McMullan, 1996; Spekman & Kamauff Jr., 1998; Stank et al., 1999
Growth (2000 - 2002)	Angeles & Nath, 2001; Choi, Dooley & Rungtusanatham, 2001; Croxton et al., 2001; Gimenez & Ventura, 2003; Gunasekaran, Marri, McGaughey & Nebhwani, 2002; Hewitt, 2000; Ho et al., 2002; Holmström, Främling, Tuomi, Kärkkaäinen & Ala-Risku, 2002 ; Jayaram et al., 2000 ; Korpela et al., 2001; Min & Mentzer, 2000; Olhager, 2002; Platts, Probert & Canez, 2002; Rogers, Lambert, Croxton & Garcìa-Dastugue, 2002; Vokurka & Lummus, 2000 ; Vorst & Beulens, 2002
Normal Science (2003 - 2006)	Al-Mudimigh et al., 2004; Auramo, Kauremaa & Tanskanen, 2005; Bolumole et al., 2003; Chen & Paulraj, 2004b; Choi & Krause, 2006; Coronado, Lyons, Kehoe & Coleman, 2004; Cousins & Menguc, 2006; Croxton, 2003; Evangelista & Sweeney, 2006; Gunasekaran et al., 2004; Hakansson & Persson, 2004; Li et al., 2005; Liu & Hai, 2005; Min et al., 2005; Moberg et al., 2004; Oke & Szwejczewski, 2005; Rodrigues et al., 2004; Sahay & Mohan, 2003; Sanders & Premus, 2005; Walters, 2006

Table 4.23: Articles from the Customer Orientation School of Thought

C) The Process Optimization School (Cluster 3)

In many respects, cluster three is similar to the Customer Orientation School. Many of the constructs that research in this cluster addresses are also of central concern for the Customer Orientation School: Lean Supply Chain Management, Performance Management, Production Management, and the formation and maintenance of relations with other partners. Still, there are other characteristics that clearly differentiate this third cluster from the previously described one.

First, there is a clear focus on chain relationships that could not be observed for the Customer Orientation School. Second, unlike cluster two, cluster three cannot be clearly characterized in terms of specific objectives that are pursued with the successful implementation of SCM practices. Third, one SCM construct plays a central role in this cluster that was of minor importance in the previous one: Supply Chain Design. Furthermore, there is a very clear focus on conceptual structured research strategies which sharpens the profile of this third cluster.

In sum, the articles that have been grouped into this cluster seem to concentrate on aspects of the design and optimization of supply chain processes and structures. This orientation is rather cost oriented and seeks to increase performance of the organizations in a supply chain rather than generate specific benefits for the customer that was a central aspect in the Customer Orientation School. Due to the evident orientation towards supply chain design improvements, the label that is proposed for this school of thought in Supply Chain Management is the "**Process Optimization School**." As table 4.24 illustrates, the Process Optimization School is marked by only a limited number of contributions. In the emergence period, the school was not yet active. A peak of the school's research activity is reached in the growth period and finally, in the normal science phase there seems to be a slight decline of the school's contributions to SCM research.

Period	Articles
Emergence (1990 - 1994)	- none -
Acceptance (1995 - 1999)	Bonney, Head, Tien, Huang & Barson, 1996; Schwarz & Weng, 1999
Growth (2000 - 2002)	Farris & Hutchison, 2001; Sundaram & Mehta, 2002; Taylor & Whicker, 2002; Villa, 2002
Normal Science (2003 - 2006)	Agrell, Lindroth & Norrman, 2004

Table 4.24: Articles from the Process Optimization School of Thought

D) The Strategic Chain Integration School (Cluster 4)

The following three clusters all have in common a strong interest into the integration of supply chains. Instead, what differentiates them is the level of analysis that the integration attempts are focused on. For cluster four, integration primarily takes place at the chain level and seeks to integrate partner organizations of both the upstream and downstream supply chain. Therefore, it is not surprising that particular emphasis is laid on Lean Supply Chain Management as a key construct investigated by researchers in this cluster. Furthermore, the successful integration of partner organizations requires the commitment and active support of strategic management which is supposed to provide the link to (potential) partner organizations. Therefore, the proposed designation for this cluster is the "**Strategic Chain Integration School**". An additional feature and characteristic of this school is the preponderance of conceptual exploratory research techniques that are most frequently applied by researchers in this school.

As table 4.25 highlights, five out of the nine articles in the emergence period stem from the Strategic Chain Integration School. Thus, this school dominated SCM research at the beginning of the analysis phase and continues to play an important role within the field, until today.

Period	Articles
Emergence (1990 - 1994)	Berry et al., 1994; Cooper & Ellram, 1993a; Ellram & Cooper, 1990; Langley & Holcomb, 1992; Sparks, 1994
Acceptance (1995 - 1999)	Gentry, 1996; Gudmundsson & Walczuck, 1999; Inger, Braithwaite & Christopher, 1995; Korhonen, Huttunen & Eloranta, 1998; Rich & Hines, 1997; Sabath, 1998; Verwijmeren & van der Vlist, 1996; Wilding, 1998
Growth (2000 - 2002)	Elliman & Orange, 2000; Fawcett & Magnan, 2002; Graham & Hardaker, 2000; Heikkila, 2002; Mentzer et al., 2001; Sheffi, 2001; Skjoett-Larsen, 2000; Sohal et al., 2002
Normal Science (2003 - 2006)	Chen & Paulraj, 2004a; DeWitt et al., 2006; Gripsrud et al., 2006 ; Ismail & Sharifi, 2006; Lejeune & Yakova, 2005; Robinson & Malhotra, 2005; Rosenzweig, Roth & Dean, 2003; Sabath & Whipple, 2004; Sheffi, 2004; Spekman & Davis, 2004; Stank et al., 2005; Surana et al., 2005; Tang et al., 2004; Towill, 2005; Wisner, 2003

Table 4.25: Articles from the Strategic Chain Integration School of Thought

E) The Supplier Integration School (Cluster 5)

In addition to the rather typical cost reduction targets, this cluster is characterized by a strong focus upon integration as an important objective of Supply Chain Management, a characteristic that this cluster shares with the fourth one. However, what differentiates the two is the level of analysis that they focus on. Where there has been a clear focus upon the

integration of chains of organizations in the Strategic Chain Integration School, the present cluster is more oriented towards the integration of two organizations, only.

Furthermore, a closer look at the SCM constructs that this cluster concentrates on suggests that the integration of these dyadic relationships are rather oriented to the integration of the suppliers than to that of the customer as there is a strong concentration upon lean supply chains, relationships and the purchasing and supply management constructs, whereas the demand chain constructs which provides the customer perspective only plays a subordinate role.

Theoretical insights in this cluster are frequently gained by means of empirical research which can be either qualitative or quantitative. Thus, field data are frequently used for the generation of insights in this cluster. In sum, the author proposes the label "**Supplier Integration School**" for this fifth cluster. Table 4.26 summarizes the school's theoretical contributions across the four differentiated periods. Evidently, the school has been active in SCM throughout the analysis period but enfolded its full capacity in the growth and normal science periods.

Period	Articles
Emergence (1990 - 1994)	Leenders et al., 1994
Acceptance (1995 - 1999)	Childe, 1998; Lewis et al., 1997
Growth (2000 - 2002)	Garver & Mentzer, 2000; Hicks, McGovern & Earl, 2000; Kaipia, Holmström & Tanskanen, 2002; Kumaraswamy, Palaneeswaran & Humphreys, 2000; Lowson, 2001; Mejias-Sacaluga & Prado-Prado, 2002; Trienekens & Hvolby, 2001
Normal Science (2003 - 2006)	Carter, 2005; Chen, Paulraj & Lado, 2004; Donk & Vaart, 2005; Falah, Zairi & Ahmed, 2003; Grover & Malhotra, 2003; Large, 2005; Lo & Yeung, 2004; Singh et al., 2005; Treville et al., 2004

Table 4.26: Articles from the Supplier Integration School

E) The Internal Organization School (Cluster 6)

Similar to the two previous clusters, a main research objective of the articles classified into cluster six is to obtain integration. However, what differentiates this cluster from the Strategic Chain Integration School and the Supplier Integration School is the level at which this integration is targeted at. Where the Strategic Chain Integration School is concerned with the integration of chains of independent organizations from the raw material supplier through to the end user, the Supplier Integration School addresses questions related to the integration of dyadic relationships. In cluster six, integration is targeted at the internal integration of functions and processes.

Furthermore, the constructs that characterize thematic emphasis in this cluster suggest that the tools through this internal organization is supposed to be achieved are lean SCM, the reconfiguration and optimization of organization structures and processes, and the implementation and use of information technology. In addition, a central topic in this school of thought is the design of products in the internal supply chain.

In terms of research strategy, this cluster is empirically focused, i.e. both qualitative and quantitative techniques are applied. Because of the objectives and constructs that are central to this cluster, an appropriate label for the school of thought is the "**Internal Supply Chain Organization School**". Taken together, the centre of this last school of thought is marked by only three contributions occurring in the growth and normal science periods as highlighted by table 4.27.

Period	Articles
Emergence (1990 - 1994)	- none -
Acceptance (1995 - 1999)	- none -
Growth (2000 - 2002)	Paik & Bagchi, 2000
Normal Science (2003 - 2006)	Gimenez, 2006; Ho & Lin, 2004

Table 4.27: Articles from the Internal Organization School

4.4.3 Interim Summary

In this chapter, data analysis was concerned with the identification of the core schools of thought underlying SCM research and thus provides an answer to research question number four. Schools of thought were identified on the basis of four characteristics: level of analysis, objectives, constructs and research strategy. Thus, regarding the theoretical framework, the second pillar is essentially composed of elements of the two other columns.

By means of a cluster analysis of article classifications in the respective four categories, six core schools of thought in Supply Chain Management were identified:

1) the Operations Research School,
2) the Customer Orientation School,
3) the Process Optimization School,
4) the Strategic Chain Integration School,
5) the Supplier Integration School, and
6) the Internal Organization School.

Three of these schools existed from the very beginning of the analysis period in the 1990's, two of them only emerged in the acceptance period and the sixth only came about in the growth period. These six schools of thought shape the specific knowledge creation processes in Supply Chain Management according to the classification of the sample articles.

However, researchers in these different schools of thought were not always active from the beginning of the analysis period. Rather, several schools came into being over time and across different periods. The following figure 4.7 summarizes the occurrence of the different schools of thought across the four phases of Supply Chain Management research differentiated in the scope of this thesis.

In the next chapter, discussions will turn to a detailed analysis of the methodologies applied by authors from the SCM field for the development and derivation of intellectual products. Thus, although the discussion on research strategies applied by the different schools of thought only touched the surface, debates on research methodologies applied in SCM in the next section will be more detailed.

I 1990 - 1994	II 1995 - 1999	III 2000 - 2002	IV 2003 -2006	Total
		Internal Organization School (1)	Internal Organization School (2)	Internal Organization School (3)
	Process Optimization School (2)	Process Optimization School (4)	Process Optimization School (1)	Process Optimization School (7)
	Operations Research School (4)	Operations Research School (10)	Operations Research School (20)	Operations Research School (34)
Supplier Integration School (1)	Supplier Integration School (2)	Supplier Integration School (7)	Supplier Integration School (9)	Supplier Integration School (19)
Strategic Chain Integration School (5)	Strategic Chain Integration School (8)	Strategic Chain Integration School (8)	Strategic Chain Integration School (15)	Strategic Chain Integration School (36)
Customer Orientation School (1)	Customer Orientation School (12)	Customer Orientation School (16)	Customer Orientation School (20)	Customer Orientation School (59)

Figure 4.5: Occurrence of Schools of Thought in Supply Chain Management over Time

Source: own illustration

4.5 Scientific Practice - Methodologies in Supply Chain Management

According to van Gigch, the main methodologies used in a discipline shed light on its core activities (van Gigch & le Moigne, 1989, p. 132; van Gigch & Pipino, 1986, pp. 72-73). Therefore, articles were classified in terms of the research strategy and research analysis techniques in order to understand how the activity domain of SCM is defined. In the next sections, the analysis results in terms of the research strategy and research approaches will be explored and discussed. In both cases, it was possible in an article to use more than one research design and more than a single data analysis technique. Thus, the figures in this part of the analysis exceed the overall number of sample articles (282).

4.5.1 Research Strategy

For the purposes of this study, two major research strategies for theory building were differentiated: *Conceptual* research that develops theory without using any kind of field data, and *empirical* research that is based on the integration and conversion of information from the real world. Two streams can be differentiated in conceptual research: exploratory approaches that appreciate unfamiliar methods of inquiry and structured approaches. Empirical research can again be differentiated into qualitative and quantitative research, and finally, into a combination of the two, i.e. methodological triangulation. The results of the respective classification process are depicted in table 4.28.

