# A complexity perspective on logistics management
## Rethinking assumptions for the sustainability era

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## Abstract

**Purpose** – The purpose of this paper is to elaborate on how perspectives and assumptions embedded in the complexity paradigm contribute to make logistics management research better aligned with real-life logistics. This is necessary, due to increasing supply chain complexity caused by an increasing request for sustainable development (SD).

**Design/methodology/approach** – The research is exploratory and based on a narrative literature review of logistics and supply chain management (SCM) from a complexity science perspective. Qualitative research interviews have been conducted with 12 logistics and supply chain managers in international companies and have focussed on their daily experiences and the underlying assumptions related to their actual work.

**Findings** – Logistics and SCM research is embedded in the functionalistic paradigm with reductionistic assumptions as the dominant logic. These do not sufficiently align with the complexity related, for example, to the daily work of SD in logistics management practice.

**Research limitations/implications** – It is proposed that the inclusion of complexity-based assumptions in logistics management research can increase realism in the advancement of the discipline. A key result is that the recognition of logistics as complex means inclusion of human and social aspects – which is apparent in any logistics process or phenomenon – in logistics knowledge creation processes.

**Practical implications** – Increased realism in logistics management research by addressing complexity, instead of merely reducing it, will provide logistics and supply chain managers with increased understanding and appropriate knowledge when they deal with emerging challenges such as SD.

**Originality/value** – Based on Boulding's levels of complexity, this paper challenges the underlying assumptions of logistics management in research and practice, and provides reflective frameworks for advancing the discipline and aligning it to the complexity of contemporary challenges in logistics management.

**Keywords** Sustainability, Europe, Decision making, Agile, Supply chain processes, Qualitative interviews

**Paper type** Research paper

## 1. Introduction

The concern of complexity in logistics and supply chain management (SCM) is often mentioned in the literature (Sanders *et al.*, 2013; Bode and Wagner, 2015). While most literature only describes complexity in general terms, a growing body of literature explicitly addresses it in logistics and SCM (e.g. Christopher, 2016; Manuj and Sahin, 2011; Gerschberger *et al.*, 2017). In the recent special issue of *Journal of Operations Management* on complex adaptive systems (CAS), Nair and Reed-Tsochas (2019) conclude that complexity perspectives can contribute by providing increasing realism regarding models and by providing more understanding of the highly interconnected nature of contemporary supply chains. They (Nair and Reed-Tsochas, 2019 p. 80) also declare that in much of SCM research, "we consider the simplistic conceptions of organizational and interorganizational

structures, linear relationships between practices and performance, and ignore the adaptive nature of strategies and processes".

With the increasing concern for environmental and social issues in society, companies have to consider sustainable development (SD) in their strategies and not only prioritise financial performance and results (Porter and Kramer, 2011; Nair *et al.*, 2016). Consequently, the need to handle increased complexity for logistics and SCM can be expected (Sanders *et al.*, 2013; Carter and Rogers, 2008; Wittneben *et al.*, 2009). Cruz *et al.* (2006, p. 872) state that SD is "perhaps one of the most complex and important demands that has occupied managers' reflection", and Hall and Vredenburg (2003) report on the major difficulties which managers have in dealing with SD. Furthermore, Russel *et al.* (2018, p. 37) state that "everything about achieving sustainable logistics and supply chain management is complex". For example, based on the multifaceted nature of SD, the interpretation of what SD means in different parts of an organisation or a supply chain is difficult to comprehend (Abbasi and Nilsson, 2012).

SD became popular after the Brundtland Commission report of 1987. Today, the perspective on SD requires economic, social and environmental considerations (United Nations, 2005) as sustainability is required to provide economic profitability, social responsibility and environmental conservation (Elkington, 1998). Such an accomplishment requires power, commitment and collaboration as there is not necessarily any correspondence between economic, social and environmental sustainability (Low and Gleeson, 2003). Logistics is an area which is severely challenged when it comes to reaching the goals of Agenda 2030 (UN General Assembly, 2015). The movement of goods requiring set-up of logistics networks, transports between nodes (McKinnon *et al.*, 2010) and delivery policies have all contributed to the huge amounts of emissions affecting our planet today (IPPC, 2014). Furthermore, on the competitive European transport market, depletion of logistics charges has led to lowering of salaries and worse working conditions for drivers (Kummer *et al.*, 2014).

The quest for logistics management research is to evaluate current and former practices and provide guidance to practitioners and policy makers on what to do and how to act in relation to present and future challenges. In the era of SD, this means evaluation of and guidance sustainable practices, theories and methods, i.e. providing the logistics discipline with knowledge on how to work and act in order to achieve Agenda 2030 goals and develop sustainable logistics practices. However, as it is argued in this paper and pointed out in several previous studies (e.g. Mears-Young and Jackson, 1997; Arlbjørn and Halldorsson, 2002; Nilsson, 2006; Carter *et al.*, 2015), the logistics discipline has evolved from problem-solving issues in industry and has been theoretically based on a positivistic epistemology with reductionism as the central assumption.

Coming from this functionalistic paradigm with central assumptions such as controllability, optimality, rationality and objectivity (Nilsson and Gammelgaard, 2012; Nilsson and Christopher, 2018), it is challenging in many ways to handle the rapid change and the multi-natured challenges related to SD. Reflecting on the magnitude of logistics and supply chain activities involving several tiers of suppliers which are globally dispersed, theory recommends that these activities are broken into sub-units in order for us to understand and deal with them, i.e. reduce scope, context and complexity. However, what would happen if we took a holistic perspective and treated the role of logistics in SD in its complex entirety? What if, instead of trying to reduce phenomena to "controllable" and independent parts, we actually studied and understood the emergent outcomes from everyday interactions among individuals based on their self-organising processes (deliberate or not)? What happens if, instead of indisputably believing in unfolding predetermined strategies (formative and deterministic), we regard development as being more transformative as it uses adaptive strategies and activities (transformative and emergent)? As a result, what type of knowledge can we produce by addressing and understanding logistics management from a new set of assumptions better aligned to the complex reality we often experience?

A number of papers have challenged the dominant logic of logistics research and practice. Nilsson and Gammelgaard (2012), for example, investigate the use of the systems theory in logistics and SCM research and conclude that in order to generate new understanding and knowledge on issues such as innovation and learning, the dominating systems approach needs to be rethought, and more complex aspects of real-life phenomena included. Carter *et al.* (2015, p. 99) address the need to investigate logistics and SCM by acknowledging the complex systems in which companies reside. They (Carter *et al.*, 2015) conclude that multi-level research can help address important, real-world topics and that by addressing the appropriate system level, i.e. individual, team, function, organisation and/or supply chain, understanding and improvement activities can be achieved. In a supply network context, Nair *et al.* (2016) conclude that the underlying assumptions of CAS have impacts on how to manage complexity. Nilsson and Christopher (2018) discuss the strategic development of logistics management and present new ways of defining and handling paradoxes in logistics and SCM based on principles derived from a complexity paradigm. Finally, Touboulic *et al.* (2018, p. 330), in their in-depth study of carbon reduction strategies, conclude that "the focus on complexity has allowed us to explore the multilevel factors that influence the emergence of a carbon reduction strategy in a food supply network context". However, while highlighted papers address the need for new approaches, perspectives and methods to address contemporary challenges in logistics and SCM, the tradition within established domains is strong (Kuhn, 1996), i.e. the assumptions derived from the functionalistic paradigm are well anchored in both practice and research.

