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ORIGINAL PAPER

Systems theory: myth or mainstream?

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Abstract Systems thinking has by some been proposed as the 'hard core' of our discipline. Others have claimed that logistics rests on systems theory. However, glancing at how these notions are used outside of the discipline, there is reason to believe that there is more to systems theory than has been noted within our discipline. This paper therefore investigates the adoption of systems theory within the logistics discipline. The paper is entirely theoretical. It begins with a review of what is judged to be the main strands of the systems theoretical field. Thereafter, the adoption of these within the logistics discipline is studied, by means of a literature review that spans a total of 2,537 peer-reviewed journal articles as well as a sample of widespread basic textbooks. The findings indicate that a holistic or systems approach seems to have a somewhat central role in the logistics discipline. However, systems theory or systems thinking in its various forms—as it appears to be treated by those various scholars who deal with these notions explicitly—seem not to. Also, it seems that systems theory was more explicitly treated in the early days of our discipline, having become less visible explicitly in more recent publications.

Keywords Systems theory · Systems thinking · Systems approach · Logistics discipline · Literature review

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1 Introduction

1.1 Background

Every now and then statements such as 'the *systems approach* is fundamental to logistics management' are uttered in logistics literature. Stock et al. [1, p. 45] write: 'This systems approach within the firm has been the underlying premises of much of current logistics management, thought, and practice'. A similar statement is done by Quayle [2, p. 79], who, however, points to systems *theory*: 'The development of an idea of the supply chain owes much to the emergence from the 1950s onwards of systems theory, and the associated notion of holism'. Arlbjörn and Halldórsson [3] discuss the logistics discipline from the perspective of Lakatos' views on scientific research programmes and claim that the 'hard core' of the logistics discipline '…is based on; systems thinking (a holistic view)' (p. 25), and Gammelgaard [4] concludes that there are two major schools within logistics; the *analytical* and the *systems* schools. Aastrup and Halldórsson [5] claim that the dominating metaphor in the logistics field is '…one based on closed systems and functionalism…' (p. 747), but that it is '… a particular strand of systems theory that has been applied in logistics' (p. 748).

Looking at *systems thinking* the way it is treated, for example, in Senge's [6] popular *The Fifth Discipline*, there is, however, reason to wonder to what extent our discipline actually has utilised the developments within the various systems theoretical fields that exist. Undeniably, an underlying holistic approach is easily recognisable in such well-known ideas as total cost analyses. But is there more?

Given Stock's [7] argument that it is a natural step in the maturing of a discipline that constructs are borrowed from other disciplines, it seems reasonable that traces of systems

theory ought to be visible within our discipline. In that same article, for instance, Stock finds that systems theory from the disciplines of political science/sociology has been adopted by Christopher [8] and Gregson [9]. Interestingly, however, Christopher [8] mentions notions such as *a systems approach*, *systems analysis* and *cybernetics* but cites only one single introductory text on systems analysis. Similarly, Gregson [9] discusses *systems analysis* but refers only to two non-logistics publications. This raises questions as to which extent systems theory actually has been explicitly used to inform research within our discipline? Does a brief mention in passing really suffice for stating that a certain theoretical body has been *adopted*? In addition, these particular papers are a couple of decades old. What would be found if we looked closer at more recent publications? There has been an ongoing development within various strands of systems theory [see e.g. 10] but is this reflected within our discipline? Can systems theory be regarded a mainstream theoretical foundation, or are such claims mere myths?

1.2 Purpose

As seen in the quotations above, there seems to be several different but related notions used with regard to a systems perspective; *systems theory*, *systems thinking* and *systems approach*, to mention a few. Gammelgaard [11] notes that 'In the literature on systems…' these three are '…used more or less synonymously…' (p. 12). However, as will become clear in the following section, there might be reason to revise this view somewhat. For the sake of consistency, *systems theory* will be the general term used in this paper when discussing its application within logistics.

The purpose of this paper is thus to shed some light on to which extent systems theory has been adopted within the logistics discipline, in other words, to trace the roots of such statements as those presented earlier in this introduction. Can systems theory be regarded as a mainstream theoretical foundation, or are any such claims mere myths?

It should be noted that the point of this paper is *not* to question whether a systems *approach* (or similar) is central to logistics, but to explore whether, and how, systems *theory* is treated explicitly within the discipline.

The standpoint for the present paper is that in order to count as having adopted something from the systems theoretical domain, it is reasonable that the author(s) have at least explicitly cited works by systems theoretical scholars and/or explicitly discussed *systems theory* or similar notions such as *systems thinking* or *systems approach*.

1.3 Methodology

Defining exactly what constitutes *the logistics discipline* is obviously difficult, if not outright impossible. However, studying readily available publications with an obvious connection to the subject ought to be a reasonable starting point, sufficient for at least attaining a picture of what is communicated within the domain.

This paper is therefore built on a literature review consisting of three steps: First, a review of the origins and various developments within the systems theoretical domain.

Peer-reviewed journal articles of a certain discipline ought to communicate the foundations on which the published research rests. Therefore, the second step is an extensive search and review covering a total of 2,537 published articles from five of the most important logistics-related academic journals.

Basic textbooks ought to communicate the basics of the discipline to students of today (that is, the practitioners and researchers of tomorrow), and subsequently, the third step is an investigation of a selection of basic textbooks authored by knowledgeable scholars in the field.

By choosing these two sources of information, it is thus deemed that two of the most important channels of communication of our academic community are covered.

This research process is roughly outlined in Fig. 1 below. A more detailed description of the way in which the study was conducted is presented in each section, respectively.

The terms systems *approach* and systems *thinking* are also included in the study since it is reasonable to believe that logistics scholars might do as Gammelgaard [11] concludes, that is, use other expressions than systems *theory*. Other than those mentioned by Gammelgaard, words such as *cybernetics* are also included (please refer to the section on systems theory below).

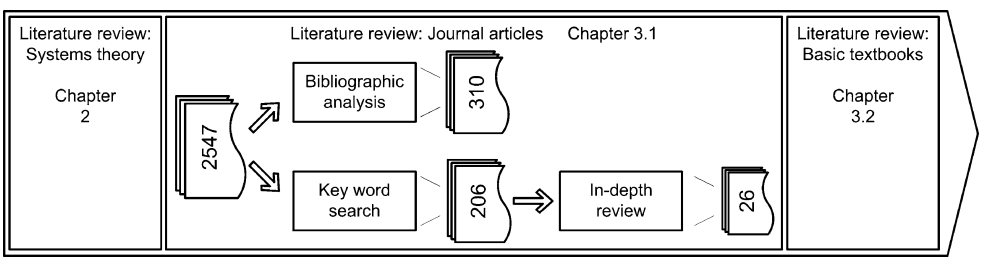

Fig. 1 An outline of the research process

In this context, it is also necessary to mention *supply chain management* (SCM). Whether and how logistics and SCM differ will not be discussed in this paper, as this is not the point of the argument being made. However, as stated by, for example, Mouritsen et al. [12] and Larson et al. [13], it is hard to see the two as not connected at all. Subsequently, given the obvious importance of the SCM notion, it is reasonable that a substantial amount of literature that is important for our discipline is concerned with SCM issues. Thus, without therefore adhering to a 'traditionalist' view [13, 14], any publications on SCM are considered logistics related and are for the purposes of this paper subsequently treated as part of the logistics domain.

The remainder of this paper is organised as follows: First, an introduction to the systems theoretical field is offered. This is followed by the intradisciplinary literature review. The paper is wrapped up with a discussion and implications for research and practice.

2 Systems theoretical 'schools'

The notion of *systems thinking* is said to have been popularised by the publication of Senge's *The Fifth Discipline*, [see 15]. Senge [6] describes systems thinking as:

'Systems thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static "snapshots". It is a set of general principles—distilled over the course of the twentieth century, spanning fields as diverse as the physical and social sciences, engineering, and management … And systems thinking is a sensibility—for the subtle interconnectedness that gives living systems their unique character' [6, pp. 68–69].

