Analogical reasoning guidelines: a review and application to sustainable supply chains

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Abstract

Purpose – This paper aims to review analogical reasoning work to distil and apply procedural guidelines that aid theoreticians to develop novel analogies.

Design/methodology/approach – The authors reviewed 189 studies from 1980 to 2020 to identify analogical reasoning guidelines.

Findings – Results revealed four procedural steps for the introduction of novel analogies: target and source domain selection; domain image mapping; relevance assessment; and proposition drafting. [. . .] shallow lakes constitute the source domain and sustainable supply chain management represents the target domain.

Research limitations/implications – The identified procedural guidelines can help future scholars to develop novel analogies with rigor and structure. The paper provides an agenda for new research that addresses gaps in current studies that reason by analogy.

Originality/value – This paper distils and applies analogical reasoning guidelines for the development of novel analogies, extending and complementing much existing theorizing on reasoning by analogy. Additionally, disjointed and fragmented research findings are synthesized to yield a comprehensive understanding of analogical reasoning, which can serve as a foundation for future theorizing in sustainable supply chain management and beyond.

Keywords Sustainability, Supply chain management, Theories, Analogies, Metaphors, Theory development, Literature review

Paper type General review

1. Introduction

Organizational scholars have long recognized the centrality of building theory to advance knowledge in their fields (Shepherd and Suddaby, 2017). Among the key tools for building theory are analogies, which create understanding of a phenomenon by referring to a seemingly unrelated occurrence (Cornelissen *et al.*, 2005; Audebrand, 2010; Foropon and McLachlin, 2013; Cornelissen and Durand, 2014). Analogy is ubiquitous as a rhetorical tool (for example, the term supply *chain* or *network* describes relations between customers and suppliers), yet instigates theory development only when scholars deliberately reason by analogy (Ketokivi and Mantere, 2010; Cornelissen and Durand, 2014). In line with others, we refer to this process as analogical reasoning (Ketokivi *et al.*, 2017).

Analogical reasoning involves the transfer of information from a well-known phenomenon or domain (the source domain) to a relatively unfamiliar phenomenon or domain (the target domain) (Tsoukas, 1991; Ketokivi *et al.*, 2017; Oswick *et al.*, 2002). As an example, the human immune system can serve as a source domain for learning about and improving supply chain risk management (Srinivasan and Tew, 2017). In this paper, we develop guidelines for the development of *novel* analogies.

A methodical and comprehensive review of the literature on analogical reasoning in an organizational context reveals that, despite much reliance on analogical reasoning to explicate or build organizational knowledge and theory, scholarly efforts to distil and present formal analogical reasoning guidelines for the development of novel analogies remain limited. Perhaps not surprisingly, Morgan (2011) has described the development of novel organizational analogies as disjointed and rarely going beyond an illustration of superficial commonalities in a source and target domain. As we show, this research deficiency is particularly evident in a (sustainable) supply chain context. Similarly, other scholars have suggested that even relatively well-established analogies – such as the marriage metaphor to advance understanding of buyer–seller relationships – can fall short in terms of creating deeper novel insights (Celuch *et al.*, 2006; Hunt and Menon, 1995). We argue that this shortcoming stems from a lack of consensus regarding procedural guidelines for analogical reasoning to develop novel analogies, and we address the following research question: *What procedural guidelines should organizational scholars follow to*

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introduce meaningful novel analogies that act as a source of knowledge creation and theory development?

To address this research question, we review works on analogical reasoning, first broadly across the management literature and then more specifically within the supply chain and operation management literature. Interestingly, although procedural guidelines for the introduction of novel analogies exist, their presentation is limited and piecemeal, indicating a lack of theoretical synthesis aimed at developing "how to" work in that space. In addressing this shortcoming, we distil four research steps for reasoning by analogy:

1 target and source domain selection;
2 domain image mapping;
3 relevance assessment; and
4 proposition drafting.

To illustrate the research steps, we apply them to develop a novel analogy in which shallow lakes [1] serve as the source domain and sustainable supply chain management (SSCM) is the target domain. We chose this context for two reasons. First, we chose SSCM because our literature review revealed that – despite substantial work on what analogies do and how they work in a broader management context (Gentner, 1983; Morgan, 1980; Cornelissen, 2005) and even in an organizational sustainability context (ermier and Forbes, 2016) – few studies have explored the relationship between analogical reasoning and operations management (OM) (for noteworthy exceptions, see Chen *et al.*, 2013; Foropon and McLachlin, 2013), and no studies do so in an SSCM context. Second, we chose SSCM because analogical reasoning has the potential to lead to a "normative leap" (Keulartz, 2007, p. 28) that can guide supply chain decision-makers toward much-needed sustainable action and simultaneously move toward answering calls to advance SSCM theory to help address human-caused ecological degradation (Touboulic and Walker, 2015; Beske and Seuring, 2014). Importantly, we found that the natural principles of a shallow lake can lead to meaningful theoretical claims in SSCM, including that supply chains are either sustainable or not – in other words, they cannot meaningfully be partially sustainable.

We make several key contributions. First, we review the literature on analogies to distil procedural guidelines (in the form of four research steps) for the development of novel analogies. Thus, we help scholars in generating novel analogies with more rigor and structure. In so doing, we also aim to generate more attentive, self-reflective and programmatic analogical reasoning efforts that challenge current knowledge and aid researchers in forming new theory (Suddaby *et al.*, 2011). Second, we apply the four research steps to develop a normative and nature-centered analogy. This analogy holds the potential for deeper reflection about relationships between humans and the natural world and for producing new insights and SSCM theory (Matthews *et al.*, 2016; Grant and Oswick, 1996). Our final contribution is to inspire theorizing in the SSCM context and beyond that has the potential to transcend the bounds of conventional thinking through analogical reasoning. To foster this goal, we present a research agenda that includes questions concerned with the environmental implications of established and often covert analogies that conceive of organizations as functioning machines (Jennings and Zandbergen, 1995).

We first present an overview of our study's research background. We then conduct a methodical and comprehensive review of the literature to determine the contribution of analogical reasoning in an organizational context (including supply chain management, sustainability and SSCM). From our review's findings, we distil an iterative framework consisting of four research steps for using analogies as a foundation for theory development. We then illustrate the research steps through an analogy of a natural ecosystem – shallow lakes. In the final sections, we present the study's implications and offer suggestions for future research.

2. Research background and review

Analogies allow for the structural mapping of two distinct domains, referred to as source and target domains, to use the familiarity of the source domain to make inferences about the target domain (Oswick *et al.*, 2002). Analogies focus on similarities between domains and divert attention away from dissimilarities (Ortony, 1975). For example, in likening managers to jazz musicians, Pasmore (1998) focuses on the need to organize for spontaneity and the expectation of immediate results (i.e. similarities between the domains) while disregarding that managers do not usually need a trumpet or saxophone to do their job (i.e. dissimilarities between the domains). We treat "analogy" and "metaphor" as synonyms in line with other research in this field (Cornelissen and Durand, 2014; Cornelissen, 2005; Tsoukas, 1991).

When scholars deliberately explore a source domain as a model for a chosen target domain, we refer to this exploration as *analogical reasoning* that can advance knowledge and (ultimately) organizational theory development (Cornelissen and Durand, 2014; Ketokivi *et al.*, 2017; Oswick *et al.*, 2002). Within this broad scope, analogical reasoning can fulfill several purposes. For example, scholars might draw on an established analogy to justify theoretical generalizations from empirical data (in this case, the analogy acts as a warrant), or might accumulate evidence on an analogy's value through an endogenous critique (in this case, the analogy acts as backing) (Ketokivi *et al.*, 2017; Toulmin, 2003). In this study, we focus on the introduction of novel analogies: "When authors argue that thinking of an organization 'as if it were X' can lead to fruitful theoretical insight, they introduce a novel analogy" (Ketokivi *et al.*, 2017, p. 642).

Novel analogies typically facilitate conceptual contribution through "seeing" or "understanding" something new in an abstract way (MacInnis, 2011). Such seeing or understanding is often only possible by drawing on conceptual assumptions and ideas derived from a novel source domain (Alvesson and Sandberg, 2011; Oswick *et al.*, 2011). On its introduction, an analogy can form the basic premise or starting point for theoretical claims and novel theory discovery. The resulting theory development, in turn, aims to make sense of organizational phenomena by addressing the questions of how, when and why things happen (MacInnis, 2011).

2.1 Literature review approach

The literature review was structured along several established steps (Durach *et al.*, 2017; Snyder, 2019). First, to reduce researcher bias and detect as much of the relevant literature as

possible, we developed a research protocol that specified the research problem and the search method (including search terms and databases as well as first study inclusion and exclusion criteria). At this stage, we also decided to explore studies between January 1980 and April 2020, the first of which coincides with Morgan's (1980) seminal publication on analogies in organizational theory. We then formed a review panel that consisted of the authors, two research assistants and a librarian and reflected each member's expertise in structured or related literature review methods and/or SSCM.