The purpose of this paper is to elaborate on how perspectives and assumptions embedded in the complexity paradigm contribute to more comprehensive research in, and management of, logistics, especially in pursuing the increasing challenge of SD. Moreover, the aim is to contribute to the paradigmatic discourse of assumptions and their effects on the kind of knowledge being created within the logistics discipline. In addition to the conclusions Wieland *et al.* (2016) make on further research developments for the discipline, i.e. the issues of sustainability, risk, humans, innovation, analytics and complexity "require strong interdisciplinary thought and rigorous approaches", this paper therefore argues that the rethinking of underlying assumptions is a vital factor for the advancement of logistics theory and practice.

The remaining paper is organised as follows: first, an assessment of underlying assumptions of logistics management research and practice is elaborated, followed by the introduction of complexity science representing theories which might prove fruitful for increased realism of contemporary logistics challenges, both in research and management. Based on a qualitative, in-depth interview study of logistics managers' everyday practice, underlying assumptions are elaborated on and key findings presented. These relate to the interplay of simplicity and complexity in logistics management practice, and are especially related to the inclusion of human and social aspects in the knowledge generation process. The paper ends with a conceptual model of the type and nature of knowledge and level of assumptions we are using and generating in order to tackle contemporary challenges such as SD. Finally, a concluding discussion of assumptions derived for a complexity perspective can contribute to the advancement of the discipline by including human and social aspects into logistics research and management.

## 2. Assessing assumptions in logistics management research and practice

In order to develop the logistics discipline, the process of knowledge creation, i.e. epistemological considerations, is central. Arlbjørn and Halldorsson (2002) address the process of knowledge creation on three different levels: the practice level, the discipline level and the meta-level. The practical level concerns the actual logistical work being accomplished in day-to-day operations. The discipline level is where the majority of the logistics-related research is focussed. It is on this level that new logistics methods are developed; either from research with an empirical focus, where best-practice solutions are reported and "glory stories" (New, 1996) presented, or as theoretical borrowing from other

theories (Stock, 1997). The meta-level is where ontological, epistemological and teleological debates are centred and thereby lie as the foundation for the paradigm the logistics researcher and practitioner belongs to. Ontological assumptions are assumptions about reality (Guba and Lincoln, 1998) which influence how we understand and explain reality with knowledge, i.e. epistemology (Burrel and Morgan, 1979). Teleological assumptions relate to how the future is considered and to what purpose a phenomenon serves (Ackoff, 1973; Stacey *et al.*, 2000).

Meta-level assumptions have direct implications for the methodology and the methods chosen and thereby constrain the basic beliefs about reality. This affects the knowledge to be produced or attained during the research process (Burrel and Morgan, 1979). Consequently, a reassessment of assumptions on the meta-level may benefit the logistics discipline by increasing our consciousness of why we as researchers and practitioners do the things we do, and of how we do them. When we enter a research field the common assumptions and beliefs which exist in the community are transferred, in explicit as well as implicit modes, and sooner or later taken for granted (Kuhn, 1996). Kuhn (1996, p. 46) states that "Scientists work from models acquired through education and through subsequent exposure to the literature often without quite knowing or needing to know what characteristics have given these models the status of community paradigm". An indication of this process is described by Rajkumar *et al.* (2016), reporting on a continuing decline in the number of PhD dissertations in logistics and SCM which contain philosophy of science discussions.

However, Trim and Lee (2004, p. 473) state that "management researchers need to have the confidence to challenge basic assumptions relating to interpreting research outcomes, and what constitutes appropriate research". Morgan (1983, p. 14) adds that if problem contexts are viewed from different paradigms we can "see and understand how we can research organiZations (and any other aspects of social life) in ways that tell us something new about the phenomenon in which we are interested". Consequently, while the reductive and formative oriented approach suits various problems where reductionism can be assumed (Dent, 1999), it may not benefit problem situations where context and phenomenon are complex. In other words, as stated by Robertson (2003, p. 61), "if the business world is viewed as being complex, it is inappropriate to consider models developed under paradigms of equilibrium, stability, and linearity to produce an analysis of a turbulent environment". Allen (2000) addresses two basic reasons for the complexity perceived in a given situation. Either the complexity is the result of many interconnected parts where the connections are known, or it is the outcome of non-linear interactions with bifurcation points, which may result in a multitude of outcomes based on creative and surprising responses. The complexity of the first kind (i.e. complicated systems) only needs more computer power to unravel it while the second type needs novel perspectives and approaches the functionalistic paradigm cannot contribute. However, as a consequence of the dominant functionalistic knowledge produced and disseminated, firms put a lot of money, time and resources into models and techniques which focus on control and prediction and where cause and effect relationships are attainable, even if the situations managers encounter are complex.

## 3. Complexity perspectives on logistics management

Complexity science entails theories of complex phenomena. As Allen and Strathern (2003, p. 8) state, it is a scientific area of change and transformation, […] without it "social and organizational change could only be driven by trial and error and by people's accumulating experience and confusion". Complexity theories challenge the Newtonian and positivist rationale of science such as order, objective reality, reductionism, deliberate design, rationality, stability, determinism, value-freeness, controllability, linearity, centralisation, hierarchy and uniformity (Nilsson, 2005; Nilsson and Gammelgaard, 2012).

Complexity theories provide transformational perspectives for the study of complex phenomena and are regarded as the evolution of systems theories together with contemporary social and behavioural theories (Simon, 1996; MacIntosh and MacLean, 2001; Nilsson and Gammelgaard, 2012; Thietart, 2016). With this perspective, changes, interrelationships, non-linearities, learning and innovative capacities, dynamics and paradoxes existing in supply chains can be studied. Complexity perspectives can comprehend transformative transition of supply chains towards sustainability targets and consider the fact that the transition path may not be uniform, deterministic and controllable for different types of supply chains (Nair *et al.*, 2016; Rotmans *et al.*, 2001).

As declared in the purpose of this paper, what are proposed are perspectives for logistics management research and practice based on an extensive set of assumptions which are more aligned to real-life logistics (see Figure 1), i.e. when logistics is considered complex. An extensive set of assumptions means that those dominating the discipline, e.g. linearity, reductionism, determinism, objective rationality, etc. (found in the middle of Figure 1) are still apparent and useful; however, they are of limited value when it comes to logistics questions being handled and understood in multi-level contexts and with human aspects being addressed (e.g. power, decision making, identity). Instead, these need to be extended with assumptions of complexity, subjective rationality, self-organisation and emergence, all of which are central to complexity perspectives and highly apparent in real-life logistics processes.