	1990-1994 (I)		**1995-1999 (II)**		**2000-2002 (III)**		**2003-2006 (IV)**		**Total**		**% difference between periods**		
	Art	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**1-2**	**2-3**	**3-4**
Exp	7	77.8	23	46.0	25	30.1	27	19.3	**82**	**29.1**	*-31.8*	*-15.9*	*-10.8*
Struc	0	0.0	8	16.0	21	25.3	40	28.6	**69**	**24.5**	*16.0*	*9.3*	*3.3*
Qual	0	0.0	5	10.0	16	19.3	23	16.4	**44**	**15.6**	*10.0*	*9.3*	*-2.8*
Quant	2	22.2	11	22.0	16	19.3	48	34.3	**77**	**27.3**	*-0.2*	*-2.7*	*15.0*
Tri	0	0.0	3	6.0	5	6.0	2	1.4	**10**	**3.5**	*6.0*	*0.0*	*-4.6*
Total	**9**	**100.0**	**50**	**100.0**	**83**	**100.0**	**140**	**100.0**	**282**	**100.0**			

Table 4.28: Breakdown of Research Strategies across Periods[2]

As table 4.28 illustrates, SCM research has been dominated by conceptual exploratory research strategies (29.1%) that have been defined as all those methods of inquiry that appreciate unfamiliar techniques. Exploratory research strategies are closely followed by empirical qualitative techniques (27.3%), i.e. those research strategies that rely on quantitative

[2] Exp = conceptual exploratory; Struc = conceptual structured; Qual = empirical qualitative; Quant = empirical quantitative; Tri = triangulation of empirical methods.

field data for theory development and refinement. The third major research strategy in SCM is conceptual structured research (24.5%) which follows predetermined methods of inquiry like mathematical modelling but does not use empirical field data. In only 15.6% of the sample articles, empirical qualitative techniques have been employed. Finally, methodological triangulation has only been used restrictively up until today (3.5%).

The deviations depicted in the last three columns of the table indicate that the type of research strategies pursued in the sample articles strongly differ with fluctuations of 18.7% between the emergence and acceptance periods, 10.4% between the acceptance and growth periods, and finally, 9.8% between the growth and normal science periods. Figure 4.6 provides a clearer picture of these fluctuations.

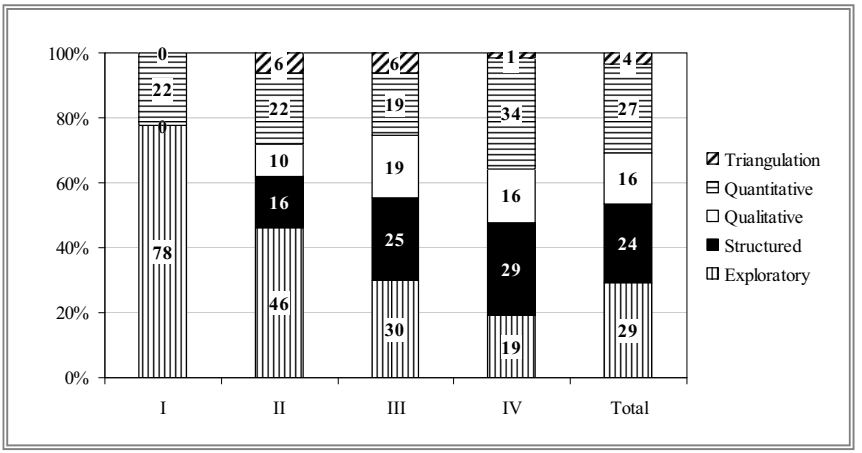


Figure 4.6: Breakdown of SCM Research Approaches across Periods

Source: own illustration

Figure 4.6 suggests that, over time, the share of conceptual exploratory research decreased to the advantage of an increase in conceptual structured and empirical quantitative research designs. Harland et al. suggest that a young research field is usually marked by a higher share of conceptual exploratory research (Harland et al., 2006, pp. 734-735). As a field becomes more established and, in parallel, as applications in practice increase, it becomes easier to obtain field data and to validate theoretical models that have been developed earlier. As a consequence, the observed phenomenon might account for the increasing recognition of SCM among practitioners and maturity of the SCM discipline.

In the *emergence* period, only two types of research strategies were used, namely conceptual exploratory research (22%) and empirical quantitative techniques (78%). In comparison to this rather simple structure, the *acceptance* period is characterized by a much more diversified picture. All of the predefined research strategies occur in this period. Although conceptual

exploratory designs still account for almost half of the overall research activity (46%), the remainder can be differentiated into empirical quantitative (22%), conceptual structured (16%), empirical qualitative (10%) and triangulation strategies (6%). Both the *growth* and *normal science* periods are characterized by further diversification of the applied research strategies and a corresponding reduction of the amount of conceptual exploratory research.

In addition, the overview in table 4.29 summarizes the most important research approaches per period, i.e. those taken together account for 80% of the research activity in each period.

1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		Total	
%	**Strategy**	**%**	**Strategy**	**%**	**Strategy**	**%**	**Strategy**	**%**	**Strategy**
78	Exploratory	46	Exploratory	30	Exploratory	34	Quantitative	29	Exploratory
22	Quantitative	22	Quantitative	25	Structured	29	Structured	27	Quantitative
		16	Structured	19	Quantitative	19	Exploratory	25	Structured
				19	Qualitative				

Table 4.29: Breakdown of Major Research Strategies across Periods

4.5.1 Research Analysis

For the purposes of this study, research analysis techniques have been defined as the specific fact-finding procedures that yield information about the research phenomenon (Frankel et al., 2005, p. 188, see chapter 3.2.5). Typically, appropriate research analysis techniques are dependent on a specific research strategy. For example, qualitative research is usually conducted by means of case studies, interviews, etc. but does not apply any quantitative data collection techniques. Therefore, specific fact finding techniques have been assigned to the different research strategies. Conceptual structured research strategies typically rely on simulation, mathematical modelling or experiments. Empirical quantitative research strategies frequently employ surveys or empirical literature reviews. Action research, case studies, focus groups, judgement tasks like Delphi and interviews are characteristic for empirical qualitative research. Conceptual exploratory research is characterized by the use of unusual methods of inquiry to seek out innovative insights for complex phenomena. As a consequence, it is difficult to predetermine those data collection techniques that characterize this last research strategy. As a consequence, only one data analysis technique has been assigned to this strategy, namely conceptual literature reviews. The remaining articles that use conceptual exploratory approaches have been classified into the category "*others*" in this part of the analysis. Several scientists use more than one research analysis technique for inquiry. Because of this methodological triangulation, it was possible to classify an article into different categories of the research analysis section. As a consequence, the number of classifications (315) exceeds the number of sample articles (n = 288). The results of the articles classification process are shown in table 4.30.

	1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		Total		% difference between periods		
	Art	%	Art	%	Art	%	Art	%	Art	%	1-2	2-3	3-4
Action	0	0.0	1	1.8	1	1.0	0	0.0	**2**	**0.6**	1.8	-0.8	-1.0
Case	1	11.1	6	10.9	20	20.6	27	17.5	**54**	**17.1**	-0.2	9.7	-3.1
C-Sim	0	0.0	1	1.8	6	6.2	9	5.8	**16**	**5.1**	1.8	4.4	-0.3
E-Sim	0	0.0	0	0.0	2	2.1	0	0.0	**2**	**0.6**	0.0	2.1	-2.1
Ethno	0	0.0	0	0.0	0	0.0	0	0.0	**0**	**0.0**	0.0	0.0	0.0
Focus	0	0.0	1	1.8	1	1.0	2	1.3	**4**	**1.3**	1.8	-0.8	0.3
Judg	0	0.0	1	1.8	4	4.1	2	1.3	**7**	**2.2**	1.8	2.3	-2.8
CLiRe	0	0.0	2	3.6	0	0.0	6	3.9	**8**	**2.5**	3.6	-3.6	3.9
ELiRe	0	0.0	0	0.0	1	1.0	4	2.6	**5**	**1.6**	0.0	1.0	1.6
Survey	1	11.1	14	25.5	17	17.5	42	27.3	**74**	**23.5**	14.3	-7.9	9.7
Mod	0	0.0	7	12.7	19	19.6	36	23.4	**62**	**19.7**	12.7	6.9	3.8
N/A	7	77.8	22	40.0	26	26.8	26	16.9	**81**	**25.7**	-37.8	-13.2	-9.9
Total	**9**	**100**	**55**	**100**	**97**	**100**	**154**	**100**	**315**	**100**			

Table 4.30: Breakdown of Research Analysis Techniques across Periods

As seen from the table, in most cases (N/A = 25.7%), there is no evident research analysis applied. Scientific articles not using a research analysis technique usually discuss a phenomenon from a purely theoretical perspective and without making an attempt to validate these results by means of any conceptual or empirical research techniques. However, the table also reveals that the share of conceptual research has been significantly decreasing over time and, in the last period of *normal science* research without any evident research analysis has been overhauled by empirical sample surveys, mathematical modelling and case study research. These developments are a clear sign of a maturing discipline where proposed theories, concepts and models are more and more submitted to empirical investigations and conceptual tests that contribute to their validity, reliability, and quality.

The second largest group of research strategies used in Supply Chain Management are empirical sample surveys (surveys = 23.5%). Again, this confirms findings in earlier sections on the dominance of positivist research in SCM and on an increasing trend towards the use of quantitative research approaches. The importance that sample surveys played in SCM varied strongly over time. Where only one example of a survey occurred in the *emergence* phase, there were already 14 in the *acceptance* phase. The overall number of sample survey applications rose to 17 in the *normal science* phase. Yet, expressed in relative terms, this constitutes a decrease of -7.9% in comparison to the previous period. Another increase of 9.7% was observed in the *normal science* phase.

Mathematical modelling (Mod = 19.7%) is the third largest SCM research activity and occurred for the first time in the *acceptance* phase of SCM. Since then, the number of mathematical modelling applications continually increased with a growth rate of 6.9% in the *growth* phase of SCM and 3.8% in the phase of *normal science*. The fact that mathematical modelling was first used in the *acceptance* phase suggests that there is a positive correlation between the use of mathematical modelling and the operations management discipline that occurred for the first time in this phase as well. In fact, a correlation analysis in SPSS reveals that there is a positive correlation between the operations discipline and the use of mathematical modelling (Pearson correlation 0.3, correlation is significant at the 0.01 level). With 17.1% overall share, case study research is another important research strategy and the first one that is clearly differentiated from positivist research. Like the *critical theory* paradigm, case study research occurred most frequently in the *growth* phase of SCM (20.6%) and experienced a slight decline in the *normal science* period (-3.1%).

In addition, there are several other research strategies used in a SCM context but, to summarize, their role is marginal. This is the case for example for computer simulations (C-Sim = 5.6%), conceptual literature reviews (CLiRe = 2.5%), judgement tasks, panels and Delphi studies (Judg = 2.2%), empirical literature reviews (ELiRe = 1.6%), Focus Groups (Focus = 1.3%), action research (action = 0.6%), and experimental simulations (E-Sim = 0.6%).

As these research strategies play only a subordinate role for SCM, they will not be considered as main activity. While being aware that there is still a substantial amount of research in SCM that does not rely on any evident research strategy, the most important SCM research activities in terms of used research strategies are sample survey, mathematical modelling and case studies. Those research strategies that account for 80% of the research activity in a certain period are summarized in the following table 4.31.

1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		Total	
%	**Analysis**	**%**	**Analysis**	**%**	**Analysis**	**%**	**Analysis**	**%**	**Analysis**
47	Case Study	29	Case Study	22	Case Study	24	Conceptual Literature Review	21	Case Study
47	None	29	None	22	None	21	Focus Group	21	None
		19	Conceptual Literature Review	15	Conceptual Literature Review	15	Mathematical Modelling	19	Conceptual Literature Review
		9	Focus Group	16	Focus Group	14	Case Study	16	Focus Group
				16	Mathematical Modelling			13	Mathematical Modelling

Table 4.31: Breakdown of Major Research Analysis Techniques across Periods

4.5.3 Interim Summary

This chapter dealt with the third pillar of the frame of reference, namely the main research methodologies that shape research activity in SCM. In order to realize this part of the analysis, methodologies were differentiated in terms of the approaches for theory building (research strategy) and the different forms of data collection techniques applied (research analysis).

The content analysis revealed that the majority of the research conducted in SCM is conceptual in nature, uses mathematical modelling techniques as research strategy and does not rely on any specific means for data analysis. Although only half as important as conceptual research, empirical quantitative research is the second most important category within SCM. Empirical data are most frequently gained by means of sample surveys and the information gained through this research strategy are analyzed by means of descriptive statistics, factor analyses and correlation analyses. Although case studies have been used in SCM since the *emergence* phase, this empirical qualitative methodology is not very important. Theory development from case studies frequently uses within-case analysis as data analysis technique. Until today, methodological triangulation plays only a subordinate role in SCM research.

At the beginning of the analyzed time period, conceptual research dominated research activity in SCM. In later phases, the picture became much more diversified with the number of conceptual studies continuously decreasing, while other approaches such as empirical quantitative and empirical qualitative approaches gradually gained in importance. However, throughout most periods except the *growth* phase, qualitative research has been less significant than the traditional conceptual and empirical quantitative research approaches. The same applies to the respective data collection and data analysis techniques used in the respective approaches.

At the beginning of the analyzed time period, conceptual research dominated research activity in SCM. In later phases, the picture became much more diversified with the number of conceptual studies continuously decreasing while other approaches such as empirical quantitative and empirical qualitative gradually gaining in importance. However, throughout most periods except the *growth* phase qualitative research has been less significant than the traditional conceptual and empirical quantitative research approaches. The same applies to the respective data collection and data analysis techniques used in the respective approaches.

