20 years of performance measurement in sustainable supply chain management – what has been achieved?

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Abstract

Purpose – The purpose of this paper is to systematically review the academic literature on sustainability performance measurement for sustainable supply chain management (SSCM) published over the past 20 years. The development and current state of instruments, concepts and systems to measure and manage sustainability performance are examined and research gaps are identified.

Design/methodology/approach – A systematic literature review is conducted spanning two decades of publications in peer-reviewed academic journals. The publications are analyzed with regard to frequency and bibliometrical metrics and research content.

Findings – The research examines the development of the field over 20 years, which has witnessed a steep rise in related publications only for the past five years, indicating a late interest in the area compared to other sustainability topics. Social performance measures entered the discussion particularly late, whereas economic and environmental measurement almost exclusively dominated the field for the first few years.

Research limitations/implications – The authors identify research gaps and discuss future directions for research. The analysis shows how the research area develops from a topic dealt with by a small group of interested researchers into a broader research field acknowledged in the scientific community.

Practical implications – Findings underline the importance of measuring performance for sustainability management of supply chains. The review identifies what measurement and management tools are discussed in the literature over time.

Originality/value – This is the first literature review on sustainability performance measurement for SSCM summarizing the development over the time span of 20 years.

Keywords Performance measurement, Performance measures, Sustainable supply chains

Paper type Literature review

1. Introduction

Similar to most business operations, sustainable supply chain management (SSCM) seeks to achieve specific performance goals. Depending on the particular focus (e.g. environmental, economic, social or integrative), these goals can be measured with a multitude of performance indicators. The main conventional economic performance indicators for supply chain management (SCM) have been summarized as quality, speed, dependability, flexibility and cost (Gunasekaran *et al.*, 2005). Simultaneous achievement of top performance in all five performance areas is already considered a challenging task (ibid.). With the introduction of sustainability considerations into SCM, however, the task has become even more challenging for several reasons. First, the aforementioned conventional indicators are not sufficient to assess the performance of sustainable supply chains, as they predominantly focus on economic issues. Second, sustainability performance is often difficult to measure (Hassini *et al.*, 2012). For example, social performance is mostly difficult to assess, and social indicators can sometimes not be quantified and are often prone to subjectivity (Burritt and Schaltegger, 2014; Wood, 2010).

Third, another challenge arises when projects designed to achieve higher performance in one dimension can be in conflict with those that have high performance in another one, creating trade-off situations for companies aiming to simultaneously improve performance in several areas. For example, environmental-friendly materials might increase procurement costs. One way to deal with such trade-offs is to define strategic priorities and make a priori strategic choices (Hahn *et al.*, 2015). Strategic priorities can create clarity about how the overall performance of the existing supply chain can be improved. However, making such conflicts transparent can also be the starting point to search for and develop new approaches which overcome initial trade-off situations (Beckmann *et al.*, 2014). Measurement of sustainability performance of supply chains can thus serve to create transparency and to initiate supply chain innovation (Schaltegger and Burritt, 2014). Additionally, especially in supply chains oriented toward environmental and social goals,

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the overall performance is hard to predict without such transparency, as the outcome relies on knowing the actual performance of the partners (Sarkis *et al.*, 2011).

Alternatively, synergetic effects exist where improved performance in one area corresponds to higher performance in other areas. Refraining from toxic dyes in textile manufacturing can reduce environmental impacts, improve the health conditions for workers and customers and reduce costs of production, leading to environmental, social and economic benefits at the same time. Hence, it is often used as an incentive for companies to engage in sustainability practices. Creating such triple win solutions is a particular challenge for managers and academics and is linked to a high rate of complexity in the sustainability management of supply chains (Rao and Holt, 2005; Seuring and Müller, 2008). Implementing SSCM is intended to generate higher performance of a company's operations in general, and it specifically aims to increase sustainability performance for the entire supply chain.

The measurement of the actual economic, environmental and social performance is an essential starting point to understand the object (what?), location (where?) and measure (how?) of sustainability in the supply chain. Such measurement can be considered an accompanying tool for the improvement of processes, which can determine the effectiveness of a SSCM strategy and complementary sustainability control (Burritt and Schaltegger, 2014). Given the importance of this topic, the literature on performance measurement and management in SSCM is surprisingly scattered and limited, both in quantity and scope (Taticchi *et al.*, 2013). Reasons for this dispersal are manifold.

First, the parameters of measurement have to be properly defined. It is necessary to have a common understanding of the performance objectives that a company intends to pursue and explanations of how to measure these objectives (Neely, 1999). What might be difficult to measure inside a focal company becomes even more complex across the entire supply chain – both upstream and downstream.

Second, the actual performance has to be measured, which requires the development and agreement on performance objectives and indicators which are clear, measurable and comparable throughout the whole supply chain (Schaltegger and Burritt, 2014). For complex sustainability issues, this is often not straightforward, as few standards on sustainability measurement exist, especially with regard to social issues.

Third, performance measurement tools and management systems need to be developed and implemented across several partners in the supply chain to ensure valid and reliable information (Schaltegger and Burritt, 2014). Numerous approaches have been proposed and developed over the past decades to handle measurement for SSCM, including the sustainability balanced scorecard (SBSC; Hervani *et al.*, 2005; Hansen and Schaltegger, 2014), life cycle assessment (LCA; Gold *et al.*, 2010) or product carbon footprint (Kronborg Jensen, 2012). These measurement and management tools aim to fulfill the aforementioned goals of SSCM. Hence, the importance of these tools and further management systems as well as their continued development cannot be stressed enough. However, a comprehensive review of such performance measurement tools and management systems for SSCM has not been conducted so far.

This paper aims to fill this gap by systematically reviewing 20 years of literature on sustainability performance measurement and management in SSCM with a particular focus on indicators, tools and systems proposed and empirically investigated. Incidentally, the first paper included in our findings was actually published by "Supply Chain Management: An International Journal" in 1998 on the topic of environmental performance indicators in integrated supply chains (McIntyre *et al.*, 1998).

The main questions guiding this paper are:

Q1. How has performance measurement and management in SSCM evolved over the past two decades?

Q2. How does the extant literature deal with sustainability performance measurement and management of sustainable supply chains?

Following this brief introduction, this paper delivers a short overview of the central terms, including SSCM, sustainability performance measurement and sustainability management tools. The third section describes the methodology of a systematic literature review, which comprises of the final paper selection for the research sample. Subsequently, Section 4 displays the main quantitative and qualitative findings from the systematic literature. The paper provides a discussion of the results (Section 5) and concludes with an outlook on implications for future research and management in this field (Section 6).