Systems thinking is, however, by no means so easily defined, and there exist several 'schools' or strands that all could to a greater or lesser extent carry this label, or be labelled systems *theory*. Flood [15], for instance, points out that Senge's version of systems thinking is rooted in *System Dynamics*, a 'harder' view of systems that originates with Forrester's early works [16, 17] on dynamics in industrial systems. According to Flood, there are, however, other strands of systems thinking that are equally important, pointing at, for example, *General Systems Theory* (*GST*) [e.g. 18], *Organisational Cybernetics* [e.g. 19], *Interactive Planning* [e.g. 20], *Soft Systems Methodology* (*SSM*) [e.g. 21] and the *Critical Systems Approach* [e.g. 22], to mention some.

Olsson [23] identifies largely the same 'schools', but does not mention Senge and *The Fifth Discipline*, nor does it contain any references to *Interactive planning*. There are, however, references to Ackoff as one of the most influential scholars within *Operations Research* (*OR*) along with Churchman, whom Flood points out as a central scholar of the *Critical Systems Approach*. Olsson also identifies *critical systems thinking* (*CST*) and ascribes this to the aforementioned Flood and also Jackson [see e.g. 24]. Two other strands that are mentioned by Olsson, but not by Flood, are *Systems Engineering* and *Systems Analysis*.

Departing from the outlines presented by Flood [15] and Olsson [23], a semi-structured literature review focused on finding more such reviews of the field of systems theory was conducted. One guiding rule was to identify such theoretical areas that has been, or is, influential to the wider area of 'management'. Since many such 'discipline overviews' are contained within publications of which the explicit topics might not be specifically to overview the field, this search was conducted by means of 'snowball sampling', rather than traditional keyword searches. That is, the citations in one publication lead to finding a few more to study, and so on. Gradually, an image of the most important strands of systems theory for management began to form, and what is presented below is a synthesis of findings from a large number of publications, of which the most important in no particular order are Olsson [23], Flood [15], Eriksson [25], Lane and Jackson [26], Umpleby and Dent [27], Ackoff [20], Jackson [28], Jackson and Keys [29], Ingelstam [30] and Jackson [31].[1] It should be noted that the 'schools' and selection of associated scholars presented below are the present author's interpretation of what is deemed the most influential, based on assertions thereof provided in the overviews on which this synthesis is built. With regard to deciding on nomenclature, this was a matter of, as far as possible, adhering to the names applied most often in those overviews. With regard to which schools and/or scholars to include or omit, this was a matter of including those that were mentioned most often, and on which there seems to be the most consensus concerning influence. There are obviously other strands that are not mentioned here,[2] and it is possible to debate whether a certain scholar should be said to belong to the one or the other.

2.1 General Systems Theory (GST)

General Systems Theory (*GST*) dates back to the 1950s and is a strand that commonly is said to have originated with the works of von Bertalanffy [e.g. 32, 33]. It has been described as a holistic meta-methodology; a set of principles, concepts, etc. that are viewed as applicable to any type of systems (hence 'general'), capable of bridging

[1] For practical reasons, this listing is not comprehensive.

[2] For example, such that, although important in their own domains, have been deemed as having had less impact on that of management in general.

various areas of application. One prominent feature of the GST view is that systems in general are open, that is, communicate with and are therefore dependent upon their environment, as opposed to closed, that is, independent of their environment. Other than von Bertalanffy, influential scholars include Kenneth E. Boulding and Anotol Rapoport.

2.2 (Organisational) Cybernetics

Cybernetics deals with structures of information and control systems. As put by one of the identified 'founding fathers', it concerns 'control and communication in the animal and the machine' [34]. Similar to *System Dynamics* (below), feedback processes are a central concern in this strand. Other important scholars than Norbert Wiener are W. Ross Ashby and indeed Stafford Beer, who is acknowledged for having pioneered application of cybernetics on organisations and for introducing what was labelled the *Viable Systems Model* (*VSM*); a general model of systems capable of autonomously surviving in a dynamic context. It is also important to mention Heinz von Foerster, who is acknowledged for introducing *Second Order Cybernetics*, which shortly can be described as a development in which a distinction is made between *observed systems* (e.g. machines) and *observing systems*, systems of which (the observing) human beings themselves are part, thus opening for social-constructivist and cognitive perspectives on systems.

2.3 'Hard' systems thinking (incl. OR and SA)

Contrary to GST or Cybernetics, the label 'hard' is not one originally applied by practicing scholars themselves. Rather, this is a label that has come in use later as a distinction relative to 'softer' approaches such as SSM (see below). The label emanates from the origins in more 'technical'/mathematical approaches to solving specific problems in various forms of operations; one such point of origin is military operations during WWII. Mathematical modelling and optimisation is quite often applied as part of the problem solving efforts, and the 'hardness' is due to the underlying assumption of the 'engineerability' of (social) systems, that is, a fundamental view of social agents as deterministic. The 'hard' school is rather wide, perhaps the least coherent of all six, and within it are approaches concerned both with more technical problems, as organisational/managerial ones. The former involves, for example, the modelling of physical systems and has gained merit within various areas of engineering research and practice in diverse ways. The latter, being most applicable to the logistics domain and that portion of the 'hard' school which is taken into account here, is claimed to have been pioneered by authors such as Russell L. Ackoff, C. West Churchman, Hugh J. Miser, and Edward S. Quade.

2.4 System dynamics

System Dynamics, by some regarded as part of the 'hard' school, is a field that is widely accepted to originate with the early works of Jay W. Forrester [16, 17][3] and is concerned with understanding and modelling the behaviour of complex systems over time, based on recognition of feedback processes. Feedbacks, along with other basic building blocks of systems—stocks and flows, time delays and non-linearities—give that complexity in a system is caused not so much by the components per se, but rather by interactions between them. Along with Jay W. Forrester, important scholars of this school are John D. Sterman and Peter M. Senge.

2.5 Soft systems thinking

The schools presented above all emanate from roughly the same time period, that is, the 1940s and 1950s. As a response to what was deemed too weak a focus on 'softer' aspects—simply put, 'the human side' of things—soft systems thinking emerged during the 1970s and 1980s. One especially prominent strand is labelled *Soft Systems Methodology* (*SSM*), and its founder is widely recognised to be Peter M. Checkland.

It is by this point in time the distinction between 'hard' and 'soft' is pointed out for the first time. This distinction lies mainly in the perception of systems as those of purposeful human activity, rather than the deterministic view of systems that dominates the 'hard' schools. System models are thus not regarded as models *of* the world, but rather models useful for *argumentation about* the world.

'Soft' systems approaches also often embraces action research, that is, collaborative processes between researchers and practitioners, aimed at intervention. It also acknowledges that problems seldom are so well structured and clearly defined as presumed, for example, by hard approaches such as OR, but rather that different actors have different perceptions and goals, and interpret situations differently. Thus, it is also necessary to embrace an actor-oriented, interpretative approach.

Some authors point out that certain 'hard' scholars during the course of time evolved towards a 'softer' stance, for example, Ackoff and his thoughts on *Interactive Planning*, as well as Churchman.

[3] In these early publications, the label was *Industrial Dynamics*.

2.6 Critical systems thinking

Critical systems thinking (*CST*) is the most recent of the schools to have emerged and become named in literature, with much of its development having taken place since the 1990. CST continues along the lines of 'soft' systems thinking in that no 'real' systems are thought to exist, but rather views or mental models of systems in the minds of people. However, it also raises criticism towards the 'soft' schools that these fall short when it comes to from whose perspective value judgments should be made. It is argued that this is a question of boundary drawing and that boundaries inevitably are dependent of which stakeholders that are affected in a certain decision situation. Characteristic is also the advocation of theoretical and methodological pluralism. Werner Ulrich, Michael C. Jackson and Robert L. Flood are pointed out as important scholars, but certain authors also point out that both Churchman and Ackoff during the course of time embraced a more critical stance.