4.6 Operational Practice in Supply Chain Management Research

Within the business and management disciplines there is an increasing awareness of the need to generate research findings that matter to practice (e.g. McGahan, 2007, p. 748; Gulati, 2007, pp. 775-777). In the frame of reference used for this analysis, the practitioner perspective provides the fundament of research in SCM. In this sense, the existence of the discipline is justified by practical relevance, i.e. successful SCM is a concern to practice, and SCM research should provide solutions to the problems occurring at the operational practice level. Although there are numerous ways to explore the link of a science to its practical domain, this research faced a specific challenge. Since the empirical data collected for the purposes of this study were scientific articles, there was only limited access to information on the link the authors of these articles made to practice. The only insights that could be drawn from articles using an empirical data collection technique were the industries and regions that these data came from.

In this respect, SCM research should be able to master the following two challenges: First, supply chains are not restricted to a single country. Instead, practitioners are usually confronted with a global dispersion of functions and organization that creates specific obstacles for successful integration. Second, inter-organizational supply chains are composed of organizations that stem from different industries. For example, in a food supply chain, organizations can stem from agriculture, food production and retail industries. In essence, SCM research should be able to generate findings that can be transferred to different regions and industries. Typically, research findings that were generated in specific industries and regions are characterized by limited transferability to other industrial and regional settings. As a consequence, articles were classified in terms of the regions and industries that were considered for empirical data collection.

4.6.1 Industrial Focus

This section explores the analysis results for the industrial sectors covered in SCM research. The results of the articles' classification process are summarized in the following table 4.32. As empirical data might have been gathered from multiple industries, multiple classifications of a single article were possible. Thus, the sum (332) exceeds the number of articles (282).

As stated earlier, there are many conceptual articles in the sample that do not use any kind of empirical data and as a consequence, could not be considered in this part of the analysis. Furthermore, in many empirical articles, no reference is made as to the industries where data were gathered from. As a consequence, the share of studies without reference to any industry is very high (48.2%). However, this share has gradually been decreasing over time. Thus,

today, less than 50% of research undertaken in SCM uses empirical data stemming from at least one industry.

	1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		Total		% difference between periods		
	Art	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**1-2**	**2-3**	**3-4**
Agr	0	0.0	0	0.0	0	0.0	0	0.0	**0**	**0.0**	0.0	0.0	0.0
Mining	0	0.0	0	0.0	0	0.0	0	0.0	**0**	**0.0**	0.0	0.0	0.0
Cons	0	0.0	0	0.0	0	0.0	1	0.6	**1**	**0.3**	0.0	0.0	0.6
Manu	0	0.0	11	20.4	27	27.0	53	31.4	**91**	**27.4**	20.4	6.6	4.4
Trapo	1	11.1	1	1.9	9	9.0	13	7.7	**24**	**7.2**	-9.3	7.1	-1.3
W-Trade	0	0.0	0	0.0	5	5.0	6	3.6	**11**	**3.3**	0.0	5.0	-1.4
R-Trade	0	0.0	2	3.7	6	6.0	12	7.1	**20**	**6.0**	3.7	2.3	1.1
Financial	0	0.0	0	0.0	0	0.0	1	0.6	**1**	**0.3**	0.0	0.0	0.6
Services	0	0.0	6	11.1	8	8.0	8	4.7	**22**	**6.6**	11.1	-3.1	-3.3
Admin	0	0.0	0	0.0	1	1.0	1	0.6	**2**	**0.6**	0.0	1.0	-0.4
N/A	8	88.9	34	63.0	44	44.0	74	43.8	**160**	**48.2**	-25.9	-19.0	-0.2
Total	**9**	**100.0**	**54**	**100.0**	**100**	**100.0**	**169**	**100.0**	**332**	**100.0**			

Table 4.32: Breakdown of Industries across Periods[3]

As stated earlier, there are many conceptual articles in the sample that do not use any kind of empirical data and as a consequence, could not be considered in this part of the analysis. Furthermore, in many empirical articles, no reference is made as to the industries where data were gathered from. As a consequence, the share of studies without reference to any industry is very high (48.2%). However, this share has gradually been decreasing over time. Thus, today, less than 50% of research undertaken in SCM uses empirical data stemming from at least one industry.

Although manufacturing occurred for the first time in the *acceptance* phase (20.4%), this industry has become the most important industry that has been submitted to the empirical data collection processes (27.0% in the *growth* period, 31.4% in the *normal science* period, 27.4% in total). Thus, manufacturing seems to the most important industry considered by SCM research.

In chapter 2, it was suggested that logistics and transportation lay one of the foundations for the origin of modern supply chain thinking. Therefore, it is not surprising that the logistics industry was among the first where empirical data were collected from (Trapo = 11.1% in the *emergence* phase). Nevertheless, supply chain management researchers turned to

[3] Agr = agriculture, forestry, fishing; Cons = construction; Manu = manufacturing; Trapo = transportation communications, electric, gas, sanitary services; W-Trade = wholesale trade; R-Trade = retail trade; Finance = finance, insurance, real estate; Admin = administration; N/A = not applicable.

manufacturing in the *acceptance* phase and paid only limited attention to the logistics industry in later periods (1.9% in the *acceptance* phase, 9.=% in the *growth* phase, 7.7% in the *normal science* phase). In total, logistics accounts for only 7.2% of all industries under consideration.

As modern economy is characterized by an increasing importance of services, research in this area is an important part for SCM (e.g. Machuca et al., 2007, p. 586). However, although service organizations have been submitted to empirical data collection, the percentage of studies considering this type of industry gradually decreased in the *growth* period and in the *normal science* phase (-3.1%; -3.3%). Retail trade is a fourth industry in the focus of SCM research. To summarize, 6.0% of the industries belong to the retail trade and the share has been gradually increasing over time (+3.7%, +2.3% and +1.1% as growth rates).

The wholesale trade (3.3%), construction industry (0.3%), administration (0.6%), and financial services (0.3%) industries have been investigated now and then. However, the low shares that these industries have suggest that they are only of minor importance. In addition agriculture and mining are two industries that have not been considered by SCM research, until today. One indicator to understand the degree to which study findings can be transferred to other industries is the degree to which it already takes into account more than one industry. The overview in table 4.33 suggests that more than one industry is used in the 26 sample articles (9.2%).

No. of Industries	**Sample Articles**	**Distribution Across Periods**
Two industries	Al-Mudimigh et al., 2004; Ellram et al., 1999; Hoek & Weken, 1998; Kaipia et al., 2002; Mangan & Christopher, 2005; McMullan, 1996; Mejias-Sacaluga & Prado-Prado, 2002; Mejza & Wisner, 2001; Spekman & Kamauff Jr., 1998; Trienekens & Hvolby, 2001; Vorst & Beulens, 2002; Wisner, 2003; Zhu & Sarkis, 2004	13 articles, thereof: II = 4 III = 5 IV = 3
Three industries	Hyland et al., 2003; Johnsen, Wynstra, Zheng, Harland & Lamming, 2000; Min et al., 2005; Rodrigues et al., 2004; Stank et al., 2001	5 articles, thereof: III = 2 IV = 3
Four industries	Angeles & Nath, 2001; Auramo et al., 2005; Cousins & Menguc, 2006; Griffis et al., 2004; Hakansson & Persson, 2004; Sahay & Mohan, 2003	6 articles, thereof: III = 1 IV = 5
More than 4 industries	Chin et al., 2004; Fawcett & Magnan, 2002	2 articles, thereof: III = 1 IV = 1

Table 4.33: Overview of Cross-Industry Studies

Table 4.33 reveals that the number of studies in which empirical material was gathered was limited in both the *emergence* and *acceptance* phase of SCM. In the *growth* phase, the number of inter-sectional studies strongly increased. In essence, the generalization of studies

that use more than one industry as a basis for empirical data analysis is increasing with the number of different industries upon which these data rest. Therefore, it can be concluded that the degree of generalization of results increased in the *growth* phase and the *normal science* period.

In order to understand which industries characterized empirical data collection over time, table 4.34 displays the industries that, taken together, account for at least 80% of the focus attributed to industries. The table confirms that research in SCM slowly increased the focus on practical data for the refinement of theory building. The main focus in the last two periods has been on manufacturing and the logistics and transportation industries.

1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		Total	
%	**Industry**	**%**	**Industry**	**%**	**Industry**	**%**	**Industry**	**%**	**Industry**
89	None	63	None	44	None	44	None	48	None
		20	Manufacturing	27	Manufacturing	31	Manufacturing	27	Manufacturing
				9	Transportation	8	Transportation	7	Transportation

Table 4.34: Breakdown of Major Industries across Periods

4.6.2 Regional Span

Frequently, no clear indication was made in an article to the countries that empirical data were gained from. For example, it might only be stated that data were collected from European countries without specifying the exact countries data were taken from. Accordingly, articles were only classified into the continents considered. In addition, they were classified into an additional category to understand whether one country or multiple ones were considered. Tables 4.35 and 4.36 summarize the findings of this section of the analysis.

	1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		Total		% difference between periods		
	Art	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**Art**	**%**	**1-2**	**2-3**	**3-4**
N-Amec	1	10.0	12	21.8	13	15.7	23	15.0	**49**	**16.3**	11.8	-6.2	-0.6
S-Amec	0	0.0	0	0.0	0	0.0	1	0.7	**1**	**0.3**	0.0	0.0	0.7
Europe	1	10.0	10	18.2	13	15.7	33	21.6	**57**	**18.9**	8.2	-2.5	5.9
Asia	1	10.0	2	3.6	4	4.8	15	9.8	**22**	**7.3**	-6.4	1.2	5.0
Australia	0	0.0	2	3.6	3	3.6	5	3.3	**10**	**3.3**	3.6	0.0	-0.3
N/A	7	70.0	29	52.7	50	60.2	76	49.7	**162**	**53.8**	-17.3	7.5	-10.6
Total	**10**	**100.0**	**55**	**100.0**	**83**	**100.0**	**153**	**100.0**	**301**	**100.0**			

Table 4.35: Breakdown of Continents across Periods[4]

[4] N-Amec = North MAerica; S-Amec = South America; N/A = not applicable.

Again, the share of research that does not make any reference to the countries is very high (53.5%). On average, the share of research that is either conceptual or does not state where empirical data came from is decreasing despite another increase in the *growth* phase.

Interestingly, most data from practice have been collected from European countries (18.9%) followed by data from North America (16.3%), Asia (7.3%), Australia (0.3%) and South America (0.3%). Thus, the number of studies that focused on the traditional countries from Europe and North America is more than three times higher than the number of studies that considered newly-industrialized or developing countries and South Africa, the least developed region, is almost entirely neglected. The focus on these two regions does not reveal any significant variations over time. Evidently, scientists in SCM do not consider this region as relevant for SCM. Nevertheless, several resources in particular in the food industry stem from African countries. A gap in research on the successful and effective integration of such countries might constitute a disadvantage in the long run.

1990-1994 (I)		**1995-1999 (II)**		**2000-2002 (III)**		**2003-2006 (IV)**		**Total**	
%	**Region**	**%**	**Region**	**%**	**Region**	**%**	**Region**	**%**	**Region**
70	None	54	None	60	None	50	None	54	None
10	N-America	21	N-America	16	N-America	22	Europe	19	Europe
10	Europe	18	Europe	16	Europe	15	N-America	16	N-America

Table 4.36: Breakdown of Major Industries across Periods

Whereas table 4.35 focuses on a comparison of the continents from which empirical data were collected, table 4.37 compares the regional span of empirical studies in terms of the number of different countries taken into consideration.

	1990-1994 (I)		1995-1999 (II)		2000-2002 (III)		2003-2006 (IV)		**Total**		% difference between periods		
	Art	%	Art	%	Art	%	Art	%	**Art**	**%**	1-2	2-3	3-4
Single	1	11.1	13	26.0	28	33.7	46	32.9	**88**	**31.2**	14.9	7.7	-0.9
Multiple	1	11.1	7	14.0	5	6.0	18	12.9	**31**	**11.0**	2.9	-8.0	6.8
N/A	7	77.8	30	60.0	50	60.2	76	54.3	**163**	**57.8**	-17.8	0.2	-6.0
Total	**9**	**100.0**	**50**	**100.0**	**83**	**100.0**	**140**	**100.0**	**282**	**100.0**			

Table 4.37: Breakdown of Regional Span across Periods

The review depicted in table 4.37 reveals that the share of research undertaken from a mono-country perspective is almost three times higher (31.2%) than the number of cross-country studies (11.0%). In addition, the fluctuations across periods do not reveal whether there is a trend towards an increase of inter-regional studies in SCM. However, cross-country studies further the understanding of differences in supply chain practices worldwide. Such an understanding is required for being able to generalize theory and to formulate guidelines for practicing managers (e.g. Prasad & Babbar, 2000, p. 213). As a consequence, the limited

number of cross-country studies constitutes an important research gap in SCM and a major unresolved research question.

4.6.3 Interim Summary

Chapter 4.6 dealt with the operational practice level of the frame of reference and sought to understand how and to what degree practice is involved in the theory development process in Supply Chain Management. In this section, answers to the research questions related to this part of the analysis will be provided.

The range of industries that empirical data are gathered from in order to develop SCM theory has been restricted. A main emphasis has been laid on the manufacturing and transportation industries and thus, on two rather traditional industries for SCM. Throughout the analyzed time period, no major changes occurred in terms of the industrial focus. Furthermore, the number of cross-sectional studies that take into consideration more than one industry in order to increase generalization of results have been limited. Consequently, it can be concluded that there are still numerous possibilities for future research to increase our understanding of effective and efficient SCM practices in sectors such as services (finance, real estate, and governmental institutions), retail, construction and many others.