Complexity-based assumptions can be related to the seminal work by Kenneth Boulding on the system theory and the hierarchy of complexity. The nine levels of complexity proposed by Boulding (1956, pp. 202-205) were aimed to provide academics with a framework for identifying gaps of theoretical and empirical knowledge (see Table I). The first level relates to static structure; the second to clockworks, i.e. dynamic, simple systems; on the third level, control mechanisms and cybernetic systems are introduced; and the fourth level introduces the first living organisms. Here, life in the form of cells is distinguished from the former levels of "not-life" and it becomes the level of open systems. Going up the levels, the fifth level introduces what Boulding calls genetic-societal level, where the "plant" is the empirical example. The sixth level represents the animal level, which is characterised by increased mobility, teleological behaviour and self-awareness. The seventh level is where the human being is introduced. Boulding states that "in addition to all, or nearly all, the characteristics of animal systems, man possesses self-consciousness, which is something different from mere awareness", i.e. the human not only knows, but
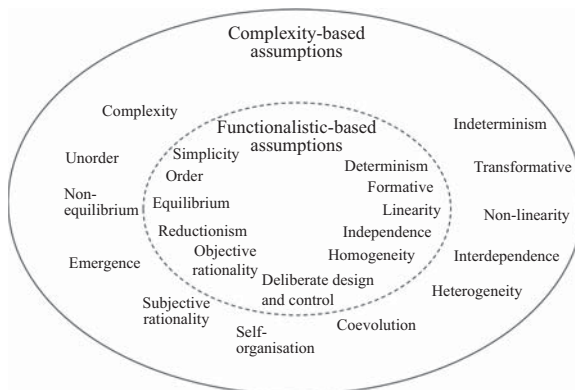


**Source:** Illustration derived and modified from Dent (1999, p. 9)

**Figure 1.**
Complexity theoretical assumptions as an extension of the functionalistic-based assumptions dominating the logistics discipline

| Level | Characteristics | Assumptions | Knowledge dimension |
| --- | --- | --- | --- |
| 1 | Static structures | Linear causality, linearity, independence, objectivity, equilibrium, order, determinism, simplicity, reductionism | Stable knowledge based on defined general laws providing predictability and determinism |
| 2 | Clockworks – dynamic simple systems | | |
| 3 | Control mechanisms and cybernetic systems | Feedback, deliberate design and control, non-linearity, rationality | |
| 4 | Living organisms, cells, level of open systems | Self-organisation, co-evolution, emergence, interdependence, multi-causality | Observable phenomena, high level of scientific understanding and transferable knowledge between contexts, identified general laws which are semi-stable in, e.g. biology and medicine |
| 5 | Genetic-societal level – plants | | |
| 6 | Animals | | |
| 7 | Human beings | Subjectivity/inter-subjectivity, unorder, non-equilibrium, bounded rationality, indeterminism, complexity, pluralism | Knowledge is changeable over time and based on perceptions and sense making. Drive for innovations which creatively "destroy" existing knowledge |
| 8 | Social organisations and society | | |
| 9 | Transcendental | | Based primarily on belief |

**Table I.**
Boulding's (1956, pp. 202-205) levels of complexity and associated assumptions, and/in addition to knowledge dimensions

knows that he/she knows. Social organisations and societies are on the eighth level. "At this level we must concern ourselves with the content and meaning of messages, the nature and dimensions of value systems, the transcription of images into a historical record, […] The empirical universe here is human life and society in all its complexity and richness" (Boulding, 1956, p. 205). He describes the final level as transcendental, which involves what he defines as the "ultimates" and the inescapable "unknowables".

Combining Boulding's levels of complexity and associated assumptions presented in Figure 1 it is possible to relate the functionalistic-based assumptions to the first three levels of complexity, while the assumptions based on a higher degree of complexity (the outer eclipse) are added on higher levels. Furthermore, knowledge can be interpreted in numerous ways related to its stability over time and context (Allen and Strathern, 2003). In one dimension, as represented in classical science with the physical laws of nature, e.g. Newton's law of gravity, knowledge can be assumed as quite stable over time and context (primarily levels 1–3). Another dimension of knowledge relates to human behaviour, perception and sense making, which are all far more dynamic and interdependent with present-day contexts, and are based on internal cognitive patterns (levels 7–8). Knowledge in terms of corporate strategies, management philosophies or consumer expectations relates to quasi-stable attractors which are socially constructed, i.e. trends and patterns which emerge in the interplay of interpretations among humans, organisations and institutional bodies. In order for companies to stay ahead, be profitable or retain attractiveness, change is needed, and novel ways of acting, responding and driving activities co-evolve in the contemporary contexts. Consequently, in the context of logistics management, knowledge needs to be seen in a dialectic way with alterations of stable and transformative knowledge.

Logistics management as a functionalistic discipline, i.e. built upon reductionistic and mechanical assumptions, often assumes logistics representable at the third level, i.e. that of

control systems (thermostats) and cybernetically derived principles. Consequently, the knowledge generation process targets the exploration and exploitation of general laws, optimisation of routes and inventory, deliberate design of logistics set-ups and the aspiration to be able to realise decided strategies and designed systems. The unquestioned assumptions of reductionism drive both researchers and practitioners to reduce observable phenomena into "solvable" parts (e.g. production or inventory) (McCarthy, 2004), fix and adjust each part (optimisation of inventories at one actor's) and then implement the solution in the "real" life setting again. Checkland (1993) exemplifies the insights in the management context by stating: "a typical management science model constructed in terms of multiple interacting feedback loops, even if complicated, is only a level 3 model and hence can cover only certain aspects of a management problem at level 8. Management scientists have been known to claim more". In the field of economics, von Hayek (1989) provides criticism of economic models derived and/or borrowed from natural science for being misleading and ways of simplifying "since it involves a mechanical and uncritical application of habits of thought to fields different from those in which they have been formed" (p. 3). Axelrod and Cohen (2000, p. 29) provide a good explanation for the dominating functionalistic and mechanical approach in management: "No doubt, machines and hierarchies provide easier metaphors to use than markets and gene pools. So it is no wonder that most people are still more comfortable thinking about organizations in fixed, mechanical terms rather than in adaptive, decentralized terms". With this level 3 (see Figure 1) and epistemological assumptions in mind, "better management is often seen as simply running the 'machine' faster or more efficiently" (Allen, 2000, p. 1). However, while this reductive process suits various problems where reductionism can be assumed (Dent, 1999), it may not benefit the result if the phenomenon under study consists of interdependent parts which are difficult or impossible to unravel, i.e. problem situations where context and phenomenon are complex.

## 4. An empirical investigation of logistics management

In order to empirically explore the role of assumptions in logistics, an interview study was designed and conducted. In total, 12 semi-structured interviews were carried out focussing on the everyday practice of logistics/supply chain managers and with a specific reflective part of the interview related to the assumptions highlighted in this paper. SD was addressed in the analysis of the interviews based on identified aspects related to economic, social or environmental issues in daily work, examples and challenges.