3 Systems theory in logistics

In order to create an overview of how systems theory is treated in the logistics discipline, it was decided to conduct a search in logistics-related academic publications, since these can be regarded as the 'face' of the discipline. Five peer-reviewed journals were thus selected to represent research and intradisciplinary discussions (see Sect. 3.1), and a number of basic textbooks were selected to represent what is taught based on the discipline's body of knowledge, thereby probably containing discussions on the alleged core, systems thinking/theory (see Sect. 3.2).

3.1 Journal article review

Based on Gibson et al.'s [35] investigation of periodical usefulness, as well as the choices in previously published literature reviews of a more extensive kind [e.g. 7, 36], it was decided to include the following five journals: *Int'l Journal of Logistics Management*, *Int'l Journal of Logistics*: *Research and Applications*, *Int'l Journal of Physical Distribution and Logistics Management*, *Journal of Business Logistics* and *Supply Chain Management*: *An Int'l Journal*.

There are of course other journals that are of importance for the discipline, but as with any literature review, the sample had to be limited for practical reasons and this sample was deemed representative. This is an obvious limitation of the present research and a suggestion for further studies is therefore to expand the search to cover a wider sample of journals.

Table 1 Overview of selection of journal articles with available fulltext

	IJPD & LM	IJLM	JBL	IJL: R&A	SCM: IJ	Total
Inauguration	1971	1990	1978	1999	1996	
Fulltext since	Vol. 24	Vol. 1	Vol. 1	Vol. 2	Vol. 1	
Total no. articles	713	360	639	281	544	2,537

The database searches were conducted during January 2011 and were limited to the volumes for which fulltext articles at the moment were available online, in databases *Emerald* and *EBSCO Business Source Premier*. Table 1 presents descriptive data on the fulltext selection, which excludes editorials, book reviews and other shorter publications.[4]

3.1.1 Bibliographic analysis

Based on the identified system theoretical scholars above, an initial database search for surnames was carried out, in order to try to figure out how many logistics authors that actually cite systems theoretical scholars. Within the selected journals, all issues with searchable bibliographies were included in the search. Every occurrence of a certain scholar name in a bibliography was counted as one hit. If a certain scholar name was cited more than once[5] in one bibliography, this still counted as only one hit, since the measurement applied here is 'percentage of articles citing scholar N. N'. Certain author names had to be omitted since the names either are words with another possible meaning (beer, flood) or were deemed too common to not be unique for this specific author (Jackson). A certain amount of search bias is nevertheless still present in the data, since it is of course possible that other authors than those intended in this study carry these surnames. In such cases, this has caused the numbers in Table 2 below to represent too large a number of hits, rather than too small. Given that the numbers for most scholar names (including any excess hits) are rather small, this bias rather strengthens than undermines any conclusions that can be drawn.

The results of this first search are presented in Table 2. Of the original 2,537 articles, 2,103 had searchable bibliographies. In these, there are 310 (14.7%) occurrences of the scholar surnames. As mentioned above, this figure is most likely an overestimation of how many articles that

[4] In Emerald's results, these are automatically excluded. For the EBSCO searches, results were limited to include only "articles".

[5] That is, several publications authored by that specific scholar being cited in the same article.

Table 2 Search results for articles for which searchable list of references were available

No. articles w. searchable bibliographies	IJPD & LM		IJLM		JBL		IJL: R&A		SCM: IJ		Total sample	
	656		119		580		270		478		2,103	
Ackoff	6	0.9%	1	0.8%	4	0.7%	1	0.4%	0	0.0%	12	0.6%
Ashby	4	0.6%	1	0.8%	0	0.0%	0	0.0%	2	0.4%	7	0.3%
Boulding	1	0.2%	0	0.0%	3	0.5%	0	0.0%	2	0.4%	6	0.3%
von Bertalanffy	4	0.6%	2	1.7%	3	0.5%	2	0.7%	2	0.4%	13	0.6%
Checkland	10	1.5%	3	2.5%	3	0.5%	3	1.1%	1	0.2%	20	1.0%
Churchman	4	0.6%	0	0.0%	2	0.3%	0	0.0%	1	0.2%	7	0.3%
von Foerster	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Forrester	48	7.3%	14	11.8%	16	2.8%	16	5.9%	44	9.2%	138	6.6%
Miser	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Quade	1	0.2%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.0%
Rapoport	2	0.3%	1	0.8%	1	0.2%	0	0.0%	0	0.0%	4	0.2%
Senge	14	2.1%	5	4.2%	6	1.0%	1	0.4%	9	1.9%	35	1.7%
Sterman	12	1.8%	5	4.2%	6	1.0%	5	1.9%	10	2.1%	38	1.8%
Ulrich	9	1.4%	4	3.4%	5	0.9%	1	0.4%	5	1.0%	24	1.1%
Wiener	3	0.5%	0	0.0%	2	0.3%	0	0.0%	0	0.0%	5	0.2%
Sum	118	18.0%	36	30.3%	51	8.8%	29	10.7%	76	15.9%	310	14.7%

actually cite the systems theoretical scholars, since any bibliography containing more than one scholar surname is counted more than once due to the way in which this search was conducted. It should also be noted that the scholar might of course have authored works that do not fit squarely into the systems theoretical field; any such cases would also contribute to an overestimation.

This mode of estimating scholars' impact within logistics was deemed appropriate since overall indices such as *Science Citation Index*[6] are based on data from a very wide spectrum of research and are therefore not deemed representative for specifically the logistics discipline. Such indices would be rather blunt instruments for the present study. Another alternative would be to conduct citation searches with online tools, for example, Scopus,[7] but again this would have rendered inferior results due to the lack of database coverage over the entirety of published volumes[8] for the selected publications.

Among the listed scholars, the search results clearly show that Forrester is by far the most commonly cited author, followed by Sterman and Senge. Together, these account for 211 (68.1%) of the total 310 systems theoretical citations in the sample.

At the other end of the scale are those authors whose names rendered only one, or no search hits at all: von Foerster, Miser and Quade.

3.1.2 Key word search

A second search was also conducted, this time based on the three terms identified in the introduction: *systems thinking*, *systems theory* and *systems approach*. The rationale behind choosing these particular key words is that these are quite general in nature, that is, not directly connected to one any specific one of the above-identified systems theoretical schools. Also, given Gammelgaards [11] reflection, there is reason to believe that these might be the terms used (perhaps interchangeably?) by logistics scholars.

All database searches included all text fields within the articles, and all hits were counted and recorded for each journal.

The results of this second search are presented in Table 3. This second sample rendered hits for 206 articles, corresponding to 8.1% of the total 2,537. Similar to above, these figures indicate the maximum number of articles in which search terms are used. Since any hit is counted, it is possible that articles contain more than one of the terms and subsequently are counted more than once.

3.1.3 In-depth article review

The next phase of the review was to assess how the keywords were used in their fulltext context, in order to assess

[6] See http://thomsonreuters.com/products_services/science/science_products/a-z/science_citation_index/.

[7] See http://www.info.sciverse.com/scopus/about

[8] For example Scopus does cover *IJPD & LM*, but only from issue 3, vol. 35 (2005).

Table 3 Results of second database search. This sample contains all articles in which search terms are mentioned once or more

Total no. fulltext	IJPD & LM		IJLM		JBL		IJL: R&A		SCM: IJ		Total sample	
	713		360		639		281		544		2,537	
Systems thinking	20	2.8%	4	1.1%	7	1.1%	5	1.8%	7	1.3%	43	1.7%
Systems theory	23	3.2%	14	3.9%	16	2.5%	3	1.1%	15	2.8%	71	2.8%
Systems approach	41	5.8%	8	2.2%	28	4.4%	6	2.1%	9	1.7%	92	3.6%
Sum	84	11.8%	26	7.2%	51	8.0%	14	5.0%	31	5.7%	206	8.1%

Table 4 Results after assessing search hits in fulltext context

Includes all articles in which it is deemed that the search terms are actually discussed, not merely mentioned

Total no. fulltext	IJPD & LM		IJLM		JBL		IJL: R&A		SCM: IJ		Total sample	
	713		360		639		281		544		2,537	
Systems thinking	5	0.7%	1	0.3%	0	0.0%	1	0.4%	1	0.2%	8	0.3%
Systems theory	6	0.8%	2	0.6%	2	0.3%	0	0.0%	4	0.7%	14	0.6%
Systems approach	4	0.6%	2	0.6%	8	1.3%	1	0.4%	0	0.0%	15	0.6%
Sum	15	2.1%	5	1.4%	10	1.6%	2	0.7%	5	0.9%	37	1.5%

whether the article really did contain a discussion on systems theory or not.

