Traceability for sustainability – literature review and conceptual framework

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Purpose – This paper examines how companies enact traceability in their global supply chains (SCs) to achieve sustainability goals and how this so-called *Traceability for Sustainability* (TfS) can contribute to (Sustainable) Supply Chain Management ((S)SCM). For this, the paper focuses on the paramount example of the apparel industry.

Design/methodology/approach – This study presents an integrative and systematic literature review of 89 peer-reviewed journal articles on the confluence of traceability and sustainability in global apparel SCs. It comprises content analysis and abductive category-building based on previous literature.

Findings – A conceptual framework emerges to describe TfS as an evolving cycle, comprising three dimensions: (1) Governance; (2) collaboration; and (3) tracking and tracing. Resources and capabilities literature set the foundations for conceiving TfS as a distinctive meta-capability construct. Hence, besides being associated to increased performance, risk management and SC process transformation, TfS ultimately blurs boundaries and integrates non-traditional SC actors into the same ecosystem with important implications for sustainability and (S)SCM. This study refers to the industrial upgrading potential of global SCs to explain how leveraging enabling technologies for TfS may help to improve the triple-bottom-line (TBL) performance of the actors in the broad ecosystem while reducing the risks associated to those technologies. Thus, TfS can contribute to (S)SCM and to TBL sustainability within and beyond SC boundaries.

Originality/value – This study conceptually frames (S)SCM exploring TfS as a meta-capability, and contributes to the underexplored question of how to achieve sustainability in global SCs.

Keywords: Traceability, Sustainability, SSCM, Apparel, Literature Review, Meta-capabilities

Paper type: Literature Review

1. Introduction

In today's interconnected, technological, global and complex supply chains (SCs), consumers and companies still struggle to trace and acknowledge the provenance and production conditions of the products they buy and distribute (Busse, Meinlschmidt, and Foerstl, 2017; Wilhelm, Blome, Wieck, and Xiao, 2016).

Traceability –understood as the ability to identify and trace the history, distribution, location and application of products, parts, materials and services (ISO 9000)– has gained prominence in relation to total quality processes since the end of the last century. Its ability to provide and verify detailed historical information and localize parts, materials and products across the SC by means of documented, recorded identification (ISO, 2000) has been historically linked to uncertainty and complexity reductions in manufacturing systems (Cheng and Simmons, 1994).

Recently, the absence or incompleteness of traceability has been behind different social and environmental sustainability crises, tragedies and scandals affecting industries as powerful and diverse as food, toys, mineral extraction and apparel (Busse, Schleper, Niu, and Wagner, 2016; Khurana and Ricchetti, 2016; Wilhelm et al., 2016). These events have given rise to emergent voices that couple it with the need to transform complex global SCs into more transparent, sustainable and responsible networks (Closs, Speier, and Meacham, 2011), enabling companies and suppliers to trace social and environmental breaches (Pagell and Wu, 2009). Traceability, understood in this broader meaning –what the authors refer to as *Traceability for Sustainability* (TfS)– is the focus of this study.

However, in practice, TfS still remains a utopia (Doorey, 2011; Egels-Zandén, 2016), hindered by the generalized growth of SCs at the transnational level with many SC actors located in developing countries (Gereffi and Korzeniewicz, 1994). This has resulted in great geographic and cultural distances and a lack of visibility beyond direct suppliers (Boström, Börjeson, Gilek, Jönsson, and Karlsson, 2012; Busse et al., 2016).

Its deficit is also evident in (Sustainable) Supply Chain Management ((S)SCM) research where, to date, there has been little scholarly work addressing the intersection between traceability and sustainability (Marucheck, Greis, Mena, and Cai, 2011; Thöni and Tjoa, 2017) save for two exceptions. First, there is a notable number of academic work dedicated to industries with higher levels of regulation and/or where consumer health might be a risk (e.g., food, agriculture and health care) (Moe, 1998; Regattieri, Gamberi, and Manzini, 2007; Roth, Tsay, Pullman, and Gray, 2008; Zhou and Piramuthu, 2015). However, their link to the social and environmental dimensions of sustainability is mainly reduced to product health and safety concerns. Second, a growing number of academic work addresses the topic of traceability in relation to technological advances –mainly IoT, RFID and blockchain technologies. That notwithstanding, the focus of this scholarly attention has been on the economic/operational dimension of sustainability, and only in a few cases has it extended to include the environment (Cannon, Reyes, Frazier, and Prater, 2008; Green, Zelbst, Sower, and Bellah, 2017; Kshetri, 2018). Surprisingly, this lack of research focused on the intersection between traceability and (S)SCM contrasts with the number of published articles that frequently mention traceability as playing an important role in the (S)SCM equation (Ansari and Kant, 2017a; Gold, Trautrims, and Trodd, 2015; Pagell and Wu, 2009).

Advancing TfS is particularly important in dynamic and complex SCs such as those in the retail and fashion industries, whose representative features –global scope, high volume, dynamism, fierce competition and intensive resource use– generate high environmental and social risks related to air and water pollution, resource depletion and inhuman working conditions (de Brito, Carbone, and Blanquart, 2008; Stevenson and Cole, 2018).

Thus, this study aims to help advance knowledge of TfS and analyze how it can contribute to (S)SCM. To this end, the authors examine the global apparel industry where fostering traceability is particularly needed due to

its fragmented production and the pervasiveness of illegitimate subcontracting (European Commission, 2017b), in addition to the high social and environmental sustainability risks (and opportunities) associated to its activities (Gobbi and Massa, 2015; Greer and Purvis, 2016; Laudal, 2010). Concretely, this paper seeks to answer the following research questions (RQs):

RQ1: How is TfS developed and implemented in global SCs?

RQ2: How does TfS contribute to (S)SCM?

To respond to these questions, the authors carry out an integrative and systematic literature review by means of content analysis, based on the confluence of traceability and sustainability in global apparel SCs. The researchers approach and report on this review in a systematic manner, ensuring the transparency and replicability of the process and analysis while avoiding a lack of rigor or any bias in the results (Tranfield, Denyer, and Smart, 2003).

This study makes several contributions to theory and practice. First, it presents a comprehensive definition of TfS for global SCs, adding the sustainability goal to the traditional approach. Second, using the example of the apparel industry, the research proposes a conceptual framework that explains the emergence and deployment of TfS as a second-order construct formed by three main dimensions: (1) Governance; (2) collaboration; and (3) tracking and tracing. In turn, the latter are all shaped around three main elements: Actors, enablers and barriers. Third, the mutually reinforcing interaction among these variables serves as the basis for considering TfS as meta-capability (Ambrosini et al., 2009; Collis, 1994), which is argued to be able to blur SC boundaries, integrating traditional and non-traditional SC actors into the same ecosystem and, thus, enhancing TBL sustainable performance throughout and beyond SC systems (Govindan, Seuring, Zhu, and Azevedo, 2016). Finally, this review detects an underexplored potential of enabling technologies associated to TfS to contribute to TBL sustainability and to foster disruptive SC models as the circular systems.

These findings, which require further development, could serve as the starting point for researchers, managers and institutions to provide new insights on traceability as a means to achieve greater and true sustainability in global SCs (Pagell and Shevchenko, 2014), hence contributing to (S)SCM.

2. Theoretical background

2.1. Sustainability and (S)SCM

In 1987, one of the most important and coordinated international attempts to reconcile growth and social and natural environment, the United Nations World Commission on Environment and Development, concluded with the release of the Brundtland Report. The latter includes the most widely accepted definition of sustainable development: such development "that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 41). Furthermore, on September 2015, UN member countries agreed on a universal agenda for sustainable development, consisting of the 17 United Nations Sustainable Development Goals (SDGs) and their 169 associated targets. This agenda unites governments, private sector, civil society and citizens around a common objective that goes from agreeing on the goals to implementing and achieving them (Stafford-Smith et al., 2017; UN General Assembly, 2015).

In the business management field, sustainable development is generally operationalized through Elkington's triple-bottom-line (TBL) concept (Elkington, 1998), which also represents the authors' understanding of sustainability: *the convergent area of three dimensions –economic, environmental and social–, where none of which is compromised for the benefit of the others* (Elkington, 1998; Carter and Rogers, 2008; Seuring and Müller, 2008).

SCs –defined as the "range of activities involved in the design, production, and marketing of a product" (Gereffi, 1999; Handfield, 1999, p. 38) saw a rapid and generalized growth as of the end of the last century as an attempt by companies to build competitive advantages through specialization and cost-reductions (Gereffi, 1999; Handfield, 1999, p. 38). This development took place at the transnational level, with many of the actors (mainly upstream producers) located in developing countries (Gereffi, 1999). As a result, competition commenced to take place through complex multi-level SCs with intricate business relationships rather than single companies (Lambert and Cooper, 2000) and with the associated challenge of how to successfully manage this new structure in the most responsible manner for stakeholders and the environment.

