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Review

Critical factors for the realization of sustainable supply chain innovations - Model development based on a systematic literature review

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ABSTRACT

The challenges of sustainable development require whole supply chains and networks to drive change and innovation. However, most existing research on sustainable innovations is on a company level and the dominating company focus in practice drives "silo" approaches, short-term thinking, and profit maximization. Consequently, there is a need for research and new models that facilitate sustainable supply chain innovations. The purpose of this paper is to identify, categorize, and evaluate the importance of critical factors for the realization of sustainable supply chain innovation, and to contribute with a process model for the development of sustainable supply chain innovation. A systematic literature review and content analysis of relevant sustainable supply chain innovation literature were performed in five steps starting with (1) question formulation followed by (2) locating studies, (3) selection and evaluation, (4) analysis and synthesis, and (5) reporting and using the results. The analysis resulted in 14 main categories of critical factors. Collaboration is by far the most frequently observed main category, followed by strategic orientation, culture, practices, and political context. The paper contributes with a process model for the realization of sustainable supply chain innovation. The process model is based on a design-thinking model for innovation where the critical factors are integrated into different spaces for innovation. In practice, the model could provide managers with the most critical factors for sustainable supply chain innovation, and could provide advice on when and how to manage these factors during the innovation process. The critical factors and the process model proposed could guide further research, enabling such research to adopt more complex approaches to the development of improved guidance, and provide support for the realization of sustainable development.

Contents

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1. Introduction

To realize sustainable development (SD) drastic sociotechnical transitions are needed (Fuenfschilling and Binz, 2018; Gliedt et al., 2018; Markard et al., 2012). The appearance of emerging economies, growing global population, and increasing environmental burden calls for innovations based on all three pillars of SD (Mclellan et al., 2014; UN General, 2015). A number of researchers put forward the notion that it is no longer enough just to improve existing operations or develop incremental innovations based on existing know-how or technology (Azevedo, 2014; Hellström, 2007; Huesemann, 2003). Instead, radical innovations are needed; these typically emerge from paradigm shifts with high sustainability potential (Hellström, 2007; Adams et al., 2015) and new logics of doing business e.g., going from linear, one-way supply chains to circular supply chains (Ripanti and Tjahjono, 2019). While companies, authorities, and organizations individually engage in the creation of sustainable innovations (SI), it is when they are working together in supply chains and networks, that they manifest the greatest potential impact (De Marchi and Grandinetti, 2013; Beske and Seuring, 2014; Carter and Easton, 2011).

Involving several stakeholders can be difficult, as established sociotechnical systems often imply structural changes within existing supply chains (SC) (Markard and Truffer, 2008) and challenge present power structures. With increased transparency and public reporting of both social and environmental abuses it is a fact that major actors like H&M, Dell, BP, etc., will suffer, and sometimes heavily, if their suppliers or sub-suppliers do not work and act in sustainable ways. However, while traditional strategies have been based on risk minimization such as enhanced contracts and demands on supplier certification, to realize SD, new concepts, systems and business models involving several stakeholders are needed (Bocken et al., 2014). The concept of circular economy (Blomsma and Brennan 2017; Korhonen et al., 2018; Pearce and Turner, 1989) is a growing field of practice and research, targeting one-way, linear concepts on an SC level as well as addressing resource scarcity (Govindan and Hasanagic, 2018). As identified by Geissdorerfer et al. (2017), system design and innovations are the main drivers for fulfilling the purpose of both circular economy and SD. De Angelis et al. (2018) highlight new designs of products as well as SCs based on circular principles. However, they (ibid. p.433) conclude that "*a prolonged period of transition involving the accommodation of 'traditional, waste-based thinking' is expected before the full benefits of circular systems can take effect.*" Consequently, innovation development on an SC level to drive such transition is paramount for SD.

Working with innovation on an SC level places new and more demanding requirements on cooperation, openness and, not least, trust among the actors involved (Giguere and Householder, 2012; Nair et al., 2016), and how actors should translate sustainable innovation into practice (Lim and Sonko, 2019). Porter and Kramer (2011) highlight the potential of shared value and costs among actors, but conclude that companies predominately view value creation narrowly and emphasize short-term financial performance. Consequently, the dominating company focus, even in an SC or network context, often creates harmful imbalances from a sustainability perspective (Ras and Vermeulen, 2009) based on "silo" approaches, short-term thinking, insufficient information flow (Wolf and Seuring, 2010), cost reduction, and profit maximization (Abbasi and Nilsson, 2012; Porter and Kramer, 2011). A number of barriers have been have been reported in literature when it comes to SI in SCs e.g. cost of implementation (Drohomertski et al., 2014), political and macroeconomic factors (Jensen and Govindan, 2014), industry and organization specific barriers (Lee et al., 2014; Rossi et al., 2013) scarcity of resources and risks Tebaldi et al. (2018). These are all aspects making sustainable innovation (SI) difficult on an SC level and raises the need for identifying and categorizing critical factors to facilitate the transitions needed and overcome the barriers.

There is also a lack of knowledge when it comes to innovations on an SC level. For example, Boons and Lüdeke-Freund (2013) conclude that the knowledge of drivers for SI on a company level is much more investigated and understood than how SIs are developed in interorganizational relationships. A number of studies focusing on different aspects of SI also highlight the need for research and theory development on an SC level (Klewitz and Hansen, 2014; Karakaya et al., 2014) as well as specific concerns for sustainability related to innovation (Barth et al., 2017; Bocken et al., 2014; Silva et al., 2019). Furthermore, in the literature review by Gao et al. (2017) it is concluded that most studies are in a company context and few studies address the process of SI on an SC level, i.e., sustainable supply chain innovation (SSCI). Finally, León-Bravo et al. (2019) conclude that there is a lack of clear assessment of the main innovative actions needed for achieving sustainability.

To sum up, most existing research on SI is on a company level, and, as highlighted by several researchers there is a need for research of SI on a SC level i.e., SSCI. To our knowledge, there is little research that explores **what** critical factors are central to, and important for, the creation of SSCI, and **how** SSCI can be realized. Consequently, in line with Welford's (2000) reasoning, there is a need to develop, test, and evaluate knowledge and models that are actionable, i.e., that can contribute to the necessary transition of SCs toward a sustainable society (IPCC, 2014). This leads us to the following research question:

- *What are the critical factors for the realization of SSCIs and how can these be used to drive SSCIs?*

The purpose of this paper is to identify, categorize, and evaluate the importance of critical factors, identified in academic literature,

for the realization of SSCI, and to contribute with a process model for SSCI development to guide researchers and practitioners in increasing the scope of transitions needed for SD.