Since the purpose of this paper is to investigate the extent to which systems theory is discussed in the logistics discipline, only articles in which it (or one of the two other included terms: *systems approach* or *systems thinking*) is explicitly discussed were supposed to pass this step and remain for closer examination. In those cases when a searchable fulltext version[9] was available, a second keyword search was thus conducted, this time with the purpose of finding the instances in the text where the keywords were used.

When keywords were identified, it was assessed by studying the context whether or not the concepts were actually discussed or merely mentioned. The point was to identify works that explicitly address the topic of the keywords. Articles in which the words are only briefly mentioned with no further elaboration were omitted from further examination. During this scanning process, there was, however, one important exception to this type of exclusions and this is the instances in which it is explicitly claimed that 'systems theory is central to logistics' or similar, since following any such claims might make it possible to trace the origins of those that are referred to in the introduction of this paper.

All the identified articles in Table 3 were examined in this manner. After this scrutiny, only some 37 search hits remained for closer examination, see Table 4. Of these, it turned out that the actual number of articles to analyse was only 27, indicating that overlap of search terms was fairly common in this portion of the sample.

The next phase of this analysis was to read the remaining articles in depth and attempt to figure out how the relationship to systems theory has evolved in logistics until today. For this purpose, the articles were read in reverse chronological order, and in each instance where the search terms were discussed, notes were taken on what was stated and which citations that were used. In cases where it was stated or implied that the reference(s) made claims regarding the role of systems theory in logistics, the references were acquired and read, if available. By means of this gradual sampling, it was possible to map how systems theory has been discussed and cited, from the early days of the discipline in the 1960 (several authors mark this as the starting point of the logistics discipline, for example, 37, 38) until today.

In the two following sub-sections, all the investigated articles from the sample are presented. The first section contains articles that put forth statements on the relationship between logistics and systems theory; the second contains those in which system theory of any sorts is discussed in other fashions.

Each article is given one paragraph each, all denoted by the citation in italic. The follow-up references of each, if applicable, are denoted by a second, indented paragraph initiated by Follow-up: in italic. If necessary, new references found during the follow-up were also acquired (if possible) and included. In cases when the follow-up references are any of the basic textbooks that are included in the next part of the literature review, these are not discussed here.

References that were not possible to acquire in full text form are in the following text denoted with an asterisk (*).

[9] HTML fulltext or searchable PDF, that is, not scanned images of hardcopies. The latter were instead by necessity printed and read with the same purpose, thus performing the keyword search.

For references that were not deemed to shed any more light on the treatment of systems theory within the logistics discipline, a double asterisk (**) is used instead.

3.1.4 *Articles containing statements on the status of systems theory within logistics*

Randall and Farris [39] in a brief section claim that 'Supply chain management is based on the systems theory of the firm' (p. 671) citing Drucker [40*, 41] and that 'The adoption of a systems approach means reducing total cost by linking previously separate functions such as in- and out-bound transportation', citing Poist [42] and Ellram [43]. The subsequent extension of the system approach to encompass a network of firms and the optimisation of inter-firm flows of goods, information and knowledge is said to be the focus of supply chain management, with reference to Lambert et al. [44].

Follow-up: Based on the conclusion that the different activities that make up the physical distribution of finished goods are not necessarily the concerns of the manufacturing company alone, Drucker [41] argues that a new economic theory is needed and that companies should consider abandoning operations research-based approaches aimed at optimising mere fragments of the entire distribution process. In this sense, Drucker [41] does argue for a more holistic approach than what seems to have been common at the time; however, there is no explicit evidence that the argumentation is built upon systems theory.
Poist [42] argues that logistics system design should be based on calculations of total profitability rather than total cost and states that one of the first incorporations of total cost and systems concepts was Lewis et al. [45]*. Ellram [43] discusses the importance of including all relevant costs, that is, not just price, in supplier selection decisions, and Lambert et al. [44] evaluates process-oriented frameworks of SCM. There are, however, no claims regarding any systems theoretical roots in any of these articles.

Aastrup and Halldorsson [5] discuss the epistemological role of case studies in logistics and point at the system roots of the discipline being those of Forrester's [17]** findings, referring to Gomes and Mentzer [46]. The authors also refer to Bowersox et al. [47]* that is said to claim that General Systems Theory is the appropriate basis for analysing the performance and design of logistics systems and that systems capable of reaching desired results can be designed if objectives are given. Such an approach '…has been termed hard or unitary systems approach…' [5, p. 748].

Follow-up: Gomes and Mentzer [46] is reviewed below, since it is included in the articles selected for analysis. It should, however, be noted that, interestingly, that article does in fact not refer to Forrester [17]**.

Frankel et al. [48] offer an ambitious review of the foundations and current state of research in the SCM field, which is said to originate in the early 1980s when researchers aimed at '… understanding the system integration of business processes …' (p. 3) by drawing on works of Forrester [16]** and Heskett [49, 50]. Concerning the theoretical roots, several fields are identified along with examples of applications. One such is the much cited article by Stevens [51] on supply chain integration, which is said to draw on General Systems Theory, referring to von Bertalanffy [18, 33]**. The authors further identify four main theoretical areas that have contributed to SCM: purchasing, operations management, logistics and marketing channels of distribution. Among these, logistics is said to: 'Reflecting its evolution to include more systemic and strategic considerations, logistics has most recently begun to integrate systems and network theory (Dyer and Singh [52]; Kale et al. [53]; Lorenzoni and Lipparini [54])' (p. 13).

Follow-up: The last three references [52–54] are all concerned with interfirm relationships and do not contain any explicit claims regarding neither logistics nor systems theory.
The Stevens's [51] article interestingly does not refer to von Bertalanffy [18, 33]** or any other systems theory. *Note: As found in another reviewed article below, there is another claim that Stevens* [51] *draws on the works of Michael Porter. Obviously there has been some confusion as to which theoretical roots that article actually has.*[10]
Heskett [49, 50] does refer briefly to Forrester [16]**, but makes no explicit claims regarding systems theory per se. There are, however, clear holistic underpinnings.

Davis-Sramek and Fugate [55] conducted interviews with 13 'logistics visionaries' (leading academics in the field). One of these point to the origins of logistics being an extension of Forrester's system dynamics, referring to an early HBR article by Heskett [56].

Follow-up: Heskett [56] states that systems analysis is necessary for logistics system design, referring to an even earlier piece by Magee [57]. In that article,

[10] In fact, that article contains no bibliography in the strict sense, only two recommendations on "further reading". Interestingly, none of these actually are those claimed in the articles in this sample which cite Stevens [51]).

emphasis is placed on that the physical distribution process ought to be regarded as a system and that total cost and trade-off analyses should underlie design decisions. None of these two articles do, however, contain any explicit references to systems theory, including *Systems dynamics*.

Sanders [58] states that SCM '… takes a systems view regarding all activities and functions that are needed to bring a product or service to market' (p. 183), referring to Stevens [51] and Tan et al. [59]*. It is claimed that the theoretical foundation of this systems view is Porter's [60, 61]** value chain model.

Follow-up: It is true that Stevens [51] does apply a holistic view of the supply chain, but, as mentioned above, systems theory actually is not discussed explicitly nor is there any reference to any works by Porter.