2. Performance measurement in SSCM

A number of definitions exist for SSCM. Ahi and Searcy (2013) identified 12 individual definitions for SSCM, combining them to create a 13th one themselves. The definition provided by Seuring and Müller (2008) is the most cited and broad enough to leave freedom for further theorization. They define SSCM as:

> [. . .] the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social, into account which are derived from customer and stakeholder requirements (Seuring and Müller, 2008, p. 1700).

This definition specifically includes the cooperation of supply chain partners (Sharfman *et al.*, 2009). Another important element of this SSCM definition is the consideration of all three sustainability dimensions, which is also in line with the definition provided by Carter and Rogers (2008).

Furthermore, this definition lends itself to investigate performance measurement in sustainable supply chains, and it highlights again some of the related challenges with such measurement. Performance measurement can be defined as "the process of quantifying the efficiency and effectiveness of action" (Neely *et al.*, 1995, p. 80). Hence, the essence of a sustainable supply chain approach can only be evaluated by means of reliable performance measures. Additionally, the core practices of SSCM, such as transparency (Beamon, 2008; Carter and Rogers, 2008; Beske, 2012), supplier evaluation and monitoring (Seuring and Müller, 2008) or collaboration (Pagell and Wu, 2009; Beske *et al.*, 2014) are only feasible

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with related performance measurement and management tools. From the contemporary understanding of SSCM, it is apparent that such performance measurement indicators, tools and management systems are an essential and integral part of SSCM.

Because sustainability strategies rely not only on economic goals, but also on environmental and social goals, these additional two aspects need to be quantifiable as well. Often, this proves to be a challenging task (Gold *et al.*, 2010). Additionally, researchers are frequently investigating the effect of sustainability practices on economic performance of a single, focal company (Golicic and Smith, 2013). While this is completely justified, the economic outcome of a strategy might not be visible, and a clear cause-and-effect relationship cannot be adequately defined (Golicic and Smith, 2013). Furthermore, stakeholder requirements need to be reflected in the sustainability strategy and, thus, in the measurement systems as well. To counter these challenges, several instruments and elaborate management systems have been proposed in recent years.

An instrumental response to operationalize sustainability strategies in companies is through the development and implementation of sustainability management tools. Gladwin *et al.* (1995) emphasize that those companies pursuing sustainability management require practical decision-support tools to facilitate the organizational change process, including the design and selection of more sustainable materials, products and processes. Among the most commonly implemented and designed tool is undoubtedly the environmental management system (EMS). Other authors propose very sophisticated tools, such as the SBSC (Hansen and Schaltegger, 2014), for integration of sustainability aspects in corporate strategies. While not all sustainability management tools are intentionally designed for SCM, they can easily be converted to suit that purpose.

Sustainability management tools applicable for performance measurement and management in SSCM are diverse in nature. First, such tools can be categorized as an instrument, a concept or system (Schaltegger *et al.*, 2002, 2014). A sustainability audit can be regarded as an instrument, as it has a narrow focus and aims to achieve a specific objective of performance measurement. Further examples of such instruments for SSCM include benchmarking, indicators, labeling, LCA, reporting and stakeholder dialogue. On the other hand, concepts represent a broader approach to coordinate and integrate multiple instruments to achieve a group of objectives in multiple business functions, such as the SBSC. Systems also incorporate multiple instruments; however, they most often coordinate more and follow sequential steps (e.g. Plan-Do-Check-Act, as in a quality or EMSs).

Second, available tools for performance measurement and management can be classified according to the sustainability aspects they address, including economic, ecological, social and integrative aspects of sustainability management. The integrative aspect in addition provides the means to include environmental and social management into the conventional economic management. Such tools cannot always be neatly applied to one sustainability aspect alone, but they can address the interface between two aspects (e.g. an eco-efficiency analysis bridges economic and environmental dimensions of a focal company's products and processes).

Finally, such tools can often be linked to international standards, including organizational performance standards such as quality management (e.g. ISO 9001), environmental management (e.g. ISO 14001; the Eco-Management and Audit Scheme – EMAS) and the Occupational Health and Safety Assessment Specification (OHSAS 18001) as well as the product LCA standard (e.g. ISO 14030) and international reporting standard (e.g. Global Reporting Initiative – GRI). Table I provides an illustrative overview of tools that measure and manages various sustainability performance aspects in supply chains and classifies them according to type and sustainability aspects covered.

The fundamental inquiries pertaining to a uniform and widespread application of tools in SSCM practice remains under-researched. In addition, truly sustainable supply chains are non-existent to date (Pagell and Wu, 2009). Therefore, this paper aims to investigate those indicators, tools and management systems that target the sustainability performance of SCM and SSCM alike, especially when considering that the terms "sustainability" and

Table I Overview of performance measurement and management tools in SSCM

	Environmental	Economic	Social	Integrative
Instrument	Life cycle assessment (LCA) Eco-audit Environmental benchmarking Environmental reporting	Cost-benefit analysis Economic input-output analysis Financial reporting Risk analysis	Social LCA Social audit Social benchmarking Stakeholder dialogue Social reporting	Sustainability audit Sustainability benchmarking Sustainability reporting
Concept	Design for the environment	SCOR framework	Corporate citizenship	Sustainability balanced scorecard (SBSC)
System	Environmental management system (EMS)	Quality management system (QMS)	Social management system (SMS) Occupational health and safety system (OHS)	Integrated management system
Standard (corresponding tool)	ISO 14001 (EMS) EMAS (EMS) ISO 14040 (LCA) ISO 14064	ISO 9001 (QMS)	SA 8000 (SMS) OHSAS 18001 (OHS)	Global reporting initiative (Report) UN Global Compact

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"environmental" have continually gained recognition. Thus, the following section explains how a systematic literature review attempts to bridge the knowledge gap and shed some light on the development of this research field over the past 20 years.

3. Methodology

According to the expected diversity of performance measurement and management tools in the SSCM, the systematic literature review was steered by the following research questions:

RQ1. How has performance measurement and management in SSCM evolved over the past two decades?

RQ2. How does the extant literature deal with sustainability performance measurement and management of sustainable supply chains?

RQ3. What type of performance is being measured in SSCM? (Economic, environmental social; focal company, first tier, entire supply chain)

RQ4. Who is measuring performance? (Including business functions, e.g. procurement, as well as supply chain partners and external auditing organizations)

RQ5. What performance measurement and management tools (instruments, concepts and systems, standards) have been proposed and observed in SSCM?

To answer these questions, the academic literature on performance measurement and management in SSCM was systematically reviewed and synthesized. According to Tranfield *et al.* (2003), conducting a systematic literature review consists of five methodological stages, including:

1 identification of research;
2 selection of studies;
3 study quality assessment;
4 data extraction and monitoring; and
5 data synthesis and reporting.

These steps are described in detail below.