Thus, not surprisingly, (S)SCM has now become a mainstream topic, with some scholars even claiming for its "disappearance" as a branch of SCM, arguing it should be primitively embedded in SCM's very DNA (Ansari and Kant, 2017a; Beske and Seuring, 2014; Pagell and Shevchenko, 2014). As a result, enlightening reviews of the academic studies in the field have been published in the last few years (Ansari and Kant, 2017a, 2017b; Touboulic and Walker, 2015b). Based on Seuring and Müller (2008) and incorporating Pagell and Wu's views (2009), the authors of this study understand (S)SCM as *the management of companies and flows (material, information and capital) throughout the SC to ensure the economic viability of the network while guaranteeing (at least) no harm to the natural and social environment* (Pagell and Wu, 2009; Seuring and Müller, 2008).

Among the different actors within a SC, companies connected to the end user (focal companies) are assumed to hold the power within the chain. As they are the visible players for the market (consumers and stakeholders, in general), SC sustainability claims are also increasingly demanded of them. Hence, due to focal companies' need to remain competitive in a networked market and respond in a timely fashion to customer and stakeholder claims, (S)SCM has become paramount for companies operating in complex SCs and imperative for focal companies that are visible to their respective markets. The key challenge comes from these focal companies being responsible for the products (and their history) that they distribute, while, at the same time, their SCs lack visibility (Busse, Schleper, et al., 2017; Carter, Rogers, and Choi, 2015; Roth et al., 2008).

2.2. Traceability and (S)SCM

Traceability is defined in ISO 9000/BS 5750 as the "ability to trace the history, application or location of a product in relation to the origin of its materials and parts; the processing history; and the distribution and location after delivery". It has historically been linked to SCM as "an essential subsystem of quality management" (Moe, 1998, p. 211; Roth et al., 2008), associated to total quality management (TQM) and just-in-time (JIT) philosophies (Aung and Chang, 2014; Florea, Corbos, Popescu, and Zamfir, 2016). Scholars have also analyzed traceability as a key strategy to manage uncertainty and complexity across global manufacturing systems (Cheng and Simmons, 1994; Skilton and Robinson, 2009), being negatively related to complexity in global SCs (Skilton and Robinson, 2009). The regulatory demands fostered by product security and health crises such as mad cow disease, transgenic products and pet food scandals have advanced traceability systems in critical industries such as the food and pharmaceutical industries (Moe, 1998; Roth et al., 2008; Zhou and Piramuthu, 2015). More recently, emergent voices are coupling traceability with the need to transform complex global SCs into more transparent, sustainable and responsible networks (Closs, Speier, and Meacham, 2011), as this would enable companies and suppliers to trace social and environmental breaches (Pagell and Wu, 2009).

In keeping with the above, the United Nation's Global Compact suggests a sustainability orientation of the ISO's definition. It describes traceability as "the ability to identify and trace the history, distribution, location and application of products, parts and materials, to ensure the reliability of sustainability claims, in the areas of

human rights, labor (including health and safety), the environment and anti-corruption" (United Nations Global Compact Office, 2014, p. 6).

Furthermore, the UN recognizes the significant role of SC traceability in achieving the SDGs, particularly those related with inclusive and sustainable economic growth and decent work (SDG 8); resilient and sustainable infrastructures, industrialization and innovation (SDG 9) and sustainable consumption and production patterns (SDG 12), among others (UN General Assembly, 2015). Likewise, the European Union (EU) has defined transparency and traceability in SCs as one of the key priorities to advance sustainability, promote sustainable and responsible management in global SCs and underpin the achievement of SDGs (European Commission, 2017a, 2017b). The latter argues that traceability is particularly pertinent for the apparel industry "due to its fragmented production and the prevalent practice of illegitimate subcontracting" (European Commission, 2017b, p. 20).

Thus, integrating the given definitions and the above-mentioned functionalities, the authors define TfS as *the ability to combine SC information-sharing and visibility in such a way that actors within the chain have access to information that is accurate, trusted, timely and useful for operational reasons and to ensure the reliability of sustainability claims.* SC traceability allows retracing steps back and forward and verifying the processes, history and locations of the products under consideration (Barratt and Oke, 2007, p. 1218; Brandon-Jones, Squire, Autry, and Petersen, 2014; Fawcett, Wallin, Allred, Fawcett, and Magnan, 2011).

Accordingly, this study sees TfS as an enabling meta-capability that is developed through interorganizational governance, collaboration and tracking and tracing routines and processes. As such, it may contribute to achieve sustainability goals through regenerated competencies and knowledge that enable renewed and more complex strategic planning, (inter)organizational control and monitoring and risk management across the entire SC.

TfS is, thus, not only about information-sharing, visibility and accessibility but, rather, about regenerating and managing competencies and knowledge across the whole SC through renewed (inter)organizational practices and learning processes that are better adapted to complex SCs so that sustainability goals are met and their implementation evaluated.

Linking the above TfS definition to the authors' understanding of (S)SCM, while echoing Beske and Seuring's reflection (2014) of interorganizational information-sharing as a key factor for profound management, this study argues that TfS is a core enabler of (S)SCM, establishing a direct link to the sustainable and effective management of global SCs.

2.3. TfS applied to (S)SCM: enabling capabilities

The resource-based view of the firm (RBV) bases its analysis on the assumption that the resources and capabilities that a company holds (physical capital including technology, human capital and organizational capital) can be a source of sustained competitive advantage when meeting some requisites: Valuable, rare, inimitable, and non-substitutable (i.e., "VRIN resources") (Barney, 1991). The RBV has been subsequently adapted to the dynamic and interconnected nature of most markets by introducing a dynamic and external component: the Dynamic capabilities (DCs). DCs are defined as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al., 1997, p. 516). Due to the high-velocity of the markets and their high interconnectivity, these DCs are no longer rare or inimitable; thus, "their value for competitive advantage lies in the resource configurations they create, not in the capacities themselves." (Eisenhardt and Martin, 2000, p. 1106).

Collis (1994) further developed the notion of meta-capabilities (or regenerative DCs as referred to by Ambrosini et al. (2009)), and different scholars have proposed different levels of DCs, which represent a

continuous improvement of the resource base. According to Ambrosini et al. (2009), departing from the resource base, there is a second level that consists of incremental capabilities that evolve in stable environments to adapt the resource stocks to achieve slow changes towards more complex organizational advanced routines. The next level of DCs consists of renewing DCs referent to changing environments. Companies build on incremental capabilities to adapt, change and augment previous capabilities and organizational routines into practices that represent more complex activities and organizational learning processes. Finally, companies are able to regenerate their previous resources and DCs to achieve a higher level of complexity. This might result in a meta-capability (or regenerative DC) that transforms previous renewing capabilities into a new complex set of organizational practices and learning processes. Meta-capabilities emerge to extend and renovate the company's previous organizational routines and practices and allow it to move forward to build complex processes (Collins, 1994). These meta-capabilities would then apply the four DC processes – reconfiguration of assets and resources; leveraging processes and systems; learning; and integration of resources– over renewing DCs, changing their form (e.g., from leverage to reconfiguration) or its mix (adding leverage to an existing reconfiguration capability) (Ambrosini et al., 2009). This exponential power of meta-capabilities enables them to change the company's resource base and its processes disruptively.

The RBV further broadens this dynamic approach by adding inter-firm routines and processes to the possible sources of competitive advantage (in this case, referring to cooperative strategy/interorganizational structures, i.e., SCs). This view is also supported by Gold, Seuring and Beske (2010, p. 230) who state that "inter-firm resources and capabilities emerging from supply-chain-wide collaboration are prone to become sources of sustained inter-firm competitive advantage, since they are socially complex, causally ambiguous and historically grown and hence particularly difficult to imitate by competitors." More recently, the practice-based view (PBV), like RBV and associated theories, analyzes "publicly known, imitable activities, or practices amenable to transfer across firms" (instead of VRIN resources) (Bromiley and Rau, 2014, p. 1249) as performance drivers (instead of competitive advantage) at the firm level (Bromiley and Rau, 2014). This theory is further developed at the SC level by Carter et al. (2017) under the name of supply chain practice view (SCPV).