Mason et al. [62] refer to Giannakis et al. [63]* but also directly to the original source [64]** when stating that systems theory underpins SCM. It is also claimed that nowadays it is commonly recognised that supply chains are dynamic systems, referring to Forrester [17]**.

Follow-up: Although Giannakis et al. [63]* was not available, a contemporary piece by two of the same authors dealing with the same topic was, see [65]. In that article, it is stated that 'Research in the field of SCM has evolved from its core concerns around logistics/operations processes through the incorporation of theoretical concepts and research in… … and systems theory' (p. 29). There are, however, no references to support this, making any further follow-up impossible.

Gripsrud et al. [66] discuss the SCM concept and its role in relation to business logistics and its antecedents in marketing. An important principle in this domain is the total cost concept, which is said to rest on an 'integrating systems view' [37]. It is also stated that the dominant underlying theory of business logistics since the 1970s has been systems theory, referring to Ballou [67]* and Magee et al. [68]*. It is, however, not explicitly stated that these latter two discuss systems theory.

Follow-up: Kent and Flint [37] in turn, have identified six eras of logistics thought, of which the third, which begins in the early 60's, includes the introduction of the systems approach and the total cost concept to the discipline, marking the beginning of 'business logistics': 'when the total cost or systems approach was applied to the analysis of the firm, a logical combining of the previously separate logistics functions began to evolve. Business logistics came into its own' (p. 24). It is stated that the total cost concept was introduced by Lewis et al. [45]* and that the systems approach was first discussed by Smykay et al. [69]*.

Based on an extensive literature review, Sachan and Datta [70] conclude that more research with an interorganisational perspective is needed in the logistics/SCM domain, with reference to Arlbjörn's and Halldorsson's [3] claim that systems thinking lies at the core of the discipline.

Follow-up: Arlbjörn and Halldorsson [3], also included in the sample, is presented below.

Peck [71], referring to Naim et al. [72], states that SCM draws on both 'hard' and 'soft' [21, 73]** systems theory, the former, however, being the dominant view. Peck also points to other system theoretical works [74, 75]**, however, without explicitly linking these to the logistics domain.

Follow-up: Naim et al. [72] is a unique piece in that it is aimed at discussing the same topic as the present paper: '… logistics is now commonly seen as developing as an academic "discipline" in its own right. … In this paper, we specifically focus on the role of Systems Theory in this development…' [72, p. 549]. Several of the schools identified in this paper are mentioned, but the main discussion draws mostly on Forrester [16, 17], and the reasoning is centred around dynamics in supply chains. Logistics is said to be characterised by 'soft-hard' systems [76]**. It is concluded that 'We believe that Systems Theory is the core pillar of modern logistics management, and it has widely influenced thinking over the last century from Taylorism to Lean Thinking in the present day' [72, p. 555], but no 'hard evidence' to support this claim is actually presented.

Applying the Arbnor and Bjerke [77]** framework of methodological approaches, Gammelgaard [4] concludes that there are two major schools in logistics: the analytical and the systems schools. The systems approach is described with references to Lilienfeld [78]** and Churchman [22]**.

Pointing to Bowersox [79], it is concluded that 'A systems perspective has long been pervasive in the logistics discipline' (p. 486) and that 30 years later this still holds, referring to Bechtel and Jayaram [80] and Mentzer et al. [81]. There is also a reference to Arlbjörn and Halldorsson's [3] statement that systems thinking is the 'hard core' of logistics, and two examples of articles in which the systems approach is evident, although not explicit[11]: Cooper et al. [82]** and Lambert et al. [83]**.

[11] Since it is clearly stated in Gammelgaard [4] that these articles do not discuss systems explicitly, these references were not included in the follow-up.

Follow-up: Bowersox [79] points at the adoption of 'the systems concept' or 'system technology' as an important milestone in the development of physical distribution, the adoption of which led to development of the widespread total cost concept. It is in fact concluded that 'The first general articles directed to the subject of physical distribution relied heavily on systems technology' (p. 64), referring to Shycon and Maffei [84]*, Parker [85]*, Heskett [49] and Magee [57]. Some early references regarding the total cost concept used by Bowersox [79] are Lewis et al. [45]*, Flaks [86]* and LeKashman and Stolle [87]*. Also Forrester's industrial dynamics [16]** are related to. Heskett [49] and [57] are both discussed in previous follow-up paragraphs.
Bechtel and Jayaram [80], Mentzer et al. [81] and Arlbjörn and Halldorsson [3] are all included in the studied sample and thus presented in separate paragraphs below.

Larson and Halldorsson [14] make a brief reference to a relationship view of SCM, referring to Christopher [88], stating that this view bears similarities with a systems approach.

Follow-up: This similarity is not explicitly pointed out by the latter, but again the holistic perspective is evident.

Quayle [2] refers to New [89] and Cavinato [90] when claiming that 'the development of an idea of the supply chain…' (p. 79) owes to the emergence of systems theory in the 1950s and onwards, also referring to Boulding [91]**.

Follow-up: Quayle's statements are more or less a quotation of New [89, see p. 16], who also points to Cavinato [90] and Boulding [91]**. Cavinato [90] in turn claims that 'Interfunctional total cost is the core concept of logistics' (p. 285), implicitly referring to Heskett et al. [50], which is discussed previously. There are no further explicit claims regarding systems theory.

Arlbjörn and Halldorsson [3] make the perhaps clearest statement in the sample, by formulating a hard core[12] of the logistics discipline as '…directed towards the flow of materials, information and services; along the vertical and horizontal value chain (or supply chain) that seeks to; coordinate the flows and is based on; systems thinking (a holistic view), where; the unit of analysis essentially is the flow' (p. 25). With regard to systems thinking, there is an explicit reference to Bowersox and Closs [92], but also to suggestions by Persson [93] and Gammelgaard [11] that there is a need for a systems approach in logistics research. There is also a reflection that 'It appears that the suggestion of a systems approach to "consider the more total picture" [77] has been over emphasised' (p. 26), referring to the dominance of positivism—which contradicts the systems approach with regard to the possibility of synergies—within logistics research.

Follow-up: According to Bowersox and Closs [92], 'The foundation of logistics reengineering is based on the logic of systems analysis. The exact origin of systems analysis is difficult to trace since the concept is closely related to all forms of organized activity' (p. 459). There are no references to support the relationship with logistics, but several to exemplify systems analysis [94–100]**.
Gammelgaard [11] refers to Persson [93] when stating that the systems approach is the discipline's methodology of choice, concluding that it, however, seems that we mostly follow that approach rather implicitly. Referring to Törnroos et al. [100]*, the roots of the system approach in logistics are said to go back to 1956 and the dawning of the total cost concept.
Persson [93] offers a rather extensive discussion on the systems approach and its application within logistics research. It is stated that much of the concepts of logistics developed under influence of the growth of the systems approach in general administration and management theory, implicitly referring to Ericsson [101]. Ericsson [101] is a basic textbook, in which the entire first section (47 pages) is devoted to a thorough discussion on the systems approach under the heading 'materials administration theory'. There are, however, no references to any systems theoretical literature.

In Mentzer et al.'s [81] ambitious attempt at defining SCM, a distinction is made at how the concept in literature has been regarded as *a management philosophy*, *a set of activities* or a *set of management processes*. As a management philosophy, it is concluded that '… SCM takes a systems approach to viewing the supply chain as a single entity, rather than a set of fragmented parts, each performing its own function [102, 103*, 104*]' (p. 7). The article also takes its starting point in Forrester [16]**, stating that this in fact was an early identification of SCM.

Follow-up: Ellram and Cooper [102] do claim that SCM is a systems approach, but there are no explicit references to any systems theoretical literature.

Holmberg [105] differs from the previously presented articles of the sample in an interesting way. First, because it is concluded that systems thinking is often claimed but

[12] Drawing upon Lakatos' thoughts on research programs.

seldom explained: 'Logisticians often claim to use systems thinking when managing the flow of goods and information from the point of origin to end customers, but few authors explain why or how the concept is used' (p. 853). Second, because it is thereafter explained why systems thinking is deemed appropriate, what it is, and how it is applied, with references to Checkland [21]**, Senge [6]** and Gustafsson et al. [106]**.

