Abductive reasoning in logistics research

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Abstract

Purpose – To construct a framework for exploring and discussing the use of different research approaches – deductive, inductive and abductive – in logistics.

Design/methodology/approach – A review of research articles in three major logistics journals (*International Journal of Logistics Management*, *International Journal of Physical Distribution & Logistics Management* and *Journal of Business Logistics*) from 1998 to 2002.

Findings – Recognizes the dominance of deductive research in logistics, and the need for more inductive and, in particular, abductive research for theory development. Discusses the use of the abductive research approach in logistics.

Research limitations/implications – Keywords searches led to a small sample size; more thorough content analysis is needed to apply the findings from the constructed framework.

Practical implications – Useful source of information on the three different research approaches, their possibilities and implications for research.

Originality/value – The abductive research approach has not yet been discussed in logistics.

Keywords Distribution management, Literature, Research

Paper type Literature review

Introduction

Business logistics became a scientific discipline in the 1960s, and since then researchers in the discipline have been calling for a "rigorous orientation toward theory development, testing and application", and also criticizing logistics literature for the lack of it (Mentzer and Kahn, 1995, p. 231). Logistics research is interdisciplinary by definition: it stems from many different scientific traditions (Arlbjørn and Halldórsson, 2002) and has been influenced by economic and behavioral approaches (Mentzer and Kahn, 1995), mainly through the business disciplines of marketing and management, but also borrowing from engineering (Stock, 1997). Therefore, various methods have been used for logistics research, ranging from mathematical modeling and simulation to survey research, from case studies to interview methods (Mentzer and Kahn, 1995). Interestingly, logistics research has, however, so far favored positivist approaches, while qualitative and interpretative research is rather scarce (Arlbjørn and Halldórsson, 2002; Mentzer and Kahn, 1995; Näslund, 2002).

In line with this positivist stream, there is also a paucity of discussing different research approaches in logistics journals. The central approaches in Western research traditions have been those of deduction and induction (Kirkeby, 1990). Deductive research follows a conscious direction from a general law to a specific case (Alvesson and Sköldberg, 1994; Andreewsky and Bourcier, 2000; Danermark, 2001; Kirkeby, 1990; Taylor *et al.*, 2002). Contrary to this procedure, the inductive research approach reasons through moving from a specific case or a collection of observations to general law, i.e. from facts to theory (Alvesson and Sköldberg, 1994; Andreewsky and Bourcier,

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2000; Danermark, 2001; Kirkeby, 1990; Taylor *et al.*, 2002). Deductive positivism seems to be the predominant research approach (Alvesson and Sköldberg, 1994; Kirkeby, 1990) in business logistics research (Arlbjørn and Halldórsson, 2002; Mentzer and Kahn, 1995; Näslund, 2002). A deductive research approach is most suitable for testing existing theories, not creating new science (Arlbjørn and Halldórsson, 2002), which is why its dominance in a relatively new field of research such as logistics is surprising. On the other hand, competing research approaches are very visible – the use of new methods, or borrowing from other disciplines call for their application (Stock, 1997). This is not to say that the deductive approach would have reached the phase of its paradigm crisis in Kuhn's (1970) terms. Nonetheless a rise in using new approaches in logistics signals the limitations of the kind of answers deductive research can provide.

Logistics has been criticized for not having a rich heritage of theory development (Stock, 1997). Stock (1997) suggests using more philosophy of science material for logistics theory development, and to borrow theories from related disciplines. Nonetheless, surprisingly little logistics research has focused on theory development to date (Listou, 1998), which is possibly a consequence of the predominant positivist approach to logistics. At the same time, logistics theory development is very important in order to further validate the relatively young scientific discipline of business logistics (Stock, 1997). According to Arlbjørn and Halldórsson (2002), the development of new theory calls for more inductive research.