The motivation for the chosen method relies on the need to obtain an in-depth understanding (Merriam, 1994; Stake, 2000) of real logistics management practice; several questions included narrative examples of different situations the managers had experienced. The research approach was explorative with the aim of better understanding the many aspects, considerations, assumptions the managers experienced (Campion *et al.*, 1999), i.e. the managers' perceptions of various situations related to contemporary problems, and how these affect their approaches to different circumstances. The aim was to gain understanding of the meaning of what the interviewees said (Kvale, 1996). As in qualitative theory-building studies (Eisenhardt, 1989), data analysis and data collection were interwoven. Based on a solid foundation in theory, both on a meta-level and discipline level of logistics, the initial indications and findings from the first interview drove further exploration of the study so that it is in line with the principle of theoretical sampling (Punch, 2001). Consequently, the inclusion of interviewees was driven by the interplay between new insights and findings from interviews, literature and theoretical reflections. While the content of each interview was unique (experiences, situations, examples, etc.), a number of patterns emerged rather quickly in the process of analysis and reflection. After four interviews, the first common patterns emerged, and after the tenth interview, the first feeling of theoretical saturation was reached. Two more interviews were then conducted,

both to enrich the material and understanding, but also to elaborate on the emergent themes found. Due to the subjective nature of theoretical sampling, it was difficult to know when saturation was reached. However, for the purpose to obtain in-depth understanding of the role of basic assumptions in logistics and the everyday life of logistics and SC managers, the 12 interviews were found to contribute with comprehensive representation. Nonetheless, while the small number of informants limits the generalisability of the results, they still provide guidance for further theory-testing research. Furthermore, combined with the literature reviewed and the paradigmatic reflections provided, theoretical generalisations can be attained and guidance for the logistics discipline provided.

The interviewees chosen for this study were logistics or SC managers within large, international, companies (> 500 employees). Their experience of logistics and SC-related work ranged from four to 40 years. The companies they represented covered several industries ranging from mobile technology and medical technology to food producers. All companies were in business-to-business relationships with customers in industry or retail. The initial contact was made by phone to contacts found in my own and close colleagues' networks. After a short description of the research area and purpose, all managers expressed willingness to participate. The phone call was followed by an e-mail with a short description of the study, and the date and time we had agreed on for the interview. All interviews were carried out at the interviewees' work places in order to contextually capture their work situation. The set-up of the interview was in four major stages, starting with, open-ended questions of their everyday activities as managers with in-depth explanations of selected situations. This was followed by fixed-response schemas where the interviewees were asked to fill in pie charts of their actual and desirable work situations, followed by reflections on central assumptions in logistics. Finally, the interviews finished off with a short section of the future challenges interviewees faced in their role as logistics/SC managers. The interviews lasted between one and half and two hours, were recorded and transcribed within two days. All interviews were carried out during a two-month period.

## 4.1 Interview findings
The in-depth discussions on everyday practice with the logistics and SC managers highlighted a number of interesting aspects. A common theme found in all interviews was their need to have a holistic perspective and the perception that other parts of their organisations had a more silo-based thinking. Consequently, they viewed themselves as facilitators for how different parts of their organisations fit into the bigger picture of suppliers and customers. Governing this holistic perspective was explained to be one of the most challenging tasks in practice. Some raised the issue of information and especially the lack of sufficient information contributing to this challenge, while others the unpredictability of demand and difficulties in being able to understand how different projects and efforts affected each other as well as the ongoing supply chain operations. As a result, during the initial part of the interviews, the interviewees explained themselves being able to deal with "real" objects or entities, i.e. business functions, customer behaviour, inventory systems and suppliers, and view these from their holistic supply chain perspectives. With more information, the missing pieces of the "objective" picture were sought for by the managers, to make their life more controllable.

However, during the interviews and especially when stories of successful as well as less successful changes were told, the interviewees expressed their perceived situation out of human and social aspects, i.e. by providing a more subjective rationality and view of reality. This included how to make sense of all the information that was available and turn this into knowledge for both decision makers and other co-workers. As explained by one manager, "to reach out with information and the understanding of how to use it" presented a

major challenge. Furthermore, how different perceptions of both current and future states (desirable or not) as well as aspects of power, competition (not least internal) and understanding were explained to affect both processes and results. One interviewee expressed that "power is central in companies – positions of strength – but I hope we have a little less of it since we have a positive development right now. I think it will be more of it, I mean power battles, if the development stagnates". Furthermore, while the reliability of deliveries and the stability of inventories were expressed as highly aspirational, insights into how difficult it was to predict market changes, technology developments and social and political influences were expressed. In addition, the unpredictable behaviour of these aspects evolved, sometimes "under the radar", and turned up as surprises related to new customer demands or legislative changes affecting the business logic and models of their organisations. From their reflections on challenges they are confronting, interviewees raised a number of issues related to SD, and especially to the multifaceted nature of how future operations should be able to consider several target functions at once, i.e. not only the dimensions of efficiency and cost.

### 4.2 Logistics management assumptions

The logistics managers were asked to reflect on basic assumptions and how these mirrored their perception of their work situation. In the following sections, examples and insights from four combinations of assumptions presented in Figure 1 are described.

*4.2.1 Simplicity – complexity.* Most of the interviewees (i1–3; 6–9; 11–12) expressed their work situation as being mainly perceived as complex, two explained it as both simple and complex (i4 and 10), and one regarded it as mostly simple (i5). i8 expressed that they all the time strive for more simplicity in their activities but operate in a reality characterised by high degrees of complexity. The simplicity was expressed in the activities which had been routinised, such as receiving customer orders, picking ordered products at a storage facility, and delivery. Complexity was described in relation to human and social factors and to the interplay between details and holistic views. One interviewee expressed the challenge of "in relatively detailed questions where interests are set against each other, being able to gain enough understanding of the whole to make right decisions". A dimension related to time was also incorporated in the interviewees' reasoning and related to the interplay between the effects of small changes in activities on the whole supply chain. This time dimension related to both time-delays of wanted (or unwanted) effects), and the time needed to understand and interpret emergent patterns created by people involved.

*4.2.2 Objective rationality – subjective rationality.* Concerning the type of rationality in daily logistics practice, the managers describe several situations and examples of this being mainly subjective, from individual, functional and company perspectives. One interviewee expressed the fact that "we talk a lot about processes, but people think in functions – mine, mine. Hence, to tear down barriers is difficult, very difficult". Another made a similar statement: "we talk about processes and value chains but since our measurement systems are targeting different aspects, we act as separate functions that optimise each own parts". The use of more and more advanced enterprise resource systems with a growing number of automatic functions was raised as a way to gain more objective views of operations, as more people had access and could make use of all information. At the same time, the highly interconnected systems made it challenging for operators and decision makers to interpret changes being real or "system" failures and make correct decisions. As one expressed it, "IT and logistics are closely related, however, how do we get human beings involved?"

*4.2.3 Control – self-organisation.* One logistics manager expressed that "I can certainly try to plan everything, make superior plans and create a world class system, but then when

I turn around, having my plan ready, the customers have changed". Another explained: "we have more or less control over the minor parts, but the big picture […] how can you treat all the variables and get co-workers and partners to understand it". Two of the interviewees (i1 and 4) assumed it possible to control most of their logistics activities, while i5–6, 10–11 took the standpoint that what happened was a mixture between deliberate management efforts and self-organisation processes which emerged from local practices, misunderstanding, etc. Five interviewees (i2–3; 7–9) emphasise the role of self-organisation to be more influential on what really happened within their supply chains than what they perceived they were able to control.

*4.2.4 Independence – interdependence.* While the interviewees consider it quite easy to identify several processes and activities that could be improved in their logistics processes, they declare it to be far more difficult to understand how activities and processes affect each other and to know which efforts produce and/or the lower number of unwanted side effects. The majority of the interviewees (i1–3; 5–7; 11–12) perceive high interdependence among processes, activities, functions in their work while three (i4; 9–10) perceive some aspects to be fairly independent and other aspects interdependent. Only one interviewee (i8) perceives logistics operations and related functions and activities as mainly independent.