Follow-up: none.

Bechtel and Jayaram [80] state that 'The underpinning philosophy mentioned most often in the SCM process literature is systems thinking' (p. 21), referring to Bowersox et al. [107], Busch [108], Hewitt [109] and Camp [110]*.

Follow-up: Hewitt [111] does not discuss systems thinking explicitly, although displays a clearly holistic perspective. The same goes also for both Busch [108] and Bowersox et al. [107].

Jackson and Low [111] claim that *the systems concept* forms the basis for the total cost approach to logistics [88]* as well as 'supply channel management' [112]*.

Follow-up: none.

Novack et al. [113] present a conceptual framework of logistics management for which one of the underlying premises is the systems approach, referring to Christopher [114]*, Coyle et al. [115]* and Bowersox et al. [47]*.

Follow-up: none.

Gomes and Mentzer [46] argue for a *total systems approach* to research on just-in-time and state 'Knowledge of systems theory has enabled logistics theoreticians to rigorously examine the nature of logistics systems' [p. 77, referring to an unpublished dissertation by Karrenbauer [116]* and that '… the total systems approach is basic to logistics research…' [p. 77, referring to [117–119]* There are also references to Buckley [120]** and Churchman [121]**. Interestingly, there is, however, no evidence for the claim made by Aastrup and Halldorsson [5], above] that this article refers to Forrester [17] as the starting point for a 'total systems perspective' as 'fundamental to the logistics discipline' [see 5, p. 748].

Follow-up: none.

Lambert and Mentzer [122], in discussing integrated physical distribution, state that it is based on a total systems approach, referring to Flaks [86]*, LeKashman and Stolle [87]* and Lambert [123]*.

Follow-up: none.

Bowersox [124] states very clearly that 'The systems approach was and remains the cornerstone of the integrated logistical concept' (p. 11). This article is an excerpt from a forthcoming textbook [125]*, and there is no further reference.

Follow-up: none.

The earliest article in the sample is Anderson et al. [126] in which it is stated that physical distribution, like '… its sister discipline marketing…is moving into the systems era…' (p. 19), with reference to Walters [127]*. The systems approach to physical distribution is also discussed, referring to Jerman and Anderson [128]*.

Follow-up: none.

3.1.5 Articles discussing systems theory in other ways

Zhou et al. [129] study battery recycling systems in China and apply Soft Systems Methodology (SSM), referring to Checkland and Scholes [130]**. The authors follow the basic principles of SSM, arguing that it is suitable for tackling messy, unstructured, ill-defined real-world problems. In this sense, this particular paper does not discuss the relationship between systems theory and logistics. It is a rare example of how it is not merely mentioned, but actually explicitly applied.

Follow-up: none.

In their study of information technology internalisation, Forman and Lippert [131] utilise General Systems Theory [33]**. Its usefulness is discussed based on Baggett [132]* and also that supply chains indeed are systems comprised of subsystems, referring to Bagchi and Skjoett-Larsen [133].

Follow-up: The latter, although clearly displaying a holistic perspective, does, however, not explicitly discuss supply chains as systems or systems theory.

Moon and Kim [134] study in an experiment setting how individuals' systems thinking ability affects decision-making performance in a supply chain setting, referring to Sterman [135, 136] ** and Sweeney and Sterman [137]. It is stated that '… systems thinking is the basis of inventory management, finance, and order management (Sweeney and Sterman [137])' (p. 395).

Follow-up: Although Sweeney and Sterman [137] do relate to, for example, inventory management in the sense that the tests contained within the systems thinking inventory that the authors present are concerned with stocks and flows, these authors do not make such an explicit claim that the quotation above implies.

Towill [138] differs from the bulk of the selected articles in the sense that there is a clear and explicit application

Table 5 Selection of basic textbooks. Authors denoted by an asterisk (*) do not belong to the list of logistics visionaries by Davis-Sramek and Fugate [55]

Author(s)	Title	Edition	Publ. year
Ballou, Ronald H.	Business logistics/supply chain management	5th Int'l	2004
Bowersox, Donald J. Closs, David J. Cooper, M. Bixby*	Supply chain logistics management	3rd	2010
Bowersox, Donald J. Smykay, Edward W.* LaLonde, Bernard J.	Physical distribution management—logistics problems of the firm	2nd	1968
Christopher, Martin	Logistics and supply chain management—creating value-adding networks	3rd	2005
Coyle, John J. Bardi, Edward J.* Langley Jr., C. John	The management of business logistics	7th	2003
Stock, James R. Lambert, Douglas M.	Strategic logistics management	4th Int'l	2001

of systems theory, in this case in the form of *System Dynamics*, with references to Forrester [17]**, but also to other systems theoretical literature not belonging to that particular school [18, 21]**.

Follow-up: none.

Pisharodi and Langley [139] approach customer service from a perception point-of-view, and in doing this, develop a model thereof based on '… rooted in the principles of cybernetics and General Systems Theory' [139, p. 27], with references to two publications that deal with cybernetics [140, 142]**.

3.2 Basic textbook review

This part of the literature review is intended to study how systems theory is treated in basic textbooks of the discipline, following the logic that these ought to include the fundamentals. Examining all published textbooks in the field would of course be an immense task, rendering a selection of some of the more influential ones necessary.

After an article search in the journals included in part one of the literature review, it was concluded that there exists no easily available published study on the relative importance of basic textbooks in the logistics/SCM field. However, in their inventory of the state of logistics, Davis-Sramek and Fugate [55] identified a number of 'logistics visionaries', knowledgeable scholars that are familiar with both the past and the present of the discipline. After a search in the local library database, it was concluded that most of these scholars have authored or co-authored basic textbooks on logistics/SCM, and since the authors asked every scholar to name other 'visionaries' until saturation was reached, it is deemed that analysing at least one available textbook by each of the scholars listed by Davis-Sramek and Fugate [55] ought to render a somewhat fair picture of if and how systems theory is discussed in the basic textbooks of the discipline.

It should be noted that with one exception, all scholars in this selection are of North American affiliation, which obviously result in some bias. It also seems that four of the 'visionaries' have not authored any basic textbooks.[13]

The resulting textbook sample is presented in Table 5 below. In cases with several published editions, the latest available edition was chosen, however, limited by availability at the local university library.

Each of these textbooks were examined in the following manner: First, the introduction to the subject of logistics/SCM was read, with special emphasis on 'defining' chapters or sections [for instance 141], contains a section named 'Business logistics defined', pp. 3–7] as well as sections in which basic methodology or approaches are discussed (e.g. 'Approach to the study of logistics/SC'; ibid. pp. 28–30). Second, the subject index (if applicable) was studied in order to see whether any of the search terms above, or similar, are explicitly discussed in the book. The third and last step was to examine bibliographies (if applicable) to check for any references to systems theoretical literature.

3.2.1 *In-depth textbook review*

Bowersox et al. [143] is the most recent book in the sample. In an introduction to the subject of logistics, it is stated that 'logistics refers to the responsibility to design and administer systems to control movement and geographical positioning of raw materials, work-in-process, and finished inventories at the lowest total cost' (p. 22). In a subsequent section on cost minimisation, it is further stated: 'The focus of logistics can be traced to relatively recent developments

[13] Checked by searching online library databases as well as publication listings available via the respective scholars' professional web pages. Please note that this also is based on some scrutiny as to whether a book should be deemed "basic" or not. For, example, if authors in a foreword explicitly state that the intended audience are practicing managers, the book is not deemed "basic" in the context of this paper.