In the first stage, the relevant research was identified by constructing a search string to capture the essence of our research focus. The final search string is compiled as follows.

("Sustainability" OR "Environmental" OR "Green" OR "Social" OR "CSR") AND ("Performance Measurement" OR "Performance Management" OR "Indicator") AND ("Supply Chain Management" OR "Supply Chain") AND ("Tool" OR "Instrument" OR "Concept" OR "System").

This search string was entered exactly the same way into the following academic journal databases: EBSCO Business Source, Emerald, Science Direct and Wiley. To narrow down the possible great quantities of unrelated material, several inclusion and exclusion criteria were established, which is based on similar systematic reviews (Johnson and Schaltegger, 2015). For example, conference papers, working papers, technical reports and handbooks were omitted from the search to focus on high-quality, peer-reviewed academic papers. Additionally, to find articles pertaining to performance measurement tools in SSCM, articles were searched for in scientific subject fields provided by each database, including "Business, Management and Accounting", "Environmental Sciences" and "Social Sciences". An overview of the inclusion and exclusion criteria is provided in Table II.

The initial search using the aforementioned search string in the five academic databases resulted in 1,079 papers. In the second stage of the review, the relevant papers were selected in several steps. First, we filtered out any unwanted entries, including duplicate copies (66 papers), book chapters (19) and conference contributions (14), reducing the list to 981 papers. Second, we excluded journals that mostly do not focus on sustainability or SCM from an operational research perspective, including those with mathematical, medical or tourism with a primary focus. Journals that did not meet the quality requirements, for example not following a rigorous

Table II Inclusion and exclusion criteria

Criteria	Reason for inclusion/exclusion
Inclusion criteria	
Published articles from 1995 to 2015	The scholarly works regarding performance measurement and management in SSCM, starting back at the introduction of the *Supply Chain Management: An International Journal*
Articles in English language	Most academic journals are published in English
Articles address sustainability, environmental (green) and social (CSR) issues	To ensure the term "sustainability" was applied to ecological and social issues versus only on economic growth/long-term issues
Articles place emphasis on performance measurement in SSCM	To narrow the focus to performance measurement and management in SSCM
Articles provided management tools	To ensure the focus was on management tools dealing with performance measurement in SSCM
Scholarly published articles	To provide more rigorous scientific knowledge in the SSCM field
Exclusion criteria	
Articles do not address any of the main areas of inquiry, including sustainability, supply chain, performance measurement and management tools	The purpose of this review of the literature on sustainability performance management tools in SSCM and a reference has to be made to at least one of the main areas of inquiry
Conference papers, working papers, technical reports and practical handbooks	To ensure quality and consistency in the comparative analysis, all articles must be peer-reviewed

double-blind peer-review process, were also omitted. In total, 271 articles were excluded at this stage. Third, an additional 543 articles could be deleted, as the abstracts revealed that they did not adequately reflect our research aim – including articles with a limited notion of sustainability, that is long-term business growth, as well as not including any tools to measure or manage performance in sustainable supply chains. Even during the data extraction stage, we were able to further eliminate 18 articles, which were overlooked in our selection process. In addition, one paper was no longer retrievable online. This resulted in a final count of 149 articles.

To assess the quality of these papers (Stage 3), the review only included those which underwent a stringent peer-reviewed process and extremely relevant to this topic. No further quality screening was conducted, as we felt that the merit of the journals included speaks for itself. The final count of papers was collected and listed according to the respective basic information, including year published (or date of early view for the most recent articles), author name(s), journal, title, etc. This database also formed the basis of our investigation, subsequent analyses and synthesis of the results.

In the fourth and fifth stages, the papers were examined methodically and synthesized to derive the findings. All papers included were analyzed according to frequency analyses (year published, research methods and sustainability dimensions), bibliometrical analyses (total number of authors, main contributing authors, journal type) and qualitative data, covering the main issues from the research questions (what is measured – economic, environmental and social indicators; who is measuring it – business functions and external partners; how is it measured – performance measurement and management tools). Because there will most likely be a considerable number of articles published through the remainder of the year, we did not include the year 2015 in the frequency or bibliometrical analyses; therefore, here we only consider the 140 papers published until 2014. For the qualitative analyses however, the year 2015 is included up until April 2015 in our investigation, which gives us a sample of 149 papers. This allows us to identify and discuss the most recent trends and topics in scientific literature. All three areas of findings are provided in the following section.

4. Findings

4.1 Frequency analysis

The initial frequency analysis provides an overview of the quantifiable statistics on the final sample of 140 articles published until the end of 2014. First, the analysis on publication years reveals a sharp growing trend of articles on this subject over the past two decades (Figure 1). The trend line illustrates the average number of articles published until the previous year. It reveals a ten-fold increase from 2005 to 2014. A bibliometric observation in the research literature in general which relates to the development of the number of articles published is that a research area receives acknowledgement in the scientific community when the number of publications doubles in 10 to 20 years (Rider, 1944; De Solla Price, 1974). The literature on sustainability performance measurement and management exceeds this measure five times, which can be interpreted as a sign of very high acknowledgment in the scientific community.

The range of research methods applied on performance measurement and management tools in SSCM extends from literature reviews (LITREV), over conceptual and theoretical articles (CONCEPT), mathematical (MATH) and modeling articles (MOD) to empirically quantitative (QUAN) and qualitative (QUAL) articles. It is important to mention that not all papers could be neatly organized into one area, as they covered both mathematical and qualitative research methods. In such cases, we examined how many papers had a mixed-method approach (MIXED). Figure 2 reveals the distribution of methods applied in relation to the others in five-year intervals. As observed from the statistical evidence, the development of methods has witnessed a major boost of mathematical and modeling papers in the past five years, whereas quantitative are gradually progressing, and qualitative papers also are catching up fast in the past five years, followed by conceptual and mixed-method articles.