To sum up, the reality confronting managers could be related to both functionalistic-based and complexity-based assumptions and be highly contextually dependent. It was clear from the interviews that, depending on the scope of the supply chain, logistics could be reduced to observable operations within specific settings where the use of routines provided predictability. At the same time, in more holistic settings, the interplay between minor activities and changes in interplay with other processes or organisations, for example, more complex assumptions became apparent.

### 4.3 Management bias of functionalistic assumptions

An interesting finding from the interviews was interviewees' similar views on what constitutes good logistics management. In the section of the interviews when the managers described their work situation (i.e. in a pie chart outlining their main activities during a work period), firefighting was a common activity which constituted 20–40 per cent of their perceived work duties. When managers were asked to outline their desired work situation in another pie chart, the firefighting part was heavily reduced and work time focussing on strategic and/or tactical planning increased instead. With more time for strategic/tactical planning, a better feeling of control was emphasised in interviewees' explanations. The emphasis on planning, and thereby prediction, and control implies a formative and/or rationalist teleology (Stacey *et al.*, 2000). As a result, it implies that the logistics manager has a position outside the system being controlled, which puts them in the position of an observer. The manager or the management team has the freedom of choosing future goals for the logistics system, and the opportunity to design its structure and how and when flows are determined to take place. One logistics manager expressed the situation after a redesign of their supply chain in the following way: "I imagined a more simple supply chain than it became. The new factories have increased the complexity. The structure has not become simpler and the information has become more difficult to handle". Consequently, there seems to be a management bias related to interviewees' ambitious belief in being the designer of the logistics operations and in control of its activities, while finding themselves in complex settings with interdependence and self-organising processes generating unanticipated short-term and long-term changes, out of their control. This is in line with the observations Stacey *et al.* (2000, p. 18) made that managers in their day-to-day operations were "the ones in charge but repeatedly finding that they were not in control". The anticipation of being in control and able to plan (living in line with functionalistic-based

assumptions), while most often being in complex settings and in their practices doing "firefighting" activities (confronted by complexity-based assumptions), causes tensions, not at least for logistics managers who are "supposed" to be in charge. This finding is in line with Choi *et al.* (2001), who declare that firms' efforts to manage logistics systems and processes have often resulted in frustration and anxiety.

Consequently, the reality which confronted logistics managers was found to be both "simple" and observable (e.g. the set-up of new production facilities, new partners in sourcing), and complex and interpretive (e.g. the actual use and sense making of data and information). A key aspect related to managers' pluralistic view of reality is the inclusion of human and social aspects, which is also put forward in complexity thinking (Nilsson and Christopher, 2018) as well as other socially related theories (e.g. participatory paradigm (Towers and Chen, 2008)). As a result, in line with Boulding´s levels of complexity, it was found that different levels of complexity and associate assumptions need active reflection when logistics management issues are dealt with in order to provide relevant and useful understanding and knowledge.

## 5. Creating relevant and useful understanding and knowledge for logistics management

In the sustainability era, experts, consumers and citizens are calling for SD instead of the focus on economic development in previous eras of industrialism. Under these circumstances, it is apparent that knowledge is emergent. Existing knowledge suffers from a lack of research and experience in the complex and multifaceted dimensions of sustainability and the ongoing tranformative processes in today's experimental economies and societies.

A starting point for most applied research, as well as for management in general, is often a sense of the "real world", the messy reality that we subjectively and/or inter-subjectively relate to in our everyday practices (Figure 2). Within this world, people, at least within the fields of logistics and SCM, recognise organisations which work together (i.e. inter-organisational phenomena), and flows of products which serve industries, shops and consumers/users. The dominant logic, influenced by the classical sciences and the functionalistic paradigm, has been
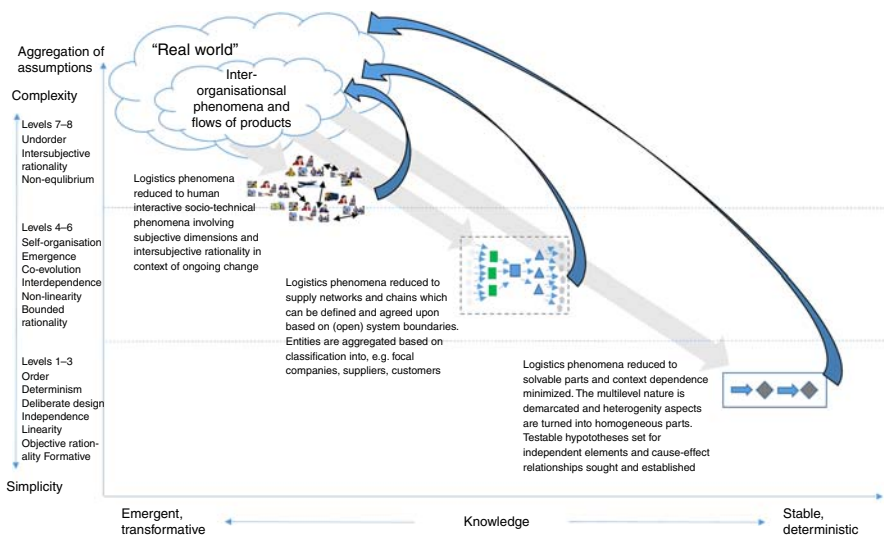


**Figure 2.**
The reduction of logistics phenomena into simplified representations based on level of complexity and the type of knowledge which can be used or generated

**Source:** Inspired by Allen (2000)

to reduce the real-world phenomena into controllable and solvable parts within clearly defined system boundaries. This logic of reasoning, i.e. simplification by reductionism, follows Occam's razor principle: "given two explanations of the data, all other things being equal, the simpler explanation is preferable" (Blumer *et al.*, 1987), one of the fundamental tenets of modern science (Domingos, 1999). In Figure 2 the process of reduction is illustrated related to the type and nature of knowledge (*x*-axis), and the aggregation of assumptions (*y*-axis).

Starting with reality and following the dominant logic of logistics research, the process of reduction leads to system descriptions (defined by the researchers and/or managers involved), in which hypotheses can be set and tested based on analytical procedures of collected data (the further separation of system elements). Cause–effect relationships are seen as particularly important for research. The knowledge generated is in its purest form stable, robust and deterministic, i.e. it can be used to explain and predict the relationship between the specific aspects defined for the system and can be generalised to other problems in other settings. Nair and Reed-Tsochas (2019, p. 89) state that "Several data sets in the operations and supply chain arena are likely non-linear in nature. Yet, we use linear methods to interpret regular structure in the data sets, with an assumption that the intrinsic dynamics of the system are governed by the linear paradigm that small causes lead to small effects". The attention from managers for simplifying deterministic models and explanations are strong since, as found in the interviews, their desire for control and predictability in their logistics operations could make their workdays less troublesome. This desire for "simplicity" is addressed in cognitive science, where it has been found that people do seem to favour explanations which are simpler, i.e. with/they have few independent assumptions or root causes (Lombrozo, 2016). Blanchard *et al.* (2018, p. 1356), from their studies of the principles of Occam's razor, suggest that "people's preference for simpler hypotheses may in part be a natural consequence of the fact that their judgments approximate Bayesian inference – although it is unlikely that all effects of explanatory considerations in reasoning can be explained in this way". Necessary assumptions for this knowledge generation process to function are independence, objective rationality, determinism and order, i.e. levels 1–3 in Boulding's hierarchy of complexity, and the lower right section of Figure 2. The transfer of results back to the real world is often seen as troublesome (Choi *et al.*, 2001).