Since the *emergence* period of SCM, empirical data have primarily been gathered from European and North American countries, whereas newly-industrialized and emerging economies for example China have barely been taken into consideration for theory building in SCM. This is problematic in so far as in particular organizations from Asian countries are an important part of global supply chains due to the low production costs and an increasing trend to purchase goods from these regions. In addition, empirical SCM research has the tendency to rely on data from one country for theory generation. This, however, significantly reduces the generalization and transferability of research results to other cultural, political and social contexts. A major avenue for research is to generate research results and theoretical models that mirror the needs of practice and that is confronted with the management of international supply chains and should be able to rely on corresponding models, concepts and guidelines.

4.7 Anomalies and Unresolved Research Questions in Supply Chain Management

The analysis results in the previous chapters reveal that Supply Chain Management has developed into a distinct sub-discipline of the business and management science. Its object of study is focused on questions of cross-functional and cross-organizational integration which clearly differentiates SCM from the object of study of other management disciplines.

Furthermore, SCM is characterized by a number of schools of thought that concentrate on the investigation of certain areas within the overall field of research and that provide the intersection to other management related disciplines. Research in SCM is strongly embedded in the positivist tradition but there is also room for research that is inspired by *critical theory*. In addition, the research activities in SCM are shaped by a set of standard techniques and procedures that are used for both conceptual and empirical research. These results indicate that, over time, a profound paradigmatic and theoretical basis has emerged that SCM is grounded on.

Yet, Thomas Kuhn's perception of the evolution of science suggests that any discipline can be challenged by anomalies and unresolved research questions that threaten its perseverance. Anomalies are defined as those research findings that run counter to the results anticipated by the paradigm. If the researchers in a paradigm (in the sense of Thomas Kuhn) are not capable of providing solutions to the threats of anomalies and fundamental unresolved research questions, the paradigm might be replaced by another one that attracts an increasing number of researchers. In fact, the curves in figures 4.1 and 4.2 both indicate a slight decline of the SCM research activity at the end of the analysis period. Potentially, this might be a sign that SCM is in a phase of decline.

Although this is only a hypothesis, the question remains whether the current period of *normal science* is challenged by fundamental unresolved questions. The identification of these could direct SCM research activity in the coming years and further substantiate the paradigmatic and theoretical basis of SCM, thus contributing to its long-term persistence. This chapter is dedicated to the exploration of major unresolved research questions and potential anomalies in SCM. Information on these has primarily been gathered in the scope of the expert study described in chapter 3.2.1. In addition, the previous content analysis revealed additional unresolved questions. In the following sub-chapters, the unresolved questions that emerged from the content analysis will be summarized. Following this, the major insights from the expert study will be presented.

4.7.1 Unresolved Research Questions - Insights from the Content Analysis

In essence, the content analysis revealed two major unresolved questions in the SCM field of study. The first and probably more fundamental one concerns the limited consideration of global and cross-sectional contexts. In the section on the object of study in SCM, it became clear that the focus on *integration* is the key characteristic that differentiates SCM from other disciplines. However, the claim that is made towards the need and importance of integration is not yet mirrored in SCM research activity. The use of empirical data that SCM research is based on is usually restricted to a limited number of industries. In addition, empirical data are is usually gathered from single countries and are restricted in terms of cultural, political and

legal contexts that they apply to. Whereas practitioners in SCM are confronted with the task of integrating functions and organizations from different industries across the globe, the guidelines that are formulated in SCM research are not sufficiently generalized. As a consequence, the first major unresolved question is the provision of managerial guidelines able to respond clearer to practical needs. Thus, the following two directions for future research in SCM can be formulated as follows:

- ⇨ SCM research should increase the generalization of findings by increasing the variety of industries that the findings are based on.
- ⇨ SCM research should increase the generalization of findings by increasing the variety of countries and regions that the findings are based on.

The second major unresolved question in SCM stems from the analysis of SCM constructs. In this part of the analysis it became clear that research in SCM has not yet sufficiently responded to a number of recent developments in the political and environmental settings. Although terrorism has been a phenomenon that modern economies already needed to cope with for several decades, the terrorist attacks on the World Trade Centre in 2001 provided a new dimension to terror as they were the first attacks that had consequences throughout the globe. These specific attacks also illustrate how far terrorist attacks can have an impact on supply chains. Immediately after the attacks, within a few hours, the whole air space over the United States of America was cleared and remained empty for couple of days. Thus, an important section of global supply chains were interrupted. Although measures for security have been increased in numerous ways, such measures will never be able to entirely protect from further attacks. Furthermore, the risk of supply chain interruptions frequently occurred in relation to natural forces, like for example the inundation in New Orleans, the tsunami in Asia, or the annual hurricanes in the Caribbean.

Accordingly, SCM research should increasingly concentrate on the investigation of what-if scenarios. In the scope of the content analysis, articles dealing with such aspects were classified into the “risk” construct. Still, the number of such studies was rather limited and, as a result reveals a third major unresolved research question, i.e. how can practice prepare for unexpected and fundamental supply chain disruptions? This leads to the formulation of the following future research direction:

- ⇨ SCM research should generate models, concepts and solutions for potential threats to supply chain disruption.

4.7.2 Unresolved Research Questions - Insights from the Expert Study

The expert study tried to gain access to expert knowledge on SCM research in two ways. First, based on a literature review, three unresolved research questions were formulated and the

experts were asked to comment on the appropriateness and exhaustiveness of these questions. Second, the experts were asked whether they were aware of any anomalies occurring in SCM research. The findings of this study are presented in this chapter.

The first proposed unresolved question is related to the debate in supply chain literature on the difficulty to find a definition of SCM that can be accepted by all researchers in the field and might therefore, enable SCM research to overcome part of the fragmentation in the field (e.g. Gibson et al., 2005; Mentzer et al., 2001). This question has been discussed ambiguously by the experts. On the one hand, there were those researchers who suggest that it is not possible to find a unique definition of SCM, as the following comment from Jayaram illustrates:

> Jay Jayaram: "I don't think we can answer the definitional issues unambiguously. Also, the network view of SCM and non-linear view of SCM puts to rest boundary issues."

Skjoett-Larsen shares this point of view. He suggests:

> Tage Skjoett-Larsen: "I do not think it is possible or desirable to define SCM in a way, which can be accepted by everyone. I suppose most SCM researchers agree that SCM is about integrating and managing processes across organizations from source of raw materials to end customers including the reverse flow of materials. The boundaries of SCM can only be defined in a specific context. It depends on the objectives of the research. In most cases, the boundaries are limited to a dyad or triad because the complexity increases dramatically, when you extend the analysis to 2. or 3. tier upstream or downstream."

Finn Wynstra goes one step further and argues that the SCM field of study would not benefit from a consensus on a unique definition, but that this would unnecessarily restrict research activity in the field:

> Finn Wynstra: "[The question…] is dangerous, as it apparently seeks to reach 'closure" - some people would say that disagreement about such definitions is necessary for a field to make progress."

On the other hand, there were those experts who felt that the extraordinarily huge variety of SCM definitions was problematic. According to Michiel Leenders the situation is not only problematic for science but also for practice:

> Michiel Leenders: "Some of the definition of supply chain management is nebulous at best and the practice is far away from the academic coverage of the field…"

Accordingly, the disagreement as to what SCM actually is makes it even more difficult to generate guidelines for practitioner assistance. James Stock, another expert in the study, evidently shares this perspective as he tries to find a solution to the problem:

> James Stock: "Regarding the 3 unresolved questions you posed, I just have an observation regarding Question 1 regarding a definition of SCM. Our research has identified approximately

> 130 unique definitions of SCM that have been published in the academic and trade press since the 1980's. We outline these definitions and come up with a consensus definition in a paper that is being submitted to the Special Issue on SCM being published by the Journal of the Academy of Marketing Science."

By the time this thesis was finished, the article was unfortunately not yet available. Still, the comment reveals two things. First, although it might be restrictive to have only one definition of SCM, the variety that exists at the moment is by far too large. About 130 unique definitions of the same phenomenon make it almost impossible for practitioners to identify guidelines and instruments that are helpful for their specific contexts. Second, it illustrates that, despite other arguments, it is possible to identify a unique definition. However, due to the research performed by Stock and some of his colleagues, it is not necessary any more to stipulate the question as a major unresolved one in SCM.

The second and third proposed, unresolved research questions referred to the different levels of analysis used in SCM research. The network perspective suggests that there is no end of SCM as it can comprise of any organization in any industry and country. However, it is not possible to manage such global chains. As a consequence, the question where the boundaries of SCM are was stipulated as a second question. Bretzke was the only expert who commented on this question. He wrote:

> Wolf-Rüdiger Bretzke: "With regard to the second question: This question can only be answered based on an answer to question 1. If, by definition, the "optimization" of supply chains as a whole (from the supplier's supplier to the customer's customer) is part of the paradigm, then the boundaries are endless."

Although Bretzke confirms the hypothesis of the endless supply chain, the comment does not reveal whether he views this critical. From the perspective of the author, research in SCM could gain in managerial relevance and thus, increase the legitimacy of the research field. In addition, if complexity increases with the number of organizations taken into consideration, this is also a problem for SCM research. Thus, scientists might benefit from setting clear boundaries to their own activities. As a consequence, the following future research direction for SCM is proposed:

⇨ SCM research should seek to precise the boundaries of SCM in terms of the organizations, functions, and tasks involved.

The third unresolved research question is linked to the second one that asks for the link to practice, i.e. if SCM is endless then how should practitioners be able to implement it into practice? Again, Bretzke was the only expert who commented on this question:

> Wolf-Rüdiger Bretzke: "If one admits, that new solutions can only be found and implemented within sectors/segments (that is: neglecting interdependencies), one will soon find out, that the barriers to implementation vary from segment to segment and are of different nature (like a lack

of standardization, a lack of trust, functional organizations, …) There is no comprehensive answer to question 3."

As Bretzke suggests there is no single answer to this question. Potentially, it was not formulated correctly and was too broad. Still, it has become evident that there is a gap between research and practice in SCM. As a consequence, SCM research in general would increase in validity if the practitioner perspective and the real-world problems occurring in practical SCM would be considered more frequently. Therefore, another direction for future research in SCM is the following:

⇨ Research in SCM should be more frequently based on problems occurring in the real world and provide solutions to managerially relevant issues.

Finally, the experts were asked to suggest unresolved research questions in SCM that they considered as fundamental. The following additional questions were posed:

Expert	Proposed question(s)
Robert Vokurka	How can we quantify the value of effective supply chain management practices?
James Stock	Are outcomes of supply chains the same, or different from the outcomes of traditional channels of distribution or vertical marketing systems? Are there any "lawlike generalizations" that can be developed for SCM theory?
Jay Jayaram	What contingency measures should be considered while considering different integration mechanisms in SCM"? How does one go about technology adoptions while considering different options of SCM technologies that bridge supply chain partners? What are the appropriate relational designs for structuring global supply chain relationships?
Tage Skjoett-Larsen	A fundamental question is how to manage a supply chain and who should manage it.

Table 4.38: Expert Propositions of Unresolved Research Questions

The questions proposed by the experts have different levels of abstraction. Whereas the ones suggested by Jayaram are rather operational, most of the others are rather fundamental. To summarize, they all constitute important areas for future research activity in SCM. In particular the question proposed by Vokurka points to an important aspect. If SCM is unable to specify the value that it delivers to practice, its long-term existence might be challenged.

4.7.3 Anomalies - Insights from the Expert Study

Anomalies have been defined as the emergence of results that run counter to the results predicted by the paradigm. In the scope of the expert study, the experts were asked whether

they were aware of any anomalies in SCM. Bretzke provides a very comprehensive comment to this issue:

> Wolf-Rüdiger Bretzke: "The answer to this question depends on the content that is regarded as an essential part of the paradigm. If the idea of managing whole chains in a holistic manner, then the real world is full of "anomalies". In many industries companies do not build systems of a higher order that can be designed planned and operated in a holistic manner. SCM advocates a management beyond the limits of ownership without delivering an answer to the question which organizational prerequisites are needed in order to achieve this and how the governance structure of a whole supply chain should look like. The forecasted/recommended shift of competition from a company-level to a Supply Chain level does not take place.
>
> The paradigm suggests that the benefits of process-integration across companies outpaces the benefits of competition, the market and the price-system (including economies of substitution). This is an assumption that in many cases does not hold. The paradigm tends to neglect that there can be significant opportunity costs associated with the concept of a strict vertical integration. This in turn partly explains why…"

The problem that Bretzke raises is similar to the open research question invoked by Vokurka. Although there is general agreement among SCM researchers that integration of the supply chain is beneficial, only limited research has been conducted so far to understand the impact that SCM has upon performance. In addition, there might be settings where SCM is not effective and traditional competition might yield better results. Until today, the conditions under which SCM is appropriate and when not are largely unclear. However, this is rather an unresolved research question than an anomaly. In addition, a similar question has already been formulated in the previous chapter. Therefore, no specific recommendation will be made for SCM research activity based on this comment.

The statement from Kotzab is very philosophical in nature. He suggests:

> Herbert Kotzab: "The dilemma of SCM is that we do not know what a supply chain is. Is it a constructed reality or not?"