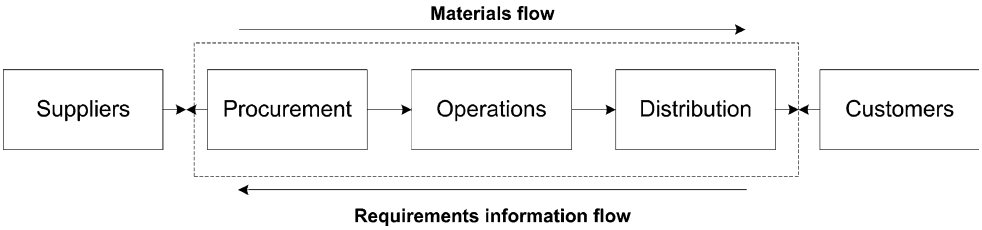

Fig. 2 The total systems concept according to Christopher [144, p. 15]

of total costing theory and practice. In 1956, a classic monograph describing potential airfreight economics provided a new perspective concerning logistical total cost' (p. 25), with reference to Lewis et al. [45]*. This is said to be the first application of a total cost concept and that it generated quite some debate at the time of publication.

The book also contains a section named 'Systems concept and systems analysis' (terms appear in the subject index), in which it is made explicit that 'The components of a logistics system are typically called functions. The logistical functions … order processing, inventory, transportation, warehousing, materials handling and packaging, and facility network design. Systems analysis, applied to logistics, seeks to quantify trade-offs between these five functions. The goal of systems analysis methodology is to create a whole or integrated effort, which is greater than the sum of the individual parts or functions. Such integrations creates a synergistic interrelationship between functions in pursuit of higher overall achievement' (p. 308).

Similar to Ballou [142], there is a reference to Forrester [17]** in a section on forecasting.

In Christopher [144], there is a section on the mission of logistics management, in which it is stated: 'The scope of logistics spans the organization, from the management of raw materials through to the delivery of the final product' (p. 15). There is also a figure that '…illustrates this total systems concept': (Fig. 2).

Further on the author writes: 'In this scheme of things, logistics is therefore essentially an integrative concept that seeks to develop a system-wide view of the firm. … Ideally there should be a "one-plan" mentality within the business which seeks to replace the conventional stand-alone and separate plans of marketing, distribution, production and procurement' (p. 16).

There is also a section on 'Logistics system dynamics', which largely draws on Forrester's [17]** *Industrial Dynamics*,[14] but no occurrences of systems concepts in the subject index.

Ballou [142] clearly rests on a holistic foundation, emphasising that logistics/SCM is about coordinated, rather than separate, management of related activities. With regard to approaches, the introductory chapter concludes with 'It is the approach of this text to describe logistics problems as simply as possible and to apply definitive methodology in solving them that has proven to be of practical value in real applications. It is a decision-making approach' (p. 30).

Apart from total cost, there are no occurrences of systems concepts in the subject index.

In the bibliography, there is a reference to Forrester [17]**, which is very briefly referred to in a section on forecasting techniques.

In Coyle et al. [145], explicit references are made to roots in the development of the 'systems concept' during the 1950s and 1960s, '…the system relationship among transportation, inventory requirements, warehousing, exterior packaging, materials handling, and some other activities or cost centers was recognized' (p. 13). The book contains a section named 'Logistics and systems analysis' in which it among other things is stated 'The general tenet of the systems concept is that we do not focus on individual variables but on how they interact as a whole. The objective is to operate the whole system effectively, not just the individual parts' (p. 58).

'Systems concept' appears in the subject index, but there are no explicit references to systems theoretical literature.

Stock and Lambert [146] display perhaps the clearest systems theoretical foundation, in that it is stated explicitly already in the beginning of the book that 'The systems approach is a critical concept in logistics. Logistics is, in itself, a system; it is a network of related activities with the purpose of managing the orderly flow of material and personnel within the logistics channel. … The system approach simply states that that all functions or activities need to be understood in terms of how they affect, and are affected by, other elements and activities with which they interact … In essence, the sum, or outcome of a series of activities, is greater than its individual parts' (p. 4), referring explicitly to systems literature such as Churchman [121]**, Ackoff [20]** and Senge [6]**. The authors continue: 'The systems approach is at the core of the next several topics discussed. The systems approach is key to understanding the role of logistics in the economy, its role in the organization, including its interface with marketing, the total cost concept, and logistics strategy' (p. 4).

Bowersox et al. [118] is by far the oldest in the sample, included as it appears to be the most recent contribution to

[14] The label that was initially used for what later became *System Dynamics*.

a basic textbook by Bernard J. LaLonde. It is interesting also in the sense that it dates from the early days of the discipline. In the introduction to this book, management of *physical distribution* (considered by the authors as synonymous with *business logistics*, p. 5) is defined as '… that responsibility to design and administer systems to control raw material and finished goods flow' (p. 5) and a little further on it is claimed that '… the job of implementing physical distribution principles requires detailed balancing and integration of disparate functions. In a managerial sense, such highly integrated performance is accomplished through system design and administration' (p. 6). The two following sections are concerned with *systems design* and *systems administration.* In a later section named 'Approaches to the study of Physical Distribution', one can read 'The study of physical distribution must include elements of both macro and micro analysis. … The orientation is concerned with the efforts of an individual firm to develop an effective and efficient physical distribution system. The individual firm's objective is to develop the best possible system to support and encourage the achievement of profitable transactions. Such development requires a cognizance of macrodistribution forces at work in the economy. Such forces act as limiting factors, barriers, and opportunities. In general, the development used in this book is classified as a systems approach' (p. 15). In the book, there is a later section in which 'the systems concept' is introduced, and entire chapters on total cost analysis and systems design.

4 Findings from literature review

Already the summaries in Sects. 3.1.1 and 3.1.2 provide some interesting results. As seen in the bibliographic analysis, Forrester is by far the most commonly cited author in the articles, followed by Sterman and Senge. These *System Dynamics* scholars together account for 68.1% of the identified citations of systems theoretical authors. Looking at the textbooks, a similar pattern emerges. Although this sample is relatively small, of the few systems theoretical references there are, Forrester is the most commonly cited author.

Among those systems theoretical scholars who render few or no search hits among the articles, von Foerster is acknowledged for having initiated *Second Order Cybernetics*. Of the other identified cybernetics scholars, neither Wiener nor Ashby render any substantial counts. This is true also for the textbook sample. It thus seems fair to conclude that *Cybernetics* has not gained any widespread attention within the logistics community. Given the rather low numbers, this actually seems fair to say about the other remaining schools as well.

Turning to the key word search, as many as 91.9% of the scanned 2,537 articles do not contain any instance of any of the three identified systems theory-related keywords. That is, the words are only rarely used, indicating that there are few explicit discussions on these notions.

But citing or using certain terminology is one thing. To actually borrow from a certain theoretical field is something else. In the keyword search, it sufficed that author names or key words were mentioned for a hit to be recorded. When looking deeper into the actual treatment of the notions in the in-depth review in Sects. 3.1.3, no more than 27 of the identified articles in which key words are mentioned passed to the second step of analysis, that is, were deemed to actually discuss the subject. That equals a mere one per cent of the original scanned sample of 2,537 articles. From this, it is possible to draw a conclusion that *systems theory* in its various forms very rarely is discussed explicitly.

The sample of articles that actually do discuss it explicitly, and all the follow-up articles together amount to 55 publications. Out of these, only 11 cite any of the systems theoretical authors presented in Sect. 2, of which 10 contain references to Forrester. Apart from this author, there are also a few references to von Bertalanffy and to Checkland.

It seems that the *System Dynamics* school is the only systems theoretical school that has gained some foothold in the logistics community. It should, however, be noted that the extent to which it is discussed and applied varies between the identified articles. Application of other schools is at best sporadic.

5 Conclusions

The question that this paper set forth to answer was whether and how systems theory is explicitly treated in the logistics discipline; can systems theory be regarded as a mainstream theoretical foundation, or are any such claims mere myths? Representative journal articles and basic textbooks were chosen as the object of study.