In addition, the development of new theories, from our point of view, calls for a discussion on the concept of abduction. The concept has gained less interest in books on philosophy of science and methodology (Kirkeby, 1990) and the use of the approach had, to our knowledge, not been utilized in the fields of logistics and supply chain management. This study examines, by conducting a literature review, the use of the three major research approaches – i.e. deductive, inductive and abductive – in logistics research. The aim of the article is to build a framework for further exploring and discussing the use of the three different approaches in logistics research. The article will distinguish between the concepts of research approach and research process: a research approach is defined here as the way of conscious scientific reasoning (Peirce, 1931), while a research process is seen as the summary of all the sequential steps a researcher engages in that are necessary for following the path of a specific research approach.

The article begins with a literature review that focuses on examining the use of the different approaches in the major logistics journals. Thereafter the abductive approach is discussed, leading to proposed frameworks for further investigating the use of the different approaches in logistics research. In conclusion a summary of findings and suggestions for further research are discussed.

Methods and choices

In order to evaluate how different research approaches are used in logistics, this study began with a literature review. Therefore, the study started out by identifying which logistics-related journals were ranked highly by academics in the discipline. The journal selection followed different rankings of business logistics journals (see Gibson and Hanna, 2003; Gibson *et al.*, 2002) in the US and Europe. These rankings had asked academics to assess logistics-related journals in terms of their usefulness for research and teaching. Four periodicals found their way into the top ten of all these rankings (in

alphabetical order): *Harvard Business Review* (*HBR*), *International Journal of Logistics Management* (*IJLM*), *International Journal of Physical Distribution & Logistics Management* (*IJPDLM*), and *Journal of Business Logistics* (*JBL*). *HBR* was subsequently eliminated from the review in this study, because its editorial scope does not show a logistics focus. In the end, the literature review encompassed the following three top journals: *IJLM*, *IJPDLM* and *JBL*.

The literature was further delimited for the last five years, the time period 1998-2002. The search used the terms "abduction", "abductive", "deduction", "deductive", "induction", and "inductive". In order to be inclusive and reach a wide range of articles discussing the research approaches, the search was not delimited to keywords or to "citation and abstract", but was widened to searching for the terms in the text of the articles.

Results from the literature review

The first "hit list" of the search included surprisingly few articles – a total of just 32. Considering the number of articles in the three journals in these five years (*IJLM* published 77, *IJPDLM* 206 and *JBL* 95 articles), this would account for only 8.47 percent of the articles. Another important point is that in those articles that mentioned any of the terms, only a few used them to actually describe their research approach. As a first assessment of these 32 articles, those that only used any of these terms in their reference list, or that were double counted due to the different searches, were eliminated from the list. Subsequently, the articles were screened for the way they used these terms. Those articles that referred to "inductive" and "induction" to describe engines or radio frequency systems were further excluded from the evaluation, as were those that used "deductive" and "deduction" for cost deductions and inferences meaning any type of conclusions (i.e. not for describing their research approach). After eliminating these articles from the list of results, the list of "usable" articles was 14. These are shown according to the terms they related to in the Appendix.

To sum up the usable results of the search, relating them to the terms searched for, no articles were found for the terms "abduction" and "abductive", eight were found for "deduction" and "deductive", and 12 were found for "induction" and "inductive". Six of the articles discussed both the deductive and inductive approaches. No statistical analysis could be made on the basis of this small sample size.

A first finding of the literature review was that the terms "abductive" and "abduction" were not used in logistics research as no article could be found referring to this research approach. Looking further into the articles, we found that, except for one article in this period discussing research approaches in general (see Arlbjørn and Halldórsson, 2002), all others were either concerned with theory development or discussed their research approach because of employing a case study method, or both. At the same time, most articles discussed their research approach because they combined inductive and deductive elements in their research. As logistics has been criticized for its focus on positivist research (Mentzer and Kahn, 1995; Näslund, 2002) and its paucity of theory development (Listou, 1998; Stock, 1997), it is not surprising that articles that are concerned with theory development would need to discuss their – supposedly inductive (Arlbjørn and Halldórsson, 2002) – research approach. A focus on positivist research in logistics would also explain why research approaches are scarcely discussed: The predominance of deductive research leads to a non-questioning

of the applicability of this approach to assess the questions of the field. Therefore, the articles that introduce an inductive element in their research are those that are concerned with discussing their research approach. This can be seen in the results of our literature review, in which we found only seven articles discussing a deductive approach, of which six had combined inductive and deductive elements in their research. Thus, a deductive approach seems to be implicitly assumed in logistics research if nothing else is discussed. However, this may be problematic for those articles that do not engage in discussing their research approach but deviate from this assumption.