There are a number of related literature reviews focusing on SI in a SC context and, more recently, on SSCI. Earlier literature reviews mainly address sustainable SC management (SSCM). Seuring and Müller (2008) report, for example, that sustainability research within the area of SC management was dominated by green and environmental issues, and Gold et al. (2010) reviewed literature to explore SSCM as a catalyst for generating valuable interorganizational resources. Sarkis et al. (2011) introduce innovation in relation to green SCs and highlight the adoption, diffusion, and outcomes of green SC management practices. Schiederig et al. (2012) present an overview of literature on green innovation, eco-innovation, sustainable innovation, and environmental innovation up to 2010. Klewitz and Hansen (2014) analyze research within eco-innovations and SIs of small and medium enterprises. They find that innovation research including all the dimensions in the triple bottom line (economic, social, and environmental) needs further research as well as examination of the role of SMEs in sustainable SCs. Karakaya et al. (2014), analyze the literature of SI in the perspective of diffusion and call for specific theory needed for SI. Bocken et al. (2014) review SI literature from a business model perspective and introduce sustainable business model archetypes. Barth et al. (2017) review sustainable business model innovation in the agri-food sector and express the need to develop systematic approaches that include both innovation and sustainability. While the above studies focus on different aspects of SIs, they also highlight the need for research on a SC level together with specific concerns for sustainability related to innovation, i.e., SSCI. Gao et al. (2017) were the first to define SSCI and propose a conceptual framework for SSCI. Building on the work of Gao et al. (2017), Tebaldi et al. (2018) reviewed literature on the integration between innovation and sustainability thematically, i.e., they present types of industries, publication outlets, scientific methods used, type of innovation, dimensions of sustainable development. In the end, a framework is suggested based on the thematic categories. While this paper shares some similarities with the literature reviews mentioned, the unique contribution results from the identified and categorized critical factors to realize SSCIs and the proposed process model for SSCI that can guide practitioners in managing SSCI processes and for further research to test, evaluate, and develop the model and the critical factors included.

In the next section, the frame of reference explains the concept of SSCIs based on the areas of sustainable SCs and innovation. This is followed by the method in which the design and fulfillment of a systematic literature review and content analysis of SSCI are described, as is development of a process model. The results of the systematic literature review and the content analysis are presented and explained in the findings, and the proposed process model for SSCI is presented and described. The findings are further elaborated in the discussion section. Finally, conclusions are made, and implications and suggested further research provided.

2. Sustainable supply chains and innovation

The literature on sustainable SCs (Carter and Rogers, 2008; Abbasi and Nilsson, 2012) is growing, and includes key aspects such as greening suppliers, risk management, stakeholder alignment, information sharing, prioritization (De et al., 2019; Mansouri et al., 2015) and collaboration (Seuring and Müller 2008; Gold et al., 2010; Parthibaraj et al., 2018). However, the role of innovation in sustainable SCs is far less emphasized.

Innovation is widely discussed in all type of contexts (e.g., on national/regional levels (Edquist, 2006), interorganizational levels, group levels), while the dominating perspective is that of the firm (Adams et al., 2006; Crossan and Apaydin, 2010; Davila et al., 2006). One definition of innovation widely used, and chosen as basis for our research, is the OECD Oslo Manual (OECD/Eurostat, 2005, p. 46) definition: *"Innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practice."* For anything to be therefore considered an innovation it has to be widely implemented and diffused in practice and/or in commerce (see Davila et al., 2006 for definitions of innovation). Innovation can be of different types where product and process are most denoted, followed by areas such as organizational innovation, business model innovation, and management innovation (Bessant et al., 2005; Chesbrough, 2007). According to Schumpeter (1934), one of the earliest scholars in this field, innovation emerge from entrepreneurial activities leading to new products, new processes, the opening of new markets, new organizational forms as well as new sources of supply. There are a number of dynamically related general factors such as entrepreneurship, creativity, culture, top management support, etc. (Davila et al., 2006) needed to facilitate innovation and innovation processes. While the economic dimension of innovation is still predominant (Gao et al., 2017) and widely seen as the basis of a competitive economy (Porter and Ketels, 2003), the concept of innovation has also evolved into social and environmental considerations. Azevedo (2014) states that this increasing interest mainly depends on emerging economies, increasing demand for resources, and the need to decouple economic growth from natural resources.

2.1. Sustainable innovation

The concept of sustainable innovations derives from eco-innovation (Hellström, 2007), environmental/green innovation (Schiederig et al., 2012), and social innovation, and builds on all dimensions of SD. Compared to the concept of green innovation, that in the past has mostly been researched on a macro level, and eco-innovation, that has its origin in greening technology and product design SI. SI is defined by Neutzling et al. (2018, p. 3449) as *"the introduction of products, production processes, management practices, or business models, new or significantly improved, that bring economic, social and environmental outcomes."* The authors (Neutzling et al., 2018) add that cultural necessities, temporal as well as spatial aspects, are intrinsic in SI.

Literature on SI has increased since 2012 (Tebaldi et al., 2018). However, while SI includes the pillars of SD it is still within a company context providing single actors with innovation concepts that encompass the pillars but do not include the SC dimension to any great extent; neither in research nor in practice. This is true, despite the fact that research has shown that organizations with proactive approaches to collaboration with SC actors develop more successful and innovative solutions (Soosay et al., 2008; Vachon and Klassen, 2008; Nair et al., 2016). Other researchers have highlighted the need for an increased holistic view on innovations and sustainability by incorporating a triple bottom line approach (e.g., Hall, 2002; Wüstenhagen, 2008). Bocken et al. (2014) propose that companies incorporate business models practice with a triple bottom line approach in order to drive and implement SI. Sustainable business models can help companies form incentives to create SD and increase interorganizational interaction and integration. Klewitz and Hansen (2014, p. 57) suggest that: "*interaction with external actors (e.g., customers, authorities, research institutes) can ultimately increase the innovative capacity.*" Consequently, in order to drive the implementation of SI initiatives there are great potential benefits in treating it on an SC level rather than on a company level (Govindan et al., 2016). This is especially the case for

the transformation from one-way, linear SCs into circular and resource effective setups; something that Govindan and Hasanagic (2018) state requires a paradigm shift.

2.2. Sustainable supply chain innovation

The concept of SSCI is relatively new. Gao et al. (2017) report that the first papers related to SSCI were published in 2007. Govindan and Hasanagic (2018) report that governments seem to ignore SCs and keep their focus on single major actors in their sustainability efforts. It is only recently that SSCI is being defined in literature where Gao et al. (2017, p. 1530) define it from an SC innovation perspective: *If the supply chain innovation results in balanced performance of economic, social and environmental dimensions, in other words, all three dimensions have positive innovation performance. It is called a sustainable supply chain innovation (SSCI).* Tebaldi et al. (2018) thematically describe identified areas in literature related to SSCI, namely: obstacles and motivations for implementation of SI, phases of innovation that have been studied, the degree and type of innovation and finally, the sustainability dimension by which the innovations are measured. Kusi-Sarpong et al. (2019) use the term SC sustainability innovation and emphasize the importance of sustainable innovation management in SSCM. De Medeiros et al. (2014) highlight internal, interfunctional integration, and wider stakeholder integration as critical success factors for sustainable product innovation. Adams et al. (2015, p.196) adopt a standpoint in sustainability-oriented innovations and present a three stage framework: *"Beyond Operational Optimization* [stage 1] *and Organizational Transformation* [stage 2] *lies highly radical, game-changing systemic innovation that targets transforming established societal relationships and interactions between industry, consumer behavior and lifestyles, institutional orientations, and even the very aims of business."* Lim and Sonko (2019), using the framework by Adams et al. (2015), conclude that the system (SC) perspective adopted by their case company is central to the realization of sustainable innovations. Finally, Geissdoerfer et al. (2018) propose circular SC management and highlight the need for innovations to not only be technological but social and organizational, if the sustainability paradigm shift needed is to happen.