The dominating logic based on Occam's razor can be contrasted with Ashby's (1956) law of requisite variety, that is, "control can be obtained only if the variety of the controller is as least as great as the variety of the situation to be controlled". Something that in complexity thinking has been further described as the concept of incompressability. Richardson (2004, p. 77) states that "the concept of incompressability suggsts [*sic.*] that the best representation of a complex system is the system itself and that any representation other than the system itself will necessarily misrepresent certain aspects of the original system. This is a direct consequence of the nonlinearity inherent in complex systems". The question therefore remains: to what degree can supply chain phenomena be reduced and still generate relevant, useful understanding and knowledge? Not least when new phenomena, knowledge and context are co-evolving.

In order for us to comprehend and handle higher levels of complexity, complexity theories (e.g. CAS and complexity thinking) brought into logistics management provide interesting approaches and models allowing us to understand, explain and improve the discipline. The number of papers using CAS theory for both understanding and knowledge generation of logistics and SCM has been growing, with Choi *et al.* (2001) providing one of the early influential papers for the discipline. Using a CAS approach, assumptions made in levels 4–6 are emphasised and often used to more accurately explain the empirical reality being captured in the research (Thietart, 2016). Logistics phenomena are described in open-system settings where "observable" elements such as different actors

(e.g. focal company, supplier, customer) in chains or networks are treated by their heterogenetic nature (illustrated in the middle of Figure 2). Knowledge is regarded as based on a mixture of context-dependent aspects of a transformative nature linked with the ability to find rules in the system which can be identified and proactively designed to change the results of an organisation (Brown and Eisenhardt, 1997). The latter aspect is much influenced by biological observations and theories such as the flocking of birds based on a set of simple rules and the self-organising behaviour of ants. The increased realism from including heterogeneity, non-linearity and emergent patterns in models eases the transferability of results back to their original context. However, while an increased complexity is considered, a formative teleology is still present and the inter-subjective dimensions of interpretation and sense making marginalised.

As recognised from the interviews and apparent in the everyday life of most people, the human and social dimensions of various organisations are multifaceted and complex; levels 7–8 in the complexity hierarchy. The "necessary" reduction of reality for a study of logistics and supply chain phenomena where human and social aspects are still considered means that an aggregated set of assumptions appropriate to the context and situation studied should be kept (upper left part of Figure 2). On this level, lower-level assumptions are included and used for the appropriate parts of the phenomena studied, e.g. the routinised processes around picking goods, the time and distance between a storage facility and a retail outlet. However, due to the inter-subjective dimensions and the emergent outcomes from creative and adaptive processes where people are involved, these aspects cannot simply be reduced but need to be included in empirical investigations to ensure an understanding of the situation and context being targeted. Treating logistics as complex implies human involvement and consideration of paradoxes created in human interactions (Nilsson and Christopher, 2018). It also means considering the concrete, actual work being done and the mental models created by the humans involved in this work. As Nilsson (2005, p. 36) puts forward, "in such a situation there is no way the paradox can be resolved or eliminated by positivistic assumptions and claims, and therefore a different kind of logic is needed; a logic of a dialectic character".

A dialectic logic of SD of supply chains, for example, calls for the need for several perspectives which can contribute to, and challenge each other in, the pursuit of improved situations. As Richardson *et al.* (2001, p. 13) state, "a principal requirement of a complexity-based epistemology is the exploration of perspectives". The prime goal is not to reach harmony or resolve these paradoxes since the generation of solutions only creates new paradoxical situations in new circumstances – it is all part of the transformational process of identities, values, etc., which humans and organisations are co-creators of. Instead, paradoxes are sources of important tensions which, due to self-organisation, can lead to new innovative configurations as well as destructive ones (Ramirez, 2012). Nonetheless, while predictability and being fully objective and rational are seen as non-valid in any complex phenomenon involving people, a central assumption in complexity theory is that approaches and solutions can be developed which are more appropriate than others. For many situations, this calls for contextually derived approaches and methods, or at least contextually modified ones in which human behaviour is included and considered.

## 6. Concluding discussion
In this paper, the emphasis on perspectives and assumptions embedded in the complexity paradigm has been elaborated on aiming to contribute to more comprehensive and appropriate research in, and management of, logistics. It is proposed that complexity assumptions can be further included as an extended set of assumptions appropriate to increased realism in the advancement of the discipline. A key result, and input for further research, is that the recognition of logistics as complex means inclusion of human

and social aspects (which is apparent in any logistics process or phenomenon) in the knowledge- creation processes of logistics. While interconnected technical artefacts, i.e. physical and information-related devices, can be regarded as both complicated and complex to a certain degree, another dimension is added when these artefacts are put into a social context. In reality, this means that the subjective and often inter-subjective perceptions and interpretations of decision makers working with the artefacts increase the complexity of logistics phenomena. Consequently, this paper manifests that logistics processes and phenomena, where humans and different levels of organisational structures are involved, are not simply a sequence of mechanical devices which can be assumed to work along reductionistic and deterministic beliefs. Instead, logistics processes consist of a complex network of interdependent, living, innovative, and creative individuals who react and adapt dynamically to their perceived environment, and try proactively to create what they themselves, or collectively with others, find to be beneficial for their own and/or their organisation's interests. It is in the interaction between people that coherent patterns of meaning and identity are perpetually created. The iterative results of these processes are paradoxical situations where the interests of different groups of people (i.e. teams, departments, functions firms, supply chains, governmental bodies, etc.) are continually creating opportunities, at the same time as these processes restrain the developments of other processes. This is a perpetual process, and as Stacey (2003, p. 326) states, there are no levels separating the interacting groups of people, "only paradoxical processes of individuals forming the social while at the same time being formed by it".

To conclude, it is proposed that by actively reflecting and deliberately considering more complexity in models constructed and knowledge generated by logistics researchers and managers, our ontological views may change, and thereafter the way we communicate our reflections and thoughts: our epistemological considerations. In the process of understanding change in any phenomenon, the individuals involved choose different levels of observation and perspectives based on their presumptions. While their choices are based on a great number of factors, the consequences of assumptions, perspectives, levels of observation and details in description are central for the type of understanding, explanation and results to be produced.

The further discourse is encouraged for the exploration and exploitation of the epistemological considerations into a paradigmatic view where the functionalistic emphasis is still incorporated, but other assumptions such as emergence, non-linearity, heterogeneity and self-organisation are brought into a comprehended view of logistics. This, not least, when the landscape in which logistics and supply chain managers are engaged in involve emerging concepts and practices such as circular economy and new business logics based on resource and value sharing in both social and industrial contexts. In line with Carter *et al.* (2015) proposing more multi-level research, and Nair and Reed-Tsochas' (2019) inclusion of CAS-based empirical techniques, this paper suggests further studies with the inclusion of an extended set of assumptions and understanding of knowledge, especially related to human and social levels of complexity.