Research on RVB and DCs is frequently applied to SCM literature (Beske, Land, and Seuring, 2014; Epelbaum and Martinez, 2014; Fawcett, Wallin, Allred, Fawcett, and Magnan, 2011). In this paper, the authors embrace the broader dynamic RBV of the firm and understand both VRIN resources and the configuration of imitable activities or practices as potential sources of competitive advantage or abnormal performance for firms or for the entire SC in which they operate. Concretely, they highlight the relational view (RV), practice-based view (PBV) and the supply chain practice view (SCPV) (Barney, 1991; Bromiley and Rau, 2014; Carter, Kosmol, and Kaufmann, 2017; Dyer and Singh, 1998) as having a key role in understanding TfS and its connection to effective (S)SCM.

2.4. Apparel industry

Finally, this study specifically focuses on apparel SCs, that is, those involved in the design, production and distribution of garments under a brand name, due to their being a perfect example of a global, complex and low-regulated industry (Doorey, 2011; Huq, Chowdhury, and Klassen, 2016; Khurana and Ricchetti, 2016). The apparel industry has enormous potential to foment the development of the countries in which it is present. It employs millions of workers worldwide, especially young women (ILO.org, 2017)–, with powerful players operating worldwide. In 2015, the average retail revenue among the top 45 apparel and accessories retailers was US$ 9,266M (Deloitte, 2017). However, the apparel industry on its own accounts for 10% of total CO^2 emissions and ranks second in water consumption worldwide (www.unece.org). Furthermore, despite its high-risk activities (Gobbi and Massa, 2015; Greer and Purvis, 2015; Laudal, 2010), the industry's environmental and

social breaches can rarely be acknowledged based on the end product (Busse, Schleper, et al., 2017). Surprisingly, despite recognizing the importance of transparent and traceable apparel SCs (Gold et al., 2015) and (the lack of) traceability being implicated in recent terrible events (such as the Tazreen fire or Rana Plaza collapse), academic peer-reviewed articles in this sector are practically non-existent (Egels-Zandén and Hansson, 2016; Egels-Zandén, Hulthén, and Wulff, 2015). This increases the potential of TfS to be leveraged in practice for (S)SCM.

3. Method

In order to answer the RQs detailed above, the authors carried out an integrative and systematic literature review conducted by means of content analysis (Seuring and Gold, 2012; Torraco, 2005), which allowed to blend qualitative and quantitative (frequency) analyses when meaningful for the research (Seuring and Gold, 2012).

The content analysis and its codification process is based on Gioia, Corley and Hamilton (2013) and Saldaña (2012). The researchers determined that the integrative review design was the most appropriate as it is "a form of research that reviews, critiques, and synthesizes representative literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated" (Torraco, 2005, p. 356). To ensure its rigor and replicability, the authors adopted a systematic review, following the milestones proposed by Seuring and Gold (2012) which are summarized in Table 1. This ensures a transparent process and analysis, and prevents a lack of rigor and biased results (Tranfield et al., 2003).

Insert Table 1 about here

3.1. Sample definition and material collection

In line with the aim of this study and its RQs, the authors searched for peer-reviewed articles intersecting traceability, sustainability and apparel topics in the SC context. Studies only addressing a unique echelon of the SC and those that only related to interchanges between focal companies and customers were not taken into account. An exception was highly-cited articles, which were added to the sample following a snowballing process described further below, and during which other work with relevant insights and implications for the global apparel industry were kept in the sample, even if pertaining to other sectors. For example, this is the case with Regattieri et al. (2007) and Roth et al. (2008).

3.2. Search strategy

The search strategy addressed the scattered nature of the literature in the targeted areas, implying a broad and transversal initial search. Thus, the authors completed a keyword search in the Scopus, Web of Science and EBSCOhost academic databases with an online search in Google Scholar. The keywords were exhaustively settled to find each document possibly related to the targeted intersection, applying an iterative process. For instance, this led the researchers to include the terms 'visibility', 'transparency', 'RFID' and 'blockchain' as inherent to traceability. The complete list of keywords and the Boolean combinations that the authors applied in the academic databases and Google Scholar searches are detailed in Appendix 1. The authors only targeted peer-reviewed journal articles as they "represent a major mode of communication among researchers" (Seuring and Gold, 2012, p. 547).

The first keyword search in the academic databases returned 185 results after filtering out duplicates. This initial sample was completed with 14 new articles stemming from the analysis of the 100 top results (by citations and relevance (GS rank)) from an online search in Google Scholar using Harzing's Publish or Perish software, thus ensuring that no seminal papers on traceability or SC sustainability were left out.

The authors first screened the 199 peer-reviewed articles retrieved by title and abstract. The authors then analyzed the full text of 65 preselected pieces, reducing the collection to 53 documents able to shed light on the RQs. As suggested by Webster and Watson (2002, p. 16), this initial sample was iteratively completed with the relevant references and citations (back and forward snowballing), a process that lasted until the last document did not produce any critical item. Figure 1 below shows the steps taken until defining the final

corpus of the literature (n=89 peer-reviewed journal articles). The publication outlets of the articles in the sample are presented in Table 2, and the reviewed documents are marked with an asterisk (*) in the list of references at the end of this document.

Insert Figure 1 about here

Insert Table 2 about here

3.3. Pattern of analytic categories

The researchers applied an abductive approach to category-building driven by the question of how TfS is developed and deployed in global SCs, all in constant dialogue with the previous literature for interpretation (Mantere and Ketokivi, 2013). Thus, the authors undertook a qualitative analysis of the literature based on inductive codification (Gioia et al., 2013; Saldaña, 2012) followed by an iterative process, comparing inductive codes and categories directly derived from the literature with the analysis of prior theory, revisited until a robust conceptual framework arose (Saldaña, 2012; Seuring and Gold, 2012; Mantere and Ketokivi, 2013). The authors then coded all the selected papers following consecutive levels or cycles of analysis, as proposed by Gioia et al. (2013).

The first step involved open coding and included informant terms that emerged after reading each paper. This resulted in more than 650 codes referring to enablers and barriers appearing in the documents. The second step involved seeking first-order concepts, analyzing similarities and differences as a descriptive analysis of the data (Gioia et al., 2013). First-order concepts included 399 nodes. The third codification step was based on second-order codes asking for highly abstracted concepts that resulted in 32 categories. The authors further revisited and compared these 32 categories to finally refine them into three main elements: Actors, enablers and barriers. These served to give content to the three aggregate dimensions of the analysis: Governance; collaboration; and tracking and tracing, all of which represent the highest level of abstraction (Gioia et al., 2013). The three dimensions are discriminant to each other while together conforming the complete picture of the phenomenon under analysis (TfS). In the findings and discussion sections below, the authors explore the three dimensions together with their dynamic interrelations.

3.4. Research validation

The specialized software, NVivo 11, supported the authors' coding process of the literature, helping to ensure the transparency and replicability of the process. To enhance the validity and reliability of the findings of the content analysis process and prevent subjective bias, four researchers were involved in the different phases (Seuring and Gold, 2012). The first author of this study was responsible for the initial first and second-order coding of the full sample. Said author randomly chose three papers which a second author coded in an early stage of the coding process. The discrepancies that arose between the two coders were resolved in dialogue with the literature, and the agreed interpretation of constructs was applied to the whole sample (Seuring and Gold, 2012). Once all the documents were fully coded, two authors independently proceeded with the consecutive cycles of analysis, consolidating second-order themes, contrasting the codes, categories and concepts. They discussed disagreements until reaching a consensus (Durach, Kembro, and Wieland, 2017; Seuring and Gold, 2012). The authors adopted a reflexive process with the previous literature and applied an iterative procedure, with constant back and forward dialogue with the theory to prevent expectancy bias (Durach et al., 2017; Mantere and Ketokivi, 2013). The final framework was open to the scrutiny of the third

author and a fourth external researcher (Durach et al., 2017) through a validation process. This reiterative process across results helped to review and improve the original framework.

4. Findings

In this section, the authors describe the results of the content analysis of the reviewed sample. In doing so, they respond to the RQs of this study regarding how companies develop and deploy TfS in global SCs and how TfS contributes to (S)SCM.

These results start with the definition of the TfS components: the three aggregate dimensions (governance, collaboration and tracking and tracing) and their main elements (actors, enablers and barriers), summarized in Table 3.

4.1. The aggregate TfS dimensions

The three TfS dimensions and elements are detailed in the following subsections in connection to the reviewed sample and their frequencies. The understanding of each dimension is presented in Table 4. This allows setting the limits of the three interlinked constructs, whose (blurred) boundaries have different interpretations in prior SCM literature (Ellram and Cooper, 1990; Chen and Paulraj, 2004; Seuring and Müller, 2008; Pagell and Wu, 2009; Cao and Zhang, 2011; Beske and Seuring, 2014; Neutzling et al, 2018). By combining these learnings with the content analysis of the reviewed sample, the authors argue that these three dimensions can be discriminant towards each other while together comprising a comprehensive framework that explains the TfS phenomenon in global apparel SCs.