To sum up, the field of SSCI is an emerging field of research and practice, with its roots in, and influences from, areas such as SD, innovation, SI, SSCM, and circular economy. Consequently, as claimed in literature (e.g., Adams et al., 2016; Gao et al., 2017; Tebaldi et al., 2018), there is a clear need for both theory building that can guide further research (Whetten, 1989), and practical actionable models for practitioners to test, use, and develop further. Based on our analysis of literature, for the rest of this paper SSCIs are defined as innovations realized in an SC context that explicitly covers all three pillars of SD, while SIs are defined as innovations realized in a company context that explicitly covers all three pillars of SD.

3. Methodology

The research motivation behind this research study grew from a five-year (2012–2017) research and innovation project with the aim of creating sustainable SC innovations within the food sector (DynahMat, 2017). This led to some preliminary research questions, and a narrative literature review (Rousseau et al., 2008) on sustainable innovations in an SC context was initially performed. The narrative review led to further specification of the purpose and the design of a systematic literature review (see Fig. 1 for an illustration of the overall research design). The design of the systematic literature review followed Denyer and Tranfield's (2009, pp. 671–672)

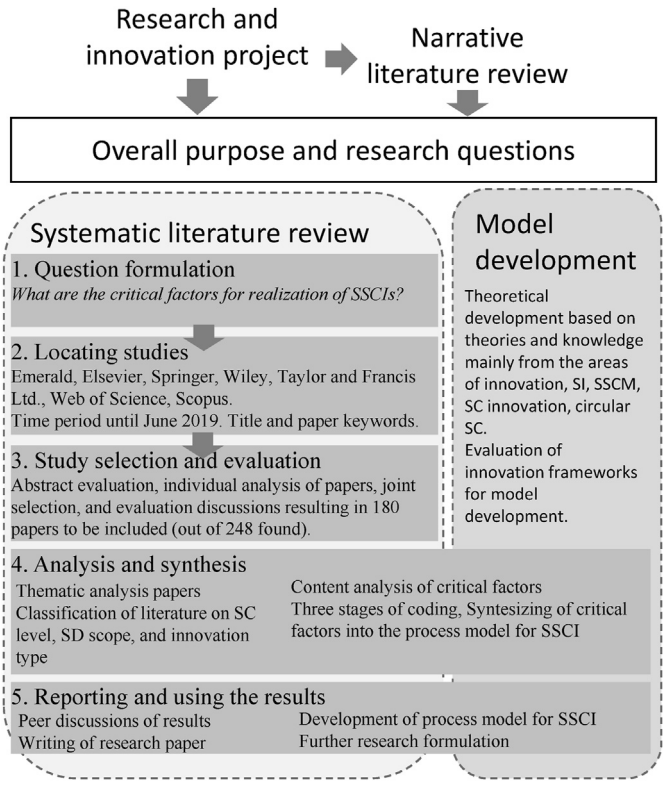

Fig. 1. The overall research design.

template, involving five sequent steps; (1) question formulation, (2) locating studies, (3) study selection and evaluation, (4) analysis and synthesis, and (5) reporting and using the results. From this process, the critical factors of SSCI realizations were identified, evaluated, and categorized. In order to *contribute with a process model for SSCI development,* the development of the model was carried out in parallel based on the theory building frameworks of Wacker (1998), Whetten (1989) and van Aken et al. (2016) and, in the final steps, as a synthesis of the systematic literature review (Rousseau et al., 2008).

3.1. Systematic literature review

3.1.1. Step 1 - question formulation

The narrative literature review entailed the importance of a paradigm shift from (almost only) incremental to radical innovations, in both research and practice (Azevedo, 2014; Gao et al., 2017; Hellström, 2007; Huesemann, 2003; Klewitz and Hansen, 2014). Literature explains that a radical SI can only be created by including all of the pillars in the "triple bottom line" (people, profit, and planet) (Elkington, 1998; Hellström, 2007). Furthermore, Klewitz and Hansen (2014), Gao et al. (2017), and Tebaldi et al. (2018) debate that SI must go beyond the single firm perspective, take a more holistic perspective and include the whole chain, to increase competitive advantage and level of sustainable solutions. However, there is little research that explains how to enable such SSCI. As a result, aligned with the overall purpose and research questions of this paper, the systematic literature review set out to synthesize existing knowledge of SSCI and in particular answer the research questions: *What are the critical factors for the realization SSCIs?*

3.1.2. Step 2 - locating studies

Based on insights from the narrative literature review, a set of keywords was generated to locate studies to be included in a systematic literature review. The keywords were separated into three categories: 1) Innovation dimension, including the keyword [*innov*]; 2) Supply chain dimension, including the keywords [supply chain*], [value chain*], and [supply network*]; and 3) SD dimension, including the keywords [sustain*], [green*], [ecologic*], [ecology*], [environm*], [social*] and [soci*]. Combining the keywords from the three categories created 30 different sets of keyword combinations. Relevant scientific literature was found by searching for scientific papers that included one of the 30 sets of keyword combinations in the title or in the subject terms (paper keywords). Searches were limited to peer-reviewed English-language documents in academic journals up to December 2019. The search engine Lund University Libraries (LUB Search) was used. The LUB Search index comprises a large basic index together with around 100 partial databases and it includes access to EBSCO databases, publisher websites (Emerald, Elsevier, Springer, Wiley, Taylor and Francis Ltd., among others), Web of Science and Scopus, and the internal databases of Lund University.

3.1.3. Step 3 - study selection and evaluation

The literature search resulted in a total of 248 academic papers. The papers were read and evaluated by both authors to properly identify relevant sources i.e., papers where the SC/network context and/or SD was explicitly treated. Papers addressing innovation (type, concept, general aspects, etc.) were also included while those in which innovation was only mentioned or not particularly addressed were removed. This resulted in 180 relevant academic papers for further analysis. Both authors have researched SCs and sustainability in various contexts. One of the authors has also innovation as a focus research area.

3.1.4. Step 4 - analysis and synthesis

The analysis of the 180 papers was conducted in four steps, mainly guided by Corbin and Strauss' (2008) data analysis procedures, but also influenced by the content analysis dimensions elaborated by Seuring and Gold (2012). The first step was a descriptive classification of paper characteristics, i.e., year of publication, journal, field of research, type of study, methods, and industry in order to provide an overview of the research field.

In the second step, a content analysis of each paper was made based on a) the organizational level in focus, i.e., company, dyadic or SC level, b) the dimensions of sustainability, i.e., environmental, economic/financial, social or combinations/all of the aforementioned, and c) type of innovation. This analysis led to a categorization of papers into different subgroups. With our focus on SSCI in this paper, the subgroup of papers addressing the SC level and all dimensions of sustainability was of particular interest for further analysis (denoted SSCI subgroup), and comparison with the other papers that either had a company or dyadic standpoint/focus and/or addressed environmental, social or financial aspects; separately or at least two of them (denoted SI/SC subgroup).