Case study research was the second stream found to discuss the research approach. This is not surprising, as case studies often involve data from many different sources in order to gather a rich picture of the case (Ellram, 1991; Yin, 2003), and it is not obvious from the case study method alone which research approach has been applied. In line with this, engaging in a case study was the only reason we could find that a deductive approach had been discussed without any inductive elements (see Stassen and Waller, 2002). Also, case studies often involve the use of qualitative research methods, some of which (e.g. grounded theory) call for an inductive approach by definition (see Alvesson and Sköldberg, 1994; Glaser and Strauss, 1967; Flint and Mentzer, 2000). Also in our literature review, articles talking about an inductive approach employed (at least partly) qualitative research methods (qualitative case studies, interviews and observations). However, some articles claim to be inductive purely on the basis of employing qualitative methods, in which case it remains unclear whether the authors argue for exploratory or inductive research (see, for example, Golicic et al., 2002).

To summarize these preliminary results, there is little explicit discussion of research approaches to be found in the logistics literature. The few articles that consider the topic seem to do so because of their theory building aim, or their case study methods. Nonetheless, an analysis of these articles cannot lead to conclusive results due to their surprisingly small sample size. Therefore, further analysis is needed in order to detect the use of the different research approaches in logistics research. The main indicator for this type of analysis is the description of the research process, which can be regarded as an implicit indicator of used research approaches.

In order to conduct a deeper analysis, a framework is needed that clearly distinguishes between the different research approaches. For the deductive and inductive research approach, it is rather easy to develop this framework, but abductive reasoning needs further elaboration. In the next section, an introduction to the abductive approach is given so as to build a framework for exploring different research approaches to logistics research.

The abductive research approach

The abductive approach stems from the insight that most great advances in science neither followed the pattern of pure deduction nor of pure induction (Kirkeby, 1990; Taylor *et al.*, 2002). While most sources quote Charles Sanders (Santiago) Peirce for coining the term "abduction" (see, for example, Danermark, 2001; Taylor *et al.*, 2002), Peirce (1931) himself traces it back to Aristotle:

> There are in science three fundamentally different kinds of reasoning, Deduction (called by Aristotle συναγ;ώγη or ἀναγώγη), Induction (Aristotle's and Plato's ἐπαγώγη) and

> Retroduction (Aristotle's ἀπαγώγη, but misunderstood because of corrupt text, and as misunderstood usually translated *abduction*). Besides these three, Analogy (Aristotle's παραδείγμα) combines the characters of Induction and Retroduction" (Peirce, 1931, p. 28, paragraph 65 – posthumous edited version of Peirce's unpublished book "*History of Science*" from 1886).

From a linguistic perspective (all following translations originate from Dictionary.com, 2004, or Oxford Reference Online, 2004), deduction is derived from the Greek terms συναγώγη (synagogy) meaning "to bring together" or "to assemble", while αναγωγή (anagogy) means "to lift up" or "spiritual uplift" in the sense of "allegorical interpretation"; both encompassing the ending "-agein" or "to lead". Deduction itself derives from the Latin *dedūcere*, meaning "to lead" or "draw down; bring away or off; establish (a colony); launch; conduct; escort; derive; compose; withdraw; subtract". For induction, ἐπαγώγη (epagogy, epagoge) means "to bring in", and is further explained to mean "the adducing of particular examples so as to lead to a universal conclusion". The Latin *indūcere* translates to "lead or conduct into; bring in; bring (performers) into the arena, on to the stage, etc.; introduce; put on; persuade; spread (with)". As for abduction, ἀπαγώγη (apagogy, apagoge) means "to lead away": the same translation is found for the Latin *abdūcere* ("to lead away; to carry off"). Peirce (1931) quotes Aristotle's παραδείγμα (paradigm) for meaning analogy: in a dictionary, a paradigm would translate to "to compare alongside, to show, to show side by side"; while analogy translates to "proportion, proportionate".