The final frequency analysis evaluated the papers according to the sustainability aspects covered in the papers, including economic, environmental and social dimensions. Figure 3 illustrates the breadth of coverage of these topics year by year. As the papers increased exponentially, so did the coverage of all three sustainability aspects. Economic and environmental aspects are the center of attention in many papers, whereas the social dimension is lagging behind. However, this figure also shows how a more holistic research paradigm, which includes all three dimensions of sustainability, has only found its way into the literature in recent years, starting in 2008 and coinciding with the rise of research which includes the social dimension. Of all 49 papers published in 2014, the remarkable number of 21 papers was already discussing all three dimensions, indicating a rising interest in a holistic research

Figure 1 Number of publications per year from 1995 to 2014 (n = 140, excluding 2015)

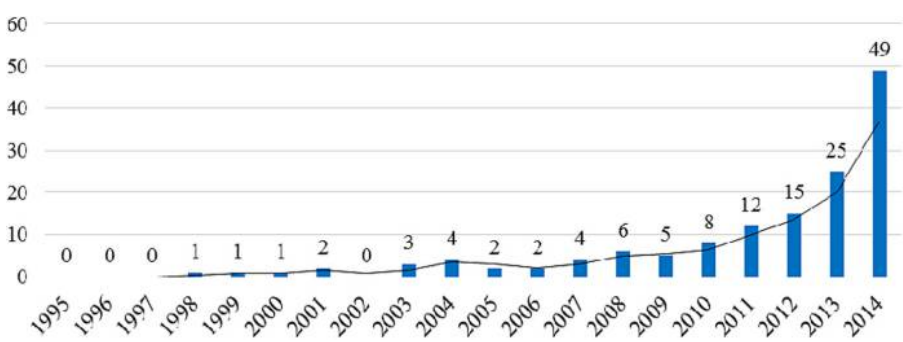


Figure 2 Distribution of research methods (n = 140, excluding 2015)

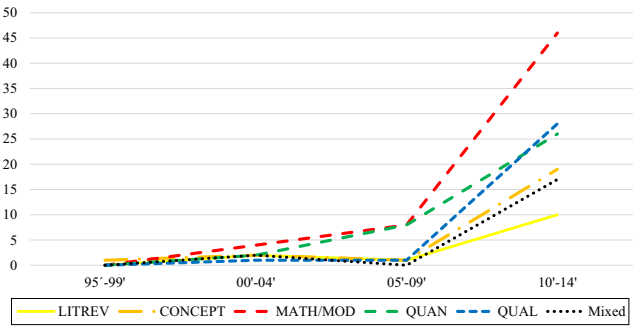
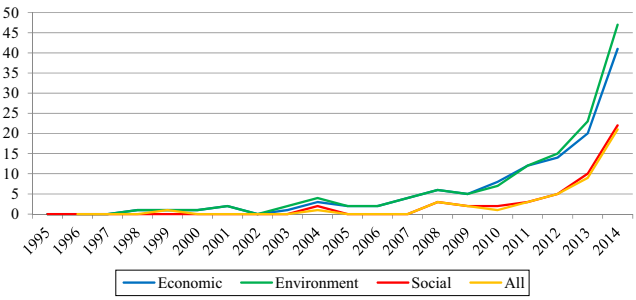


Figure 3 Sustainability dimensions addressed (n = 140, excluding 2015)



approach. As it can be observed, the line for the social dimension and the one which shows the distribution of research in all three dimensions are nearly identical.

The next section explores bibliometrical measures to evaluate if and how the subject of performance measurement and management in SSCM has become a research discipline in itself.

4.2 Bibliometrical analyses

Bibliometric measures provide indication about how a scientific area develops and whether it receives acknowledgment in the scientific community.

A first basic bibliometric measure relates to the development of the number of publications (Figure 1). A doubling in 10 to 20 years is assessed as an acknowledgement by the scientific community (Rider, 1944; De Solla Price, 1974). The *number of publications* dealing with sustainability performance measurement and management of supply chains *has increased ten times* between 2004 and 2014, which can be interpreted as a sign of very high acknowledgment in the scientific community.

Developing scientific areas are usually strongly influenced by key authors. According to the *Ortega hypothesis*, *scientific progress is driven by a small number and percentage of researchers in a field* (Cole and Cole, 1972). Table III shows the main authors who have published on sustainability performance measurement and management of supply chains. With Jo Sarkis leading the contribution list, 8 of 321 authors in total (2.5 per cent) have written 30 per cent (42 of 140) of all papers in academic journals.

For developing research fields, De Solla Price (1981) observed an *increase of co-authorship* over time. This

Table III The main authors contributing to the topic (excluding 2015)

Author	No. of articles
Sarkis	14
Searcy	7
Zhu	5
Bai	4
Burritt	3
Joa	3
Müller	3
Seuring	3

bibliometric measure has been supported empirically by Cronin (2001) for various research fields. Whereas the average number of authors in publications on sustainability performance measurement and management of supply chains was 2.0 in 2004, it has increased to 3.18 in 2014. This effect may be partially due to the establishment of research groups and increasing interactions between growing numbers of researchers. Overall, the average number of authors is 2.87 which is high above the average number of authors in the environmental management accounting literature (1.74 in 2012; Schaltegger *et al.*, 2013) and across all research areas (1.45 in 2000; Jokic and Ball, 2006). This high average number of authors may be a result of the interdisciplinary and complexity of the research area.

Another bibliometric measure is the *pattern and distribution of publications in different journals*. According to Bradford (1985), the number of publications in core journals is the same as the number of publications in the next related journals. Core journals are where most articles of a research field are published. Table IV gives an overview of journal frequencies and types for the identified publications.

In total, 57 journals have published papers on sustainability performance measurement and management in supply chains until the end of 2014, of which most journals (42) have just 1 or 2 papers on the topic. The top three journals, *the Journal of Cleaner Production*, *Supply Chain Management: An International Journal* and *the International Journal of Production Economics*, can be considered the core journals in the field. They contributed to 31.4 per cent of all publications with 44 of the 140 papers. The next 12 related journals (Number 4 to 15) produced 47 of the 140 papers (33.6 per cent). The remaining journals contributed to 49 of 140 papers (35 per cent).

Table V groups the publication according to the type of journal. Whereas the research field was dominated by sustainability management journals between 2005 and 2009 (12 of 19 publications in total), the type of publication channels is now much broader, including supply chain, operations, general, performance and accounting journals. Given the topic, it is astonishing that performance management and accounting journals are still presented weakly.

The bibliometric analysis shows *in sum* that with an outstanding growth of the number of publications, "sustainability performance measurement and management of supply chains" has developed as an acknowledged interdisciplinary research field which has been strongly developed by key authors (Sarkis, Searcy, Zhu, Bai) in three core journals (JCP, SCMIJ, IJPE) and that the number of

Table IV Journal frequency (excluding 2015)

Type/No.	Journal	Frequency
Core Journals		
1	*Journal of Cleaner Production*	20
2	*Supply Chain Management: An International Journal*	14
3	*International Journal of Production Economics*	10
Total number of publications in core journals		44
Next Related Journals		
4	*Resources, Conservation and Recycling*	6
5	*Business Strategy and the Environment*	5
6	*International Journal of Production Research*	5
7	*International Journal of Productivity and Performance Management*	5
8	*International Journal of Operations and Production Management*	4
9	*Production Planning and Control*	4
10	*Benchmarking: An International Journal*	3
11	*Ecological Economics*	3
12	*Journal of Business Ethics*	3
13	*Journal of Industrial Ecology*	3
14	*Sustainability management beyond corporate boundaries*	3
15	*Transportation Research Part E: Logistics and Transportation Review*	3
Total number of publications in next related journals		47
Other	42 Journals (with 1 or maximum 2 entries)	49
Total		140

Table V Journal type and frequency

Type	95′–99′	00′–04′	05′–09′	10′–14′
Sustainability Management	1	3	12	39
Supply Chain Management	1	2	0	27
Operations Management	0	3	3	24
General Management	0	1	1	10
Performance Management	0	1	3	7
Accounting	0	0	0	2
Totals	2	10	19	109

co-authored papers and the number of researchers in the field are growing.