Next, we began to iteratively follow the steps outlined in the protocol. We undertook an initial search of Business Source Complete (through EBSCOhost) using a search string of the fundamental keywords that reflected the research topic and problem (i.e. metaphor, analogy, OM). This initial search of (metaphor OR analogy) AND (management) in titles or abstracts yielded nearly 20,000 studies, appearing in ProQuest, Scopus, Web of Science, Business Source Complete, PsycINFO, Science Direct, Emerald, Sage journals and Wiley publications. From these studies, we obtained a synthesis sample by adding keywords in titles or abstracts captured in the following string: (metaphor OR analogy) AND ("organization theory" OR "supply chain" OR "operation management"). This approach reduced the number of studies to 878. We then exported details of these studies (i.e. journal, authors, title, year and abstract) to EndNote X8 and an Excel spreadsheet.

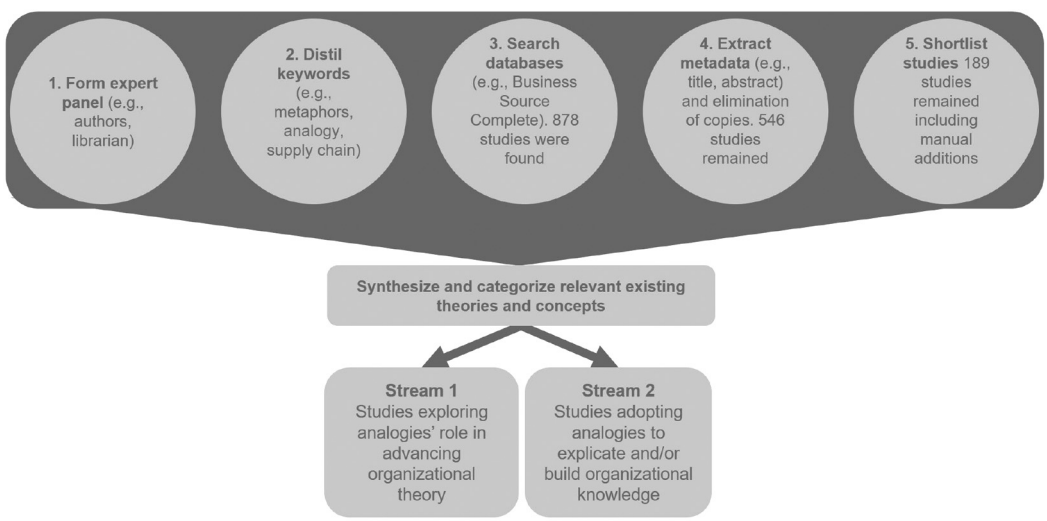
Elimination of redundant studies reduced the 878 studies to 546. The authors and two research assistants independently screened the 546 studies to eliminate those not aligned with the scope of the review or that are irrelevant to the topic. Non-English language studies were also excluded, as was work that uses analogies merely to embellish communications (Tsoukas, 1991; Ketokivi *et al.*, 2017; Cornelissen, 2005; Morgan, 2011). Given the nature of the keywords string, analogies (or metaphors) had to be explicitly mentioned for a study to become part of the final sample. However, in manually adding papers via a cross-referencing screening process, we made exceptions if the expert review panel agreed that analogical reasoning was central to a given paper [2]. For example, we included an effort to illustrate transparency in supply chain relationships via a "light shining through mineral" analogy even though analogical reasoning was not explicitly acknowledged (Lamming *et al.*, 2001), and we included the anorexia analogy for the process of lean implementation (Radnor and Boaden, 2004). We excluded most analogies using closed-loop or life-cycle assessments unless the work gave evidence of their deliberate adoption for analogical reasoning. Applying these inclusion/exclusion criteria during the screening process yielded a shortlist of 136 relevant studies. We subsequently manually added 53 studies that were relevant to our research but were not picked up with the keywords. We imported the full PDFs of these 189 studies into EndNote X8, where we read and categorized them.

To categorize, we adapted qualitative data analysis techniques in the search for themes related to the project's scope (Ryan and Bernard, 2003; Seuring and Gold, 2012). We used a process of coding, comparing, and contrasting studies to discover how related concepts and ideas are linked to one another and how theoretical synthesis might be achieved by integrating existing theories and concepts (Sovacool *et al.*, 2018) relevant to analogical reasoning guidelines. To achieve this goal, we zoomed out from individual studies to obtain a conceptual overview of the evidence base, which then allowed us to allocate studies to groups in EndNote X8 (Siddaway *et al.*, 2019). Studies were grouped into sets of investigations addressing similar issues, with some sources allocated to several categories. This process allowed our panel to identify two overarching higher-order groups that represent two research streams:

1 studies that conceptually explore analogies' role in advancing organizational theory; and
2 studies that adopt analogical reasoning to illustrate and/or build organizational knowledge.

For research stream 1, three sub-groups emerged: analogical theory-building in the context of (a) management, (b) OM/SCM, and (c) organizational sustainability. For research stream 2, four sub-groups emerged: analogical illustrations in the context of (a) management, (b) OM/SCM, (c)

Figure 1 Overview of the review process used to distil the procedural guidelines



organizational sustainability, and (d) SSCM. Figure 1 shows an overview of the main literature review steps followed.

2.2 Evidence base

Although research streams 1 and 2 can overlap – with several studies adopting at least some characteristics of both streams – the first stream is primarily concerned with analogies' role as a scientific tool. Studies in this stream reflect organizational scholars' interest in theory development and the role language plays in (re)presenting organizational life (Cornelissen, 2005; Oswick *et al.*, 2002; Weick, 1989). More specifically, studies in research stream 1 address questions about what analogies are, what they do (i.e. their functionality), and how they can be used (Morgan, 1980; Cornelissen and Durand, 2014; Oswick *et al.*, 2011; Cornelissen *et al.*, 2005). Research in this stream has provided criteria for evaluation of the development of meaningful novel analogies, which help "gauge the relevance, structural soundness, and factual validity of the core analogy that lies at the foundation of a theoretical argument" (Ketokivi *et al.*, 2017, p. 638).

Studies that fall into the second research stream primarily apply analogies' inherent imagery to illustrate and explicate by articulating, charting, describing, or depicting different organizational phenomena. Through this explication, scholars aim to convey new ideas and make complex subjects easier to comprehend (Cornelissen, 2005). Subjects are diverse and encompass many fields, including innovation, entrepreneurship, strategic change and marketing. Across these studies, scholars deliberately draw on various source domains, from chaos (Thietart and Forgues, 1995), jazz (Zack, 2000), organizational identity (Gioia *et al.*, 2000) and loosely coupled systems (Weick, 1976) to garbage cans (Cohen *et al.*, 1972). In addition, a significant body of work uses analogies for the sustainable management of organizations. For example, the stewardship analogy is put forth to advance responsible and sustainable management. "The traditional responsibility of the steward toward an owner (e.g. shareholder) remains, but the metaphor introduces wider obligations to the general public, to future generations, to other species, and to the natural world" (Audebrand, 2010, p. 421) [3]. OM studies in the second research stream also draw on several source domains, including the immune system (Srinivasan and Tew, 2017), anorexia (Radnor and Boaden, 2004) and blood cells (Sodero, 2019). Similarly, the sustainable and environmentally destructive nature of organizations' *modi operandi* has been described through various analogies, such as viewing firms as psychopaths pursuing private gain while rendering public pain (Morgan, 2011).

In summary, both research streams influence organizational theorizing. Stream 1 provides theoretical guidance and an impetus to apply analogical imagery to advance scholarship, whereas Stream 2 primarily uses the rich imagery of one or more analogies to convey new ideas and make complex subjects easier to comprehend (Cornelissen, 2005). The Appendix lists selected studies for each of the two research streams and specifies whether studies cover sustainability, supply chain management or SSCM-related issues. Importantly, the literature has some shortcomings, which act as a catalyst for our study.

2.3 Shortcomings unveiled by the review

Despite researchers' many forays into analogies' role in advancing organizational theory (Stream 1), theoretical syntheses that integrate current theories and concepts into frameworks that help with the introduction of novel analogical imagery are largely absent. Instead, the literature mainly investigates what analogical reasoning does, how it works and, more recently, how to assess its theory-developing potential. Consequently, the literature lacks procedural guidelines on how to introduce meaningful novel analogies in a structured manner. Not surprisingly then, studies that develop novel analogical imagery to explicate and generate organizational knowledge (Stream 2) typically supply scant evidence of having followed established procedural guidelines. We argue that without such guidelines, analogical reasoning remains limited to illustrations of superficial commonalities between a source domain and the phenomenon being studied (i.e. the target), and thus studies likely fall short "in terms of creating deeper novel insight and value" (Morgan, 2011, p. 468).