According to Peirce (1931), the term "abduction" originates from a mistranslation and should be called retroduction instead. While social scientists further differentiate between abduction and retroduction (Danermark, 2001), as Peirce himself usually calls "retroduction" for abduction[1], the latter term will be used in this study.

Different streams of abductive research coexist in modern science (Kirkeby, 1990). For one, abduction has entered various different disciplines, each of which have developed the approach further in their own way. These disciplines range from learning (Andreewsky and Bourcier, 2000; Taylor *et al.*, 2002), logic, neural networks and artificial intelligence research (Eiter and Gottlob, 1995) in computer science stemming from Peirce's own background in logic, to abduction as a semiotic method in linguistics (Andreewsky and Bourcier, 2000) or abductive reasoning in social sciences (Danermark, 2001). But apart from the differences in the approach due to its use in different disciplines, Kirkeby (1990) argues that the evolution of the concept in Peirce's works has itself led to various schools of abductive research. In fact, Peirce has no unified definition of the concept, but introduces various definitions throughout the evolution of his work (Kirkeby, 1990).

General observations about the abductive approach

A first stream of researchers sees abduction as the systematized creativity or intuition in research to develop "new" knowledge (Andreewsky and Bourcier, 2000; Kirkeby, 1990; Taylor *et al.*, 2002). Creativity is necessary to break out of the limitations of deduction and induction, which both are delimited to establish relations between already known constructs (Kirkeby, 1990). Instead of following a logical process, advances in science are often achieved through an intuitive leap that comes forth as a whole, and which can be called abductive reasoning (Taylor *et al.*, 2002). This intuition often results from an unexpected observation that calls for explaining an anomaly that

cannot be explained using an established theory (Alvesson and Sköldberg, 1994; Andreewsky and Bourcier, 2000; Dubois and Gadde, 2002). In introducing the concept of intuition into a scientific approach (Taylor *et al.*, 2002), abduction deviates from previous methods of scientific explanations (Danermark, 2001).

The abductive approach also differs from deduction and induction in its research process (see Figure 1). Deductive research scans theory (e.g. in a literature review), derives logical conclusions from this theory and presents them in the form of hypotheses (H) and propositions (P), tests these in an empirical setting and then presents its general conclusions based on the corroboration or falsification of its self-generated H/P (see, for example, Arlbjørn and Halldórsson, 2002; Kirkeby, 1990; Wigblad, 2003). The logical sequence of the research is from rule to case to result (Danermark, 2001; Kirkeby, 1990). Inductive logic follows the opposite path: not even the knowledge of a general frame or literature is definitely necessary (Andreewsky and Bourcier, 2000; see also grounded theory, for example Alvesson and Sköldberg, 1994; Glaser and Strauss, 1967; Flint and Mentzer, 2000); instead, observations about the world will lead to emerging propositions and their generalization in a theoretical frame. This follows the pattern case-result-rule (Danermark, 2001; Kirkeby, 1990; Wigblad, 2003).