## References

Abbasi, M. and Nilsson, F. (2012), "Themes and challenges in making supply chains environmentally sustainable", *Supply Chain Management: An International Journal*, Vol. 17 No. 5, pp. 517-530.

Ackoff, R.L. (1973), "Science in the systems age: beyond IE, OR, and MS", *Operations Research*, Vol. 21 No. 3, pp. 661-671.

Allen, P.M. (2000), "Knowledge, ignorance and learning", *Emergence*, Vol. 2 No. 4, pp. 78-103.

Allen, P.M. and Strathern, M. (2003), "Evolution, emergence, and learning in complex systems", *Emergence*, Vol. 5 No. 4, pp. 8-33.

Arlbjørn, J.S. and Halldorsson, A. (2002), "Logistics knowledge creation: reflections on content, context and processes", *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 1, pp. 22-40.

Ashby, W.R. (1956), *An Introduction to Cybernetics*, 1st ed., Chapman & Hall, London.

Axelrod, R. and Cohen, M.D. (2000), *Harnessing Complexity – Organizational Implications of a Scientific Frontier*, 1st ed., Basic Books, Perseus Books Group, New York, NY.

Blanchard, T., Lombrozo, T. and Nichols, S. (2018), "Bayesian Occam's razor is a razor of the people", *Cognitive Science*, Vol. 42 No. 4, pp. 1345-1359.

Blumer, A., Ehrenfeucht, A., Haussler, D. and Warmuth, M.K. (1987), "Occam's razor", *Information Processing Letters*, Vol. 24 No. 6, pp. 377-380.

Bode, C. and Wagner, S. (2015), "Structural drivers of upstream SCC and the frequency of SC disruptions", *Journal of Operations Management*, Vol. 36 No. 1, pp. 215-228.

Boulding, K.E. (1956), "General systems theory-the skeleton of science", *Management Science*, Vol. 2 No. 3, pp. 197-208.

Brown, S.L. and Eisenhardt, K.M. (1997), "The art of continuous change: linking complexity theory and time-paced evolution in relentlessly shifting organizations", *Administrative Science Quarterly*, Vol. 42 No. 1, pp. 1-34.

Burrel, G. and Morgan, G. (1979), *Sociological Paradigms and Organizational Analysis; Elements of the Sociology of Corporate Life*, 1st ed., Heinemann Educational Books, London.

Campion, M.A., Campion, J.E. and Hudson, J.P. Jr (1999), "Structured interviewing: a note on incremental validity and alternative question types", *Journal of Applied Psychology*, Vol. 79 No. 6, pp. 998-1002.

Carter, C.R. and Rogers, D.S. (2008), "A framework of sustainable supply chain management: moving toward new theory", *International Journal of Physical Distribution & Logistics Management*, Vol. 38 No. 5, pp. 360-387.

Carter, C.R., Meschnig, G. and Kaufmann, L. (2015), "Moving to the next level: why our discipline needs more multilevel theorization", *Journal of Supply Chain Management*, Vol. 51 No. 4, pp. 94-102.

Checkland, P. (1993), *Systems Thinking, Systems Practice*, John Wiley & Sons, Chichester.

Choi, T.Y., Dooley, K.J. and Rungtusanatham, M. (2001), "Supply networks and complex adaptive systems: control versus emergence", *Journal of Operations Management*, Vol. 19 No. 3, pp. 351-366.

Christopher, M. (2016), *Logistics and Supply Chain Management: Creating Value-Adding Networks*, 3rd ed., Prentice-Hall, Harlow.

Cruz, L.B., Pedrozo, E.A. and de Fátima Barros Estivalete, V. (2006), "Towards sustainable development strategies – a complex view following the contribution of Edgar Morin", *Management Decision*, Vol. 4 No. 7, pp. 871-891.

Dent, E.B. (1999), "Complexity science: a worldview shift", *Emergence*, Vol. 1 No. 4, pp. 5-19.

Domingos, P. (1999), "The role of Occam's razor in knowledge discovery", *Data Mining and Knowledge Discovery*, Vol. 3 No. 4, pp. 409-425.

Eisenhardt, K.M. (1989), "Building theories from case study research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-550.

Elkington, J. (1998), *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*, New Society Publications, Gabriola Island.

Gerschberger, M., Manuj, I. and Freinberger, P. (2017), "Investigating supplier-induced complexity in SCs", *International Journal of Physical Distribution & Logistics Management*, Vol. 47 No. 8, pp. 688-711.

Guba, E.G. and Lincoln, Y.S. (1998), "Competing paradigms in qualitative research", in Denzin, N.K. and Lincoln, Y.S. (Eds), *The Landscape of Qualitative Research*, SAGE Publications, Thousand Oaks, CA, pp. 195-220.

Hall, J. and Vredenburg, H. (2003), "The challenge of innovating for sustainable development", *MIT Sloan Management Review*, Vol. 45 No.1, pp. 61-80.

IPCC (2014), "Climate change 2014: synthesis report: contribution of working groups I, II and III to the fifth assessment report of the intergovernmental panel on climate change", in Core Writing Team, Pachauri, R.K. and Meyer, L.A. (Eds), IPCC, Geneva, p. 151.

Kuhn, T.S. (1996), *The Scientific Revolution*, 3rd ed., The University of Chicago Press, Chicago, IL.

Kummer, S., Dieplinger, M. and Furst, E. (2014), "Flagging out in road freight transport: a strategy to reduce corporate costs in a competitive environment: results from a longitudinal study in Austria", *Journal of Transport Geography*, Vol. 36 No. 1, pp. 141-150.

Kvale, S. (1996), *Interviews: An Introduction to Qualitative Research Interviewing*, Sage Publications, NY.

Lombrozo, T. (2016), "Explanatory preferences shape learning and inference", *Trends in Cognitive Sciences*, Vol. 20, pp. 748-759.

Low, N. and Gleeson, B. (2003), *Making Urban Transport Sustainable*, Global Issues Series, Palgrave Macmillan.

McCarthy, I.P. (2004), "Manufacturing strategy: understanding the fitness landscape", *International Journal of Operations & Production Management*, Vol. 24 No. 2, pp. 124-150.

McKinnon, A., Cullinane, S., Browne, M. and Whiteing, A. (2010), *Green Logistics: Improving the Environmental Sustainability of Logistics*, Kogan Page Limited, London.

MacIntosh, R. and MacLean, D. (2001), "Conditioned emergence: researching change and changing research", *International Journal of Operations & Production Management*, Vol. 21 No. 10, pp. 1343-1357.

Manuj, I. and Sahin, F. (2011), "A model of SC and SC decision-making complexity", *International Journal of Physical Distribution & Logistics Management*, Vol. 41 No. 5, pp. 511-549.

Mears-Young, B. and Jackson, M.C. (1997), "Integrated logistics – call in the revolutionaries!", *Omega*, Vol. 25 No. 6, pp. 605-618.

Merriam, S.B. (1994), *Fallstudien som forskningsmetod*, Studentlitteratur, Lund.

Morgan, G. (1983), *Beyond Method – Strategies for Social Research*, 1st ed., SAGE Publications, Beverly Hills.

Nair, A. and Reed-Tsochas, F. (2019), "Revisiting the complex adaptive systems paradigm: leading perspectives for researching operations and supply chain management issues", *Journal of Operations Management*, Vol. 65 No. 2, pp. 80-92.