Further, despite the rich analogical imagery used across the OM/SCM field (Srinivasan and Tew, 2017; Radnor and Boaden, 2004), few studies explore the relationship between analogies and SSCM (see the Appendix; Stream 2). To some extent, this shortcoming stems from a relative lack of theoretical forays into analogies' role in advancing OM/SCM theory, and SSCM theory even more, as our review revealed no meaningful work concerned with analogies' theory-building role in advancing this important field (see the Appendix; Stream 1). This inadequacy in the literature is noteworthy given analogies' potential to guide supply chain decision-makers toward much-needed sustainable action (Gruner and Power, 2017). Indeed, analogies become particularly relevant in light of calls for more theorizing efforts across all organizational disciplines, but especially sustainability and SSCM. While organizational scholars recognize SSCM as a pivotal research field (Touboulic and Walker, 2015; Beske and Seuring, 2014), theory development in SSCM remains insufficient or inadequate in reversing human-caused ecological degradation, including climate change and biodiversity loss (Pagell and Shevchenko, 2014; Matthews *et al.*, 2016; Touboulic and Walker, 2015).

3. Procedural guidelines and their application

As when searching for themes related to our project's scope, we adapted qualitative data analysis techniques to achieve theoretical synthesis (Ryan and Bernard, 2003; Siddaway *et al.*, 2019; Sovacool *et al.*, 2018) and used a process of coding, comparing and contrasting studies to identify and extract procedural guidelines for analogical reasoning. We thus extended our review efforts and adopted a more targeted evaluation and analysis of the literature to identify the steps followed (mainly in Research Stream 2) or proposed and described (mainly in Research Stream 1) for introduction of analogies that can act as knowledge sources. More specifically, the review panel's experts rated the identified studies' relevance in addressing the question of whether *procedural guidelines exist for the meaningful introduction of novel analogies that act as a source of knowledge creation and theory development* as high or low. The score was included as a variable in the data analysis stage, with studies low in relevance (~80% of studies) contributing less, if

anything, to the process. Measures were taken to ensure high levels of inter-rater reliability. Specifically, we followed a discursive alignment of interpretation, which involved the two authors and one research assistant classifying several articles and then comparing these to assess and resolve differences and ensure consensus (Seuring and Gold, 2012). As data were conceptualized at higher levels of abstraction (i.e. as research steps for analogical reasoning emerged), each study was reviewed to verify that the new conceptualization was congruent with primary sources and that emerging steps could be logically ordered. Minor differences among the researchers on our panel arose mainly over whether studies' analogical reasoning efforts could belong to a distinct procedural step and, if so, what step(s). Ultimately, four main research steps emerged to comprise the procedural guidelines for the deliberate introduction of novel analogies:

1 target and source domain selection;
2 domain image mapping;
3 relevance assessment; and
4 proposition drafting.

The first step is determination of the source and target domain, with the former being the field or phenomenon from which insights are drawn and the latter being the field or phenomenon of interest. The second step relates to knowledge transfer from the source domain onto the target domain: images are concepts or meaning inherent in the source domain that can be transferred (i.e. mapped) onto the target domain. The third step is assessment of gathered insights' utility and potential to develop theory. During this step, the most meaningful commonalities between the images are collected. The fourth step is development of propositions by extracting and communicating gathered insights.

We describe each step in more detail and include an illustration of how it can be applied in an SSCM context. Specifically, we explore whether SSCM insights can be gleaned from thinking of supply chains as the target domain and shallow lakes as the source domain. As mentioned, although scholars have explored the potential benefits of analogical reasoning by modeling organizational processes on processes within natural ecosystems (Ehrenfeld, 2004; Ehrenfeld, 2003), we are unaware of similar efforts in an SSCM context (see Stream 1's first and third columns in the Appendix). There are a few exceptions among those studies that adopt analogies to explicate or build organizational knowledge (see Stream 2 in the Appendix). For example, Gruner and Power (2017) use general natural ecosystems principles as a source domain to develop principles for more sustainable management of supply chains. Established procedural guidelines for these theory-building efforts have not been followed, however.

3.1 Description of the research steps for the introduction of novel analogies

3.1.1 Target and source domain selection (Step 1)

This research step determines the source and target domains. The target domain describes the field or phenomenon of interest (i.e. the image recipient). To foster understanding of the target domain, theorists use the source domain (i.e. the field or phenomenon from which insights are drawn). Target domain selection should be based on a study's ontological and epistemological artifacts. These artifacts include study context, definitions and unit of analysis. For example, supply chain scholars should query whether the entity being studied (and thus the target domain) is a single dyadic linkage between a manufacturer and a retailer or comprises all upstream and downstream actors (Durach *et al.*, 2017). In selecting a target domain, beneficiaries or research goal(s) should also be determined. Because insights are drawn from the source domain, its selection determines analogies' potential to constitute the basic premise of an argument, which in turn leads to theoretical claims. Our literature review revealed that the two questions outlined below are fundamental in guiding theorists in selecting target and source domain.

Are the target and source domains conceptually distant (Q1(a))? The source domain should not tap into neighboring domains of knowledge but should cross distant categories of understanding (Cornelissen, 2005). Distance plays a role in the theorizing process because more distant domains may provoke surprising and revelatory insights and inferences (Cornelissen and Durand, 2012). However, the distance should not be total (Oswick *et al.*, 2002).

Do the target and source domain exhibit strong system relationships (Q1(b))? Strong systems relationships exist if a source domain (which should also be conceptually more developed) is regarded as potentially yielding new and revelatory insights (Cornelissen, 2005). For this to be the case, the system relationships that hold in the source domain should also hold in the target domain (Gentner, 1983); similarity between the two domains should be more than superficial or coincidental.

3.1.2 Domain image mapping (Step 2)

This research step uses knowledge transfer from the source domain onto the target domain (identified in Step 1). Images are concepts or meaning inherent in the source domain that can be transferred (i.e. mapped) onto the target domain. Image mapping constitutes knowledge transfer from the source domain to negotiate, discover and understand unknown aspects in the target domain (Ketchen and Hult, 2011; Chen *et al.*, 2013). The image mapping efforts act as a catalyst for new insight by "involving the conjunction of whole semantic domains in which a correspondence between terms or concepts is constructed, rather than deciphered, and the resulting image and meaning is creative, with the features of importance being emergent" (Cornelissen, 2005, p. 751). Thus, the mapping process allows theorists to become aware of shared elements as well as limitations and differences between the domains. Our literature review revealed that the two questions outlined below are central in guiding theorists in mapping images.

What elements do the domains share (Q2(a))? In this step, scholars should look beyond broad similarities between target and source domain and discern shared elements. Identifying shared elements is a subjective–interpretive process that requires reflective exploration of what works and what does not when connecting source domain knowledge with the target domain (Chen *et al.*, 2013; Morgan, 2011).

What dissimilarities and limitations exist (Q2(b))? Although an analogy's "creative edge" stems from its emphasis on "similarity" and "optimum overlap" (represented by shared elements), delineation of limitations and dissimilarities of each

element is also important (Oswick *et al.*, 2002). Ideally, dissimilarities and limitations should not outweigh relevant similarities between target and source domain, and should likewise lead to novel insights.

3.1.3 Relevance assessment (Step 3)

This research step assesses gathered insights' utility and potential to develop theory. Relevance assessment is a reductionist process that distils the most meaningful commonalities between the images (identified in Step 2). Assessment of relevance further limits gathered insights on the basis of their potential to contribute to the target domain. In Research Step 2, theorists are likely to be able to identify many shared elements and generate potentially hundreds of new insights by mapping images, making assessment of insights' theory-developing potential for the target domain crucial. In seeking distance from literal similarity in image mapping, researchers can create space from what is typically assumed, and challenge conventional ways of seeing and understanding (Davis, 1971). At the same time, theorists' imagination should not produce rampant and naïve insights (Jermier and Forbes, 2011). While potentially novel and interesting, insights do not equate with meaning and impact (Davis, 1971). Our literature review revealed that the two questions outlined below are fundamental in guiding theorists in assessing relevance.

Are analogical insights aligned with a study's purpose (Q3(a))? This step comprises scholars querying whether identified elements can advance knowledge development in the target domain and provide "a novel way of grasping, seeing and acting in any given situation" (Morgan, 2016, p. 1030).

Do novel insights have the potential to inform theory beyond the study at hand (Q3(b))? Scholars should assess whether a novel analogy has the potential to transform into a way of reasoning (Ketokivi *et al.*, 2017). Analogies should link to multiple research questions and target domains and also have the potential to advance theory.

3.1.4 Proposition drafting (Step 4)

This research step develops an inventory of propositions. Proposition drafting distils and communicates the outcome of previously gathered insights of the analogical reasoning process (Steps 2 and 3). The drafting of propositions involves articulating insights gathered via analogical reasoning processes. To be valuable in creating theory, analogies should not be limited to non-propositional knowledge representations. That is, "the imagery contained in the analogy must assist the theorist in deriving specific propositions and/or hypotheses about the phenomenon being studied" (Bacharach, 1989, p. 497). Our literature review revealed that the two questions outlined below are essential in guiding theorists in drafting propositions.