The abductive approach follows yet another process, from rule to result to case (Danermark, 2001, Kirkeby, 1990). In Peirce's (1932) terms:

> An originary Argument, or *Abduction*, is an argument which presents facts in its Premiss which present a similarity to the fact stated in the Conclusion, but which could perfectly well be true without the latter being so, much more without its being recognized; so that we are not

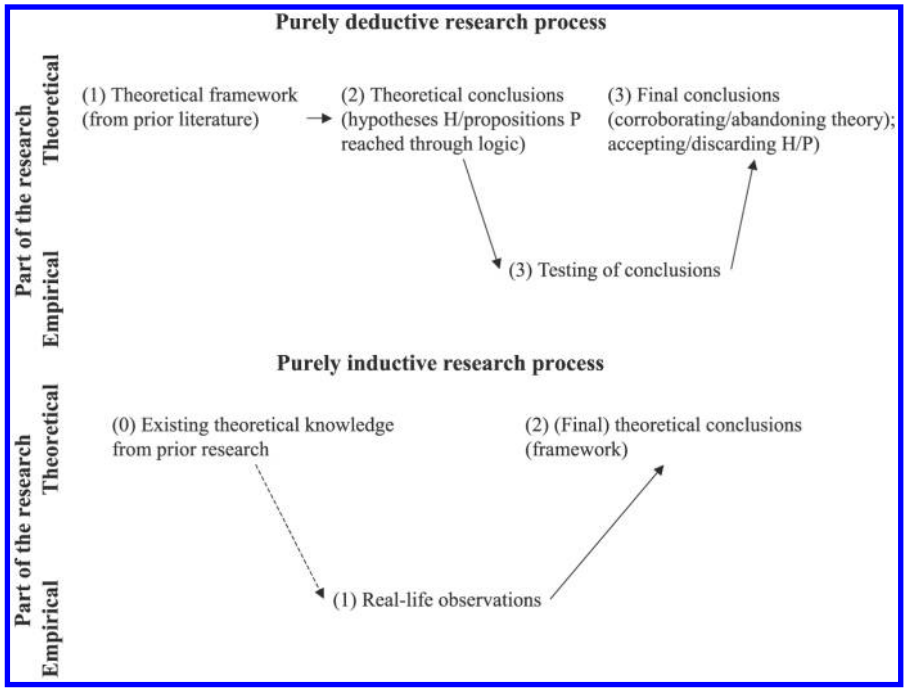

Figure 1.
Purely deductive and inductive research processes

> led to assert the Conclusion positively but are only inclined toward admitting it as representing a fact of which the facts of the Premiss constitute an Icon (Peirce, 1932, p. 53 paragraph 96 – posthumous edition of Peirce's *Minute Logic*, 1902).

In abductive reasoning, the case presents a plausible but not logically necessary conclusion, provided that its anticipated rule is correct (Danermark, 2001). An empirical event or phenomenon is related to a rule, which gives new insight (or supposition) about the event or phenomenon. On the other hand, abduction can also lead to "suggesting" general rules (Andreewsky and Bourcier, 2000; Kirkeby, 1990).

Rather than focusing on generalizations and/or their specific manifestations only, the abductive approach is concerned with the particularities of specific situations that deviate from the general structure of such kinds of situations (Danermark, 2001). As such, it helps to determine which aspects of a situation are generalisable and which others only pertain to the specific situation itself, stemming, for example, from situational environmental factors. The ability of a researcher to distinguish between general and particular features of a situation will depend on his/her previous experience and cultural setting (Danermark, 2001; Kirkeby, 1990). This ability will again lead to abduction "suggesting" general rules – hypotheses (H) or propositions (P) – or theory (Andreewsky and Bourcier, 2000; Kirkeby, 1990).

The creative-intuitive aspect of abductive research (Taylor *et al.*, 2002) along with its ability to distinguish between the general and the particular (Danermark, 2001) makes it very suitable for the first phase of research, which is concerned with the formulation and selection process of H or P (Kirkeby, 1990). In this context, abductive research will help to derive H/P that can later be tested in a deductive phase of research.

Abduction also works through interpreting or re-contextualizing individual phenomena within a contextual framework, and aims to understand something in a new way, from the perspective of a new conceptual framework (Danermark, 2001; Dubois and Gadde, 2002). Here, translations are useful for distinguishing deduction from abduction, the former relating to the direction of subtraction (from the general to the particular), the latter introducing the notion of "carrying off", for example from a pre-designed path to a new framework. Thus, taking an abductive approach leads to new insight about existing phenomena by examining these from a new perspective. This way of creating knowledge is rather common in logistics research that borrows theories from other scientific fields (Arlbjørn and Halldórsson, 2002; Stock, 1997). This relates to logistics being a relatively new discipline: according to Eiter and Gottlob (1995), strong, established theories will abduce less, the research will be "carried off" the track to a lesser extent.