The third step covered further in-depth content analysis of each paper to identify critical factors for realization of SSCI and, from that, contribute to the existing body of knowledge further (Tranfield et al., 2003). Both authors reviewed the literature and separately identified critical factors in line with the open coding procedure suggested by Corbin and Strauss (2000). In practice, this involved whole sections or paragraphs of the papers being chosen and notes made on the identified critical factors. Including whole sections or paragraphs meant that contextual factors could be included in further analysis. The sections were then compared, discussed, and documented. For example, conclusions made by Neutzling et al. (2018, p. 3450) "*an effective development of innovative SSCM strategies relies on the integration of inter-organizational relationships,*" Chinomona and Omoruyi (2016, p. 331) "*Corporate social responsibility influence on innovation in a positive and innovative fashion,*" and by Goddard et al. (2016, p. 1547) "*the development of strategic alliances may be crucial for innovation,*" were coded as critical factors. In the cases when the authors had used different codes, in-depth discussions were held and on several occasions research colleagues were involved to add their perspectives on the codes and the motivation behind.

The open coding was followed by two stages of coding into higher order categories (Corbin and Strauss, 2000); first into subcategories and then grouped into a set of main categories. For example, critical factors categorized into the subcategories "internal cooperation", "trust", "interorganizational collaboration", and "clusters" were grouped into a main category of "collaboration". With all the critical factors categorized, the emergent main categories and subcategories could be classified, discussed, and reevaluated based on their properties and dimensions to find a proper structure for categorization. For example, the main category "information sharing" was moved to become a subcategory under the main category "collaboration", as all the critical factors in information sharing were related to the importance of collaboration. As a result, in line with Corbin and Strauss (2018, ch.9), conceptual saturation was reached when the properties and dimensions were found to be sufficient to each main category. In Fig. 2 below, the stages of coding for the main category collaboration are exemplified.

In the fourth step critical factors in the SSCI subcategory and the SI/SC subcategory were compared with each other to analyze and evaluate the importance of the categorized critical factors for the realization of SSCI.

3.1.5. Reporting and using the results

A central task for literature reviews is to make the findings available to researchers and practitioners in a format that is trustworthy and provides insights into further research as well as changes in practice. In this paper, we have created critical factor categories and a process model for SSCI implementation from relevant literature in the context of SSCI to make the results useful for both researchers and practitioners. For the validity and reliability of the findings from the content analysis, we have worked separately on data for the different stages of coding; together, we have discussed our results and have also included research colleagues in the analysis process. For example, when differences in the coding were found or when the first set of subcategories as well as the final main categories were set, research colleagues were included and in-depth discussions were held to reach unity. The proposed process model has also been presented at conferences and has been discussed with practitioners and researchers in order for us to verify its usefulness and gain input on any misunderstandings.

3.2. Model development - toward a process model for SSCI

The systematic literature review provided a broad view of knowledge related to SSCI, in particular the critical factors reported for the realization of SSCIs, enabling a foundation for synthesizing and theory development (Rousseau et al., 2008). A unified theme in the literature was the notion that realization of SD requires SC stakeholders, individually and together (Klewitz and Hansen, 2014; Govindan and Hasanagic 2018) to develop and innovate products, processes, services, business models, and organizations that maximize reuse and recovery of resources while meeting the needs of customers and society (Adams et al., 2016). Consequently, the

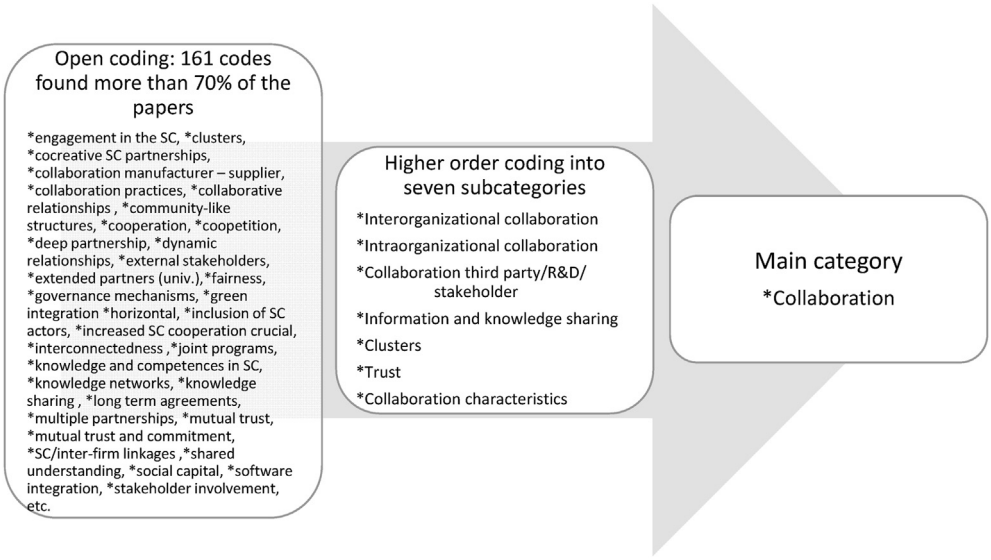

Fig. 2. The emergent categories from the coding process, exemplified by the main category of collaboration.

transition to sustainable circular SCs from linear one-way setups requires innovations to be developed and adopted in SCs i.e., going from mainly SI to SSCI. Consequently, as a starting point for the theory development (illustrated in Fig. 3), SSCI in this paper is considered a central mediator in order to transform linear, one-way SCs into circular, sustainable SCs taking on the challenges of SD.

For further theory development we followed Whetten's (1989) four elements of theory building, starting in the coding process of critical factors based on the criteria of comprehensiveness and parsimony. The second element deals with the relation between the factors and from that provide guidance on how these can be used to develop SSCI, both for research and practice. This phase took its standpoint in innovation theory in which it is clear that innovation is dependent upon successful management of the innovation process (Balachandra and Friar, 1997; Cooper, 1979; Di Benedetto, 1999) and the literature provides a number of models for innovation that address what to do to make innovation happen and how. Several innovation models are based on the assumption of linear and stage-gate based processes e.g. Goffin and Mitchells' (2010) pentathlon framework that builds on the development funnel by Wheelright and Clark (1992) and Tidd and Bessants' (2009) innovation process that is based on the assumption of a clear innovation strategy and an innovative organization. In contrast to common stage-gate models, Brown and Katz (2011) consider innovation to be a dynamic and cyclic interplay between spaces of inspiration, ideation, and implementation based on design thinking. These spaces integrate practices that comprise individuals and their perspectives, knowledge, and mindsets (Brown and Katz, 2011; Davila et al., 2006) and target the viability, feasibility, and desirability of users, customers, and stakeholders (Brown, 2009). In this paper, an integrative view of innovation processes, based on the spaces of inspiration, ideation, and implementation, is adopted instead of the linear, stage-gate based approaches, due to the complex nature of SSCI and sustainable development in general (Nilsson, 2019). Consequently, a design science perspective (Simon 1996; van Aken et al., 2016) is chosen in order to synthesize the identified critical factors into a process model for SSCI that guide practitioners in managing SSCI processes, and for researchers to test, evaluate and further develop it (Wacker 1998).