It is important to underscore that the dimensions and their elements respond to the development and deployment of *traceability for sustainability*. Dissimilar findings may be expected if the sustainability goal is removed from the *TfS* equation.

Insert Table 3 about here

Insert Table 4 about here

4.1.1. Governance

Definition

In the global apparel SC context, the paramount example of buyer-driven SCs, governance is inevitably defined as the "authority and power relationships that determine how financial, material and human resources are allocated and flow within a chain" (Gereffi, 1994). The literature reflects how retailers located downstream lead the global network and are subject to external scrutiny, and describes different governance processes and mechanisms that retailers promote or support which foster TfS throughout the SC (Egels-Zandén, Hulthén, and Wulff, 2015). In the case of TfS technologies and practices, they transform (S)SCM governance, promoting new non-SC actors, and transforming the power and authority relationships of SC and non-SC actors to frame the integration of TBL dimensions.

Actors

The analysis revealed the importance of non-SC actors, especially NGOs, together with traditional SC players such as retailers, acting as focal companies, and (multi-tier) suppliers, to articulate the organizational routines and practices of the TfS governance dimension.

Enablers

In line with the extant literature on interorganizational governance (Heide, 1994; Neutzling, Land, Seuring, and Nascimento, 2018; Wang and Wei, 2007), this analysis found both formal and informal mechanisms shaping the governance dimension:

(i) Formal governance mechanisms include regulations, compliance mechanisms, corporate and supplier codes of conduct, industry-wide standards and certifications, industry self-regulation, audits, and monitoring (Boström et al., 2012; Gobbi and Massa, 2015) that facilitate the emergence of TfS. In contrast to the food industry, in the globally deregulated apparel SCs, rules and mandates from focal firms appear to be more relevant than regulatory frameworks and standards from governments and institutions which, if they exist, are scarcely enforced (Bailey, Bush, Miller, and Kochen, 2016; Roth et al., 2008; Wognum, Bremmers, Trienekens, van der Vorst, and Bloemhof, 2011).

(ii) Informal governance mechanisms include soft governance practices based on trust (or distrust) and relational control that retailers promote to enable TfS across the SCs (Aulakh, Kotabe, and Sahay, 1996; Ciliberti, de Groot, de Haan, and Pontrandolfo, 2009; Egels-Zandén et al., 2015; Hernandez-Espallardo, Rodriguez-Orejuela, and Sanchez-Perez, 2010). These informal governance mechanisms include whistle-blowing mechanisms, "name and shame" campaigns, informal visits to suppliers and factories, etc.

Barriers

The literature points to three main barriers that hinder the efficacy of the above TfS enablers: the lack of regulation and enforcement compelling traceability; the non-existence of globally accepted standards (Boström et al., 2012; Laudal, 2010; Roth et al., 2008); and the audit-related problems such as audit fatigue or double record keeping practices (Huq et al., 2016; Marshall, McCarthy, McGrath, and Harrigan, 2016; Plambeck, Lee, and Yatsko, 2012).

Table 5 summarizes the governance dimension and shows the number of articles that mention each category in relation to TfS in the reviewed sample.

Insert Table 5 about here

4.1.2. Collaboration

Definition

Collaboration is defined as two or more autonomous firms that form long-term relationships and work closely to plan and execute SC operations to achieve common goals, thereby reaping more benefits than if acting independently (Cao, Vonderembse, Zhang, and Ragu-Nathan, 2010). This is the backbone of SCM (Chen and Paulraj, 2004; Ellram and Cooper, 1990). Collaboration constitutes a strategic issue when targeting sustainability (and (S)SCM), compelling the participation of non-SC actors (Pagell and Wu, 2009; Seuring and Müller, 2008; Touboulic and Walker, 2015b). Traditionally linked to enhanced communication, information-

sharing and technological integration (Beske and Seuring, 2014; Cao and Zhang, 2011; Chen and Paulraj, 2004), it is not surprising that collaboration appears as one of the three main aggregated dimensions involved in TfS development.

Actors

Also not surprisingly, the actors found to be involved in the collaboration dimension of TfS are a combination of SC and non-SC actors who collaborate using different formulas: from long-term relationships to all kinds of multistakeholder initiatives and partnerships, including peer-to-peer collaboration (Boström et al., 2012; Doorey, 2011; Egels-Zandén et al., 2015).

Enablers

Under this category, the study situates collaborative practices, policies and routines that retailers display to collaborate with other members to enhance shared goals towards the implementation of TfS (Cao and Zhang, 2011). In this respect, the reviewed literature shows the emergence of new types of collaboration (Pagell and Wu, 2009; Selsky and Parker, 2005; Touboulic and Walker, 2015a) between focal firms, suppliers and non-traditional SC actors to implement TfS. These include collaborative practices between peers (e.g., between focal firms or between suppliers) and between SC actors and non-SC stakeholders such as NGOs, private institutions and foundations forming multi-stakeholder collaborations (Doorey, 2011; O'Rourke, 2006; Plambeck et al., 2012). Through long-term relationships (Boström et al., 2012), collaboration ultimately results in alliances and partnerships (Burchielli, Delaney, Tate, and Coventry, 2009; de Brito et al., 2008; Khurana and Ricchetti, 2016).

Examples include Fair Wear Foundation (FWF), Community of Practice (CoP), the Australian Fair Wear Campaign (FWC) and the Bangladesh Accord on Fire and Building Safety (Burchielli et al., 2009; de Brito et al., 2008; Egels-Zandén et al., 2015; Huq et al., 2016).

Barriers

The analysis of the literature revealed two main obstacles: Cultural differences and the lack of shared values and vision. These were responsible for hindering integration in global apparel SCs, in turn complicating the development of effective collaboration (Gobbi and Massa, 2015; Gold et al., 2010; Wilhelm et al., 2016). These barriers can be considered endemic within the global apparel industry due to their direct connection to complex and geographically dispersed SCs (Busse, Meinlschmidt, et al., 2017; Roth et al., 2008). Eliminating these barriers is thus required for TfS to be effectively deployed in the apparel industry.

Table 6 summarizes the collaboration dimension and shows the number of articles that mention each category in relation to TfS in the reviewed sample.

Insert Table 6 about here

4.1.3. Tracking and tracing

Definition

The tracking and tracing dimension comprises the conditions, organizational practices, processes and mechanisms required or directly involved in facilitating real-time tracing and monitoring of products and their history throughout the SC (Ajana, Harroud, Boulmalf, and Elkoutbi, 2011).

Actors

For its deployment, the analysis revealed the participation of SC and non-SC actors, both in bilateral relationships or through multi-actor platforms and networks. Regarding (S)SCM, the integration of enabling TfS technologies interconnects SC actors across traceability systems, incorporating TBL variables (Ajana, Harroud, Boulmalf, and Elkoutbi, 2011; Azevedo and Carvalho, 2012; Cannon et al., 2008; Marucheck et al., 2011).

Enablers

Visibility and transparency are the interlinked preconditions for effective tracking and tracing as they refer to having access to and enabling others to access qualitative and relevant data for their mutual operations and benefit (Barratt and Oke, 2007; Gold and Heikkurinen, 2017).

The literature shows that the presence and development of these preconditions is mainly supported by the consolidation of tracking and tracing capabilities such as technological tools and management systems (from the simplest record-keeping mechanisms to complex blockchain technology assuring provenance) (Golan et al., 2004; Tian, 2016) and traceability-oriented innovations that enhance capabilities and practices. Under this category, the literature includes both technological and organizational innovations seeking to extend information beyond SC and non-SC actors and authorities (Bailey et al., 2016; de Brito et al., 2008; Gobbi and Massa, 2015).

First, the integration of visibility is important, referring here to the extent to which actors have access to or share information that they consider important, useful and of mutual benefit (Barrant and Oke, 2007). Second, transparency becomes a core element, not only as a principle but also as a practice. SC actors include new enabling technologies that facilitate continuous disclosure and detailed information about their operations, sources and impacts (Gold and Heikkurinen, 2017). Third, the integration of traceability systems facilitates real recordkeeping and information-tracking processes throughout the entire SC (Golan et al., 2004). Fourth, traceability-related innovation including technological and organizational creativity is needed to extend transparency from SC actors to non-SC actors, customers and society, integrating TBL variables (Bailey et al., 2016).