Abductive reasoning emphasizes the search for suitable theories to an empirical observation, which Dubois and Gadde (2002) call "theory matching", or "systematic combining". In this process, data is collected simultaneously to theory building, which implies a learning loop (Taylor *et al.*, 2002), or at least a "back and forth" direction between theory and empirical study (Dubois and Gadde, 2002; Wigblad, 2003). This interactive aspect between theory and empirical study is rather similar to the methods of action research (Wigblad, 2003; see also Näslund, 2002), and can also be found in case study research (Alvesson and Sköldberg, 1994; Dubois and Gadde, 2002).

The abductive research process

In conclusion, a framework for investigating the abductive approach can be proposed which describes its research process and summarizes its essential points (see Figure 2).

Like induction, the abductive approach starts with a real-life observation (Alvesson and Sköldberg, 1994). On the surface, this does not hold for all abductive research, because researchers start out with some pre-perceptions and theoretical knowledge. Sometimes, the theory used is already determined prior to empirical observations (Dubois and Gadde, 2002). However, a closer examination of this starting point leads to the conclusion that even if prior theories are given, abductive reasoning starts at the point at which an observation in the empirical research does not match these prior theories (see, for example, Dubois and Gadde, 2002; Kirkeby, 1990). In this case, the theoretical framework used prior to this otherwise falsifying (Popper, 1959) observation is not able to explain the anomaly of the observation itself (Andreewsky and Bourcier, 2000; Danermark, 2001). Therefore, a creative iterative process (Taylor *et al.*, 2002; Wigblad, 2003) of "theory matching" or "systematic combining" starts (Dubois and Gadde, 2002) in an attempt to find a new matching framework or to extend the theory used prior to this observation (Andreewsky and Bourcier, 2000). The empirical starting point with an anomaly in the observation should not lead to the notion that an abductive research process can only start out with a surprise. On the contrary, the researcher can also introduce a creative element consciously by applying new theory, or a new framework, to already existing phenomena (Kirkeby, 1990).

The aim of this process is to understand the new phenomenon (Alvesson and Sköldberg, 1994) and to suggest new theory (Kirkeby, 1990) in the form of new hypotheses or propositions (Andreewsky and Bourcier, 2000). The abductive approach closes with the application of these H/P in an empirical setting (Alvesson and Sköldberg, 1994; Wigblad, 2003): however, this last step can already be characterized as a deductive part of the research. Thus, strictly speaking, abductive reasoning starts with a deviating observation (point 1 in Figure 2) and concludes in H/P in point 3 (see Figure 2).

It is argued that case studies and action research (Alvesson and Sköldberg, 1994; Dubois and Gadde, 2002; Wigblad, 2003) use abductive reasoning very commonly. This occurs due to simultaneous data collection and theory development (Dubois and Gadde, 2002), and the theory-building element in both methods.

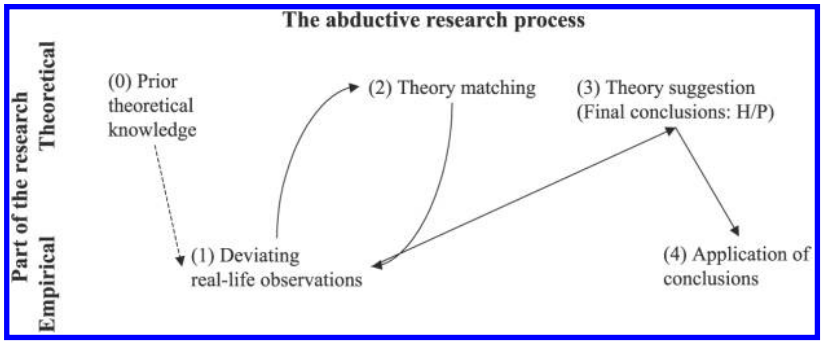

Figure 2.
The abductive research process

Indicators for different research approaches

Few articles in the scientific discipline of logistics discussed their research approach in our literature review. To further explore the use of these approaches in logistics research, it is thus necessary to find indicators for these approaches. These indicators derive from the differences between abductive, deductive and inductive research processes. When comparing these processes in Figures 1 and 2, the following indicators become visible: these processes differ in

- their starting point;
- their aim; and
- the point in which they draw their final conclusions.