In the sampled textbooks, variations of a *systems approach* are rather clearly visible. In different ways, authors inform students that logistics entails some kind of holistic approach. More often than not, at the heart of this lies the analysis of total logistics costs. With regard to *systems theory*, several authors refer to Forrester, the founding scholar of the *System Dynamics* school, and in such instances, it is mostly the demand amplification and distortion mechanism in distribution channels known as the 'bullwhip effect' that is discussed.

Turning instead to the journal articles, it is not as easy to see many distinct patterns for the sample as a whole. There

is a very low occurrence rate of the included key words *systems theory*, *systems thinking* and *systems approach*—in fact, only roughly 8% of the analysed 2,537 mention these terms at all. Among these articles, fewer still actually discuss the notions at any length, roughly one per cent.

Among those that do discuss the notions explicitly, the in-depth review reveals a pattern that the more recent articles, when discussing the 'systems roots' of logistics, to a larger extent cite intradisciplinary publications. Also, it seems that evidence for the alleged systems theoretical roots is more implicit than explicit. That is, such statements are reiterated every now and again, but not always with references that support such claims. Looking instead at the older publications, an aspect of the pattern is that discussions on the topic seem slightly more thorough and there are also more interdisciplinary citations to systems theoretical works of the 1950s and 1960s. This pattern is perhaps an indication of the disciplinary maturing that Stock [7] discusses.

Many of the authors mentioned in Sect. 2 are present in the sample, but most of them only at a few instances. The school that is most prominent seems to be *System Dynamics*, with Jay W. Forrester as the most commonly cited author, followed by John D. Sterman and Peter M. Senge. This finding corroborates the claims made by Aastrup and Halldorsson [5]. As logisticians, we have adopted the early thoughts that formed the basis of this particular school. Looking at the object of study in Forrester's early publications [16, 17], this is by no means peculiar, since this is basically the object of study in the early days of our discipline: physical distribution.

However, since the 1960s *System Dynamics* has evolved and is an active school with an ongoing intradisciplinary debate. There is today more to *System Dynamics* than bullwhip effects in distribution channels. This is, however, not reflected in the publications studied here.[15] And again, this is merely one school out of the diverse field that can be labelled *systems theory*.

Apart from *System Dynamics*, there are a rare few occurrences of logistics scholars having drawn upon the works of either von Bertalanffy or Boulding, that is, *General Systems Theory*, or Checkland, that is, *Soft Systems Methodology*.

From this analysis, it seems that there is no clear systems theoretical base that is commonly used by logistics scholars. Only a rather small portion of the sample of articles either mentions any of the key words or cite any of the identified influential systems theoretical scholars. None of the findings in this paper thus support any of those claims that 'logistics rests on systems theory', or the like. Had that been the case, much more obvious patterns of reappearing citations of 'central' publications would have surfaced during the course of this analysis.

It is thus reasonable to conclude that such a claim is more of a myth than anything else. There is no clearly distinguishable systems theoretical foundation that can be considered 'mainstream' as far as logistics research is concerned. The early scholars of the discipline might very well have been *influenced* by developments in systems theory. The strongest impression left by this early adoption seems to be that of total cost reasoning and efforts to integrate business functions that previously were managed as separate entities. The influence from systems theory was, however, not strong enough for the logistics community to engage in any sustained borrowing from the systems theoretical domains. However, the story about the influence of systems theory has been passed on. It has become a myth within our discipline, but it is not a mainstream theoretical base.

6 Implications and future research

Does this imply that systems theory has had no impact at all on our discipline? Certainly not. The image that emerges from this study is that the integrative character of logistics management is a result of the early influences. That is, that it was recognised that optimising separate functions without regard to the total impact on the enterprise was insufficient. And also that, this total impact in the early days was judged by total costs: 'When the total cost or systems approach was applied to the analysis of the firm, a logical combining of the previously separate logistics functions began to evolve. Business logistics came into its own' [37], p. 24].

From this departure, the scope of unit of analysis has during the discipline's journey gradually evolved to include not only functions, but entire chains and networks. And the scope of impact has come to include not only costs, but also, for example, customer satisfaction and social responsibility. In one sense, this is obviously a 'bigger picture' than that of the early days of the discipline. But is this really all there could be to 'a systems approach'? Could our discipline perhaps gain even more from going further than passing on myths? Producing answers to these questions cannot be done within the frame of this paper; it will have to be the topic of future research. Some thoughts can nevertheless be shared on the topic.

Some of the identified schools are still rather young, especially the 'softer' ones. It is therefore likely that a lively debate is taking place within the systems theory community, meaning that new developments are taking place that might prove valuable for us. One viewpoint that

[15] This is not to say that there exist no logistics/SCM scholars who are knowledgeable in *System Dynamics*.

is put forward by some scholars is for instance that there are not actually any 'real' systems, but rather *perceptions of* systems. These are perceptions by individuals, and such perceptions might differ. Note here the interpretive stance taken, which is quite different from that of the dominating positivism of our discipline [37, 147].

Without plunging into a philosophical debate on whether or not logistics systems actually do exist, let's for a while ponder this standpoint. What if actors' perceptions of the systems of which they are part actually differ? Are we as logistics researchers armed with a methodological arsenal that can cope with this? Consider what Aastrup and Halldórsson [5] state regarding the dominant systems approach of logistics: '… it emphasises the mechanics and the purposefulness of logistics systems. It represents a deterministic view on social agents, that also shapes the majority of approaches and models in the logistics literature; the views and desires of social agents are detached from the logic of the model' (p. 749). But, as the authors continue to argue, actors (social agents) can have agendas and objectives, and create meaning, of their own. And actors affect and are affected by 'the system'. What if the informants we choose when conducting research (quite often executives/managers) simply cannot convey objectively true descriptions of their logistics systems? Can we still claim to produce objectively valid results? These concerns surely deserve deeper penetration, because the possible implications for validity of the positivistic research being carried out are profound. A proposed path is therefore to explore methodologies that can aid us in gaining better insight into the world-views of actors in the systems we study.

The above is about the objective-subjective tension between views of reality, that is, an ontological, and thereby also epistemological, concern. This aside, can we really claim that there are logistics systems to be engineered, to the extent that these are clearly distinguishable entities, rather than activities and processes entwined with others within much larger entities? Will a furthering of systems theory within the logistics discipline alone, aimed at stimulating more systems thinking within logistics practice, bring us farther away from the sub-optimisation traps of functional silos? Again, a question that cannot be fruitfully answered within the frame of this paper, but which deserves more contemplation and debate.

This paper has produced some evidence that logistics scholars have not yet adopted much of what is available in terms of systems theory. This evidence can be enhanced by increasing the scope of journals and other publications to undergo examination. Another addition of value would be to turn to those who have forwarded the myths, that is, the scholars within our discipline and attempt to chart their attitudes towards, and extent of utilising system theory. Also, given the findings herein, questions arise regarding to which extent we have actually borrowed from other theoretical domains that are touched on every now and then?

Returning to such questions as initiated by the fragments of systems theoretical reasoning glimpsed previously, these linger… What if we were to adopt concepts and methods from other systems schools? Certain authors argue that this is exactly what we ought to do. In fact it is argued that the logistics discipline needs to make a paradigmatic shift: 'Logistics is in need of its own revolutionaries who will explore other paradigms to see what these have to offer. … In a new, interpretive logistics, logisticians would have to accept that a logistics system to be engineered cannot be easily identified; that there is more than their own view of reality and that different world-views do exist' [148, p. 616].

There are obviously systems theoretical schools that are rooted in different world-views than those that dominate our discipline. World-views that inform us about the possibility that individuals might hold world-views of their own, which in turn affect their behaviour in various settings. That the individuals who comprise the enterprises we wish to support might not always see things the same way we as logisticians do, they might not always share the goals, priorities, and rationalities that we perhaps take for granted. It is not possible at this point to produce any solid argument for what could be gained from making such a shift towards a more interpretive stance that Mears-Young and Jackson [148] argue for. But would it not be interesting to at least make an attempt in order to see what might be 'in it for us'?

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