Barriers

Similar to the findings for the previous dimensions, tracking and tracing processes are mainly obstructed by the social and geographic complexity of the apparel industry stemming from outsourcing and delocalization (Boström et al., 2012; Egels-Zandén, 2016; O'Rourke, 2006) and the lack of commonly accepted standards. These barriers range from the non-existence of a common definition of traceability to the lack of a unique technological language that would support the dimension's emergence and continuance (Marshall et al., 2016; Regattieri et al., 2007). Equally important is the cost of traceability both economically and organizationally (Cheng and Simmons, 1994; Stranieri, Cavaliere, and Banterle, 2017) which is preventing the originally predicted, widespread implementation of tracking technologies such as RFID (Balocco, Miragliotta, Perego, and Tumino, 2011). The lack of resources and capabilities among SC actors (mainly upstream suppliers) aggravates the problem (Boström et al., 2012; Plambeck et al., 2012).

Table 7 summarizes the tracking and tracing dimension and shows the number of articles that mention each category in relation to TfS in the reviewed sample.

Insert Table 7 about here

4.2. Conceptual framework: TfS as a meta-capability

As Torraco explains (2005), the ultimate goal of an integrative literature review is the emergence of a conceptual framework that generates a novel perspective to the studied phenomenon. In this case, the findings from the analysis of the literature enable conceiving TfS as a distinctive meta-capability construct built on advanced levels of renewing DCs (Ambrosini et al., 2009; Collis, 1994). Thus, drawing on the dynamic RBV of the firm and its ramifications (RV, PBV and SPCV), the authors propose the following conceptual framework (Figure 2) that explains the development of TfS in global SCs.

Insert Figure 2 about here

The following subsections provide details on the emergence of the framework applying the DC transformation lens.

4.2.1. Renewing capabilities for TfS

The results of the content analysis allow the authors to suggest that the interconnected activities and interactions among the three aggregate dimensions and their main elements lead to advanced renewing DCs which, as discussed above, are capable of transforming the existing resource base through four main processes: –reconfiguring; leveraging; learning; and integrating practices, routines and tools (Ambrosini et al., 2009). In doing so, these renewing DCs generate a higher meta-capability: *TfS*.

Table 8 below describes the six main renewing DCs (Ambrosini et al., 2009), together with the number of articles that mention each DC in relation to TfS in the reviewed sample. These renewing capabilities are: knowledge-sharing; interorganizational learning; interorganizational transparency; information-sharing; strategic collaboration; and integration.

Insert Table 8 about here

The first two renewing capabilities link to knowledge management. First, knowledge-sharing for TfS requires advanced organizational routines and learning practices related to traceability and sustainability that let focal firms, suppliers and other SC and non-SC actors transfer, recombine and create specialized (S)SCM knowledge. Therefore, the simplest form of codes of conducts between focal firms and suppliers or the individual audits carried out by a single firm would turn into public agencies, specialized media or platforms storing information or consortium audits preventing audit fatigue (Carter and Rogers, 2008; Guercini and Runfola, 2009; Huq, Chowdhury, and Klassen, 2016; Khurana and Ricchetti, 2016; Plambeck, Lee, and Yatsko, 2012). Second, interorganizational learning for TfS follows with the acquisition of new knowledge among different partners that include collective learning synergies and interactions (Larsson et al., 1998). Departing from ad-hoc supplier training given by individual focal firms, complex learning routines end up in collective learning processes between SC actors and non-SC actors (Chkanikova and Kogg, 2015; Ciliberti, de Groot, de Haan, and Pontrandolfo, 2009; Huq et al., 2016; O'Rourke, 2006). The next two renewing capabilities are related to information: Interorganizational transparency fosters and allows for the exchange of open information inside the SC network (Egels-Zandén, Hulthén, and Wulff, 2015; R. C. Lamming, Caldwell, Harrison, and Phillips, 2001; R. Lamming, Caldwell, and Harrison, 2004). Information-sharing for TfS is based on seeing transparency and exchanges on TBL issues and impacts as a strategic and tactical practice that leads to increased efficiency (Barratt and Oke, 2007; Cao et al., 2010; Fernie, Sparks, and McKinnon, 2010). The last group of renewing

capabilities are related to strategic goals. First, the strategic collaboration among SC partners to share objectives in the pursuit of TfS (Gold, Seuring, and Beske, 2010; Huq et al., 2016; Kim and Lee, 2010), leads to the sixth capability: integration. Integration is based on unified economic, social and environmental (S)SCM governance practices and processes (Flynn, Huo, and Zhao, 2010; Guercini and Runfola, 2009; Khurana and Ricchetti, 2016; Soosay and Hyland, 2015), and represents an advanced renewing capability that requires focal firms and suppliers to constantly collaborate and align themselves to achieve common goals and performance.

4.2.2. The enabling cycle: TfS as a meta-capability

Finally, the authors argue that the sequenced interaction between this set of six renewing DCs with the practices, tools and actors within each dimension ultimately results in the emergence of TfS as a meta-capability that acts upon the system, to transform and interconnect prior managerial, organizational and knowledge-based capabilities across SCs, towards more connected governance, collaboration and tracking and tracing dimensions. The understanding of TfS as a meta-capability (or regenerative DC) (Ambrosini et al., 2009; Collis, 1994) refers to the creation of a virtuous cycle in which previous DCs are reconfigured, leveraged, learned and integrated, giving rise to more complex and specific practices and tools that can disruptively transform prior (S)SCM processes and systems. This frames the emergence of new sustainable SC models in which traditional and non-traditional SC actors are integrated into the same ecosystem and, with the adoption of the TBL approach, sustainable performance is enhanced throughout and beyond SC networks (Govindan, Seuring, Zhu, and Azevedo, 2016).

The integration of economic, social and environmental needs in TfS demands new forms of governance and increasing collaboration. This, in turn, fosters new collaborative practices, for example, sustainability certifications, industry-wide codes of conducts and consortium audits. In addition, enabling technologies facilitate detailed transparency, sharing information and continuous knowledge exchange between SC and non-SC actors to change prior conditions, practices, processes and traditional (S)SCM mechanisms.

The virtuous TfS cycle is illustrated in the next subsection, bringing together different examples from the reviewed literature.

4.3. TfS in practice

This literature review provides numerous examples of how TfS would work in practice as a disruptive meta-capability.

For this illustration, the authors take the case of TfS' enabling cycle, starting with the need to develop trust when traceability and transparency are difficult to achieve (Roth et al., 2008). Informal governance based on trust replaces formal and difficult-to-employ governance mechanisms in the presence of the above-mentioned governance barriers endemic to global SCs operating in countries with low or non-existent regulations and enforcement (Boström et al., 2012). For these reasons, focal companies in SCs often adopt trust and relational capabilities as the primary mechanisms for sustainability governance (Li, Zhao, Shi, and Li, 2014). While it takes time for trust to develop and govern the different SC actors (Gold et al., 2010), other informal governance mechanisms (informal visits, fear, and "name and shame" campaigns) take the lead in fostering knowledge-sharing and mutual learning, the building blocks for collaboration within and beyond SC boundaries (Macchion et al., 2017; Wilhelm et al., 2016). This results in well-nourished collaboration that demands the development of interorganizational transparency among the actors (Doorey, 2011) and the will to share information (Soosay and Hyland, 2015) to be able to meet TfS' needs and demands. This interorganizational level of transparency and willingness to share information, in turn, facilitates the development of the tracking and tracing capabilities (Fernie et al., 2010) and overcomes the obstacles to

visibility placed by outsourcing and subcontracting practices, high costs and the mentioned traceability barriers (Plambeck et al., 2012; Wognum et al., 2011).