Both induction and abduction start out with empirical observations prior to any theoretical framework given or indicated in the research process. In an inductive process, this theoretical framework is missing entirely, while an abductive process can also start out with discarding a theory. On the contrary, deductive research always starts from a given theoretical framework: the hypotheses (H) or propositions (P) that should be further evaluated are already given prior to any empirical research.

Considering the aim of the different research approaches, the inductive and abductive approaches both aim at developing theory, while the deductive approach is testing or evaluating this theory (see Arlbjørn and Halldórsson, 2002). However, the primary aim of abduction is to develop the understanding of a "new" phenomenon (Alvesson and Sköldberg, 1994), while induction traditionally aims at generalizing findings from empirical data.

Theoretical conclusions are the starting point of the deductive approach, which applies previously set H/P to empirical research. Final conclusions are drawn from the corroboration or falsification of the prior H/P (Popper, 1959). The starting point of a deductive approach can be the conclusions from inductive, or abductive reasoning. These both aim at inductively generalizing, or abductively suggesting H/P, i.e. at developing new theory. Inductive research stops here, while the abductive approach arguably includes the application of these H/P to the empirical research (Alvesson and Sköldberg, 1994; Wigblad, 2003). However, this application process can itself result in new deductive research.

While qualitative methods are well suited to theory development (Alvesson and Sköldberg, 1994; Arlbjørn and Halldórsson, 2002; Ellram, 1991; Glaser and Strauss, 1967; Yin, 2003), this is not to say that they could not be applied in deductive reasoning. One key difference between deductive and inductive or abductive research is that while H/P – the theoretical frame – emerges from the data in both the abductive and inductive approaches, the deductive approach takes these as its input and evaluates them throughout the research process. Therefore it is important to determine at which stage of the research these H or P came into the picture, also for assessing the generalizability of the conclusions.

Conclusions and further research

This paper draws upon two major issues called on by previous researchers in the logistics discipline – firstly the positivist focus and the scarcity of qualitative and interpretative research; and secondly the lack of logistics research focusing on theory development. The development of new theories, in our point of view, calls for a

discussion on the concept of abduction. The abductive approach has thus been elaborated upon and discussed in relation to the more common research approaches of deduction and induction. In order to reveal the use of the different approaches in business logistics research an analysis of the explicitly mentioned research approaches in main logistics journals was conducted. The findings are that there is little explicit discussion of research approaches to be found in logistics literature. The articles that take up the topic seem to do so because of their theory building aim, or their case study methods. The analysis of these articles cannot, however, lead to conclusive results due to the small sample size. Further analysis thus has to be conducted that not only focuses on the explicit discussions put forward in the articles, but also implicit discussions to be able to detect the use of the approaches in logistics research. In order to conduct this deeper analysis, frameworks for assessing the use of research approaches in business logistics research are proposed. The frameworks proposed, in addition to functioning as tools for further investigation, could also function as triggers for more discussion in articles on the research approaches used in logistics.

Note

1. In Peirce's collected papers, the editors (Charles Hartshorne and Paul Weiss) of volume I note that Peirce himself later usually calls "retroduction" abduction, sometimes even hypothesis. However, according to Kirkeby (1990), Peirce is not consequent in mixing these terms. Rather, his work can be categorized into two periods: until 1890, Peirce calls abduction a hypothesis; later, he distinguishes between abduction and retroduction.