This *constructivist* position challenges the existence of SCM itself and suggests that it does not exist in reality but has been created by researchers and practitioners. In fact, it has been noted earlier that the extent to which managers in one organization can really *manage* associated partners can be doubted. In addition, in the following comment Skjoett-Larsen reveals that SCM does not lead to visible performance increases: This challenges the justification for the existence of SCM. As a consequence, SCM still needs to provide the proof that it really leads to improvements and performance increases. Otherwise, the value that SCM produces remains obtrusive.

> Tage Skjoett-Larsen: "A fundamental assumption in most SCM literature is that the more integration in the supply chain the better. This assumption has been challenged by recent

> empirical research, which shows that more integration does not necessarily increase performance. Fabbes-Costes & Marianne Jahre presented a literature review of SC integration articles at Nofoma conference in June 2007, showing that about half of the empirical studies showed no relationship between integration and performance."

This challenges the justification for the existence of SCM. As a consequence, SCM still needs to provide the proof that it really leads to improvements and performance increases. Otherwise, the value that SCM produces remains obtrusive. To summarize, these comments suggest that SCM is confronted with the challenge to clearly demonstrate the value it generates. Otherwise, it risks being nothing else than a buzzword instead of a real business discipline.

4.7.4 Interim Summary

Scientific revolutions can lead to the replacement of a paradigm in the sense of Kuhn by another paradigm. Typically, such scientific revolutions are the result of pressures raising from the inability of the 'old' paradigm to find solutions to major unresolved questions or from the occurrence of anomalies, i.e. results that run counter to the results anticipated by the paradigm. As a consequence, a full understanding of the state-of-the art of the paradigmatic and theoretical status of SCM research required an understanding to the potential major unresolved questions and anomalies SCM is currently faced with and that research should focus on in the near future to be able to maintain SCM as paradigm. The respective analysis was presented in chapter 4.7 and this final section summarizes the results.

Both the content analysis and the expert study yielded in the identification of important unresolved research questions. The insights content analysis provided to the link between science and operational practice revealed that the generalization of research findings have been limited in terms of the transfer to varied industries and international contexts. Furthermore, future research should focus on the formulation of concepts and models to prevent from the harms of supply chain disruption. The results from the expert panel yielded in the identification of several other major research questions. Among these, the most important probably is the necessity to precise the borders of SCM and to increase practical relevance of theory building.

Finally, the expert panel revealed an important anomaly in SCM research. Until today, research in SCM did not really succeed in proving that the realization of SCM leads to clear and measurable performance increases. Consequently, if SCM research will remain incapable of demonstrating that its object of study is relevant and significant, it risks to be replaced by other more promising concepts.

4.8 Conclusions on Data Analysis and Evaluation

The primary objective of this thesis was to understand how the processes of knowledge creation in Supply Chain Management can be characterized and how they evolved over time. In order to be able to answer this question, a comprehensive frame of reference was proposed in chapter two and the operation thereof was set forth in chapter three. In this chapter, answers to each of the elements of the frame of reference were provided. In order to recognize how the knowledge creation processes in each of the elements of the frame of reference evolved over time, four periods of scientific activity in Supply Chain Management were differentiated: the emergence period, the acceptance period, the growth period, and finally, the period of normal science. Table 4.39 provides a summarized overview of the findings for each component of the frame of reference in the four periods.

Frame of Reference	**Emergence**	**Acceptance**	**Growth**	**Normal Science**
Paradigm	Positivist Approaches	Positivist Approaches, Critical Theory	Positivist Approaches, Critical Theory	Positivist Approaches, Critical Theory
Object of Study - Definitions	Chain of processes, Integration, Value	Integrative Philosophy, Chain of processes	Chain of processes, Integration, Value, Efficiency	Chain of processes, Integration, Value
Object of Study - Constructs	Lean SCM, Relationships, Strategy, Inventory, Demand, Performance, Production, Risk, Logistics, Quality	Lean SCM, Relationships, Inventory, IT, Demand, Production, Performance, Purchasing, Organization, Strategy, Product, Logistics	Lean SCM, Production, Relationship, Strategy, Organization, IT, Demand, Performance, Inventory, Purchasing, Logistics, Product	Lean SCM, Relationship, Demand, Production, Strategy, IT, Performance, Purchasing, Inventory, Organization, Logistics, Quality
Object of Study - Level of Analysis	Chain, Dyad	Chain, Dyad, Internal	Chain, Dyad, Internal	Chain, Dyad, Internal
Object of Study - Objectives	Cost, Integration, Delivery, Flexibility	Cost, Integration, Delivery, Flexibility	Cost, Integration, Delivery, Flexibility	Cost, Integration, Delivery, Flexibility

Frame of Reference	Emergence	Acceptance	Growth	Normal Science
Schools of Thought	Customer Orientation, Strategic Chain Integration, Supplier Integration	Operations Research, Customer Orientation, Process Optimization, Strategic Chain Integration, Supplier Integration	Operations Research, Customer Orientation, Process Optimization, Strategic Chain Integration, Supplier Integration, Internal Organization	Operations Research, Customer Orientation, Process Optimization, Strategic Chain Integration, Supplier Integration, Internal Organization
Methodologies - Research Strategy	Exploratory, Quantitative	Exploratory, Quantitative, Structured	Exploratory, Structured, Quantitative, Qualitative	Quantitative, Structured, Exploratory
Methodologies - Research Analysis	Case Study	Case Study, Conceptual Literature Review, Focus Group	Case Study, Conceptual Literature Review, Focus Group, Mathematical Modelling	Conceptual Literature Review, Focus Group, Mathematical Modelling, Case Study
Operational Practice - Industries		Manufacturing	Manufacturing, Transportation	Manufacturing, Transportation
Operational Practice - Region	North America, Europe	North America, Europe	North America, Europe	Europe, North America
Anomalies	N/A	N/A	N/A	Boundaries, Managerial Relevance, Performance

Table 4.39: Summary of Findings

Table 4.39 suggests that over time, SCM experienced a strong increase in diversification in almost each of the elements of the frame of reference. However, a direct comparison of the growth and normal science periods reveals that the activities of scientific knowledge creation do not vary substantially between these two phases. Thus, it might be suggested that the picture drawn by these two periods mirror SCM as a field of study. Still, as the last line of the table reveals, the current state of SCM research rises concerns among scientists who claim that the boundaries of SCM ought to be précised and that the degree of practical relevance for a lot of the research activity is not clearly visible. In addition, the expert study assert that SCM still owes a fundamental proof for its existence, namely the verification that increase

integration a major objective of SCM automatically leads to increases in performance. The results of this last section of the analysis ought to determine the SCM research agenda for the coming years.

5 Summary and Implications

This last section of the thesis is dedicated to a discussion of the key findings from the research and their relation to the research questions stipulated in chapter 2. In addition, this section sets forth the specific contribution this research made to knowledge in Supply Chain Management with a particular emphasis on the implications for theory and, to a minor extent, for practice. Finally, limitations of the research are discussed and directions for future research are indicated.

5.1 Answers to Research Questions

This thesis was guided by the main question, what characterizes the nature of Supply Chain Management, i.e. how knowledge in Supply Chain Management comes about and how the it evolved over time. This, this question is related to an examination of the nature of SCM research. In order to provide a comprehensive answer to this research question, this major question has been decomposed into a number of smaller questions in chapter two. In this section, findings from section four are related to the research questions as stipulated in chapter two in order to provide dedicated answers to these findings.

Regarding the evolution of Supply Chain Management research, an analysis of the distribution of the sample articles revealed that, in essence, four major periods of SCM research activity can be different (chapter 4.1). First, the *emergence period* ranging from 1990 to 1994 when only a limited number of articles were dedicated to the examination of SCM related topics and marked the occurrence of Supply Chain Management as a specific area for scientific interest. Second, the *acceptance period* that covers the years 1995 to 1999 is characterized by an increasing institutionalization of SCM-related research among a limited number of scientists. Third, the *growth period* covers the years 2000 to 2002 and is characterized by a very high increase of SCM related articles and an associated recognition of SCM as a research domain among scientists. Fourth, the period of *normal science* that spans the phase from 2003 to 2006 when the number of SCM related contributions did not grow substantially, but rather stagnated at a high level. The differentiation into the four periods made it possible to compare the evolution of knowledge creation processes in SCM over time by comparing the four periods.

Research Question 1: *What are dominant research paradigms in Supply Chain Management and how did these evolve over time?*

In order to provide an answer to this question, the sample articles were analyzed in terms of their underlying philosophy of science which could either be positivist, critical theory, participatory or constructivist. Throughout the analysis period, no article was found which

was based on a constructivist tradition. In addition, participatory research was found only scarcely in the sample. Instead, Supply Chain Management has strongly been influenced by and rooted in the positivist tradition. Thus, researchers in SCM have the tendency to believe in the existence of an objective "*outside there*" reality that can be assessed and understood independently and objectively through the application of specific fact procedures. Although by far not as important for SCM research as the positivist tradition, the critical theory paradigm has been present in SCM research from the beginning of the analysis period and gradually increased in importance across the four phases. Thus, there seem to be a number of authors who challenge the dominance of the positivist paradigm and, instead, favour the analysis of various political, social, cultural and similar influences upon the shape of reality that is usually case specific. Therefore, the results from this section contradict earlier findings (e.g. Mentzer & Kahn, 1995, Burgess et al., 2006) that did not find a similar importance of other paradigms than the mere positivist one. One explanation for this contradiction could be that this research covers a larger time span of SCM publication than any of the other earlier studies and might therefore cover many articles that were not subject to analysis in earlier studies.

Research Question 2: *What is the object of study of SCM research and how did it evolve over time?*

In order to understand the object of study of Supply Chain Management, articles were analyzed in terms of the SCM definitions that were used in them to delimit their specific focus. The SCM object of study was analyzed in terms of four criteria in chapter 4.3: the definitions used, the constructs SCM is composed of, the level of analysis, and the value contribution that SCM delivers to practice.

In terms of the SCM definitions, two aspects were considered. First, from a more quantitative perspective, articles were classified in terms of the stipulation or non-stipulation of specific definitions of SCM. Second, from a rather qualitative perspective, definitions of Supply Chain Management used in the sample articles were analyzed in terms of the scope they covered, the objectives pursued and the predictions they made. As a result, it was found that at the beginning of the analysis period (emergence and acceptance period), the SCM object of study was used rather homogeneously to describe an integrative philosophy to manage the flow of material and information throughout a chain of organizations. However, during the growth and normal science periods, this perception became increasingly disintegrated. Today, disagreements exist in terms of the number of organizations and functions involved in SCM and the value contribution that SCM can make. This disintegration might be a first sign of decline of the SCM research field, as Kuhn suggests that such processes of increasing disintegration might be first indicators of an approaching scientific revolution and as a result, an emerging new paradigm might replace SCM. Thus, researchers in the discipline ought to strive for the formulation of a clear and comprehensive SCM definition.

Second, regarding the main constructs that SCM is composed of, it was possible to identify a set of SCM constructs that seem to play a central role for SCM, as research in SCM strongly concentrates on these twelve out of a total of 22 proposed constructs. The central constructs are: Lean Supply Chain Management, Relationship Management, Demand Management, Production Management, Information Technology, Strategy and Leadership, Performance Measurement, Inventory Management, Purchasing and Supply Management, Organizational Design, Logistics and Transportation, and finally, Product Management. In terms of the role that different SCM constructs played during the analysis periods, no fundamental alterations were observed. In essence, these twelve constructs characterized SCM research activity throughout the analysis and altered only slightly in terms of the number of contributions that were made. Still, similar to the employment of SCM definitions, a similar observation could be made regarding the increasing disintegration of SCM constructs. Thus, whereas the emergence was characterized by ten core constructs, this number increased to twelve in the normal science that did not alter significantly in terms of their importance.

The third element in this section dealt with the level of analysis SCM research focused on that could be the internal supply chain, dyadic relationships, chains of organizations or whole networks. As the name Supply Chain Management suggests, the majority of the sample articles (47%) was situated at the chain level. Interestingly, however, a closer analysis of the levels of analysis that were examined by SCM research reveals that the preponderance of the chain as a main level of analysis in SCM is gradually decreasing. Instead, the share of other levels of analysis and in particular analyses at the internal and dyadic level gradually increases. Today, SCM research is characterized by the almost equal consideration of internal dyadic and chain of organization as core levels of analysis.

The fourth and last aspect analyzed in relation to the SCM object of study were the objectives pursued with SCM and thus, the value contribution that SCM is supposed to deliver to practice. Therefore, a set of eight core SCM objectives was identified and articles were classified into each of these objectives. The result revealed a very clear picture of the core SCM objectives that remained constant throughout the four periods. The central objectives pursued with the effective realization of SCM are cost reduction, integration, increase of delivery performance and increase in flexibility.

To summarize, three out of the four factors reveal that the objective of study in SCM has been comparatively specific at the beginning of the analysis periods and strongly disintegrated and diffused in the last two phases. According to Thomas Kuhn this fragmentation should not be perceived positively as an increase of diversity of the field, but should rather stimulate the scientific debate as to precise the object of study of SCM in order to clearly differentiate it from other fields.