4. Findings

4.1. Descriptive classification

The systematic literature review includes 180 scientific journal papers published between January 2001 and December 2019 (see Fig. 4). More than 83% of these papers are published 2013 or later. The 180 papers were found in 108 journals with two dominating journals; *Journal of Cleaner Production* followed by *Sustainability* (see Table 1 for the top six; a full list is provided in Appendix 1).

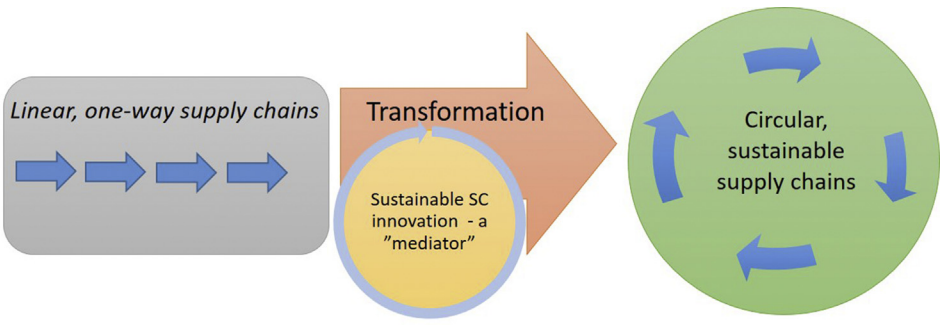

Fig. 3. Initial model of the transformation process of linear, one-way SCs into circular, sustainable SCs where SSCI is a central mediator to facilitate the huge transition needed.

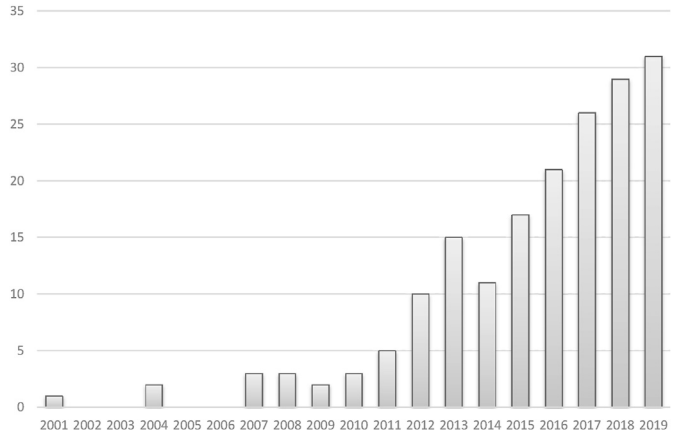

Fig. 4. Number of publications/year of the 180 reviewed papers in total.

Table 1
Number of publications/journals in the reviewed literature. Journals including four papers or more are included (a full list of journals is provided in Appendix 1).

Journal	No.
J. of Cleaner Production	22
Sustainability	16
Int. J. of Production Economics	6
Production Planning and Control	5
Supply Chain Management: An Int. J.	4
Business Strategy and the Environment	4

4.2. Thematic analysis

From the thematic analysis of the papers, we found different levels of organizational focus. 86 papers had a single company perspective, often mentioned as a focal company or SC champion. Hence, while SC are mentioned and contextually included the focus is on single actor or a single actor's perspective in relation to its SC. However, while not always explicitly studied, suppliers, customers, and stakeholders were often mentioned as important for innovation. Consequently, in our analysis we have found the company-focused papers contain SC implications, even if they merely focus on company effects (e.g., Jabbour et al. (2018)). 14 papers within the systematic literature review covered or handled dyadic relations and setups (e.g., Zhang et al. (2017)). A noteworthy number of 80 papers had an SC focus, and covered studies of SCs involving three or more actors, or industry clusters. Some of these studies followed one company, however; the SC level was the main focus (e.g., Silvestre (2015b)).

The thematic analysis also included an analysis of the sustainability focus of the papers. We found 69 papers that took a comprehensive view of sustainability including environmental, social, and economic aspects. A large number of the papers, 88 papers, focused primarily on environmental aspects, 13 papers focused mainly on social aspects, and ten papers mainly emphasized financial aspects.

Building further on our analysis, we combined sustainability and organizational levels to identify the distribution of the papers (see Table 2). The largest category was found to be papers with an environmental and company focus followed by papers providing a comprehensive view of sustainability on an SC level. The 43 papers providing a comprehensive view were denoted as the SSCI subgroup.

Finally, the thematic analysis continued with an innovation perspective. Guided by the innovation literature, the coding was open, i.e., without any predefined innovation types due to the numerous types of innovation and innovation concepts covered in the sample. This resulted in nine distinctive types of innovation areas. The largest group of papers (55) were found to address general aspects related to innovation such as culture, entrepreneurial activities, policy, as well as conceptual frameworks linking together combinations like technology, product, process, and management innovations. The second largest group (38) focused on innovation of product and process in an integrative manner while a number of papers either put a focus on product (22) or process (20). A number of papers addressed innovation types such as technology (14), business model (11), management (8), organizational innovation (7), and social (5).

Table 2
Sustainability focus i.e., all pillars or particular focus on one of the pillars (environmental, social or financial) in relation to organizational focus i.e., company, dyad or supply chain, of the reviewed literature.

Organizational focus/Sus. focus area	Company (86)	Dyad (14)	SC (80)
All (69)	22	4	**43**
Environmental (88)	50	8	30
Social (13)	9	1	3
Financial (10)	5	1	4

Table 3
Innovation focus of the reviewed literature in relation to supply chain level.

Innovation type	Company (86)	Dyad (14)	SC (80)
General (55)	19	1	35
Product and process (38)	22	4	12
Product (22)	13	3	6
Process (20)	11	3	6
Technology (14)	9	1	4
Business model (11)	4	0	7
Management (8)	4	0	4
Organizational (7)	2	2	3
Social (5)	1	0	4

Combining the innovation type with the organizational level it was found that general aspects dominated (35) even more on an SC level while innovation types related to product and process were more common on the company level (see Table 3).

In the subgroup of SSCI papers the dominance of general aspects is more common; 24 papers out of 43 illustrated this while there was a spread of 0–4 papers with the other innovation types as listed in Table 4.

4.3. Critical factors analysis

The in-depth content analysis of the 180 papers resulted in a total of 633 observations of critical factors mentioned in the literature. As a result, in most of the papers we identified more than one factor as critical to the realization of SSCI. Based on the coding process, these factors were grouped together in subcategories and ended up in 14 main categories (see Fig. 5 for an overview and Appendix 2 for the list of subcategories forming each main category). While all the main categories are found to be vital for the realization of SSCIs, the emphasis in literature varies from collaboration being the most frequently mentioned critical factor down to timing only being mentioned nine times. The gray scale coding of Fig. 5 indicates the relevance of the critical factors in terms of observation in relation to number of papers. Overall then, based on their occurrence in literature, four different clusters of critical factors can be established.

The first and largest is the main category of **collaboration**,

Table 4
Innovation focus of the subgroup of SSCI papers.