Are gathered insights summarized and described (Q4(a))? Although "the partial and ambiguous applicability of analogies stimulates theory builders to be creative in their interpretations and to generate new insights" (Boxenbaum and Rouleau, 2011, p. 291), as part of this step, the distilled insights should be stated succinctly and communicated clearly to become meaningful and guide theory development and organizational action.

Are captured insights empirically adequate (Q4(b))? Propositions should be drafted with an analogy's potential contribution to empirical research in mind. Analogical reasoning acts as a precursor to theory (i.e. as one building block of a full-blown theory or research program). Research shows that propositions lay the groundwork for theory if their imagery has the potential to be sharpened into theory formulations and testable hypotheses (Cornelissen, 2005; Morgan, 1983).

3.2 Application of the research steps in an SSCM context

3.2.1 Target and source domain selection (Step 1)

As our target domain, we chose a holistic supply chain perspective encompassing all upstream and downstream actors. The adoption of a holistic view beyond single firms or single dyadic linkages (e.g. between a manufacturer and a retailer) is crucial in mitigating operational impacts on the environment (Durach *et al.*, 2017; Genovese *et al.*, 2017). More specifically, our target domain pertains to SSCM's goal of establishing sustainable operations that benefit the environment, which is about trading partners' efforts aimed at reducing companies' negative impact on the natural environment (Simpson and Power, 2005). Similar efforts could take place through reductions in waste generation, landscape degradation, habitat loss and ecosystem pollution (Olivetti and Cullen, 2018). Thus, in our illustration, the natural environment is the primary beneficiary, and social as well as economic dimensions are secondary beneficiaries. Secondary benefits include operational efficiencies and various traditional, profit-related success metrics (Melnyk *et al.*, 2004) as well as the social dimension, constituting the triple bottom line (Elkington, 2004).

As our source domain we chose a natural ecosystem – shallow lakes. Natural (biological) ecosystems have been shown to hold theoretical value through the creation of nature-inclusive analogies (Ehrenfeld, 2004; Korhonen, 2001). This approach is aligned with industrial ecology (Frosch and Gallopoulos, 1989; Graedel and Lifset, 2016; Sarkis, 2003), which is a "systems-based, multidisciplinary discourse that seeks to understand emergent behavior of complex integrated human [including supply chain] and natural systems" (Allenby, 2006, p. 33). Shallow lakes in particular have been identified as a useful analogy for many man-made ecological problems (Mäler *et al.*, 2004), including those pertaining to supply chain operations. Crucially, shallow lakes exhibit nonlinear dynamics, which in an SSCM context translates into non-convex decision problems. That is, multiple locally optimal solutions may exist, which can take much time and effort to identify. While shallow lakes (unlike deep ones) harbor many scales of complexity, they are still a manageable size that can be studied and understood.

In line with *Q1(a)* and *(b)*, we found the crossover between shallow lakes and supply chains to exhibit both conceptual distance and strong system relationships. Biological systems as a source domain are conceptually distant from the target domain because they cross distinct categories of understanding that may yield surprising and revelatory insights and build novel theory rather than extending existing theory (Cornelissen, 2005). Shallow lakes are no exception. In fact, the preservation and sustainability of shallow lakes are generally better understood than most (relatively novel) SSCM phenomena. Further, complex supply chain systems (unlike shallow lakes) typically operate under multiple institutional logics (e.g. sustainability logic versus financial logic and competing logics at different supply chain tiers) (Sayed *et al.*, 2017). At the same time, the differences between the man-made (i.e. supply chains) and natural (i.e. shallow lakes) domains are not total. Instead, evidence of strong systems

relationships is present – the similarity between the two domains is not superficial or coincidental. The main reasons for this resemblance are threefold. First, shallow lakes and supply chains are both complex heterogeneous systems associated with non-convex decision problems that, nevertheless, follow generic rules of system behavior. Second, despite harboring many scales of complexity, both systems are manageable in size and can be studied and understood. Third, as shallow lakes are supplied by extensive upstream networks, their ecological nature is comparable in some key ways to the social and economic nature of supply chains (Scheffer, 2009).

3.2.2 Domain image mapping (Step 2)

In transferring knowledge from one domain (i.e. shallow lakes) to the other (i.e. SSCM), we became aware of many commonalities between the two domains. However, the image mapping process also involves becoming sensitive to problems, deficiencies and disharmonies as well as often hidden knowledge to overcome problems (i.e. find solutions) associated with a target domain. The identification of solutions is particularly valuable in this research step, as problems pertaining to sustainability of supply chain management are easily identified whereas solutions are not (Matthews *et al.*, 2016).

In line with *Q2(a)* and *(b)*, we identified shared elements between the domains and explored dissimilarities and limitations associated with the analogy. The identification of shared elements between shallow lakes and SSCM led to insights that advance solutions to rarely considered aspects of the contingencies involved in creating SSCM. As part of this step, we cast a wide net and captured insights ranging from the nature of lakes' circularity to concepts that are more abstruse (from an operational management perspective), such as the interplay between biotic and abiotic elements. We found reviewing work on natural ecosystems and their transitions from a state of unsustainability (turbid lake) to a state of sustainability (clear lake) particularly revelatory (Jensen *et al.*, 2011; Quarshie *et al.*, 2016; Sarkis, 2003). We also considered relevant dissimilarities and limitations to avoid hasty generalizations (Ketokivi *et al.*, 2017).

At this point, we discussed the socially constructed nature of supply chains and the notion of agency that is absent in shallow lakes, whereas interplay between biotic and abiotic elements is typically present only in shallow lakes. We also considered and debated the prescriptive nature of work in SSCM versus the much more descriptive nature of work on shallow lakes and their implications. Natural scientists typically focus on describing and explaining phenomena rather than prescribing and suggesting solutions (as in the SSCM field). However, while dissimilarities and limitations did not outweigh relevant similarities, dissimilarities could also yield valuable insights in the target domain. For example, we found that shifts between alternative stable equilibria of sustainable or unsustainable states occur much more abruptly, frequently, and even simultaneously in the same lake (Dokulil and Teubner, 2003) than is the case for supply chains. This discovery raises interesting future research questions about the nature of possible sustainable and unsustainable sub-systems in a supply chain.

3.2.3 Relevance assessment (Step 3)

Assessing relevance requires further refining the many insights gathered in the image mapping process to discern what specific insights gathered from shallow lakes lead to impactful new knowledge. Exact procedural steps to meet these two criteria are idiosyncratic and difficult to describe. In our illustration, many insights that were aligned with our study's objectives were entertained briefly and then dismissed because they failed to meet the basic theory development criterion of being *interesting*. That is, they were incapable of denying the audience's assumptions and had no impact beyond the study at hand or the considered target domain (Davis, 1971).

We achieved this goal by addressing *Q3(a)* and *(b)* as to whether analogical insights are aligned with a study's purpose and have the potential to inform theory beyond the study at hand. Our focus on the study's purpose led to the dismissal of many irrelevant insights gained from shallow lakes, such as those related to the chemical compositions of sustainable versus unsustainable lakes. This elimination further ensured that the applied subjective imagination (see Step 2) did not result in naïve analogical reasoning, and ultimately led to a distillation of shared elements that meaningfully contribute to SSCM (Jermier and Forbes, 2011). For example, a relevant finding was that lakes are either turbid (unsustainable) or clear (sustainable), with no in-between grades. If this element is held in common with supply chains, interesting implications follow for the way we view SSCM as lending support to the notion that sustainability in supply chains should not be viewed as a continuous variable (i.e. viewed in terms of more or less sustainable operations) (Pagell and Shevchenko, 2014). That is, "reducing environmental harm is *not* sustainability" (Markman and Krause, 2016, p. 4; emphasis in original). Additionally, lakes provide useful guidance and inspiration in developing an understanding of difficulties and compounding factors – hysteresis and heterogeneity – that keep supply chains from transitioning into a sustainable stable state.

3.2.4 Proposition drafting (Step 4)

This step requires communicating the identified relevant and potentially most insightful elements shared between shallow lakes and SSCM (see Step 2). Propositional representations that summarize and describe gathered insights best achieve this goal [see *Q4(a)*]. Indeed, many of the most interesting analogies might seem impractical until they can be expressed as meaningful propositions, which are then connected to established theory. In this step of the analogical reasoning process, we also questioned the empirical adequacy of gathered and distilled insights [see *Q4(b)*]. Propositions lay the groundwork for future theory development, but only if the imagery conveyed by the propositions has the potential to be sharpened into theory formulations and testable hypotheses (Cornelissen, 2005; Weick, 1989; Morgan, 1983). In Table 1, we offer illustrative propositions based on identified shared elements between shallow lakes and SSCM that could lead to future operationalization and empirical testing.