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Appendix

Keyword	Journal	Number of articles	References
Abduction and abductive	*IJLM*, *IJPDLM*, *JBL*	No results	–
Deduction and deductive	*IJLM*	1	Svensson, G. (2001), "The impact of outsourcing on inbound logistics flows", *International Journal of Logistics Management*, Vol. 12 No. 1, pp. 21-35
	IJPDLM	4	Arlbjørn, J.S. and Halldórsson, Á. (2002), "Logistics knowledge creation: reflections on content, context and processes", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 1/2, pp. 22-40 Faber, N., de Koster, R.B.M. and van de Velde, S. (2002), "Linking warehouse complexity to warehouse planning and control structure: an exploratory study of the use of warehouse management information systems", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 5, pp. 381-395 Svensson, G. (2000), "A conceptual framework for the analysis of vulnerability in supply chains", *International Journal of Physical Distribution & Logistics Management*, Vol. 30 No. 9, pp. 731-749 Svensson, G. (2002) "A conceptual framework of vulnerability in firms' inbound and outbound logistics flows", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 1/2, pp. 110-134
	JBL	3	Garver, M.S. and Mentzer, J.T. (2000), "Salesperson logistics expertise: a proposed contingency framework", *Journal of Business Logistics*, Vol. 21 No. 2, pp. 113-132 Stassen, R.E. and Waller, M.A. (2002), "Logistics and assortment depth in the retail supply chain: evidence from grocery categories", *Journal of Business Logistics*, Vol. 23 No. 1, pp. 125-143 Waller, M.A., Dabholkar, P.A. and Gentry, J.J. (2000), "Postponement, product customization, and market-oriented supply chain management", *Journal of Business Logistics*, Vol. 21 No. 2, pp. 133-159
Induction and inductive	*IJLM*	3	Bolumole, Y.A. (2001), "The supply chain role of third-party logistics providers", *International Journal of Logistics Management*, Vol. 12 No. 2, pp. 87-102

(*continued*)

Table AI.
Usable results from the literature review

Keyword	Journal	Number of articles	References
	IJPDLM	6	Hingley, M. (2001), "Relationship management in the supply chain", *International Journal of Logistics Management*, Vol. 12 No. 2, pp. 57-71 Svensson, G. (2001) "The impact of outsourcing on inbound logistics flows", *International Journal of Logistics Management*, Vol. 12 No. 1, pp. 21-35 Arljbørn, J.S. and Halldórsson, Á. (2002) "Logistics knowledge creation: reflections on content, context and processes", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 1/2, pp. 22-40 Golicic, S.L., David, D.F., McCarthy, T.M. and Mentzer, J.T. (2002), "The impact of e-commerce on supply chain relationships", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 9/10, pp. 851-871 McCarthy, T.M. and Golicic, S.L. (2002), "Implementing collaborative forecasting to improve supply chain performance", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 6, pp. 431-454 Sankaran, J., Mun, D. and Charman, Z. (2002), "Effective logistics outsourcing in New Zealand: an inductive empirical investigation", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 8, pp. 682-702 Svensson, G. (2000), "A conceptual framework for the analysis of vulnerability in supply chains", *International Journal of Physical Distribution & Logistics Management*, Vol. 30 No. 9, pp.731-749 Svensson, G. (2002), "A conceptual framework of vulnerability in firms' inbound and outbound logistics flows", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 1/2, pp. 110-134
	JBL	3	Flint, D.J. and Mentzer, J.T. (2000), "Logisticians as marketers: their role when customers' desired value changes", *Journal of Business Logistics*, Vol. 21 No. 2, pp. 19-45 Garver, M.S. and Mentzer, J.T. (2000), "Salesperson logistics expertise: a proposed contingency framework", *Journal of Business Logistics*, Vol. 21 No. 2, pp. 113-132 Waller, M.A., Dabholkar, P.A. and Gentry, J.J. (2000), "Postponement, product customization, and market-oriented supply chain management", *Journal of Business Logistics*, Vol. 21 No. 2, pp. 133-159

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