4.3 Qualitative findings

4.3.1 What is measured?

While all publications deal with performance measurement and management in one way or another, surprisingly few articles actually define their construct of sustainability performance. Some authors (Taticchi *et al.*, 2013) use the aforementioned definition by Neely *et al.* (1995). Others describe performance as the ability of a firm to lower pollution (Green *et al.*, 2012) or contribute "towards maintaining or improving the natural environment" (de Burgos Jiménez and Céspedes, 2001, p. 1565). Performance is sometimes also described generally as reaching set targets (Shaw *et al.*, 2010; Yakovleva *et al.*, 2012).

First, the majority of the papers included in our analyses focuses on economic (130 or 87.2 per cent) and environmental (141 or 94.6 per cent) performance, while the social dimension is only considered by 34.9 per cent (52) of the publications. Such a comparatively low consideration of social issues is not uncommon in the sustainability literature (Beske *et al.*, 2008), especially in earlier years. However, a noticeable trend showing a rise of publications, which includes the social dimension, can be observed in recent years. Of the total 49 papers considering the social dimension, 42 have been published in the past five years.

Second, coinciding with the rise of research on social performance measurement, the number of papers addressing performance in all three sustainability dimensions is increasing (Wiedmann *et al.*, 2009; Nikolaou *et al.*, 2013). In total, 32.2 per cent (48) of our sample investigate all 3 dimensions. Among the first papers calling for a comprehensive consideration of all sustainability dimensions are papers which describe SSCM as a management approach (Seuring and Müller, 2008), whereas only some take a performance measurement and management focus (Cuthbertson and Piotrowicz, 2008).

Third, a comparatively large group of articles (12; 8.1 per cent) was found to only focus on environmental performance. Many authors investigate what impact the implementation of SCM has on economic and/or environmental performance (Govindan *et al.*, 2015a). This reflects the origins of this research field, where EMSs were first introduced and argued for their positive impact on both of these performance dimensions. Interestingly, a majority of these papers deal with carbon footprinting or offsetting (Acquaye *et al.*, 2014; Ewing *et al.*, 2012; Rinaldi *et al.*, 2014) and specific related measures. Although exceptions exist (Gerbens-Leenes *et al.*, 2003), papers concentrating solely on environmental performance only begin to emerge around the year 2012. Additionally, two publications were identified which exclusively deal with social performance (Perry and Towers, 2013; Ahi and Searcy, 2013).

Two papers were found which specifically investigate the impact of environmental practices on economic performance or shareholder value (Kleijnen and Smits, 2003; Dam and Petkova, 2014). One publication concentrates on the direct relationship between social and economic performance (Bernardes, 2010). Furthermore, two papers focus on the combination of social and environmental performance (Carter and Jennings, 2004; Spence and Rinaldi, 2014).

It can be summarized that most publications focus on the performance measurement of one or two sustainability dimensions. While environmental performance is slightly ahead of economic performance, and leagues ahead of social performance, most reviewed papers reveal a link between two dimensions, especially between the environmental and economic dimensions. In the first couple of years, the research dealt with the measurement of sustainability performance, particularly environmental performance, of conventional supply chains. However, Shaw *et al.* (2010) recognize a shift in the discussion of performance over time. While the focus used to center around the target measures speed, cost and dependability, that is quantifiable economic measures, the research focus in this area has moved on to include

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compliance in the environmental and social dimensions as well.

With regard to the focus of measuring and managing the sustainability performance of the whole supply chain, the vast majority of publications (85 or 57 per cent) concentrate on performance-related processes or operations and do not adopt a product view. This includes publications proposing conceptual models (Wolf, 2011; Bai *et al.*, 2012), quantitative studies applying new methods, such as structural equation modeling (Govindan *et al.*, 2015b), and mathematical studies, for example fuzzy logic algorithms (Dou *et al.*, 2014). Nine publications focus on the sustainability performance of products, mostly by applying case study research (Rinaldi *et al.*, 2014). Finally, 41 (27.5 per cent) of the publications focus on operations and products alike, for example, by investigating product groups.

The focal firm is the focus of 98 (65.8 per cent) papers of our sample. But to what extent the performance measurement covers the whole supply chain is difficult to assess, as this is often not described in detail. Only nine papers explicitly state that the focus lies on the performance of the whole supply chain and not on the focal firm. Another 14 articles specify that the performance measurement is extended to the first-tier stage as well. Almost half of the publications (70 or 46.9 per cent) consider multiple tiers of suppliers in their research. A surprisingly large number of publications (56 or 37.6 per cent) do not specify their scope of research, thus making it impossible to identify whether the focal company and first- or multi-tier stages are the scope for their discussion of performance measurement. Nevertheless, the level of detail in the description of the scope of research seems to increase in quality as the number of unspecified publications is decreasing in the later years of the research.

Of all, 64 (43 per cent) of the papers discuss the performance of both upstream and downstream operations of SCM. As closed-loop supply chains (Mutingi, 2013; Shokravi and Kurnia, 2014) or reverse logistics (Bai and Sarkis, 2013; Colicchia *et al.*, 2013) are commonly applied in sustainable or green SCM, this is to be expected. Almost as many (57 or 38.3 per cent) concentrate on the upstream part of the supply chain and investigate practices like supplier selection or development (Genovese *et al.*, 2013; Harms *et al.*, 2013) or control in general (Dou *et al.*, 2014; Parmigiani *et al.*, 2011). Only one paper focuses on the downstream side of the supply chain (Validi *et al.*, 2014). If we had included journals with a marketing focus, then this number would most likely have been higher. With regard to the temporal distribution of the publications over time, no specific pattern is apparent. The remaining papers either do not cover this topic at all or in a manner that a conclusive classification cannot be reached.

4.3.2 Who measures?

The question "Who" does, could or should measure sustainability performance of supply chains is mostly not answered explicitly. Papers discussing the configuration or coordination of supply chains rarely state if the focal firm or rather various or all actors in the supply chain should be in charge. In most cases, the focal firm is implicitly implied as the core actor which may be a result of prevailing definitions of SSCM. According to Seuring and Müller (2008, p. 1699), "focal companies are those companies that usually (1) rule or govern the supply chain, (2) provide the direct contact to the customer, and (3) design the product or service offered". Hence, they both have the power and the interest to manage and control sustainability performance. Focal companies are furthermore usually held accountable by consumers, NGOs and media for the products and the supply chain practices.