3.3 Synthesis

The few studies that refer to steps (particularly across Research Stream 1) often imply a linear approach to analogical reasoning. However, we suggest that the process is iterative and that the order of steps is subject to some flexibility (Literature Stream 2 supports this notion). More specifically, as shown in Figure 2, the first three research steps are iterative in nature, with proposition drafting (Step 4) being both part of the process and an outcome of

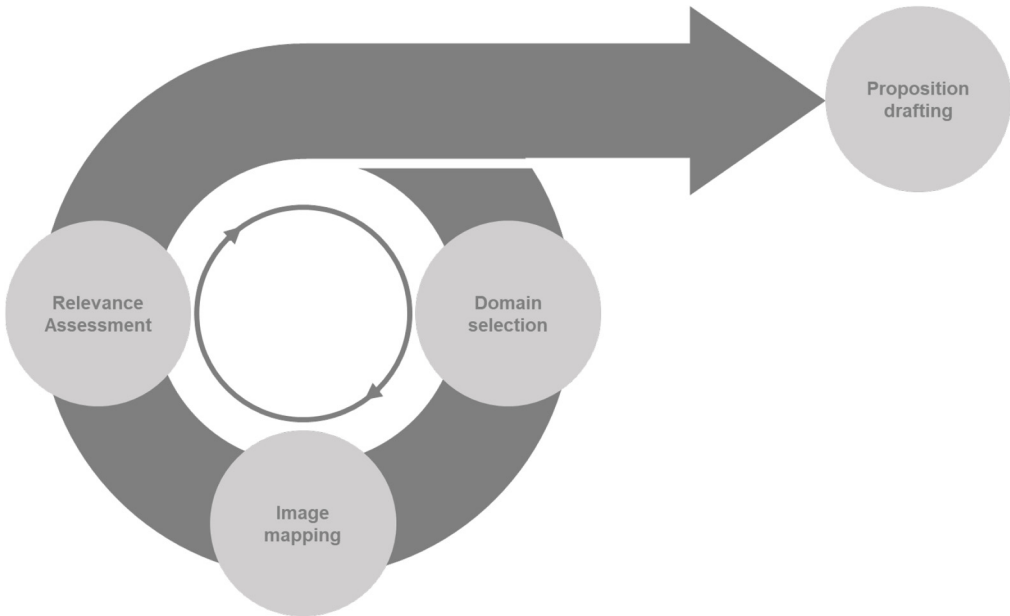
Table 1 Propositions on shared elements between shallow lakes and sustainable supply chain management (SSCM)

Element	Proposition	Explanation and justification
Alternative stable equilibria	P^1: Supply chain systems do not oscillate between states of sustainability and unsustainability, or become sustainable to different degrees, but transition and lock into a sustainable stable state	• In shallow lakes, the concept of alternative equilibria refers to typically abrupt changes between different stable states. The clear (sustainable) stable state describes lakes with clear water and rich vegetation. The turbid (unsustainable) stable state happens if lakes switch from a clear state to one dominated by phytoplankton (Dokulil and Teubner, 2003) • In a supply chain context, most studies focus on activities that support incremental sustainability increases. These studies usually view sustainability as a continuous variable, i.e. in terms of greater or lesser sustainability. Alternative equilibria in shallow lakes, however, foster an understanding of how and why supply chain sustainability should be seen as a categorical variable (i.e. as either sustainable or unsustainable) • The existence of alternative stable equilibria supports the claim that "reducing environmental harm is not sustainability" (Markman and Krause, 2016, p. 4). Instead, at the core of any transition is the notion of a stable (even resilient) sustainable state
Hysteresis	P^2: Hysteresis slows down, and thus negatively affects, supply chains' transition to a sustainable stable state	• Hysteresis describes inertia, or the delay between an input and an output. In shallow lakes, hysteresis is associated with a transition from one steady-state equilibrium to another. In the context of clear and turbid lakes, hysteresis describes the phenomenon whereby, once turbid, simply restoring the environmental conditions that existed before the transition is insufficient • In a supply chain, hysteresis is related to effects of irreversibility and path dependencies. Once a supply chain is in an unsustainable stable state, it will exhibit hysteresis (i.e. resistance). Changing operating conditions – even if these are intended to facilitate a transition to sustainability – will not easily create a sustainable stable state • Hysteresis illustrates the importance of full commitment to reversing unsustainable supply chain practices or committing to full sustainability from a firm's inception
Heterogeneity	P^3: Heterogeneity slows, and thus negatively affects, supply chains' transition to a sustainable stable state	• Heterogeneity describes the connections among and between organisms and their environment. Lakes are not isolated homogenous systems; most are connected through streams and channels (Scheffer, 1998) • In a supply chain, heterogeneity refers to both diversity of trading partners and diversity in interdependency and cooperation. Diversity of interests, for example, can create an obstacle to the generation of a sustainable stable state. Just as bio-manipulation efforts (aimed at rendering lakes more sustainable) are often easier to realize in more homogenous lakes, simpler, more local supply chains could more easily reach a sustainable stable state • Heterogeneity illustrates the importance of understanding diversity and complexity in transitioning to sustainable supply chains. If homogeneity cannot be achieved, unraveling the mechanisms and components that comprise spatially extensive (often global) supply chain systems is key

Steps 1–3. We also note that the framework is not exhaustive, as other steps or sub-steps could be introduced. Nevertheless, providing a guiding framework is valuable as the research steps anchor the analogical reasoning process.

In Figure 3, we provide an overview of each step and how it might be applied in the SSCM context. By approaching the field of SSCM and natural ecology simultaneously through juxtaposed images, we demonstrate how the research steps can be used to develop new supply chain knowledge necessary to challenge conventional worldviews and negotiate the environmental sustainability imperative. However, the research steps apply beyond an SSCM context. As our illustration of the steps reveals, the four steps are not only distinct (despite a possible back and forth between Steps 1 and 3) but also equally important, as they inform one another. Thus, all steps should be followed to maximize the chances of developing meaningful

Figure 2 Illustration of the iterative nature of analogical reasoning research steps



new theory and fostering the emergence of a foundation for knowledge creation in the early, more creative discovery stages of theory development (Swedberg, 2014).

4. Key contributions

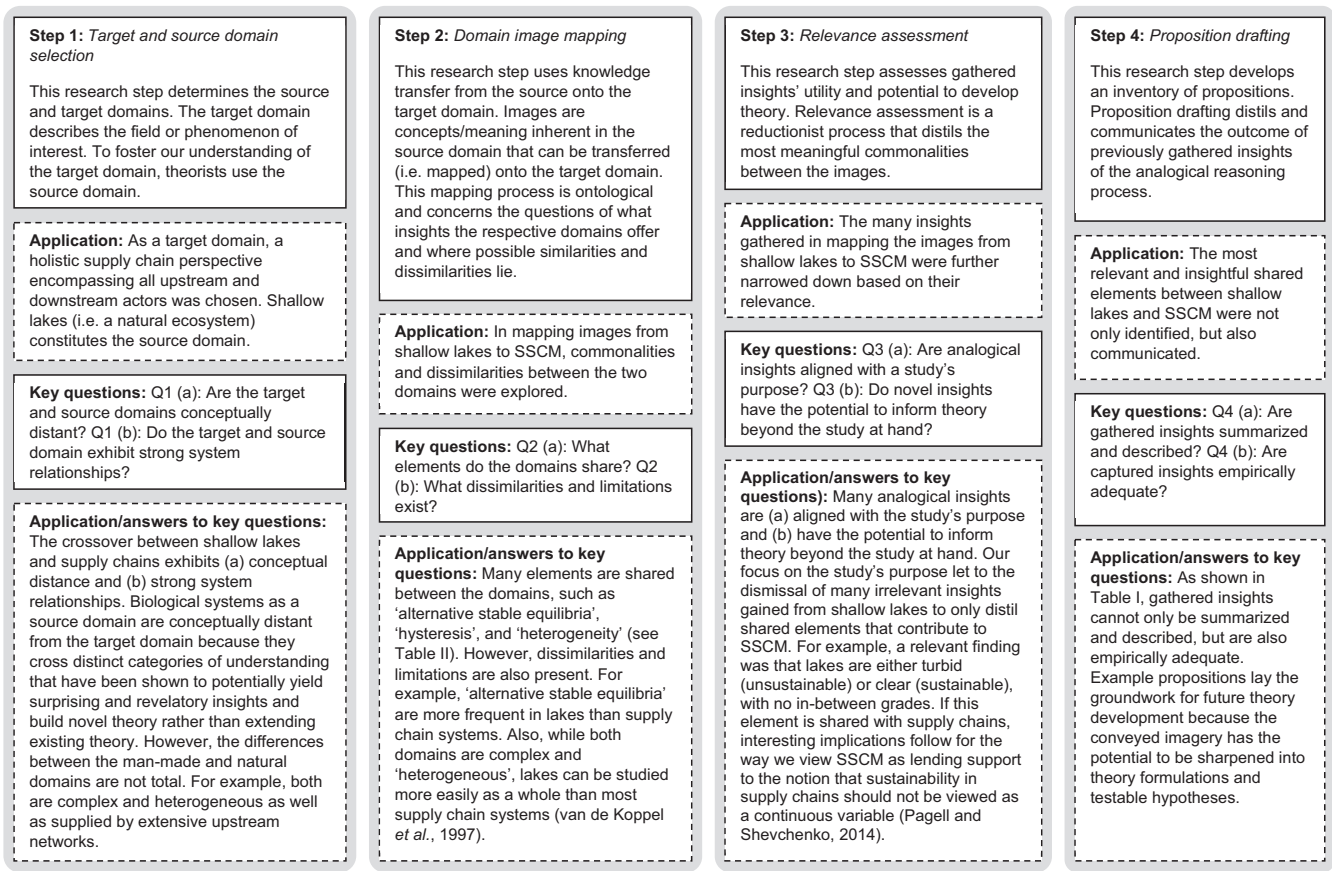
Our work makes several contributions to theory. First, our literature review allowed us to distil procedural guidelines for the development of novel analogies. These guidelines can help scholars in forming analogies with rigor and structure. Prior guidelines are piecemeal and disjointed, which likely contributes to analogies' "flaky reputation among scientists" (Von Ghyczy, 2003, p. 90). This shortcoming is surprising given the rich body of literature concerned with the nature and use of analogical reasoning as well as analogies' widely recognized potential in igniting creative thinking and idea development (Morgan, 2011). Theory can originate from analogical reasoning as much as from equations. Einstein's theory of relativity, for example, began as an analogy where he imagined how the world (i.e. the target domain) would appear to an observer riding a beam of light (i.e. the source domain) (Von Ghyczy, 2003). Against this background, our work aims to generate more attentive, self-reflective and programmatic analogical reasoning efforts that challenge existing knowledge and aid researchers in developing new theory (Suddaby *et al.*, 2011).