Nair, A., Yan, T., Ro, Y., Oke, A., Chiles, T. and Lee, S. (2016), "How environmental innovations emerge and proliferate in supply networks: a complex adaptive systems perspective", *Journal of Supply Chain Management*, Vol. 52 No. 2, pp. 66-86.

New, S.J. (1996), "A framework for analysing supply chain improvement", *International Journal of Operations & Production Management*, Vol. 16 No. 4, pp. 19-34.

Nilsson, F. (2005), *Adaptive Logistics – Using Complexity Theory to Facilitate Effectiveness in Logistics*, Division of Packaging Logistics, Lund University, Lund, ISBN 91-628-6511-0.

Nilsson, F. (2006), "Logistics management in practice – towards theories of complex logistics", *International Journal of Logistics Management*, Vol. 17 No. 1, pp. 38-54.

Nilsson, F. and Christopher, M. (2018), "Rethinking logistics management – towards a strategic mind-set for logistics effectiveness and innovation", *Emergence: Complexity and Organization*, 30 June (last modified: 24 February 2019), Edition 1, Vol. 20 No. 2, pp. 1-24.

Nilsson, F. and Gammelgaard, B. (2012), "Moving beyond the systems approach in SCM and logistics research", *International Journal of Physical Distribution & Logistics Management*, Vol. 42 Nos 8/9, pp. 764-783.

Porter, M.E. and Kramer, M.R. (2011), "The big idea: creating shared value", *Harvard Business Review*, Vol. 89 Nos 1-2, pp. 62-77.

Punch, K.F. (2001), *Introduction to Social Research*, 1st ed., SAGE Publications, London.

Rajkumar, C., Kavin, L., Luo, X. and Stentoft, J. (2016), "Doctoral dissertations in logistics and supply chain management: a review of Nordic contributions from 2009 to 2014", *Logistics Research*, Vol. 9 No. 5, pp. 1-18.

Ramirez, G.A. (2012), "Sustainable development: paradoxes, misunderstandings and learning organizations", *The Learning Organization*, Vol. 19 No. 1, pp. 58-76.

Richardson, K.A. (2004), "Systems theory and complexity: part 1", *Emergence: Complexity and Organisation*, Vol. 6 No. 3, pp. 75-79.

Richardson, K.A., Cilliers, P. and Lissack, M.R. (2001), "Complexity science: a 'gray' science for the 'stuff in between'", *Emergence*, Vol. 2 No. 3, pp. 6-18.

Robertson, D.A. (2003), "Agent-based models of a banking network as an example of a turbulent environment: the deliberate vs. emergent strategy debate revisited", *Emergence*, Vol. 5 No. 2, pp. 56-71.

Rotmans, J., Kemp, R. and van Asselt, M. (2001), "More evolution than revolution: transition management in public policy", *Foresight: The Journal of Futures Studies, Strategic Thinking and Policy*, Vol. 3 No. 1, pp. 15-31.

Russel, D.M., Swanson, D. and Blinge, M. (2018), "Sustainable logistics and supply chain management: a holistic view through the lens of the wicked problem", *World Review of Intermodal Transportation Research*, Vol. 7 No. 1, pp. 36-56.

Sanders, N.R., Zacharia, Z.G. and Fugate, B.S. (2013), "The interdisciplinary future of supply chain management research", *Decision Sciences*, Vol. 44 No. 3, pp. 413-429.

Simon, H.A. (1996), *The Science of the Artificial*, 3rd ed., MIT Press, Cambridge, MA.

Stacey, R.D. (2003), *Strategic Management and Organisational Dynamics: The Challenge of Complexity*, Prentice-Hall, Pearson Education, Harlow.

Stacey, R.D., Griffin, D. and Shaw, P. (2000), *Complexity and Management – Fad or Radical Challenge to Systems Thinking?*, Routledge, London.

Stake, R.E. (2000), "Case studies", in Denzin, N.K. and Lincoln, Y.S. (Eds), *Handbook of Qualitative Research*, 2nd ed., Sage Publications, California, pp. 435-453.

Stock, J.R. (1997), "Applying theories from other disciplines to logistics", *International Journal of Physical Distribution and Logistics Management*, Vol. 27 Nos 9/10, pp. 515-539.

Thietart, R.-A. (2016), "Strategy dynamics: agency, path dependency and self-organized emergence", *Strategic Management Journal*, Vol. 37 No. 4, pp. 774-792.

Touboulic, A., Matthews, L. and Marques, L. (2018), "On the road to carbon reduction in a food supply network: a complex adaptive systems perspective", *Supply Chain Management: An International Journal*, Vol. 23 No. 4, pp. 313-335.

Towers, N. and Chen, R. (2008), "Employing the participative paradigm as a valid empirical approach to gaining a greater understanding of contemporary supply chain and distribution management issues", *International Journal of Retail & Distribution Management*, Vol. 36 No. 8, pp. 627-637.

Trim, P.R.J. and Lee, Y.I. (2004), "A reflection on theory building and the development of management knowledge", *Management Decision*, Vol. 42 No. 3, pp. 473-480.

UN General Assembly (2015), "Transforming our world: the 2030 agenda for sustainable development", 21 October 2015, A/RES/70/1, available at: www.refworld.org/docid/57b6e3e44.html (accessed 30 May 2019).

United Nations (2005), "United Nations World Summit outcome, sixtieth session – items 48 and 121 of the provisional agenda (A/60/150)", available at: www.un.org/en/events/pastevents/worldsummit_2005.shtml (accessed 21 February 2019).

von Hayek, F.A. (1989), "The pretence of knowledge", *The American Economic Review*, Vol. 79 No. 6, pp. 3-8.

Wieland, A., Handfield, R. and Durach, C.F. (2016), "Mapping the landscape of future research themes in supply chain management", *Journal of Business Logistics*, Vol. 37 No. 3, pp. 205-212.

Wittneben, B., Bongardt, D., Dalkmann, H., Sterk, W. and Baatz, C. (2009), "Integrating sustainable transport measures into the clean development mechanism", *Transport Reviews*, Vol. 29 No. 1, pp. 91-113.

## Further reading

Gripsrud, G., Jahre, M. and Persson, G. (2006), "Supply chain management – back to the future?", *International Journal of Physical Distribution & Logistics Management*, Vol. 36 No. 8, pp. 643-659.

Himanen, V., Lee-Gosselin, M. and Perrels, A. (2004), "Impacts of transport on sustainability: towards an integrated transatlantic evidence base", *Transport Reviews*, Vol. 24 No. 6, pp. 691-705.

Larsen, M.M., Manning, S. and Pedersen, T. (2018), "The ambivalent effect of complexity on firm performance: a study of the global service provider industry", *Long Range Planning*, Vol. 52 No. 2, pp. 221-235.

Lyons, G. (2004), "Transport and society", *Transport Reviews*, Vol. 24 No. 4, pp. 485-509.

Morgan, G. (1997), *Images of Organization*, 2nd ed, SAGE Publications, Thousand Oaks, CA.

Nilsson, F. and Darley, V. (2006), "On complex adaptive systems and agent-based modelling for improving decision-making in manufacturing and logistics settings – experiences from a packaging company", *International Journal of Operations & Production Management*, Vol. 26 No. 12, pp. 1351-1373.

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