These enabling tracking and tracing capabilities and systems (both technological and non-technological) require intensive resources, investment and information availability that can only be obtained with the development of strategic collaboration among SC and non-SC actors (Florea, Corbos, Popescu, and Zamfir, 2016; Gobbi and Massa, 2015). This strategic collaboration is based on practices that (i) facilitate TBL goals for the different SC and non-SC actors (e.g., focal firms invest in RFID technology and training throughout the SC and its different actors and, in turn, they get information that can be incorporated into their ordinary decision-making processes, such as when selecting suppliers, allocating orders or determining the country of production); (ii) increase efficiency and market response; and (iii) manage reputational risk (Bailey, Bush, Miller, and Kochen, 2016; Green et al., 2017; Weil, Fung, Graham, and Fagotto, 2006). Engaging in training and investments with different actors also helps to diminish cultural barriers and advance integration in global SCs (Greer and Purvis, 2015; Macchion et al., 2015). The examples of collaborative initiatives provided above (Fair Wear Foundation (FWF), Community of Practice (CoP), etc.) allow actors throughout the network to exchange information, facilitate mutual learning practices and share their knowledge, physical resources, etc., enabling new tracking tools to be extended across global SCs (Huq et al., 2016; Marucheck et al., 2011; Soosay, Hyland, and Ferrer, 2008). Thus, conflicts and trade-offs are transformed into shared value which increase trust among SC actors, re-starting the cycle again but with SC capabilities already departing from a higher level and non-SC actors already included in the ecosystem (Neutzling et al., 2018; Roth et al., 2008; Soosay et al., 2008). For instance, the increased level of transparency and the integration of non-SC actors allow whistle-blowing systems to be effective governance mechanisms capable of solving problems before becoming public crises (Madsen, 2009). Similarly, shared objectives around TfS give rise to non-governmental regulatory systems capable of compensating for the lack of regulation and enforcement in developing countries (Li et al., 2014; O'Rourke, 2006)

5. Discussion and implications

This paper offers a review of TfS in SC settings to achieve (S)SCM. This is done by analyzing 89 papers and summarizing their core findings into a conceptual framework (see Figure 2). It provides an advanced analysis of TfS and (S)SCM, building a new approach about what and how TfS can be applied in complex SCs with disruptive effects. This research contributes to existing literature in that such an attempt has not been made previously despite the relevance of traceability for sustainability according to numerous scholars (including Gobbi and Massa, 2015; Greer and Purvis, 2016; and Laudal, 2010, among others). This study also makes three main novel contributions with important research and practical implications for sustainability and (S)SCM:

i. Traceability is re-conceptualized under the name of TfS as a core enabler of (S)SCM, incorporating new applications that include not only economic and operational efficiency aspects but also social and environmental implications,
ii. TfS arises from the interaction of six renewing DCs and TfS practices and tools in a self-sustained cycle of interactions between SC and non-SC actors, and
iii. TfS is conceived as a meta-capability, thus associated to increased TBL performance (and competitive advantages), risk management and SC process transformation.

These contributions are discussed below with a special reflection on the key role that enabling TfS technologies play in disruptively changing (S)SCM and encouraging the achievement of truly sustainable SCs.

5.1. Re-conceptualization of traceability as a meta-capability and implications for (S)SCM

This study contributes to (S)SCM literature by integrating TfS as a core element of (S)SCM. The authors have operationalized TfS into three main TfS dimensions (governance, collaboration and tracking and tracing) and advanced towards the study of TfS as a meta-capability for (S)SCM. This paper shows how TfS is able to disrupt the governance, collaboration and tracking and tracing practices and processes of global SCs, fostering the emergence of a transparent and reported system that is compatible with truly sustainable SCs.

The review of the literature has shown that, despite the voices in academia and practice coupling traceability with sustainability, a broadly accepted definition and operationalization is still missing. The attempt of the Global Compact (2014) to incorporate a sustainability claim to the broadly accepted definition of traceability from the ISO does not integrate the economic/operational dimension, thus missing the opportunity to integrate a TBL focus.

The definition proposed in this study offers an integrative approach that leverages efforts and investments to overcome the potential barriers related to its development and deployment. Addressing sustainability might not be in apparel companies' core interest (Moretto et al., 2018), but timely adapting to customers' needs and being able to respond to their rising demands is crucial for the profitability of all SC actors (Rai, Patnayakuni, and Seth, 2006; Rajala, Hakanen, Mattila, Seppälä, and Westerlund, 2018). Thus, this integrated approach understands TfS as a self-reinforced mechanism not only demanded by non-SC actors; but also pursued within the SC as a core business tool –a meta-capability potentially enhancing the competitive advantage of SC actors and allowing for TBL performance within and beyond SC boundaries-.

Furthermore, the suggested definition contains the notion of information materiality (that is, it is "accurate, trusted, timely and useful"), thus overcoming the concerns regarding inefficient data processes or the disclosure of sensitive information that should not be revealed publicly (Kache and Seuring, 2017).

This conceptualization of traceability as TfS helps to advance knowledge about how to approach sustainability with a TBL orientation, as demanded by (S)SCM scholars.

TfS can leverage advanced technology (e.g., IOT, RFID and blockchain) to achieve sustainability goals in (S)SCM because it facilitates the ability to trace and, therefore, manage social and environmental issues, attaching them to economic efficiency. Specifically, TfS facilitates four main features that are currently underdeveloped in (S)SCM (Busse, Meinlschmidt and Foerstl, 2017; Carter and Rogers, 2008; Pagell and Wu, 2009; Seuring and Müller, 2008):

i. Building transparency between SC partners in order to have direct and detailed TBL information about the processes and the final products, including multiple variables in sustainability-related areas that focal firms and suppliers have assumed explicitly in their codes of conducts,
ii. Generating the information that makes it possible to align the entire SC system, including focal firms and suppliers, to achieve the key sustainability performance goal,
iii. Developing sustainability-related risk and uncertainty management anywhere in the SC based on the updated information, and
iv. Facilitating collaboration between focal firms, suppliers and non-SC actors on TBL performance issues.

Once TfS has been incorporated as a core business activity, the self-sustained cycle of renewing DCs that focal firms promote to diminish traceability barriers can arise, providing indirect benefits to SC and non-SC actors in terms of learning from training and other developmental practices. From the different practices and tools, the enabling technologies associated to the tracking and tracing dimension deserve special attention due to their potential to leverage TfS beyond SC boundaries. These technologies can only operate systemically, when all the actors are connected in a single ecosystem (Rad and Ahmada, 2017; Rajala et al., 2018). Thus, focal companies will be interested in supporting other actors in the SC, while governments in developing countries

can leverage this upgrading to offset the potential risks that enabling technologies may pose in the near future (Siddivo, 2017). Suppliers and their workers will also benefit from the training and from the creation of qualified products that the spread of TfS along the SC will provide. This disruptive change in power relations within the SC can set the conditions to truly transform (S)SCM with TBL impact beyond SC boundaries.

As a meta-capability, TfS fosters the reconfiguration of previous organizational routines, leveraging them to instill new complex processes, assimilate complexities and integrate knowledge and practices. Advancing the work by Rai et al. (2006), the authors of this study posit that this is the case with disruptive changes that affect (S)SCM in connection with traceable systems and enabling digital technologies (Kshetri, 2018). This research shows how the systemic orientation of the enabling technologies associated to TfS blurs boundaries and integrates non-traditional SC actors into the same ecosystem (Rad and Ahmada, 2017; Rajala et al., 2018). In this way, this study also contributes to DCs literature.

In addition, with the nascent application of many enabling technologies, the increase in benefits and productivity currently comes from the fostered changes in processes and practices rather than from the technology itself (Rad and Ahmada, 2017; Rajala et al., 2018). This reinforces the TBL value creation of TfS in today's global SCs.

Finally, the recent calls for circular models add a disruptive component to traditional linear systems according to which companies will only be able to respond with disruptive changes in the way they operate (Kache and Seuring, 2017). TfS, as a meta-capability capable of disruptively changing (S)SCM processes, can be seen to play a key role in the new configuration.

While some scholars claim that reshoring is one of the opportunities that has arisen with disruptive technologies and that it is the solution to mend sustainability breaches and meet demands for transparency (Busse et al., 2017; Foerstl, Kirchoff, and Bals, 2016), the authors of this study believe that TfS is the way forward. This is due not only in terms of the responsibility that focal firms, big traders, governments and consumers have assumed as regards producing countries, but also due to the economic and environmental point of view as current production areas are expected to be the biggest markets in a few decades (Siddivo, 2017).

5.2. Implications for managers and institutions

From a managerial perspective, there are some implications that arise from this work. In the governance dimension there is a need to understand the intense interdependence between SC and non-SC actors and a mandate for focal companies to better manage relations with non-SC actors, both formal –e.g. NGOs- and informal ones –e.g. social media. In the case of collaboration, focal companies have to, on the one hand, build trusting relationships with suppliers and, on the other, understand the strategic value of cross-sector partnerships to deal with competitors. In the case of tracking and tracing technologies, traceability information, though accurate, trusted, timely and useful for SC actors, must be dealt with in a transparent way from the perspective of consumers, so that their privacy is not threatened but TBL benefits can be derived (Stevenson and Cole, 2018).

From an institutional perspective, there is a need for governments and institutions to respond to demands for global standards and supervision (perhaps in the form of a public agency that substitutes non-governmental systems and avoids audit fatigue and the public disclosure of rather useless information). The coordinated advancement in initiatives already taken by some governments (the UK Modern Slavery Act or the French Due Diligence Law) may help solve many of the TfS barriers and foster sustainability industry-wide.

6. Conclusions and limitations

Over the past decade, researchers have advocated traceability as a powerful mechanism to transform SCM (Cheng and Simmons, 1994; Roth et al., 2008; Skilton and Robinson, 2009). Currently, as enabling technologies open new possibilities to apply traceable systems, the authors of this study propose reconsidering how traceability is understood in (S)SCM literature. This paper aims to answer the questions about how TfS is developed and deployed in global SCs and, therefore, how TfS helps to transform (S)SCM, thus contributing to the underexplored question of how to be sustainable (Pagell and Shevchenko, 2014).