Second, we showcase the proposed procedural guidelines through the analogical mimicry of a natural ecosystem, a normative and nature-centered analogy that holds the potential to lead to deeper reflection about human–nature relationships and new insights and theory about organizations negotiating the environmental sustainability imperative. Indeed, analogical reasoning can help orchestrate a move away from deeply ingrained, instrumentally rational analogies (e.g. "organizations as machines") originating from neoclassical economic paradigms [4]. In line with other studies (Shrivastava, 1995b; Gruner and Power, 2017; Allenby, 2006), we demonstrate how SSCM can be reshaped by analogical reasoning and potentially reverse unsustainable practice (Banerjee, 2003). In the absence of analogical reasoning guidelines and example applications, SSCM scholars have largely forfeited an opportunity to introduce meaningful new theory through analogies. As a corollary, we bridge two research streams, one focusing on the potential of analogical reasoning to enrich organizational theory and the other consisting of practical applications of analogical reasoning to build knowledge about specific organizational processes (see the Appendix).

Third, we take stock of and interpret what we know about analogical reasoning in the organizational literature, leading to identification of many promising research questions. Such future endeavors are timely, given mounting calls for more creative theorizing efforts in SSCM and for work on the creative potential and use of analogical reasoning in both a broader organizational context (Chen *et al.*, 2013; Foropon and McLachlin, 2013) and an organizational sustainability context (Audebrand, 2010; Jermier and Forbes, 2016). Consequently, the research agenda we present aims to stimulate novel approaches to questions concerned with reversing the negative consequences of many unsustainable business practices (Grant and Oswick, 1996; Matthews *et al.*, 2016).

These theoretical contributions also provide our study with practical implications. Foremost, in developing guidelines, we pave the way for more purposefully used analogies and thus managerial insights, such as those illustrated in our application of the four steps (see Figure 3). The research steps could provide a starting point for managers who are keen to reason by analogy to generate new business strategies. The aim is not to find the "right" analogy, but to catalyze strategic thinking through exposure to diverse domains. Further, the work of gathering insights from a seemingly unrelated field (i.e. the source domain) can lead to novel insights and potentially a "normative leap" (Schön, 1979) that not only answers calls for more creative and sophisticated SSCM theory, but can also guide decision-makers toward action (Touboulic and Walker, 2015; Beske and Seuring, 2014).

Figure 3 Overview of the procedural guidelines and their application in a sustainable supply chain management (SSCM) context



Analogies not only support scientific exploration but also augment everyday thinking that influences thinking about organizations. New and unorthodox practices may emerge through encouragement of a search for unexpected combinations (pertaining to different domains) to overcome "functional fixedness" and imagine that which is not (Jermier and Forbes, 2016; Bouquet *et al.*, 2018). As the turbulence and supply chain disruption brought about by the COVID-19 pandemic demonstrate, such innovative theory-building efforts are more needed than ever. Indeed, at the time of writing (April 2020), emerging data increasingly show that, despite many past supply chain disruptions associated with natural disasters, the COVID-19 pandemic still caught most companies unprepared (Choi *et al.*, 2020).

Our guidelines can also be useful for reflecting on the images managers use in their daily activities – for instance, by creating awareness of the role largely unsustainable analogical thinking plays based on "organizations as machines" (Morgan, 2006). Our work can aid supply chain managers in generating novel analogies and can illuminate the potential meanings of current analogies (Schoeneborn *et al.*, 2016). Managers could then replace images that yield unintended and counterproductive effects, such as those that neglect the natural environment. In this respect, our guidelines might also aid managers in thinking about ways to redesign certain *modi operandi* or in using analogies to strategically communicate with stakeholders about organizational goals.

5. A research agenda for analogical reasoning

An interesting research opportunity arises from a tension inherent in our study: our definition of the target domain as collaborative efforts between trading partners to bring about *incremental* environmental improvements, and Proposition 1, which advocates a view whereby supply chains are either sustainable or not (see Table 1). Could generating other novel analogies help resolve this tension and shed light on the question of whether – and to what extent – sustainability has to happen on a spectrum? To what extent (if at all) does this insight extend to related notions, such as supply chain disruption? Indeed, as we note, the supply chain disruption accompanying the COVID-19 pandemic exposed shortcomings in supply chain systems around the world, including supply shortages in the medical sector (Ranney *et al.*, 2020). These revelations underscore the need for novel analogical insights beyond the sustainable management of supply chains.

More research avenues lie within well-established and often hidden analogies, although *challenging* such analogies through an exogenous critique can call into question the foundation of entire research paradigms (Ketokivi and Mantere, 2010). Nevertheless, a case can be made for revisiting and contesting often outdated and taken-for-granted theoretical assumptions and analogies. Gkeredakis and Constantinides (2019), for example, argue that covert and outdated analogies should be revisited in light of emerging digitally enabled coordination phenomena. We concur that digitally enabled coordination (the internet of things, artificial

intelligence and blockchain) among trading partners manifests a different type of interdependence that often does not reflect present organizational theories, thus also rendering many existing metaphors obsolete.

Additionally, researchers could further test our suggested procedural guidelines. Although we apply the guidelines to develop a novel analogy, whether the procedural steps can be fruitfully applied to test the value of existing analogies remains unclear. The question arises as to whether applying our research steps to prior studies yields insights by extending and challenging previous results and theory while generating knowledge on how best to use, extend and adapt the proposed procedural guidelines. In exploring the few studies that adopt analogies in an SSCM context, we found stark differences in the centrality of analogical reasoning (see the Appendix). This centrality affects the extent to which formal steps have been followed in transferring knowledge from one domain to another. Although not all steps matter equally, we suspect that if our guidelines had been considered and the studies' analogical reasoning presented in a more structured fashion, the results could have added to the studies' rigor and replicability and yielded additional insights. Consider potential dissimilarities and limitations between source and target domains. Clearly, an analogy's value is subject to the validity of the similarity mapping between source and target domains as well as the quality of the insights that emerge, although dissimilarities might also yield insights. The iceberg analogy, for example, can illustrate the often invisible adverse impact of lower tier trading partners on social and environmental dimensions (Meinlschmidt *et al.*, 2018), but do dissimilarities between the iceberg and lower tier trading partners in a supply chain also matter? (see *Q2(b)* in Figure 3). Similarly, whether target and source domain exhibit strong system relationships often remains unaddressed (see *Q1(b)* in Figure 3). However, if these issues are not considered, analogies can lead to superficial mappings, where readily available and shallow similarities then lead to conclusions. This phenomenon has been explored in the context of managers' strategic decision-making and cognitive psychology (Gavetti *et al.*, 2005), but to a lesser extent in an organizational theorizing context. In Table 2, we summarize additional research opportunities across three broad categories, each associated with distinct research questions.