The "What" and "Who" should measure are in some cases intertwined. Sustainability strategies such as "green purchasing" (Hwang *et al.*, 2010) or "supplier selection" (Bai and Sarkis, 2014; Genovese *et al.*, 2013) imply, on the one hand, that the focal company evaluates suppliers and supplier performance and, on the other hand, that the focal firm conducts sustainability measurement and evaluation processes of products for the customers. Whether procurement, the sustainability department, marketing, accounting or another business function should be responsible for sustainability performance measurement and management of supply chains has so far not been discussed in existing publications. Exceptions are papers exclusively focusing on specific departments (e.g. Carter and Jennings (2004) investigate the role of purchasing in CSR), but they do not answer the question whether further departments should deal with performance measurement, too. How much a focal firm can actually measure and manage sustainability performance of a supply chain depends largely on the level of influence it has on the other partners in the chain (Parmigiane *et al.*, 2011).

4.3.3 How is it measured?

When analyzing what the extant literature says about how sustainability performance measurement and management could be realized in sustainable supply chains, surprisingly, many studies do not mention any instruments (e.g. LCA), concepts (e.g. SBSC), management systems (e.g. EMS) or standards (e.g. ISO 14,001). Of the 140 studies examined, 32 articles (21.5 per cent) did not mention the use of tools, management systems or standards at all. Furthermore, another 43 articles (28.9 per cent) only mentioned one tool or management system. In sum, over half of the studies say little to nothing about specific measurement and management methods to deal with sustainability performance in SSCM. The majority of articles discusses the "enhancement" of sustainability performance, but does not describe a specific way for "how" to measure it. This raises the question: if application of tools or standards is not proposed, then how else may performance of sustainable supply chains be uniformly measured and managed?

Hints on how sustainability performance could be measured and managed to SSCM are provided in the remaining 74 studies, revealing a range of different tools. The proposed application on an EMS in the supply chain is the most commonly observed tool (40 articles), followed by LCA (30), audit (16), SBSC (13) and key performance indicator (10). Auditing as a process is mentioned quite often in conjunction with specific standards, such as the ISO 14001 for environmental performance (Dey and Cheffi, 2013) or social performance certified by the SA 8000 (Perry and Towers, 2013; Schaltegger and Burritt, 2014). Because certification according to a certain standards is an established practice, auditing is mentioned for the whole period that we analyzed. Two further traditionally economic-oriented tools are proposed in several studies in conjunction with other

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sustainability management tools, including the SCOR framework (7) alongside the SBSC and the economic input-output assessment (6) combined with LCA followed by the ISO 14032 guideline on environmental performance evaluation. The SCOR framework (supply chain operations reference) has been adapted from its original conception and expanded to include not only economic criteria (cost, time, quality, flexibility and innovation), but also environmental performance measures (Bai *et al.*, 2012; Gunasekaran and Kobu, 2007; Sarkis and Talluri, 2002).

However, the indicators tied to these proposed tools are very diverse and span topics like driver training (Cuthbertson and Piotrowicz, 2008), safer manufacturing (Parmigiani *et al.*, 2011), gender diversity and harassment (Erol *et al.*, 2011) and human rights (Shokravi and Kurnia, 2014; Varsei *et al.*, 2014). Unsurprisingly, the most commonly mentioned indicator with regard to social issues is the rather general category "Occupational Health and Safety" (Akamp and Müller, 2013; Ellram *et al.*, 2008). Further social indicators, such as fair trade and fair labor metrics, have, in spite of their high practical relevance and media attention, only been addressed in few studies (Hassini *et al.*, 2012). Additionally, very few researchers discuss specific units of how to measure the metrics. Again, precise economic units are currently the majority, including turnover per year, cost reduction per product and various currency units. For the past couple of years, environmental metrics are on the rise, which include indicators such as waste production per unit output (Testa and Iraldo, 2010), CO_2 emissions per ton (Validi *et al.*, 2014; Wiedmann *et al.*, 2009) or land use in hectares (Ewing *et al.*, 2012). On the social dimension, specific measurement units are very scarce, examples being the ratio of direct and indirect employees (Shokravi and Kurnia, 2014) or training time per employee (Erol *et al.*, 2011). Overall, it can be noted that specific metrics and units of how to measure sustainability performance of supply chains have only recently entered the discussion and have been disregarded almost completely until 2005. Furthermore, the available tools for sustainability performance measurement and management are considered few and far between.

5. Discussion

5.1 Strategies of SCM and performance measurement goals

A key issue of performance measurement is to determine which goal it should reinforce. Whereas the existing research mainly focuses on creating transparency about social and environmental impacts of a supply chain, the key goals of sustainability management are to reduce risk and improve performance (Seuring and Müller, 2008; Schaltegger and Burritt, 2014). While some of the literature on sustainability performance measurement of supply chains focuses on creating transparency (Bavaria, 1999; Beske and Seuring, 2014) or reducing risk, most publications deal with performance improvement.

The vast majority of the performance improvement-oriented literature so far implicitly takes an inside-out perspective (Schaltegger and Wagner, 2006), where the measures (including the indicators, the information management and accounting system) are deducted from policy papers, such as the corporate strategy, corporate sustainability priorities, international reports or the concept of sustainable development. To fulfill the information requirements of stakeholders, however, this may require an additional approach to first identify (e.g. in a stakeholder dialogue or survey) what performance measures are of particular interest to whom and then to develop the respective performance measurement approach from an outside-in approach (Schaltegger and Wagner, 2006). While both approaches of developing the performance measurement and management system in a focal company have advantages and disadvantages, a combination is recommended (a so-called "twin approach") to align performance measurement and management with strategy, stakeholder expectations and reporting (Burritt and Schaltegger, 2010). In our literature review, we found some examples for collaborative approaches to manage sustainability issues, including planning, control or information sharing (Colicchia *et al.*, 2013; Reefke and Trocchi, 2013; Perry and Towers, 2013).