The authors propose TfS as a complex meta-capability (regenerative DC) that can provoke positive TBL performance across the SC level. TfS integrates advanced and complex processes to achieve continuous learning across multiple actors and levels of activities, and contributes to SC sustainability as it supports TBL value creation and risk management.

Based on the results of this study, the authors argue that TfS can help minimize sustainability risks and impacts by the mimetic effect of interorganizational collaboration strategies, alliances and initiatives, distributing and transferring knowledge, learning and resources more evenly along the entire SC. When deployed for sustainability, traceability may also facilitate a profound development of capabilities which are commonly associated in the literature to outstanding operational performance and competitive advantage (Beske and Seuring, 2014; Carter et al., 2017; Gold et al., 2010). It may also foster strategic collaboration between SC and non-traditional SC actors and, ultimately, foment their integration in the same ecosystem (Pagell and Wu, 2009; Seuring and Müller, 2008).

TfS helps to align information management needs and specific sustainability-related topics (Schleper and Busse, 2013), mainly due to the capacity of enabling technologies to develop new capabilities across focal firms and the entire system, thus fostering integrated TBL performance (Carter and Rogers, 2008; Pagell and Wu, 2009; Seuring and Müller, 2008).

As a result, this analysis contributes to the literature on (S)SCM (Gold et al., 2010; Pagell and Wu, 2009; Seuring and Müller, 2008) and SC collaboration (Chen and Paulraj, 2004) by showing the potential value of TfS as a key capability to mobilize (S)SCM towards a framework that leverages information-sharing in global SCs and achieves TBL equilibrium, improved decision-making processes and SC interconnection along tiers. This also links to DC literature, presenting TfS as a meta-capability that can potentially lead to greater efficiency and sustainability performance. The authors re-conceptualize traceability within (S)SCM to incorporate new value that includes not only economic and operational efficiency aspects but also social and environmental implications. Thus, this study also adds to operations literature with knowledge about how traceability connects to sustainability.

Despite these contributions, the authors would like to highlight some limitations.

The first stems from the potential biases commonly associated to qualitative research and literature reviews (Durach et al., 2017). In order to neutralize any possible subjectivity, the authors adopted a transparent and systematic process when selecting the sample and interpreting the results. The authors selected a broad range of keywords and applied an iterative, comprehensive search on academic databases and Google Scholar to ensure that no relevant document was omitted. The initial coding, undertaken by the first author, was supervised by the second contributor, while further coding cycles and the final synthesis were carried out or contrasted by two to four additional researchers, thus minimizing within-study and expectancy bias (Durach et al., 2017).

The second main limitation of this study relates to the nature of the documents in the sample. As a large percentage are conceptual, their viewpoints and qualitative studies hinder the possibility of drawing conclusive

results from this analysis and its results. The authors feel that these works should be interpreted as theoretical hypotheses that open future research avenues regarding their operationalization and empirical testing.

Third, the authors developed the TfS framework through a DC transformation lens, which, though providing insightful results for the aim of this research, implies a somehow normative approach to the literature review. This is also the case regarding the analysis of traceability to achieve sustainability (TfS).

Finally, due to space constraints, the authors focus the discussion section on the technological enablers of TfS. However, TfS has a non-technological component that cannot be forgotten (as mentioned in the Findings section above). The latter also plays a key and complementary role in the development and deployment of TfS.

Future research on TfS should work on validating TfS and the proposed framework empirically, including qualitative and quantitative research. Empirical research is needed to test the enabling cycle and its TBL impact. Contrasting the validity of this framework in other global industries (such as food) would also provide valuable insights on understanding TfS and its application in practice. Finally, in terms of technical issues associated to enabling technologies, moving forward on standardizing technologies and protocols is needed, as is interconnected research between engineering and organizational areas.

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Papers contained in the literature review are signaled with an asterisk (*).

Figure 1. Search strategy and sampling process

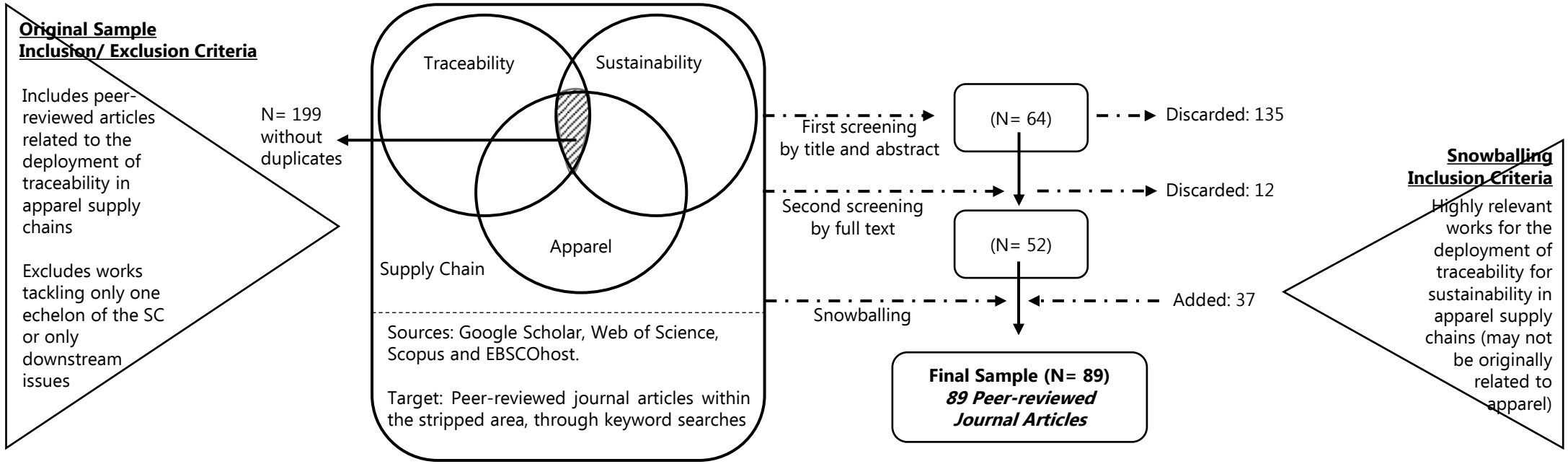
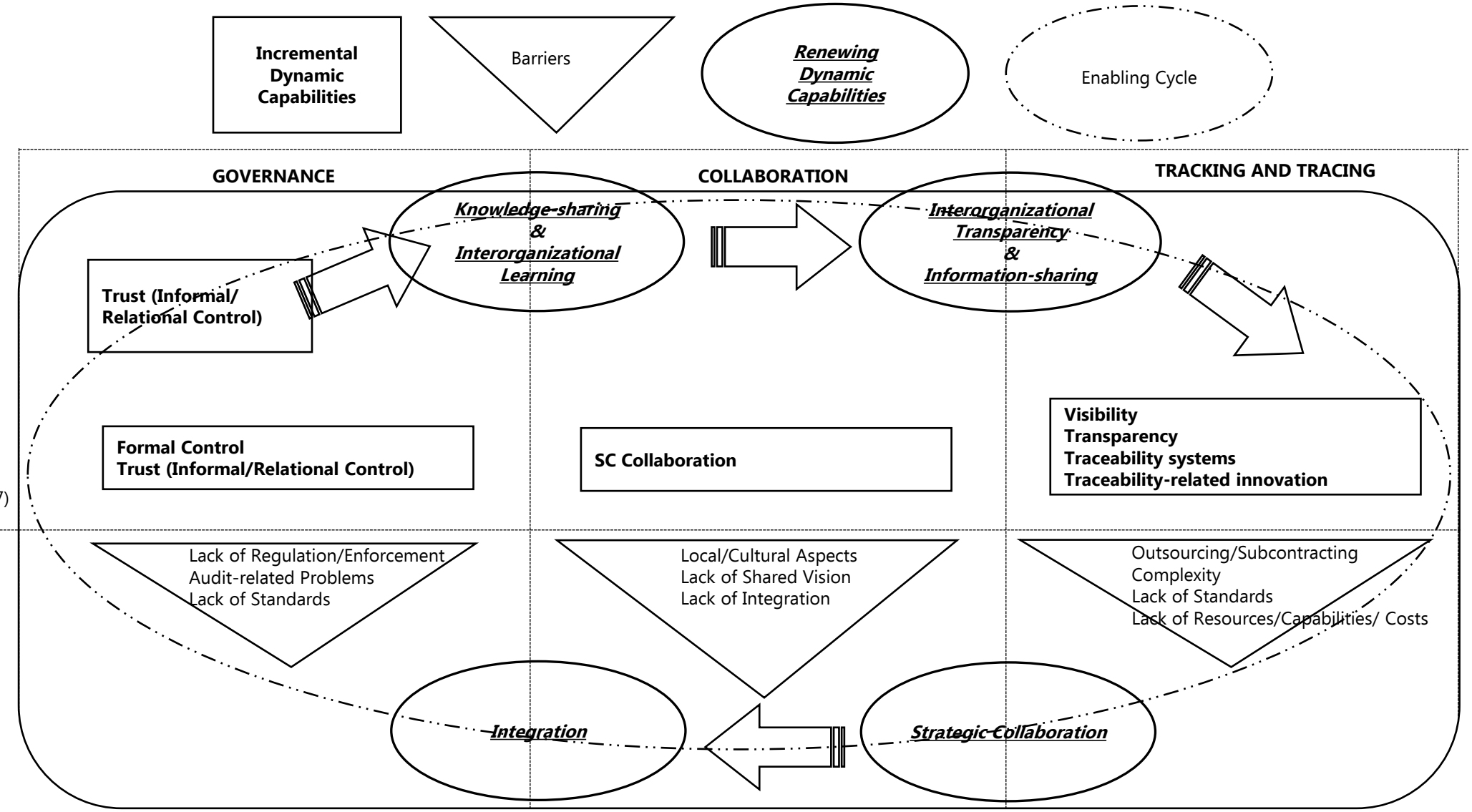