Research Question 3: *What are the main schools of thought underlying the SCM discipline and how did these evolve over time?*

A cluster analysis was performed in order to identify rather homogenous groups of articles from the sample that might be considered as schools of thought. The variables that were taken into consideration for the cluster analysis were the SCM objectives, constructs, levels of analysis, and the research strategy employed in a certain article. As a result, six major schools of thought were identified. These were the Operations Research School, the Customer Orientation School, the Process Optimization School, the Strategic Chain Integration, the Supplier Integration School, and finally, the Internal Organization School. In essence, the names of these schools are supposed to reflect the central characteristics differentiating one school from another. For example, Supplier Integration Schools focuses on the exploration of dyadic relationships in a supply chain context with a particular emphasis on the relations that an organization entertains with its suppliers. The primary objective of this emphasis is to integrate the suppliers. Three of these schools existed from the very beginning of the analysis period whereas the Operations Research School and the Process Optimization School only appeared in the acceptance period. Finally, the Internal Organization School occurred only in the growth period.

Research Question 4: *What are the central methodologies used to gain insights into SCM and how did the use of these methodologies evolve over time?*

Answers to this question were provided in chapter 4.5 by means of the analysis of two aspects. First, an investigation of the specific research strategies sought to understand the most important research designs in SCM. These could be conceptual or empirical research strategies. Conceptual research strategies might be either exploratory or structured and empirical research might be either qualitative or quantitative or a combination of the two. The analysis revealed that the majority of research conducted in SCM was conceptual or empirical quantitative in nature. Until today, methodological triangulation plays only a subordinate role in SCM research. The comparison of the different research strategies across the four periods revealed that towards the end of the analyzed periods, empirical research gradually replaced conceptual research as the most important research strategy.

Data analysis techniques are usually directly linked to the type of research strategy and the particular analysis techniques that have been employed in an article, which constitute the second factor, were investigated in this section. Due to the dominance of the positivist paradigm that was identified in chapter 4.2, one might expect empirical quantitative data analysis techniques such as surveys to dominate here. However, at least in the emergence and growth periods, case studies and mathematical modelling were used more frequently rather than empirical surveys. Thus, the preponderance of the positivist paradigm seems to be primarily due to the frequent use of mathematical modelling in SCM rather than the employment of empirical surveys.

Again, a certain trend towards increased diversification in the last two analysis periods could be observed. At the beginning of the analyzed time period, conceptual research dominated research activity in SCM. In later phases, the picture became much more diversified with the number of conceptual studies continuously decreasing while other approaches such as empirical quantitative and empirical qualitative gradually gained in importance. However, throughout most periods except the *growth* phase qualitative research has been less significant than the traditional conceptual and empirical quantitative research approaches. The same applies to the respective data collection and data analysis techniques used in the respective approaches.

Research Question 5: *Which industry sectors are in the focus of empirical SCM research and how did this focus evolve over time?*

Whereas all previous research questions dealt with the field of science SCM per se, this last question seeks to provide a link between research and practice in SCM, however, from a mere theoretical starting point. The question had to be limited to empirical articles as only these directly considered practice as a data source for the stipulation and precision of theories and models. An answer to this question was provided in chapter 4.6 where it was found that, in essence, the manufacturing industry and to a limited extent, the logistics and transportation industries are the most important data sources for empirical analyses in SCM. The differences across the four analysis periods were only marginal. Although this result is not surprising, as it constitutes an important barrier to the generalization of SCM research results and its transferability to other industries.

Research Question 6: *How far does empirical research consider supply chains in an international as opposed to a national context?*

This research question sought to understand how far the practice of SCM research corresponds to its theoretical ideal of the global integration of organizations involved in a supply chain. The underlying assumption is that, if SCM is targeted at the integration of chains of organizations across the globe, this should be reflected in the empirical data collection. Otherwise, the applicability of theories and models generated from the data might be questioned. In order to respond to this question, articles were classified into categories by the continents and number of countries from which empirical data were gained. As a result it was found that throughout all four analysis periods most authors gathered empirical data either from European countries or from the United States. Out of the articles that were empirical in nature, three quarters were based on empirical data from a single country and only one quarter of the empirical articles used data from more than the country of origin. As a consequence, the generalization of SCM research must be seriously questioned as of the current state of research.

Research Question 7: *What are major unresolved questions and anomalies in SCM research?*

Whereas answers to all previous questions had been provided by means of a content analysis of published articles, this last research question was primarily assessed by means of an expert study. In addition, some results of the content analysis were integrated into the answers to this part of the thesis, for example the problem of the generalization of results or the increasing disintegration of research in the field as just described. In addition, the experts expressed concerns regarding the managerial relevance of huge parts of SCM research. In addition, from their perspective a major unresolved question in SCM research is the clear definition of the boundaries of SCM and the tasks and functions that should be subsumed under the SCM label. Finally, in terms of potential anomalies, the experts expressed some concerns regarding the benefits of integration. In fact, they expressed some doubts whether full integration really leads to increased performance or not. This proof still needs to be delivered by SCM research.

To summarize, answers to the research questions one to six describe the nature of international Supply Chain Management research as they characterize the discipline in terms its underlying values, beliefs and principles and describe the evolution of scientific practice in terms of its object of study, the central schools of thought underpinning work in the discipline and the methodologies applied for the generation of knowledge in the field.

Research question seven does not characterize the nature of international Supply Chain Management research per se, but rather points to major unresolved research questions and anomalies that SCM research should focus on in the near future. Otherwise, it risks to be replaced by another research field that seems to be more appropriate to respond to these challenges. Regarding the curve on the evolution of international publication activity in Supply Chain Management that was presented in figures 4.1 and 4.2, the question is now, whether SCM research is able to maintain or even increase its research output. Otherwise, the curve will potentially decline as described in chapter 2.3.1 and the corresponding figure 2.1. The current situation of SCM research in terms of the unresolved research questions, the underlying anomalies and the publication activity in the field is illustrated in the following figure 5.1.

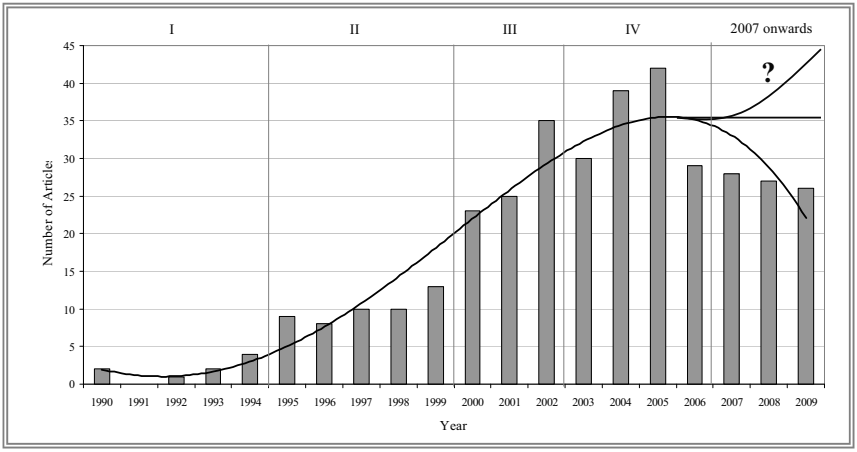


Figure 5.1: Evolution of Supply Chain Management Research
Source: own illustration

5.2 Contributions to Supply Chain Management Research

This thesis has numerous implications for theory in Supply Chain Management and beyond. These will be assessed and described in this chapter.

First, the frame of reference proposed for this thesis provides a theoretical framework for the systematic analysis of the components of a scientific discipline and might serve as a model for similar investigations in other disciplines. It comprises three different layers ranging from very abstract philosophical reflections on the values underlying a discipline, to covering a range of activities and processes shaping research activity in a field, and goes as far as to include the degree to which practice is involved in the knowledge generation processes of a discipline. There are certainly numerous improvements and specifications that can be added to this frame of reference. Still, its application in the scope of this thesis highlighted that it is capable of assisting in the identification of tensions, contradictions, unresolved questions and anomalies that a discipline ought to seek to solve.

Second, this research is one of the very few and certainly the most comprehensive example of the application of content analysis in a Supply Chain Management context. As the discussions in chapter 3 revealed, there has only been a very limited number of articles in SCM that used content analysis as research methodology. Frequently, these applications provided only limited evidence about the measure that was employed in order to ensure a high level of reliability and validity of results. A positive exemption to this is the work from Spens and

Kovacs (Kovàcs & Spens, 2005; Spens & Kovacs, 2006). In addition, only limited explanations were provided regarding the identification and definition of appropriate classification categories (e.g. Seuring & Müller, 2007), in most cases. The detailed description and explanation of the content analysis methodology applied in this thesis as well as methodological triangulation used for the identification and definition of appropriate classification categories might serve as an example for future applications of content analysis in a Supply Chain Management context.

Third, regarding the definition of classification categories, this research sought to overcome a major weakness of earlier studies that were targeted at the identification of SCM constructs. As the discussion in chapter 3.2.5 suggests, there have been several attempts to specify constructs that SCM is composed of. However, these strongly differed in terms of their span and scope and frequently, were overlapping, therefore violating some basic statistical rules. In the present thesis, three techniques were applied to ensure a high degree of comprehensiveness and specificity in the identification and definition of SCM constructs: a literature review, an expert study and a keyword analysis. Thus, the constructs that were defined in the scope of this thesis might inspire further theory building in Supply Chain Management.

Fourth, up until today, there has not yet been any research that provided a comprehensive picture of the discipline as done in the present thesis. As illustrated by the literature review in chapter two, earlier research frequently only concentrated on parts of the present frame of reference. However, none of the reviewed articles and pieces of research described SCM research in so many respects as in this thesis. In addition, earlier, frequent research was already several years old and, therefore, was unable to capture any actual developments. Finally, earlier literature reviews usually concentrate on a limited time horizon (typically five years), whereas this research has a long time span of more than fifteen years. Thus, this research is capable of differentiating and tracking the evolution SCM research has undergone.

Fifth, the stringent application of the frame of reference and the differentiation into four analysis periods made it possible to reveal trends and evolutions. In addition, it was possible to unveil contradictions and tensions within the theoretical debate that might not have been discovered otherwise. For example, it became clear that SCM theory building is not sufficiently based on international empirical data. Furthermore, SCM research still owes the proof that increased integration automatically leads to increased performance. Finally, the analysis of core SCM constructs revealed that several topics such as risk management have only been explored to a limited extent, although they should be of primary concern to SCM research and practice. In a recent article from Ballou similar observations have been made (Ballou, 2007).

Sixth, the frame of reference and the maps of science for SCM research constitute a valuable tool for researchers within SCM that makes it easier for SCM scientists to locate and classify their own work into existing research.

Seventh, it became clear from the debate that, despite some criticism and shortcomings, Supply Chain Management has the potential to be established as a stand-alone discipline within the business and management fields of science. It has a specific object of study, certain targets, a set of underlying values and principles, definite constructs, set of methodologies etc. that justify its recognition as discipline. Thus, this thesis has substantial implications regarding the recognition of Supply Chain Management within the scientific community.

5.3 Limitations and Directions for Future Research

At this point, it is important to acknowledge important limitations of the present thesis that might provide opportunities for future research.

First, concerning the theoretical framework used for this thesis, this has primarily been based on the work of Thomas Kuhn and, to a limited extent, the hierarchy of inquiring systems as proposed by Van Gigch. Still, there are many other authors who are concerned with philosophy of science and the processes and forces leading to the generation and accumulation of knowledge in a certain area: Karl Popper and his notion of logic of knowledge production, Imre Lakatos and Alan Musgrave with their differentiation of a core and a protection belt in science, Feyerabend's stipulation of "anything goes" or Luhmann's perception of constructivism all constitute totally different and valuable perceptions of the philosophy of science in a research field. Thus, future research might assume different perspectives for the analysis of the SCM discipline and contrast the findings from these analyses.

Second, a number of criticisms can be brought forward concerning the methodology applied in the scope of this thesis. With the selection of content analysis as the main methodology, this thesis applies a research strategy that is not yet very common among SCM researchers. However, some parts of the theoretical framework might have been explored by the use of different methodologies. For example, citation and co-citation analysis is an interesting tool for the identification and tracking of schools of thought in a discipline. Accordingly, future research might want to increase the methodological spectrum by using the application of alternative research methodologies.

This research concentrated on the publication activity of scientists in Supply Chain Management to understand the values, topics, streams, methods and link to practice of the field of science. However, there are a number of other institutional factors that shape the body of knowledge in a discipline. For example, conferences constitute an important platform for

debate and exchange among authors in a certain area. Frequently, these discussions are documented in the form of conference proceedings which are usually published by the time a conference takes place and, as a consequence, are available rather quickly in comparison to articles published in refereed journals which undergo a long process of reviewing and reworking before publication. Thus, future research might broaden the perspective by taking into consideration the impact of scientific conferences on a research field such as SCM.

Other institutional factors that have not been taken into consideration in this thesis are the role certain key authors play for SCM. As an example, Houlihan has been one of the most important authors for SCM for several years already. Thus, an interesting venue for future research might be to identify the most important authors in SCM and to understand how far these authors have influenced and shaped the international scientific debate. In similar vein, it might be of interest to identify some core theoretical frameworks such as the one provided by Cooper, Lambert and Pagh in 1997, and concentrate the analysis of the driving forces behind SCM research in terms of the influence such theoretical frameworks have upon research activity.