Innovation type	SSCI (43)
General	24
Product and process	4
Product	2
Process	3
Technology	0
Business model	4
Management	2
Organizational	3
Social	1

which is by far the most frequently observed critical factor for SSCI realization, with 161 observations in over 70% of the papers. This is in line with sustainable SC management theory where collaboration among SC actors is essential for successful practice. For example, Neutzling et al. (2018, p. 3451) state that "*when collaborative relationships are integrated and synergistic, it is possible to exchange knowledge, develop innovative capabilities, and generate complementary resources, thereby increasing the possibility of value creation for the entire supply chain.*" Other researchers provide collaborative setups such as Berti and Mulligan (2016, p. 2) who report on food hubs (local/regional) as organizational innovations. The food hubs are based on collaboration in clusters that overcome *"the organizational and infrastructural limitations that impede small farms to reach the growing demand of local produce."* Papers where collaboration has not been identified as a critical factor may, however, not necessarily consider collaboration as an unimportant factor for SSCI, rather more of a prerequisite.

A second cluster covers the categories of **strategic orientation, culture, practices, and political context**. Strategic orientation (73 observations) can be defined as the overall direction and objectives of a firm, driven by top management and oriented in the business context for the future (Voss and Voss, 2000). Hsu et al. (2016, p. 88) provide *"evidence of the critical role of eco-reputation and eco-innovation strategic orientations in deploying sustainable supply chain initiative programs."* Internal and external practices are seen as critical factors for SSCI (63 observations). Beske et al. (2014, p. 132) describe SSCM practices as activities that "*enhance relationships between the partners, the flow of goods and information or issues of sustainability.*" One example of practice characteristics is systematic behavior. "*Sustainable supply chain innovation is a collection of interacting activities that are operated by different participants to achieve a common goal, and it is the typical systematic behavior.*" (Gao et al., 2017, p. 1530). Kähkönen et al. (2017, p. 413) provide evidence that *"green and ethical practices in supplier collaboration lead to higher innovation performance of the focal firm."* Culture in organizations and SCs is viewed as a critical factor (62 observations). The organizational or SC culture represents the collective values, beliefs, and managerial mindset of its members. Strategic Direction (2014, p. 28) states that "*innovation that increases sustainability must consider culture, institutions, behaviors and norms if it is to prove genuinely transformational.* They continue *to* elucidate the importance of the managerial mindset by stating *"The success of innovation for sustainability will often demand an effective blend of top-down and bottom-up initiatives. … An integrated approach, dynamic partnerships and strong leadership will better position an organization to connect with the wider context that might include crossing into unfamiliar territories."* (Strategic Direction, 2014, p. 30). Neutzling et al. (2018, p. 3450) state that, "*to integrate sustainability objectives into an organizational and supply chain level, the initial impulse for corporate decisions comes from external pressures and stakeholder incentives (customers, competitors, governments, NGOs).*"

The third cluster of critical factors for SSCI realization contains five main categories, namely, **market influence, governance mechanism, technology development and innovation, training and education,** and **organizational capabilities**. Rodriguez and Da Cunha (2018) identify several of these critical factors in their conceptual framework on how big data and predictive analytics can affect SSCI (i.e., market influence, technology development and innovation, capabilities, as well as the aforementioned critical factors of collaboration and political context). They found several external drivers for SSCI. Some examples are customer pressure on organizations to engage in sustainable practices, and consumer and NGO demands for environmentally friendly performances. Furthermore, they found it crucial to understand the use and implications of big data and predictive analytics in disrupting traditional business patterns. In addition, absorptive capacity is presented as "*mediating factor on the relationship between disruptive innovation and the performances of sustainable supply chain inside the company.*" (Rodriguez and Da Cunha, 2018, p. 156). Whalen

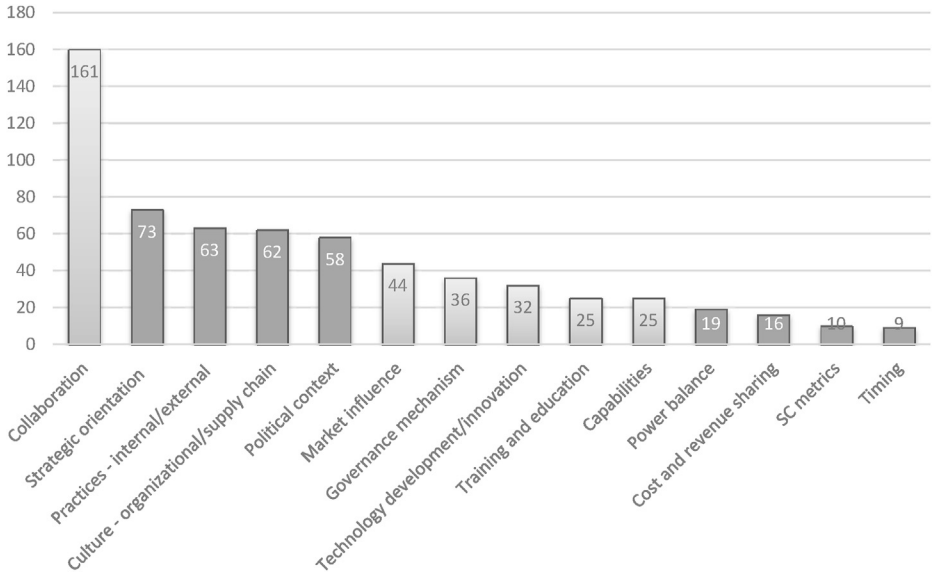

Fig. 5. Main categories of critical factors observed in the reviewed literature and number of observations in literature/main category.

(2012, p. 67) stresses the need for governance strategies as "*enormous business value is hidden in the 'white space' of sustainability that individual players cannot easily access on their own*" and Govindan et al. (2016) state that governing strategies can foster high impact on an organization's sustainability management. Finally, Silvestre (2015b) states that SC learning is essential for SD, especially in turbulent environments. He continues by stating that becoming a sustainable SC is not a destination, but a journey. As a result, sustainable SCs can occur only through learning and innovative solutions.

A fourth cluster of main categories of critical factors for SSCI realization are **power balance, cost and revenue sharing, SC metrics,** and **timing** (with 9–19 observations). The innovation strategies of an SC are highly dependent on the power balance constellation within an SC or network. Mylan et al. (2015) argue that retailers within food SCs (which are power dominant) can act as SC champions to stimulate upstream eco-innovation. Another power constellation within the food industry is discussed by Peano et al. (2017). They state that cluster organizations can rebalance the contractual power within the SC and act as drivers for innovation in the agricultural sector. Silvestre (2015a) states that collaboration enhances innovation and sustainability in SCs. However, critical elements for innovation in sustainable SCs are aligned objectives, open communication, sharing of resources, risks, and rewards. Yenipazarli (2017, p. 583) continues the discussion on sharing resources by arguing that "*revenue-sharing is more appropriate for collaboration in terms of the impact of upstream environmental innovation on total environmental performance of the supply chain and the resulting supply chain profits.*" SSCI can be promoted and SD can be monitored by introducing sustainability metrics. Nevertheless, Miller and Buys (2013) stress the need for better and more generic (less industry specific) measures. When every piece in the complex puzzle of SSCI is in place there is still one important variable to consider: timing. The market and customers need to be receptive to innovation. Verghese and Lewis (2007, p. 4397) point out that "*planning is essential for a successful project. This must consider a number of issues, including the best timing for a change and the impact on other stakeholders in the supply chain.*" Timing is especially important in developing and emerging economies as "*the existence of highly turbulent business environments and institutional voids*" increase the degree of uncertainty Silvestre (2015b, p. 156).