Figure 2. The enabling cycle of TfS



Enablers
Practices, processes and capabilities that allow an increase in SC traceability (adapted from "Sources" in Tachiçawa and Thomsen, 2007)

Barriers
Circumstances or obstacles that keep people or things apart or prevent communication or progress (Oxford Dictionary of the English Language, 2017)

Table 1. Milestones for conducting literature reviews as content analysis (based on Seuring and Gold, 2012)

Milestones	Critical Considerations
Sample definition and material collection	Peer-reviewed articles exploring how TfS is developed and deployed in apparel SCs. Keyword search in academic databases (Scopus, Web of Science and EBSCOhost), completed with top 100 Google Scholar hits per relevance and citations.
Pattern of analytic categories	Open coding process that derived in key categories or themes to analyze and/or synthesize the material around the RQs.
Material evaluation	Critical assessment of the material that gave rise to the proposed conceptual framework.
Research quality	Reported quality measures in terms of replicability, reliability and validity.

Table 2. Publication outlets

Academic Journal	Number of Papers	%
International Journal of Production Economics	9	10.11%
Journal of Business Ethics	6	6.74%
Journal of Cleaner Production	5	5.62%
Journal of Operations Management	4	4.49%
Journal of Supply Chain Management	4	4.49%
Supply Chain Management: An International Journal	4	4.49%
International Journal of Operations and Production Management	3	3.37%
International Journal of Physical Distribution and Logistics Management	2	2.25%
Production and Operations Management	2	2.25%
Mit Sloan Management Review	2	2.25%
Food Control	2	2.25%
European Management Journal	2	2.25%
Business Horizons	2	2.25%
International Journal of Retail and Distribution Management	2	2.25%
Others	40	44.94%
Total	**89**	**100.00%**

Table 3. TfS aggregate dimensions and main categories

Governance Dimension	Collaboration Dimension	Tracking and Tracing Dimension
SC actors Focal companies (retailers) and (multi-tier) suppliers. **Non-SC actors** Societal stakeholders (e.g., NGOs, media and environmental networks). **Enablers** Methods, actions, practices and systems that allow for the development or existence of TfS. **Barriers** Circumstances or obstacles that prevent TfS from progressing.		

Table 4. Aggregate dimensions definition

Category	Definition	Core References
Governance	"Authority and power relationships that determine how financial, material and human resources are allocated and flow within a chain."	(Gereffi, 1994, p. 90)
Collaboration	Two or more autonomous firms that form long-term relationships and work closely to plan and execute supply chain operations towards common goals, thereby achieving more benefits than if acting independently.	(Cao & Zhang, 2011)
Tracking and Tracing	Conditions, organizational practices, processes and mechanisms required or directly involved in facilitating real-time tracing and monitoring of products and their history through the SC.	(Ajana, Harroud, Boulmalf, & Elkoutbi, 2011).

Table 5. Governance dimension

Governance Dimension Categories	Definition	Core References	Frequency (number of articles in the sample referring to the issue in relation to TfS)
Governance-related enablers			
Formal mechanisms	Formal control based on internal rules and audits: Focal-firm-initiated mechanisms which are generally linked to specific economic (output control) and behavioral (process control) outcomes, respectively.	(Aulakh, Kotabe and Sahay, 1996, p.1013)	38
Informal mechanisms	Relational control based on trust: It does not control behavior through explicit, verifiable measures. Rather, an informal control system consists of common values, beliefs and traditions that direct the behavior of group members. Trust: Expectation that parties will make a good faith effort to behave in accordance with any commitments, be honest in negotiations and not take advantage of the other, even when the opportunity is available.	(Falkenberg and Herremans, 1995; Aulakh, Kotabe and Sahay, 1996, p.1008).	18
Governance-related barriers			
Lack of regulation/enforcement			18
Lack of standards			6
Audit-related problems			8

Table 6. Collaboration dimension

Collaboration Dimension Categories	Definition	Core References	Frequency (number of articles in the sample referring to the issue in relation to TfS)
Collaboration-related enablers			
SC collaboration	Two or more autonomous firms that form long-term relationships and work closely to plan and execute supply chain operations towards common goals, thereby achieving more benefits than if acting independently.	(Cao et al., 2010).	69
Long-term relationships	Long-term contractual commitments exist, but the relationship is often arm's-length and adversarial, pitting the customer against the vendor in a battle focused on low price.	(Webster, 1992).	12
Partnerships	Small number of vendors/suppliers and focal firms incorporate a pattern of cooperation in the early stages of product development.	(Webster, 1992)	20
Alliances	Partnership to achieve some long-term, strategic goals and vision.	(Webster, 1992)	8
Collaboration-related barriers			
Local/cultural aspects and cultural distance			5
Lack of shared vision and/or values			7
Lack of integration (resulting from the above)			9

Table 7. Tracking and tracing dimension

Collaboration Dimension Categories	Definition	Core References	Frequency (number of articles in the sample referring to the issue in relation to TfS)
Tracking and tracing-related enablers			
Visibility	"Extent to which actors within a supply chain have access to or share information which they consider as key or useful to their operations and which they consider will be of mutual benefit."	(Barrat and Oke, 2007 p.1218)	30
Transparency	"Acting in a way that enables others, both internal and external stakeholders to perceive and understand what the company does, as well as the quality disclosure of the information needed for this". "Transparency is not merely about sharing information but also about acting transparently."	(Gold & Heikkurinen, 2017, p. 5)	37
Traceability systems	"Recordkeeping systems designed to track the flow of product or product attributes through the production process or supply chain."	(Golan et al, 2004 p. 1)	33
Traceability-related innovation	Technological and organizational innovations necessary to extend information beyond SC actors and authorities.	(Bailey et al, 2016)	21
Tracking and tracing-related barriers			
Outsourcing/subcontracting			15
Complexity			39
Lack of standards			9
Costs			44
Lack of resources/ capabilities			7

Table 8. Renewing capabilities

Renewing Capabilities/ Constructs	Definition	Core References	Frequency (number of articles in the sample dealing with the issue in relation to TfS)
Knowledge-sharing for TfS	Regular pattern of inter-firm interaction that permits the transfer, recombination or creation of specialized knowledge.	(Dyer and Sign, 1998, Grant, 1996)	14
Inter-organizational learning for TfS	The collective acquisition of knowledge amongst a set of organizations. It includes the learning synergy or interaction effect between those organizations and it would not have occurred if there had not been any interaction.	(Larsson et al, 1998; Jean and Sinkovics, 2009)	11
Inter-organizational transparency	"Extent to which information is readily available to [...] other firms in the supply chain."	(Awaysheh and Klassen, 2010 p.1249)	12
Information-sharing for TfS	The willingness to make strategic and tactical data available to firms forming supply chain nodes.	(Cao et al, 2010).	47
Strategic-collaboration for TfS	"Extent to which SC partners actually carry out planning on business activities with a shared objective to jointly improve the long term well-being of each other."	(Kim and Lee, 2010 p.956)	16
Integration	Unified control (or ownership) of several successive or similar process formerly carried on independently.	(Flynn et al. 2010)	12