Another limitation related to the research methodology is the selection strategy that has been applied to the identification of journals and sample articles. The journals that sample articles were drawn from were chosen in terms of the absolute number of SCM related contributions and in terms of their ranking. However, SCM is an interdisciplinary field that touches many different areas such as operations, logistics, purchasing etc. Thus, articles on SCM are spread across a broad array of different journals and it was not possible to perform any test regarding the representativeness of the selected journal sample in comparison to all journals that serve as publication outlets for SCM research. For this reason, future research should broaden the variety of journals taken into consideration.

In addition, sample articles were chosen if the term Supply Chain Management featured either in an article title, in its abstract or in both. However, authors frequently do not use the term SCM but still discuss topics that are closely related to SCM such as Kanban, Supply Network Management or buyer supplier integration, to provide some examples. Thus, future research should apply a more qualitative strategy for the identification of relevant articles.

Finally, in terms of data analysis, only a limited number of data analysis techniques could be applied to the results from the article classification process. In essence, this was a direct consequence of the classification process that only allowed for dual classification (criterion existent or criterion not existent). There are only a limited number of statistical operations that can be conducted for the analysis of such kind of nominal data. There is a debate going on within content analysis, as to the possibility to generate ordinal classifications from textual information. For example, word frequency counts can be transformed into categories for the intensity of a certain criterion. However, up until today, this discussion is still at its beginnings and frequently, the authors might be blamed for a high degree of subjectivity in

their attempts to generate ordinal and metric scales from textual information. This criticism offers two avenues for future research. First, scientists might want to explore how far objective instruments can be developed and applied in content analysis to generate scalable data from textual information. Second, they might apply these instruments to similar questions such as those posed in this thesis and therefore, add more profound information into the different sections of the theoretical framework.

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Appendices

Appendix 1 - List of Experts

Name	University	Country
Bretzke, Wolf-Rüdiger	Universität Köln (Emeritus)	Germany
Jayaram, Jayanth	University of South Carolina	United States of America
Leenders, Michiel	University of Western Ontario	United States of America
Stock, James	University of South Florida	United States of America
Svensson, Göran	Halmstadt University	Sweden
Vokurka, Robert	Texas A&M University	United States of America
Wynstra, Finn	University of Rotterdam	Netherlands

Appendix 2 - Expert Study Questionnaire

Question 1

Another characteristic of a scientific paradigm in the sense of Kuhn is that the existence of unresolved research questions capable of guiding future research in the field. Within SCM, we identified the following fundamental unresolved questions:

1. What can be a suitable definition of Supply Chain Management that can be accepted by all researchers within the field?
2. Where does SCM need to end / what are the boundaries of SCM?
3. How can comprehensive (i.e. comprising all tasks and functions described in table 1) SCM be implemented in practice?

- Do you have additional suggestions for fundamental unresolved research questions?
- Do you believe these questions have been formulated correctly?

Question 2

Kuhn defined anomalies as those research findings which run counter to the results anticipated by the paradigm they have been formulated in. From my literature review, no anomalies could be found within SCM.

- Are you aware of any anomalies within SCM and which are they?
- How would you describe these anomalies?

Question 3

Do you have any another ideas and thoughts on the perception of Supply Chain Management as a scientific paradigm in the sense of Thomas Kuhn that you would like to share with us?

Appendix 3 - Sample Articles

[1] Abad, P. L., & Aggarwal, V. (2005): Incorporating transport cost in the lot size and pricing decisions with downward sloping demand. *International Journal of Production Economics,* Vol. 95 (3), pp. 297-305.

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Appendix 4 - Codebook

1) Overview of Classification Scheme and Categories

Level	Class	Category
Philosophy of Science	Ontology & Epistemology	Positivist Approaches Critical Theory Constructivism Participatory
Scientific Practice	Definition	None Modified Existing Own
	Constructs	Closed-Loop Supply Chain & Environmental Protection Demand Chain Management Human Resource Management Information Technology & E-Business Inventory Management Knowledge Management Lean Supply Chain Management & Integration Legal Affairs Marketing & Sales Organization Structure & Processes Performance Measurement & Reward Systems Power, Reach, Interdependence Product Management Production Management Quality Management Relationships, Alliances & Collaboration Risk Management Strategy & Leadership Supply Chain Design Supply Management & Purchasing Transportation & Logistics Others
	Level of Analysis	Internal Dyadic Chain Network
	Research Strategy	Conceptual Exploratory Conceptual Structured Empirical Quantitative Empirical Qualitative Empirical Triangulation
	Research Analysis	Conceptual Literature Review Simulation Mathematical Modelling Experiment Survey

Level	Class	Category
		Empirical Literature Review Action Research Case Study Focus Group Judgement Task Interview Others
Operational Practice	*Industry*	Agriculture Mining Construction Manufacturing Transportation Wholesale Trade Retail Trade Finance, Insurance, Real Estate Services Public Administration Not Applicable
	Region	North America South America Europe Asia Australia Single Multiple Not Applicable

Data language for all categories:

0 = the recording unit is not classified into the category

1 = the recording unit is classified into the category

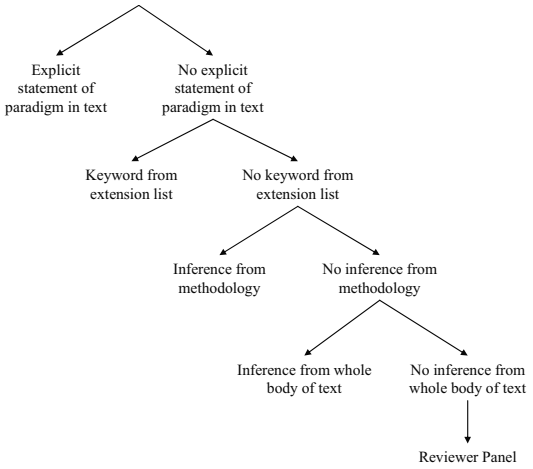
2) Section: Philosophy of Science

Code (Paradigm)	Definition	Extensional List
Positivist Approaches	*Ontology*: Critical realism; reality imperfectly apprehendable because of flawed human intellectual mechanisms and intractable nature of phenomena *Epistemology*: Modified dualist and objectivist; dualism cannot be maintained; objectivity as regulatory ideal; replicated findings are probably true *Methodology*: Modified experimental and manipulative; falsifying or verifying of hypotheses; natural settings, situational information, increased use of qualitative techniques	falsification, falsify, support of hypothesis, Karl Popper, verification, verification of hypotheses, true, truth, modelling, determine, determination, confirmation, proof
Critical Theory	*Ontology*: Historical realism; reality shaped over time by congeries of social, political, cultural, economic, ethnic, and gender factors; inappropriately taken as "real" *Epistemology*: Transactional/subjectivist; inevitable linkage	Historical realism, poststructuralism, postmoderinsm, restitution

	of investigator and object; value-mediated findings *Methodology*: Dialogic/dialectical; dialogue between investigator and subjects of inquiry	
Constructivism	*Ontology*: Relativist; multiple, intangible mental constructions, socially and experimentally based, local and specific in nature, dependent of persons *Epistemology*: Transactional and subjectivist; investigator and investigated object are interactively interlinked; findings are created during investigation *Methodology*: Hermeneutical/dialectical; interaction between and among investigator and respondents; data interpretation through hermeneutical techniques to distil sophisticated constructions	construction, constructed, reconstruction
Participatory	*Ontology*: Participative reality; subjective/objective reality, co-created by mind and given cosmos *Epistemology*: Critical subjectivity in participatory transaction with cosmos, extended epistemology of experimental, propositional and practical knowing; co-created findings *Methodology*: Political participation in collaborative action inquiry; primacy of practical; use of language grounded in shared experiential context	co-creation, critical subjectivity

The extensional list provides an overview of keywords that, in the context of the interpretation of results and the corresponding conclusions of an article assist to identify the correct paradigm. This is section provides exclusive categories, i.e. an article can be classified into one paradigm, only. This paradigm receives the code "1" whereas all remaining paradigms receive "0" for this article.

Decision Scheme for Philosophy of Science



In case that it is necessary to recur to the reviewer panel, this needs to come to a consensus on the final classification of an article.

3) Section: Scientific Practice - Object of Study

Class	Code	Definition
Definition	Own	Explicit definition stated without reference
	Existing	Direct citation of a definition with reference (track reference)
	Modified	Indirect citation of a definition with reference (track reference)
	None	No definition explicitly stated
Level of Analysis	Internal	Integration of business functions involved in the flow of materials and information from inbound to outbound ends of the business
	Dyadic	The management two party relationships with immediate suppliers or customers
	Chain	The management of a chain of businesses including a supplier, a supplier's suppliers, a customer, a customer's customer, and so on
	Network	The management of network of interconnected businesses that must not be directly linked to the process of production and delivery of a good or services (e.g. consultancy agency)
Objectives	Cost	All activities targeted at and related to the reduction of costs and prices
	Delivery & reliability	All activities related to improve the features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs
	Environmental protection	All activities related to the protection the environment
	Flexibility	All activities targeted at improving the capability to adapt or vary.
	Innovation	All activities related to the generation of value by means of new products, services or features that are valuable from the perspective of the customer.
	Learning	All activities related to the development of skills and competencies.
	Quality	All activities related to improve the features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.
	Security	All activities related to the prevention and minimization of risks of supply disruption.

In this section, the classes “definition” and “level of analysis” provide mutually exclusive codes, i.e. an article can be classified into one of the respective categories, only. This category receives a “1” whereas all remaining codes receive “0” for this article. Codes in the classes

"objectives" and "constructs" are not mutually exclusive, i.e. one article can be placed into more than one of the predefined objectives.

Coding instructions for level of analysis

Classification of an article into the highest level of analysis an article is concerned with.

Example 1: An article describes the activities of the purchasing function (i.e. internal) in order to best integrate its direct suppliers.

Classification: Dyadic

Example 1: An article describes the activities of the purchasing function (i.e. internal) in order to best integrate its direct suppliers and the suppliers to the organization's direct suppliers

Classification: Chain

Code	Definition	Extensional list
Closed-Loop Supply Chain & Environmental Protection	Activities, processes, methodologies and tools related to returns management and remanufacturing.	Green SCM, Recycling, Waste Removal, Returns, Closed-loop, Remanufacturing
Demand Chain Management	Activities, processes, methodologies and tools to recognize customer needs and customer value and to respond to these expectations for the benefit of the supply chain.	Customer Value, Customer Relationship Management, Customer Service, Customer Perspective, Demand Chain Management, Customer Involvement, Customer Needs, Delivery
Human Resource Management	Activities, processes, methodologies and tools related to personnel recruitment, development retention with a specific emphasis on particular requirements in a Supply Chain Management context. This includes measures for the generation and development of skills, competences and capabilities at the level of the individual.	Personnel Retention, Job Satisfaction, Balanced Scorecards, Training, Personnel Selection, Personnel Recruitment, Learning, Coaching, Education, Career Development, Training, Ability
Information Technology & E-Business	Activities, concepts and procedures related to the design of information technology and technology infrastructure in a supply chain context as well as internet-based tools and communication procedures to execute front-end and back-end business processes.	Communication, Communication Technologies, Computer Architecture, Virtual Enterprise, Virtual Supply Chain, Technology, E-Commerce, Internet, B2B, B2C, EDI, E-Business, Intranet, e-Procurement
Inventory Management	All policies and procedures that monitor inventory levels and determine the timing and quantities of replenishment.	Stocks, Lot-Size, Inventory Control, Consignment

Code	Definition	Extensional list
Knowledge Management	Climate, processes and infrastructure targeted at the generation of knowledge and (inter-) organizational learning at the level of the organization and the supply chain as a whole.	Knowledge Management, Organizational Learning, Inter-Organizational Learning
Lean Supply Chain Management & Integration	Activities, processes, methodologies and tools targeted at synchronizing, smoothening and balancing the flow of products in the supply chain.	JIT, Kanban, Channel Coordination, Channel Flow, Bullwhip-Effect, Build-to-stock, Build-to-order
Legal Affairs	Topics related to the impact of laws and legal regulations upon Supply Chain Management.	Law, Act, Contract
Marketing & Sales	Activities, processes, methodologies and tools related to the development, implementation and execution of a marketing strategy in a supply chain context and to selling the respective products and services.	Market Segmentation, Marketing Management, Marketing Channels, Marketing Strategy
Organization Structure & Processes	Activities and procedures related to the organization internal design of processes and structures.	Business Planning, Process Improvement, Organization Structure
Performance Measurement & Reward Systems	Concepts, tools and methodologies to determine the financial impact of Supply Chain Management and to develop systems for reward sharing among supply chain partners.	Performance, Performance Measurement, Reward Sharing, Incentives, Controlling, Key Performance Indicator
Power, Reach, Interdependence	Topics related to the degree of influence and impact one partner in a supply chain has upon associates.	Power, Reach, Interdependence, Dependence
Product Management	Activities related to conceptualization, development and testing of existing and new products.	Product Development, Product Life Cycle, Product Control, Product Safety, Product Obsolescence, Modularization, Product Range, Standardization of Products
Production Management	Design and management of the transformation processes of goods and services.	Agile Production, Enterprise Resource Planning, Customization, Forecasting, Workload Control, Capacity Management
Quality Management	Methodologies and techniques related to quality assurance and quality improvement.	Continuous Improvement, Quality Control, Total Quality Management
Relationships, Alliances & Collaboration	Activities, tools and procedures related to the design and implementation of alliances with external partner organizations. This includes all activities related to the identification of suppliers, supplier selection, supplier base management and	Embeddedness, Trust, Commitment, Relationships, Partnerships, Alliances, Values, Norms, Culture, Cultural Difference

Code	Definition	Extensional list
	supplier development	
Risk Management	Activities and procedures related to the identification, evaluation and mitigation of risks.	Risk Management, Risk Assessment, Risk Sharing, Risk Mitigation
Strategy & Leadership	All questions related to the development of Supply Chain Strategies, the achievement of strategic fit of a company's strategy and its Supply Chain Strategy and the generation of competitive advantage with Supply Chain Management.	Leadership, Strategy Alignment, Environmental Uncertainty, Strategy Alignment, Strategic Fit, Competitive Capabilities, Competitive Priority, Competitive Strategy, Critical Success Factor
Supply Chain Design	Decisions and activities related to the optimal configuration of supply chains in terms of plant locations, warehouse locations, supply chain partner locations etc. This category differs from the "organization and process" category in terms of its long-term orientation and the difficulty to revise a realized decision.	Plant Location, Outsourcing, Industrial Design, Industrial Clusters, Industrial Engineering, Warehousing
Supply Management & Purchasing	Activities related to the procurement of goods and services including supply management and category sourcing strategies, gathering of market information, handling RFx processes, negotiating and supply contract management. Supplier Management is not included into this category but considered as part of the relationships and alliances construct.	Purchasing Process, Negotiation, Ordering, RfX, Bargaining, Procurement, Industrial Procurement, Materials Management, Selection, Certification, Development, Involvement, Early Involvement, Evaluation, Supply Base Management
Transportation & Logistics	Activities related to planning, implementing and controlling the efficient and effective forward and reverse flow of goods, services and related information.	Business Logistics, Cargo Handling, Logistics, Transportation, 3 PL
Others	All articles that do not directly address one of the previously identified parts but contribute purely to the theoretical base of SCM research.	