When comparing the observations made in the subcategories of SI/SC and SSCI literature some interesting distinctions were found (see Table 5).

In the 43 SSCI papers, collaboration was observed 53 times to be a critical factor, i.e., there were 44% more observations of the critical factor collaboration in SSCI literature than in SI/SC literature (108 times in 137 papers). This may not come as a surprise as SSCI literature involves whole SCs and networks and therefore necessitates a higher degree of collaboration. However, the results also elucidate the importance of collaboration in the realization of SSCIs.

In addition, political context, governance mechanisms, and power balance also seem to be of greater importance in SSCI literature. Realizing innovation that includes several actors, stakeholders, and sometimes entire industries, is complex. An SSCI realization requires, to a higher degree, aligned incentives and one champion or whole SCs or industries to govern the resources, risks, and rewards. In some cases this means that political means are required to enforce sustainability measures on a business or industry.

On the other hand, market influence seems to be of less importance in SSCI literature. On many occasions, SSCI is, due to its complexity, a radical innovation. The market may not know the need for the innovation in advance and as a result, market forces may be less influential than for other types of innovations.

5. A process model for sustainable supply chain innovations

Based on the critical factors and their importance and impact on SSCI outcomes, as well as on the process of innovation development and implementation, the proposed model aims to provide guidance on how to improve the SSCI process and facilitate the transformation from one-way, linear SCs to circular, sustainable ones. The proposed model is based on Brown and Katz' (2011) innovation model but has been contextually changed from a company focus and level, to an SC level. It is also based on social, environmental, and economic dimensions, i.e., it functions as a model for SSCI. With the notion that SSCI is a central mediator for sustainability transitions to take place, the model acts in the transformation process from linear, one-way SC setups to circular, sustainable SC setups (as illustrated in Fig. 3). Brown (2009) declares that the innovation processes of inspiration, ideation, and implementation should not be seen as separate and predefined steps, but instead as a system of spaces in which different activities are performed. We will therefore discuss the critical factors for SSCI and designate these to the inspiration, ideation, and implementation spaces in the SSCI model.

The SSCI model (see Fig. 6) has its foundation in the most emphasized critical factor in this research, namely collaboration. Collaboration is placed in the center due to its importance for any SSCI to be realized and is included in all three spaces of the design cycle for innovation, i.e., inspiration, ideation, and implementation. Collaboration covers not only intra- and, to a large degree, inter-organizational collaboration but also aspects of trust (Jali et al., 2017; Kim et al., 2017), information, and knowledge sharing (Yang et al., 2015). Depending on which phase in the innovation cycle collaboration is in, collaboration changes its form and focus when combined with the other main categories of critical factors for SSCI.

The inspiration space includes activities related to an explorative approach in identifying and understanding ongoing and coming changes in the external environment. Critical factors such as the political context (Steiner et al., 2019), the role of markets as well as technological development/innovations (Wang et al., 2018) can act as sources for inspiration as well as factors critical to handle raw-material supply and other resources needed. For example, the ongoing discussion on digitalization has made organizations in most industries rethink their processes, business models as well as their product portfolios. Furthermore, as found in this paper, the role of market demands, regulations as well as technological breakthroughs, as motivators and drivers of innovation, open up for both internal and external collaborative efforts to find new needs and opportunities for innovations (Su et al., 2016). The role of collaboration becomes central here as research also emphasizes the need for new partners/suppliers for more radical innovations (Nair et al., 2016) while established partners/suppliers will be beneficial for incremental innovation efforts.

A number of critical factors exist in the movement from inspiration to ideation, so that the organizations involved have a strategic orientation (De Marchi et al., 2013; Dai et al., 2015) and a culture (Zhu et al., 2012) supporting and facilitating actions needed to be taken and the investment necessary for the realization of innovation. In the SC setting another critical factor is also prevalent, namely the SC power balance. As a number of researchers have reported (e.g., Isaksson et al., 2010; Matus 2010), a strong and proactive focal company driving progress toward SD benefits the development of SSCI. However, if this power is predominantly used for economic and financial benefits, this in turn hampers the development and creation of SSCIs.

During different ideation processes, another set of critical factors emerges as important for the realization of SSCI. Central here is the actual practices being carried out, both internally and externally (Gualandris and Kalchschmidt 2014), i.e., making the ideas

Table 5
Statistical difference between numbers of observations per main category of critical factor in the sub categories of SI/SC and SSCI literature.

Main categories	Observations in SI/SC (137 papers)	Difference	Observations in SSCI (43 papers)
Collaboration	108	44%	53
Strategic orientation	55	1%	18
Practices - internal/external	47	3%	16
Culture (organizational/supply chain)	48	-3%	14
Political context	37	22%	21
Market influence	39	-17%	5
Governance mechanism	21	19%	15
Technology development/innovation	23	4%	9
Training and education	19	0%	6
Capabilities	19	0%	6
Power balance	9	17%	10
Cost and revenue sharing	12	0%	4
SC metrics	5	2%	3
Timing	4	3%	3

Fig. 6. Proposed process model for sustainable supply chain innovations in the transformation from linear, one-way supply chains to circular, sustainable supply chains.

generated into prototypes, testing them on markets or in trials with customers and other stakeholders. The adoption of new ideas and their practice also demands appropriate organizational capabilities (Dewick and Foster, 2018) including risk-taking. Here the role of dynamic capabilities as well as training and education for staff, partners, customers, and other stakeholders become central in order to enable forthcoming implementation of ideas and turn them into innovations.

The third space in the model focuses on the implementation aspects of taking ideas to realized products/processes/business models or management practices. In this part, the ideas should move toward implementation in various key customer setups or selected processes. In the interorganizational context, the quality of the established collaboration among actors will be tested, as reality will prove whether efforts made are enough when set in practice. Here, the critical factors of cost/revenue sharing (Yang et al., 2015), SC metrics (Razak et al., 2016), and governance mechanisms (Kumar et al., 2016) need specific emphasis in order to establish business conditions that can last and support further implementation. Finally, as reported in research, the role of timing (Dev and Shankar, 2016; Verghese and Lewis, 2007) is essential for successful implementations, or putting it into use when other necessary factors are established (e.g., infrastructure, political conditions, technology).

Out of an innovation process, the implementation space involves several learning activities as early pilot projects in the ideation space are carried out under tailor-made conditions. Furthermore, when a concept or idea is forced into actual user value, a number of unknown aspects often emerges. These aspects can be central to both inspiration and ideation, and the process can continue with more or less significant changes of concept, target users, business models, and measurement processes of sustainability as well as changes in collaboration with new partners involved. This seems especially to be the case when all pillars of SD are included, i.e., failing to address one of the dimensions could have devastating effects on the whole concept.