With regard to the strategies to improve the sustainability performance in a supply chain, efficiency, consistency and sufficiency approaches can be distinguished (Schaltegger and Burritt, 2014). Interestingly enough, the extant research has so far not considered what information requirements and systems would be needed to measure sustainability performance with regard to implementing these three strategies of sustainability performance improvement. While all three strategic approaches are applicable, efficiency strategies may be most common in practice and have gained most attention in the existing literature (Sahamie *et al.*, 2013). Typically, issues like resource efficiency (including energy efficiency, material efficiency, water efficiency, etc.) have been extensively covered. The majority of indicators mentioned in the literature fall into the efficiency category (Erol *et al.*, 2011; Perotti *et al.*, 2012; Shokravi and Kurnia, 2014). Consequently, various case studies show the high potential of this approach to improve eco-efficiency (von Weizsäcker *et al.*, 2009). Obviously, efficiency approaches, however, have limits, as products cannot be produced completely without materials and energy. Consistency is another approach which has been promoted to redesign products with regard to their material content. Consistency of material flows with material flows known in nature can either be achieved with biodegradable products or strictly closed recycling loops. A closer look reveals important limitations of the consistency strategy, and even recycling systems require energy and biodegradable materials need to be produced (often in large-scale agricultural systems with substantial negative impacts). Sufficiency has thus been proposed as another strategic approach (Halldórsson *et al.*, 2009), which challenged to think about whether a part of a product or the whole product – and thus its supply chain – is needed at all, or if this is not adding to the sustainability problems.

The information requirements and measures are of course quite different to support efficiency improvement, consistency achievement or sufficiency (Schaltegger and Burritt, 2014). Future research on sustainability performance measurement and management for supply chains is challenged to better align with how it can support improvement strategies. The

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need for a more comprehensive approach to measure all three dimensions has been mentioned by other researchers as well (De Giovanni, 2012; Seuring and Müller, 2008), although the rising numbers in this regard seem to show that the call has been heard by the community. Nevertheless, realistic approaches need to be developed that create improvements without having negative impacts on other dimensions. A particular challenge for future sustainability performance measurement and management research is, thus, to enable the identification of potential trade-offs and triple win potentials.

5.2 What should be measured to improve sustainability performance?

While the systematic literature review revealed that the all considered publications deal with performance in one way or another, surprisingly few actually define what their understanding of sustainability performance is and what exactly should be measured. Some describe performance as the reduction of pollution (Green *et al.*, 2012) or the contribution "towards maintaining or improving the natural environment" (de Burgos Jiménez and Céspedes, 2001, p. 1565). Performance is overall either implied or explicitly stated as reaching set targets (Shaw *et al.*, 2010; Yakovleva *et al.*, 2012) but it either often remains largely vague on what exactly should be reached or a very specific focus is pursued (e.g. reduction of carbon emissions, see Kronborg Jensen, 2012; reduction of water use, see Kozlowski *et al.*, 2015). Further authors often speak of "high performance" without constituting when a performance can be considered "high" or "low" or what reference system is used to evaluate performance. By defining these issues, researchers could clarify the discussion further.

Moreover, when social performance is considered by researchers, it is usually on conjunction with the other two sustainability dimensions. On the one hand, this is a very good development and such a holistic view is very important. On the other hand, research concentrating on the social performance or its relationships to only one of the other two might reveal interesting insights that are otherwise overlooked, as such an approach would possibly allow for more focused attention on specifics to the social dimension.

These findings raise the question of what should be considered from a corporate sustainability perspective in measuring the sustainability performance of a supply chain. Referring to fundamental aspects of most sustainable development and corporate sustainability definitions (van Marrewijk, 2003; Schaltegger and Burritt, 2005; Ahi and Searcy, 2013) at least the following areas and topics need to be considered:

- *Content*: social, ecological and economic perspectives;
- *Linkages*: the links between these perspectives;
- *Time*: future orientation; and
- *Stakeholders*: participation.

A frequently referenced framework to indicate how these topics could be captured with a broad set of indicators is the GRI guideline for sustainability reporting (GRI, 2014). Whereas various contextual issues are addressed by the GRI guideline other aspects are less explicitly considered, such as the time frame. Still the indicators proposed in the GRI guideline would already provide a much broader set of issues to be considered in sustainability performance measurement and management than what has been considered so far in the SCM- and SSCM-related research. However, as performance measurement always requires the definition of priorities, the large indicator set may need to be put in context, such as the planetary boundaries and the current state of the world. Thus, other reference points could be the reports on the ecological state of the world, such as published by Rockström *et al.* (2009), Steffen *et al.* (2015) and the UNMEA (2005), or reference publications on the social state of the world, such as UNDP (2010).

Whereas publications focusing on climate change-related performance measures, for example carbon footpring reduction (Parmigiani *et al.*, 2011; Kronborg Jensen, 2012), obviously address a key sustainability challenge. At the same time, other major challenges, such as the loss of biodiversity (the most urgent ecological challenge according to Rockström *et al.*, 2009) or the large number of people living in slums and with less than one dollar income per day (UNDP, 2010), have not yet been addressed adequately in depth in the extant literature on sustainability performance measurement and management of supply chains, with some exceptions to the rule (Shokravi and Kurnia, 2014). Although the relative neglect of social issues in SCM and even SSCM is generally not surprising and has already been mentioned in earlier publications (Srivastava, 2007; Beske *et al.*, 2008), we find increasing attention on all three dimensions over time, with a noticeable rise more recently. While focused performance measurement (e.g. on carbon emission impacts and reductions) may make sense to answer specific questions (e.g. how much the supply chain contributes to climate change and how much has been reduced or increased), future research needs to take a broader set of topics into account and particularly also links between difference performance perspectives. To avoid trade-offs, it is first necessary to see whether the reduction or increase of a certain issue (e.g. carbon emissions) is related to other impacts (e.g. economic, social or other environmental impacts). So far the literature usually discusses the impacts of sustainability measures on the financial or operational performance (Golicic and Smith, 2013).

Another aspect which has so far not been covered in the extant research literature is future orientation. While practically all existing publications discuss the measurement of sustainability-related impacts which occurred in the past, the concept of sustainable development is also about creating an economy and society which secures a good life for future generations. Research and corporate practice on sustainability performance measurement and management of supply chains are thus challenged to capture sustainability impacts, improvements and developments in the future. In accounting terms, this requires a shift from information management tools, such as cost and impact accounting to budgeting and financial and impact planning (Burritt *et al.*, 2002). What probably can be related best to a timeframe perspective in the literature is research on LCA, which explicitly tries to consider future sustainability impacts of products (Koehler *et al.*, 2005).

In SSCM, participation may relate to the aim of developing suppliers (Harms *et al.*, 2013) to ensure that they better

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understand why and what needs to be improved and to support their education and the effectiveness of their improvement processes. An outside-in approach as mentioned above (Schaltegger and Wagner, 2006; Burritt and Schaltegger, 2010) may help developing measures which match the requirements not only of societal actors but also of suppliers, if they are asked explicitly. Such participation-oriented SSCM requires performance measures which are clearly focused on the relevant aspects that a supplier can influence and the contribution of improvement to the overall supply chain performance.