This section provides codes that are not mutually exclusive, i.e. one article can be classified into several constructs.

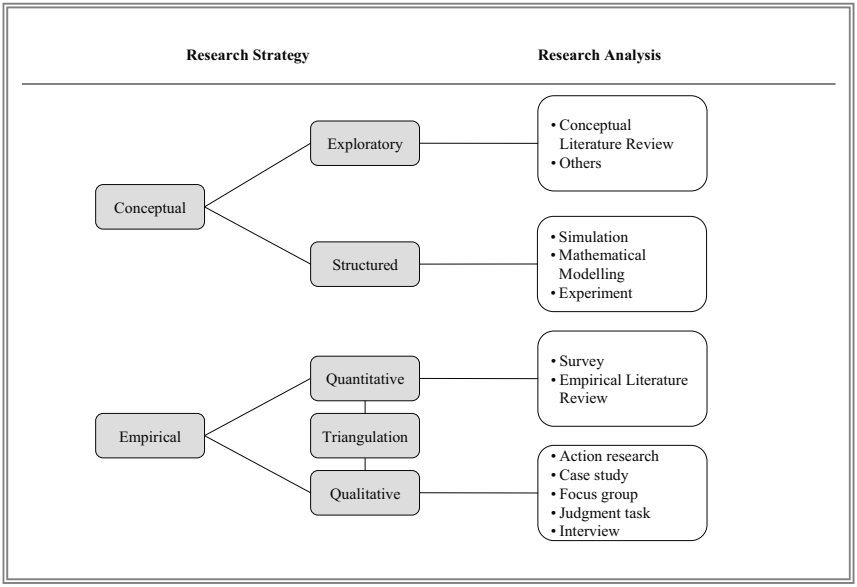
4) Section: Scientific Practice - Methodology

Class	Construct	Definition
Research Strategy	Conceptual Exploratory	Encouragement of theoretical debate; theory development without using any kind of field data.
	Conceptual Structured	No empirical field data; use of structured tools to increase reliability and validity.
	Empirical Quantitative	Usage of field data; emphasis on measurement and analysis of causal relationships between variables; attempt to establish cause effect laws.
	Empirical Qualitative	Usage of field data; emphasis on qualities of entities, processes and meanings; no measurement in terms of quantity, amount, intensity or frequency.
	Empirical Triangulation	Combination of both empirical quantitative and empirical qualitative.
Research Analysis	Conceptual literature review	The objective of the conceptual literature review is to critically review existing literature and to map knowledge in an area in order to conceptualize models for empirical testing; classification of only those articles that used a literature review as core methodology in the main body of text.
	Others	No empirical research; no indication of applied research strategy technique; research strategy applied not covered in coding scheme.
	Simulation	Simulations refer to experiments on the reactions of a model through targeted manipulation of variables in an artificial environment. They can be realized with the assistance of computers (computer simulation) that involve the artificial creation of data and the realization of the simulation by means of specialized software programmes and techniques.
	Mathematical Modelling	Mathematical modelling is a research analysis technique that uses abstract mathematical language to describe the behaviour of a system.
	Experiment	As in simulation, the researcher uses an experiment to manipulate some variable(s) in order to observe the resulting changes. What differentiates an experiment from a simulation is that they take place in natural settings
	Survey	A survey uses an instrument (usually a questionnaire) for the collection of factual-data on a certain topic in order to enable statistical data analyses
	Empirical literature review	The objective of this type of literature review is to empirically summarize knowledge in an area without necessarily developing models for empirical testing. The major difference between a conceptual literature review and an empirical one is that the former relies on statistical techniques to map knowledge whereas the latter relies on narrative summarizing techniques. Classification of only those articles that used a literature review as core methodology in the main body of text
	Action research	Action research is a social change process of a phenomenon that requires the direct involvement and participation of the researcher in the object of study. Characteristics: direct involvement of the researcher, the object of study might vary in the course of investigation
	Case Study	A case study is a method of inquiry that investigates a phenomenon within its real-life context in order to understand the dynamics present

Class	Construct	Definition
		in single settings; no direct involvement of the researcher
	Focus Group	Focus groups are collective conversations or group interviews. Unlike panel studies (see below), the group is physically assembled on the invitation of a facilitator who asks questions. Each member has the opportunity to give his opinion on the question to the entire group. The overall goal is to reach consensus on the topic of discussion.
	Judgement Task	The primary objective of a panel study is to obtain consensus on a certain questions, e.g. on the definition of a term or the identification of future trends. A panel study requires the identification of experts in the field of investigation. These experts are invited to respond to questions in written form. Anonymous responses are distributed randomly to the members of the panel who are asked to give further comments and to revise their own responses. This procedure is repeated until consensus is reached.
	Interview	An interview study is one where the data and findings are based on researcher-to-respondent conversations by means of a questionnaire. What differentiates interviews from survey research is that the questions asked are open questions that ensure conversation.
	Not applicable	No empirical research; no indication of applied research strategy technique; research strategy applied not covered in coding scheme

This section comprises mutually exclusive and non-exclusive categories:

- Exclusive: nature of theory building and approach for theory building
- Non-exclusive: forms of empirical data collection (triangulation), research strategy and research analysis



5) Section: Operational Practice - Industrial Sector

Category	Definition
Agriculture, Forestry, Fishing	Establishments primarily engaged in agricultural production, forestry, commercial fishing, hunting and trapping, and related services
Mining	Establishments primarily engaged in mining. The term mining is used in the broad sense to include the extraction of minerals occurring naturally: solids, such as coal and ores; liquids, such as crude petroleum; and gases such as natural gas
Construction	Establishments primarily engaged in construction. The term construction includes new work, additions, alterations, reconstruction, installations, and repairs
Manufacturing	Establishments engaged in the mechanical or chemical transformation of materials or substances into new products. These establishments are usually described as plants, factories, or mills and characteristically use power driven machines and materials handling equipment
Transportation, Communications, Electric, Gas, Sanitary Services	Establishments providing, to the general public or to other business enterprises, passenger and freight transportation, communications services, or electricity, gas, steam, water or sanitary services
Wholesale Trade	Establishments or places of business primarily engaged in selling merchandise to retailers; to industrial, commercial, institutional, farm, construction contractors, or professional business users; or to other wholesalers; or acting as agents or brokers in buying merchandise for or selling merchandise to such persons or

	companies
Retails Trade	Establishments engaged in selling merchandise for personal or household consumption and rendering services incidental to the sale of the goods
Finance, Insurance, Real Estate	Establishments operating primarily in the fields of finance, insurance, and real estate. Finance includes depository institutions, non-depository credit institutions, holding (but not predominantly operating) companies, other investment companies, brokers and dealers in securities and commodity contracts, and security and commodity exchanges. Insurance covers carriers of all types of insurance, and insurance agents and brokers. Real estate includes owners, lessors, lessees, buyers, sellers, agents, and developers of real estate
Services	Establishments primarily engaged in providing a wide variety of services for individuals, business and government establishments, and other organizations. Hotels and other lodging places; establishments providing personal, business, repair, and amusement services; health, legal, engineering, and other professional services; educational institutions; membership organizations, and other miscellaneous services, are included
Public Administration	The executive, legislative, judicial, administrative and regulatory activities of Federal, State, local, and international governments
Not applicable	No empirical research; no indication of industrial sectors from which empirical data were gathered

This section provides non-exclusive codes.

6) Section: Operational Practice - Region

Code / Category	**Definition**
Africa	Empirical data gathered from organizations in African countries.
Asia-Pacific	Empirical data gathered from organizations in Asian-Pacific countries.
Australia	Empirical data gathered from organizations in Australia.
Europe	Empirical data gathered from organizations in European countries.
North America	Empirical data gathered from organizations in North American countries.
South America	Empirical data gathered from organizations in South American countries.
Single	Empirical data gathered from organizations in a single country.
Multiple	Empirical data gathered from organizations in multiple countries.
Not applicable	No empirical research; no indication of regions/countries from which empirical data were gathered

This section provides non-exclusive codes for the contents and exclusive codes for the number of countries covered during the empirical data collection process.

Appendix 5 - Krippendorff's Alpha Results for Test - Retest

Class	Category	Krippendorff's Alpha	Rate of Agreement
Paradigm	Positivist Approaches	0,74	90,00%
	Critical Theory	0,84	96,67%
	Constructivism	1,00	0,00%
	Participatory	1,00	0,00%
Definition	None	0,72	86,67%
	Own	1,00	100,00%
	Modified	0,79	96,67%
	Existing	0,66	86,67%
Analysis Level	Internal	0,76	90,00%
	Dyadic	0,76	90,00%
	Chain	0,74	86,67%
	Network	0,65	96,67%
Objective	Cost reduction	0,61	90,00%
	Quality	0,72	86,67%
	Delivery	0,73	86,67%
	Flexibility	0,79	90,00%
	Innovation	0,72	86,67%
	Security	1,00	100,00%
	Environmental Protection	1,00	100,00%
	Capability, Competence	0,76	93,33%
	Integration	0,73	86,67%
Construct	Closed-Loop Supply Chain	1,00	100,00%
	Demand Chain Management	0,85	93,33%
	Human Resource Management	1,00	100,00%
	Information Technology & E-Business	0,92	96,67%
	Inventory Management	1,00	100,00%
	Knowledge Management	0,84	96,67%
	Lean Supply Chain Management & Integration	0,65	83,33%
	Legal Affairs	1,00	100,00%
	Marketing & Sales	1,00	100,00%
	Organization Structure & Processes	0,84	96,67%

	Performance Measurement & Reward Systems	0,84	96,67%
	Power, Reach, Interdependence	1,00	100,00%
	Product Management	1,00	100,00%
	Production Management	0,84	96,67%
	Quality Management	0,84	96,67%
	Relationships, Alliances & Collaboration	0,84	96,67%
	Risk Management	1,00	100,00%
	Strategy & Leadership	0,80	93,33%
	Supply Chain Design	0,65	96,67%
	Supply Management & Purchasing	0,87	96,67%
	Transportation & Logistics	1,00	100,00%
	Others	1,00	100,00%
Res. Strategy	Conceptual Exploratory	1,00	100,00%
	Empirical Qualitative	1,00	100,00%
	Empirical Quantitative	1,00	100,00%
	Empirical Triangulation	1,00	100,00%
	Conceptual Structured	1,00	100,00%
Res. Analysis	Action Research	1,00	100,00%
	Case Study	0,84	93,33%
	Simulation	1,00	100,00%
	Ethnography	1,00	100,00%
	Focus Group	-0,02	93,33%
	Judgement Task / Delphi Study	0,00	96,67%
	Literature Review	-0,14	56,67%
	Survey	0,83	93,33%
	Mathematical Modelling	0,74	90,00%
Industry Sector	Agriculture	1,00	100,00%
	Mining	1,00	100,00%
	Construction	1,00	100,00%
	Manufacturing	0,82	93,33%
	Transportation	0,65	96,67%
	Wholesale	0,65	96,67%
	Retail Trade	1,00	100,00%
	Finance, Insurance	1,00	100,00%
	Services	0,71	90,00%
	Public Administration	1,00	100,00%

	Not Applicable	0,87	93,33%
Region	North America	0,87	96,67%
	South America	1,00	100,00%
	Europe	0,80	90,00%
	Asia	1,00	100,00%
	Australia	1,00	100,00%
	Single	0,90	96,67%
	Multiple	0,91	96,67%
	Not Applicable	0,73	86,67%