5.1 Established analogies' role in sustaining unsustainable organizational practices

In focusing on the deliberate introduction of novel analogies, researchers neglect the role of often hidden established analogies in creating and sustaining current, *un*sustainable *modi operandi*. Indeed, some authors argue that much discourse on key environmental issues rests on a few pervasive analogies that carry profound implications (Romaine, 1996). In this vein, a departure from analogies that currently pervade organizations' ethos could help avert ecological crises (Starkey and Crane, 2003; Audebrand, 2010). Two such pervasive "unsustainable" analogies repeatedly emerge in the literature. For example, the machine analogy (leading to a mechanical view of a supply chain) has been faulted for holding back managers' thinking about sustainability-related actions. A mechanical view of supply chains can lead to the perception of organizations as structures of interrelated parts, as having inputs that are converted into outputs, and as employing people that become cogs in wheels (Morgan, 2011). This view is in line with a neo-classical manufacturing and goods-dominant logic whereby organizations can be engineered to maximize profits and create wealth. In contrast, this paper advocates a view that organizations can symbiotically co-exist with their natural environments. Managers who regard organizations as machines are more likely to adopt a worldview that sees nature as exploitable and instrumental (Morgan, 2006). We thus encourage researchers to explore and question this and other dominant analogies – such as the war analogy – as part of a wider network of analogies that includes individualism, patriarchy, mechanism and progress (Jermier and Forbes, 2011).

5.2 Pluralistic use of analogical imagery

In our illustration of the outlined research steps, we approach the field of SSCM and natural ecology simultaneously through juxtaposed images from two domains. We demonstrate how analogical reasoning can generate new and prescriptive insights about supply chains by negotiating environmental sustainability and thus counter supply chains' anthropocentric paradigmatic underpinnings. However, our illustration for the development of SSCM is limited to one source domain – nature – and one natural ecosystem – shallow lakes. Any single analogy is "capable of creating valuable insights, but is also incomplete, biased, and potentially misleading" (Morgan, 2006, p. 5). A way of seeing is always also a way of not seeing, by closing off alternative ways of seeing (Morgan, 2011). And no single analogy is best (Keulartz, 2007).

Unlike natural ecosystems, such as lakes, humans are involved in supply chain decisions that confront a host of issues, such as biases, opportunism and agency. Perhaps not surprisingly, some authors criticize the use of natural ecosystems to understand organizations by pointing out that firms are not biological systems but institutions created and maintained by human beings (Penrose, 1952). Therefore, future research should consider many more source domains – including but not limited to the realm of natural ecology – with strong inductive links that can challenge familiar (unsustainable) images of organizations and networks. Similarly, scholars could consider different target domains. Even for scholars focused on SSCM, analogical reasoning efforts aimed at differentially addressing the three dimensions of the triple bottom line will likely prove fruitful. We hope our suggested principles bring about rich future theorizing via different source and target domains that give rise to a more complete SSCM theory.

5.3 Empirical research and consequences

As noted, inadequate and incremental SSCM theorizing efforts are partly the result of scholars' tendency to cling to established methods (Matthews *et al.*, 2016). We also contend that SSCM theory is inadequate because empirical theory testing has begun to outpace the field's conceptual advances before a solid conceptual basis has been built: "When scholars regard validation as the best test of a theory's value, preliminary steps to this stage can be degraded" (Jermier and Forbes, 2011, p. 450). Although for now we view conceptual contributions as more significant than empirical research in advancing analogical reasoning in SSCM, ultimately, validation through empirical data is in order (Oswick *et al.*, 2011). Such theory-testing efforts might be useful to assess the link between analogical reasoning and different outcomes, both within SSCM and extending beyond sustainability-related implications. These explorations should include immediate firm

Table 2 Research agenda

Topics	Research questions
Established analogies' role in sustaining *un*sustainable organizational practices	• How are established analogies associated with a worldview where environmental degradation is rationalized as normative reality? • To what extent is our thinking still captured by anthropocentric worldviews and analogies that are conducive to incremental change, thus marginalizing radical perspectives on change needed for the development of SSCM? • How do the established machine analogies act as obstacles to more SSCM? • What role does a wider network, or system, of multiple analogies play in sustaining and perpetuating unsustainable *modi operandi*? • As analogies can lead to action through new ways of seeing, when and how can we best reappraise existing analogies and thus current unsustainable ways of seeing and operating? • What source domains (other than nature) challenge entrenched organizational analogies, such as long-held neoclassical views of the organization as a machine, which promotes operational effectiveness and efficiency above all else
Pluralistic use of analogical imagery	• What research fields should be invoked for future cross-disciplinary analogical reasoning in an SSCM context? Promising research fields encompass a wide range of both social and natural phenomena pertaining to geography, cultural, environmental and sensory studies – among others • What specific source domains are most promising in advancing organizational practices and SSCM theory? Source domains include human senses, natural phenomena/ disasters, musical compositions and even theory itself • What role does the interplay of different source domains/analogies and the notion of human agency play in creating a more holistic understanding of SSCM theory via analogical reasoning? • What insights does analogical reasoning produce if different target domains are considered (how do different ones benefit the dimensions of the triple bottom line)? • Could different analogies push different sustainability-related agendas?
Empirical research and consequences	• How can empirical assessments complement the inductive component of analogical reasoning? • Can analogical reasoning in SSCM be validated through empirical research? • How can analogical reasoning best be tested empirically while taking into account its rich, multidimensional nature (including an interplay of imagery from potentially multiple source domains)? • How can analogical reasoning be measured across cultures and industries? • What is the relationship between analogical reasoning and different (short- and long-term) outcomes related specifically to SSCM, the triple bottom line and more broadly extending beyond sustainability-related implications?

outcomes as well as an assessment of how these outcomes influence customers both up- and downstream.

In conclusion, while the use of analogies to advance science has long been encouraged, guidelines for their development have been largely neglected. In proposing such guidance for the introduction of novel analogies, we foster a more systematic and thoughtful use of analogies to expand organizational knowledge and cultivate new theory. By matching and mapping diverse domains and insights, analogical reasoning invites innovative learning and discovery at an abstract level with practical implications.

Notes

1 Shallow lakes are permanent standing water bodies that are sufficiently shallow to allow light to penetrate to the bottom. Shallow lakes are among the most abundant natural ecosystems in the global landscape and are well understood compared to oceans, forests, and other natural ecosystems (Scheffer and van Nes, 2007).

2 Manual additions are necessary because the outlined review approach is limited to keyword searches in studies'

titles and abstracts and can thus miss important contributions to a field (Pittaway *et al.*, 2004). Important manual additions include work on developing sustainable organizations via analogical reasoning (e.g. Kopnina, 2016; Barter and Russell, 2013) and work that predates 1980 (e.g. Penrose, 1952).

3 Audebrand (2010, pp. 419–421) offers a more detailed overview of the stewardship as well as other popular analogies for the sustainable management of organizations, such as the gardening and earth as a lifeboat metaphors.

4 Some scholars support this move away from rational analogies (e.g. Jermier and Forbes, 2016). Shrivastava (1995b), in particular, has long lamented scholars' practice of advancing images that frame organizations as severed from natural ecosystems, putting forth an analogy of a "castrated environment."

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Appendix

Table A1 Identified thematic streams and selected sources

Author(s)	Title	Study type	Source and target domain (s)	Analogy's role	Key insights	Topics covered		
						Sustain-ability	SCM/ OM	SSCM
Stream 1: Selected studies that explore analogies' role in advancing organizational theory								
Audebrand (2010)	Sustainability in strategic management education: The quest for new root metaphors	Conceptual exploration/ essay	War and organizational sustainability	The war analogy is reappraised for its impact on sustainable strategic management education	The war analogy constitutes a root metaphor that creates a bias toward adversarial business relationships that negatively influence firms' sustainability. The development of analogical pluralism is encouraged to guide management education toward new perspectives on running sustainable businesses	Yes	No	No
Boxenbaum and Rouleau (2011)	New knowledge products as bricolage: metaphors and scripts in organizational theory	Conceptual exploration	Analogies and novel organizational theory	Analogies are one of three building blocks that enable the conception of new theory	Analogies play a role in the conception and presentation of new theories. The authors suggest that scholars evoke many different analogies, which can then be assembled and integrated with theoretical concepts and empirical material through three epistemic scripts of knowledge production	No	No	No
Chen *et al.* (2013)	Theorizing through metaphorical transfer in OM/SCM research: Divorce as a metaphor for strategic buyer-supplier relationship	Theory development	Divorce and supply chain management	Divorce and buyer–supplier relationship dissolution serve to illustrate the value of analogical reasoning	The divorce analogy can shed light on issues such as asset division, breach of contract, warranty support and complexity. However, the divorce analogy is only an example to illustrate that formal analogical transfer (beyond illustrative/ rhetorical purposes) between source and target domain can be invaluable in building SCM/OM theory	No	Yes	No
Ehrenfeld (2003)	Putting a spotlight on metaphors and analogies in industrial ecology	Review/ editorial	Ecology/biology and organizational sustainability	The ecological/biological analogy is explored as the foundation of the field of industrial ecology	The concepts of a simile, analogy and metaphor are often confused in industrial ecology. However, distinguishing between these concepts is important to understand the origins and potential consequences of industrial ecology	Yes	No	No