6. Discussion

The need for considerable transitions in both industries and society as a whole is emphasized in most literature related to SD. SCs represent strong institutions in our globalized economies that, due to rigid structures, efficient processes, and established businesses are often obstacles when major changes are required.

However, in order to transform industries to adopt SD, innovations that can change the setup of SCs as well as their way of sourcing, producing, and delivering value to their customers might represent a major potential. While collaboration is a central critical factor to deal with barriers of SSCI, this research indicates that it is also essential to include critical factors such as political context, governance mechanisms, and power balance. These findings are in line with the conclusions drawn by Nari et al. (2016). They (ibid.) conclude that the effectiveness of initiatives depends both on the controllability of an individual (dominant) company, and the ability to respond and nurture self-organizing processes in related industries/nations or parts of SCs. In the study of green innovation key determinants, Zailani et al. (2015) report the top six as being: regulations (68%), market demand (40%), firm internal initiatives (68%), technological capability (8%), competitive advantage (8%), and customer benefit (4%). While these determinants can be compared to similar categories in our study (political context, market influence, strategic orientation etc.), it is interesting that collaboration is not put forward as a key determinant as it is both in the results of this paper and of Tebaldi et al. (2018). One reason might be the perspective of the firm in Zalini et al.'s (2015) study and the SC perspective in our studies.

A reflection can also be made about collaboration, as it is the most emphasized factor for SSCI. This is not a surprise since collaboration is one of the central factors raised in both SC management (Bowersox et al., 2000) and SSCM literature (Carter and Rogers, 2008). Consequently, collaboration and its constituent constructs (e.g., integration (Dai et al., 2015), information sharing (Lee and Whang, 2000), trust (Fawcett et al., 2017)) have been researched to a large degree and knowledge in this area has been greatly supplemented. However, with theory of the firm underlying most SC management theory (Nilsson and Gammelgaard, 2012) and the economic/financial dimension being central in much of existing SC management research, key characteristics and central assumptions might be different when innovations for SD is being worked on. For example, in efforts to increase transparency (e.g., product origin and impact) or influence social dimensions of societies (e.g., increased equality), information sharing in SCs might be treated differently than in the case of strictly competitive situations. This is in line with Tebaldi et al. (2018, p.13) concluding that there is *"no research exploring how supply chain collaboration can improve social sustainability."* As a result, further research could investigate and compare collaboration constructs such as trust or information sharing when innovations are developed for purely competitive reasons or when these innovations target broader sustainability effects. Another factor we found in the literature review was that of power balance, which influences the collaborative ability of companies in SCs. Lee (2019, p.13) reports on the need for collaborative and implementation activities for SSCI and concludes *"firm size may be a decisive factor in altering implementation activities while performing eco-friendly activities in sustainable SCM."* Consequently, as explained by Kim et al. (2017), fairness and referent power have a positive impact on innovativeness among SC partners. Finally, in the case of SSCI it is reported that collaboration with stakeholders (Dewick and Foster, 2018) and other industry partners i.e., others than direct suppliers and customers (Nair et al., 2016), as well as universities (Bendavid and Cassivi, 2012) is more central to SSCI than it is to innovation in general. This might be as SD addresses both new and more complex issues while challenging existing structures and the close relationships that are established in existing SCs.

The critical factors found in this paper for SSCI contribute with some of the necessary elements for researchers and practitioners to develop and implement SSCIs more successfully than up to the present. However, treating the critical factors as separate constructs will not sufficiently target the issues of SSCI due to the complexity inherent in SD (Kumar et al., 2016) and the "wicked" nature of the challenges to be addressed (Russell et al., 2018). Instead, comprehensive and integrative models and frameworks (Kumar et al., 2016) that combine the critical factors are needed to guide researchers and practitioners in approaching and developing SSCI. The main motivation for initiating this study was to find a framework or model to guide a major research and innovation project aiming to develop and implement SSCIs. We can conclude with this literature review that no such model has been found in this sample and it therefore became imperative to provide both the academic and the practitioner community with such a model.

7. Conclusions

In this paper, we set out to identify critical factors central to the creation of sustainable SC innovation (SSCI) and to contribute with a process model for SSCI development. Based on a systematic review and content analysis of 180 papers, critical factors for SSCI have been identified and categorized into 14 main categories. Collaboration was found to be by far the most frequently observed main category of critical factors, followed by strategic orientation, culture, practices, and political context. The thematic analysis revealed that 43 (out of 180) papers discussed innovation on an SC level and covered all pillars of sustainability (SSCI literature). The remaining literature (137 papers, SI/SC) did not include both SC level and all pillars of sustainability. As a result, research embracing whole SCs and the development of SSCI is still in its early stages and demonstrates that several research opportunities exist.

Most of the existing papers addressing SSCI are based on conceptual studies and there is a need for empirical studies to test proposed frameworks and suggested critical factors. The factors identified and categorized in this paper could therefore form one of the foundations for further empirical studies. However, for relevant empirical research to be conducted, methodological development is also needed as more complex phenomena, e.g., innovation ecosystems and SCs, need to be studied as comprehensive entities and not, as today, as separate units (single or dyadic perspectives) based on reductionistic assumptions.

The process model for SSCI proposed, building on the design-thinking framework for innovation by Brown and Katz (2011), aims to provide guidance on how to improve the SSCI process. The model embraces the requested holistic perspective involving whole SCs in the innovation process in order to reach sustainable development together with the identified critical factors. A central aim with the proposed model is to open up for further research and development to test and develop the process model as well as the critical factors identified in different SC contexts. For example, in order to provide guidance to managers on how to realize SD, the relative importance of the main categories could be tested and evaluated from both a category and a process perspective. It seems from our research that wider collaborative efforts with external stakeholders are more emphasized within SSCI than innovation in general. Consequently, while collaboration is by far the most emphasized critical factor for SSCI, more research related to collaboration in the SC in the context of sustainable innovations versus economic driven innovations is suggested.

This study has a number of limitations that need to be highlighted. The literature included is limited to academic journals and peer-reviewed papers written in English. While this is based on the assumption that the most substantial research contributions are published in such outlets, contributions to the research area might, of course be found in conference papers, books, as well as reports and other documents that are not published in academic journals. Furthermore, the selected papers have been found using specific

keyword setups that may have resulted in an exclusion of literature that could have provided insights for this study. Using only title and keyword in our literature search might also limit the sample. Initially, abstract was included in the search and resulted in many more hits. However, after analyzing the papers and excluding duplicates we observed that the remaining papers were more or less the same as those found from literature search using only title and keywords. As in qualitative and conceptual studies, interpretation of the literature and coding processes is influenced by the researchers involved. While we have tried to include research colleagues in the interpretation and coding process for increased validity, there still might be a certain bias in interpretation due to the authors' experience and prior knowledge. Finally, the cumulative occurrence of factors to judge the emphasis of each critical factor for SSCI can be questioned as the factors are interdependent and, as raised in the discussion section, some factors are fundamental for areas studied e.g. strategic orientation to business in general, collaboration to SC management. These limitations can be overcome by further research, using other methods to not only test the validity of these results, but also to clarify the contexts in which they might not be applicable.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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