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Table A1

Author(s)	Title	Study type	Source and target domain (s)	Analogy's role	Key insights	Topics covered		
						Sustain-ability	SCM/ OM	SSCM
Foropon and McLachlin (2013)	Metaphors in operations management theory	Literature review/ theory development	Organism/ political system/ machine and ISO 9,000 implementation	Analogy's role in organizational and supply chain management theory building is explored. Analogical reasoning is then applied to ISO 9000 implementation	Analogies can play a crucial role in knowledge generation in SCM/OM, particularly in the early stages of theory development. Managers' images (i.e. organismic, political or mechanistic analogies) of ISO 9000 candidate organizations differentially influence their approach to quality management during the ISO 9000 implementation process	No	Yes	No
Jermier and Forbes (2016)	Metaphors, organizations and water: Generating new images for environmental sustainability	Conceptual exploration	Water exploiters/ keepers and organizational sustainability	Morgan's (2006) analogy of organizations as instruments of domination is extended to develop an analogy that is normative and more nature-centered ("organizations as water keepers")	"Organizations as water keepers" is an analogy developed to change thinking and practice related to environmental sustainability, particularly issues related to water conservation. This new analogy helps organizations move away from underlying assumptions of anthropocentrism (including its underlying analogies) to a more inclusive eco-centrism perspective	Yes	No	No
Ketokivi *et al.* (2017)	Reasoning by analogy and the progress of theory	Conceptual exploration	Analogies in organization theory are explored broadly without relying on specific ones	The use of analogies in organization theory is examined and evaluation criteria for analogical reasoning are developed	Analogies are methodological tools that constitute the basis of much theorizing in organization studies. However, analogies should not be taken for granted, but deliberately developed and evaluated (with the help of here presented criteria) in their impact and usefulness to our discipline	No	No	No

(*continued*)

Table A1

Author(s)	Title	Study type	Source and target domain (s)	Analogy's role	Key insights	Topics covered		
						Sustain-ability	SCM/ OM	SSCM
Morgan (2011)	Reflections on images of organization and its implications for organization and environment	Conceptual/ invited commentary	Morgan's images of organization and management/ sustainability	The author of *Images of Organization* (1986) – a popular framework for understanding and using analogies in organizational studies – reflects on the framework's use over the years (including in the context of sustainable operations)	In a sustainability context, analogical reasoning has much potential that remains, to date, often under-used. In particular, more eco-centric analogies (e.g. cradle-to-grave, life-cycle models) can help move away from an overly anthropocentric worldview where self-interest over nature's needs has become part of the very fabric and functioning of modern organizations	Yes	No	No
Stream 2: Selected studies that adopt analogies to explicate and/or build organizational knowledge						Topics covered		
Clarke *et al.* (2014)	Re-imagining the growth process: (co-) evolving metaphorical representations of entrepreneurial growth	Conceptual exploration	Biology and entrepreneurship/ sustainability	Growth analogies derived from biology are assessed for their impact on entrepreneurial economic growth as well as more sustainable *modi operandi*	The analogy of co-evolution has been under-used but is valuable in enriching our understanding of organizational growth. Specifically, the analogy of co-evolution can help shift operations toward more inclusion, with the result that entrepreneurial firms' growth necessitates a parallel evolution of the environment as much as trading partners and even competitors	Yes	No	No
Garud and Kotha (1994)	Using the brain as a metaphor to model flexible production systems	Conceptual exploration	(Human) brain and manufacturing flexibility	The brain serves as an analogy to explicate how organizations might design flexible production systems	Drawing on an exploration of two contrasting operations (the brain and organizational production), the authors suggest that organizations should move away from localized sequential processes to distributed ones occurring in parallel if they are to successfully design flexible production systems	No	Yes	No

(*continued*)

Table A1

Author(s)	Title	Study type	Source and target domain (s)	Analogy's role	Key insights	Topics covered		
						Sustain-ability	SCM/ OM	SSCM
Gond *et al.* (2009)	Reconsidering instrumental corporate social responsibility through the Mafia metaphor	Conceptual exploration	Italian Mafia and corporate social responsibility/ social welfare	The Mafia crime organization is evoked and sociologically explored to draw inferences about the behavior of legitimate organizational practices	Parallels can be drawn between behavior and drivers in the Mafia and legal organizations, including a strong profit focus and firms' instrumental view of corporate social responsibility practices. Such analogical reasoning might help illustrate an organization's transition to an unethical and even criminal status, and can potentially help counter these trends	Yes	No	No
Gruner and Power (2017)	Mimicking natural ecosystems to develop sustainable supply chains: a theory of socio-ecological intergradation	Conceptual exploration	Natural ecosystems and SSCM	Natural ecosystem principles are derived to enable their analogical mimicry and provide guidance in developing more sustainable supply chains	Although not without its limitations, natural ecology and its operating principles – such as system locality, heterogeneity and interdependence – can provide valuable guidance for manager and scholars concerned with developing more sustainable supply chains	Yes	Yes	Yes
Lewis and Brown (2012)	How different is professional service operations management?	Qualitative in-depth case study	Medical analogy and service operations management	The medical analogy is included to aid in understanding professional service interactions as a process of diagnosis, inference and treatment	Professional service operations management theory is refined. The medical analogy helps in doing so ex ante, mainly through parallels drawn between the diagnosis and a previously in the literature identified high degree of service process "variation" and a relatively slow "throughput time"	No	Yes	No

(*continued*)

Table A1

Author(s)	Title	Study type	Source and target domain (s)	Analogy's role	Key insights	Topics covered		
						Sustain-ability	SCM/ OM	SSCM
Matos and Hall (2007)	Integrating sustainable development in the supply chain: the case of life cycle assessment in oil and gas and agricultural biotechnology	Qualitative; two case studies	Fitness landscape/life-cycle assessment and sustainable development in the supply chain	Fitness landscape/life cycle assessment concepts are borrowed from biology and used to illustrate the complexity inherent in sustainable development	The authors propose (and test) a framework to help managers tackle sustainable development challenges; a rugged landscape was found to represent the most suitable approach to search for high performance across environmental, social and economic parameters. The framework also aids in assessing whether a life-cycle assessment is appropriate	Yes	Yes	Yes
Meinlschmidt *et al.* (2018)	Tackling the sustainability iceberg: a transaction cost economics approach to lower tier sustainability management	Qualitative; multiple case studies	Iceberg and suppliers' sustainability business conduct	The iceberg is used to illustrate that with respect to unsustainability in the supply chain the biggest threats often remain invisible (i.e. what is seen is the proverbial "tip of the iceberg")	An approach for the management of suppliers' sustainable conduct is suggested. This approach can help buying firms "tackle the sustainability iceberg" by managing their lower tier sustainability where much of supply chain's environmental and social burden occur	Yes	Yes	Yes
Milne *et al.* (2006)	Creating adventures in wonderland: the journey metaphor and environmental sustainability	Literature review/ conceptual exploration	Journey and organizational sustainability	The limitations of the journey analogy are explored in influencing sustainable organizational action	"Sustainability" is often constructed as a journey to avoid specifying goals Specifically, the journey analogy leads to a view of sustainability as a rather undefined process instead of a particular end state that sidesteps debate about how to change course	Yes	No	No

(*continued*)

Table A1

Author(s)	Title	Study type	Source and target domain (s)	Analogy's role	Key insights	Topics covered		
						Sustain-ability	SCM/ OM	SSCM
Radnor and Boaden (2004)	Developing an understanding of corporate anorexia	Qualitative multiple case studies	Health/human body/anorexia and organizational leanness	The analogy of corporate anorexia helps understand the outcomes of organizational efforts to become lean (i.e. efforts to improve the utilization of organizational resources)	A diagnostic tool is developed and applied to a set of organizations to assess their state of "health," which contributes to our understanding of corporate change processes particularly regarding firms' attempts to become leaner	No	Yes	No
Shrivastava (1995a)	Ecocentric management for a risk society	Conceptual exploration	Ecology and organizational sustainability	Parallels are drawn between natural and industrial ecosystems to provide the foundations for a more eco-centric management paradigm	Natural ecosystems inform the proposed eco-centric paradigm that aims to create sustainable economic development by rejecting an anthropocentric worldview based on notions of perpetual growth and the exploitation of environmental resources. In other words, this paradigm aims for a harmonious co-alignment between organizations and the natural environment	Yes	No	No
Srinivasan and Tew (2017)	Supply chain immune system: concept, framework and application	Conceptual exploration	Biological immune system and supply chain risk management	Immune systems are used as an analogy to learn about and neutralize supply chain risks	An analogy-based framework – containing multiple layers of defense – to counteract different types of supply chain risk is developed to advance research on risk management processes and technologies	No	Yes	No