5.3 Who should measure?

The question who should measure and design the measurement approach is often implied in the extant literature, but it is not specified in detail. In principle, three approaches are possible that could organize and conduct the sustainability-oriented performance measurement:

1. a focal company for its supply chain(s);
2. all actors in the supply chain, each passing information on to the next tier; and
3. a third party organization specialized on sustainability performance measurement of suppliers.

For climate change, Heede (2014) shows for the period from the eighteenth century to 2010 that nearly two-third of the worldwide emissions of industrial CO_2 and methane were emitted by approximately 90 companies. Large companies, which are usually focal companies in various supply chains, are of high influence and a logical starting point to organize sustainability performance measurement and management of supply chains. They, however, face a multitude of problems to receive reliable data, particularly from sub-contractors in multiple tiers of the supply chain.

One possibility to counter such information asymmetry (Sarkis, 2012) is thus to standardize data collection and to facilitate exchange throughout the supply chain, similarly proposed by Yakovleva *et al.* (2012) and Bai and Sarkis (2010). Whereas this approach may have advantages of decentralized data collection, it faces the problem of standardization and incentives to engage all suppliers and necessary audits to check the information creation at all stages of the supply chain.

Given the practical problems of the first two approaches, various proactive companies, industries and NGOs have thus founded third party organization specialized on sustainability performance measurement of suppliers for a whole industry (e.g. the Business Social Compliance Initiative for the textile industry, the Sustainable Apparel Coalition for apparel, etc.). These organizations collect data from suppliers, develop databases which are accessible for all financing members of the organization, conduct supplier audits and also organize supplier training.

Whereas the extant literature on measuring and managing sustainability performance of supply chains still takes the perspective of a focal company (first approach), in many industries, corporate practice has for the past couple of years ever more realized a different organizational model with specialized supply management organizations. Research is thus challenged to change the perspective and to consider the new organizational approaches and the consequences this has for sustainability performance measurement and management.

5.4 How should it be measured?

The question how should be measured bridges answers to what should be measured by whom with tools of accounting and information management. While the current SCM research has taken up LCA as a largely product-life oriented approach (Gerbens-Leenes *et al.*, 2003; Shokravi and Kunia, 2014; Spence and Rinaldi, 2014) and database-oriented approaches of using macro data to estimate impacts (de Burgos Jiménez and Céspedes, 2001), the actual sustainability problems in supply chains require specific, accurate, reliable and timely information for each supplier (Schaltegger, 1997). In short, better information quality is needed than that used in LCA practice and suggested in the whole existing research on sustainability performance measurement of supply chains, so far. Measurement has to get much nearer to where the sustainability impacts are caused and the improvements can be realized.

The current development in industry practice to organize sustainability assessments and measurement of supply chains with specific organizations tries to create more proximity to the suppliers while still reducing the costs of audits, assessments and measurement, as one organization measures for many focal companies instead of many measuring the same impacts of the same supplier. This shift of the organization perspective has consequences for the assessment on which particular measurement methods are most apt to create reliable sustainability performance information of a supply chain. A move from methods that are based on a focal company perspective is needed for accounting and performance measurement tools, which support an industry-wide organization in collecting, analyzing and communicating supplier-specific information to different focal companies. This includes that the addressees of the focal companies, which are the customers of the industry-wide "sustainability performance measurer" are differentiated with regard to decision situations and further requirements. Of particular interest may be that with this organizational development, measurement and management of sustainability performance are not left in one hand but split between actors. Whereas the strategic issues of managing performance improvements remain with the focal companies, the "sustainability performance measurer" organizes not only of the measurement but also of supplier development and improvement. The suppliers, however, are those who realize the actual improvement in operational terms in daily business.

Whereas the framework for environmental management accounting (Burritt *et al.*, 2002), which differentiates measurement tools according to decision situations, could be one possible starting point for future research, further approaches will have to be developed to adequately consider the specific requirements of measuring and managing sustainability performance of whole supply chains.

6. Conclusion

The development of a new research area like sustainability performance measurement and management of supply chains can be analyzed from the perspective of the research object

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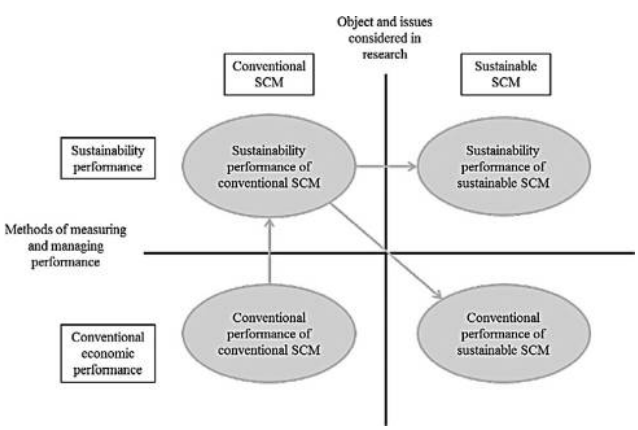
(what are the objects and problems analyzed?) and the examined and proposed methods (what methods are proposed to deal with the analyzed research objects and problems?). The development of the sustainability performance measurement and management research dealing with supply chains of the past two decades and future research foci are depicted in Figure 4.

The literature review reveals that with regard to sustainability, the focus of the research has moved from initially the measurement of conventional, that is financial and operational performance, supply chains in three distinctive directions. The first shift from the lower left corner upwards in Figure 4 (just before and after the beginning of the new millennium) shows that papers discussing sustainability or unsustainability – particularly environmental problems – of conventional supply chains initiated research on sustainability performance measurement and management of supply chains. Particularly, contributions which can be associated with the critical accounting school contributed to analyzing negative aspects of conventional supply chains. The focus of this research is on social and environmental problems in various kinds of supply chains and the role of SCM is seen to create transparency (Bavaria, 1999). This research stream contributes to creating awareness about the social and environmental problems, complexities and relevance for procurement and SCM.

More recent research has started to deal with measurement and management of sustainability performance in the context of SCSM (shift from upper left to upper right in Figure 4). The core objective of sustainability management of supply chains (column to the right in Figure 4) is to develop designs for supply chains which are less harmful or even create contributions to sustainable development. Measurement and management of sustainability performance of sustainable supply chains is thus interested in what improvements sustainable supply chains can achieve, for example, compared to conventional supply chains. Comparisons over time and also with conventional supply chains of course still require monitoring and measurement of negative impacts, at the same time. Publications which can be associated with the pragmatic accounting school of thought (Baker and Schaltegger, 2015) deal with approaches to create solutions and are, thus, concerned about what sustainability designs of supply chains

Figure 4 Past and current development of the research field



can be expected to create social and environmental improvements and whether implemented sustainability designs of supply chains do achieve the planned sustainability improvements (Schaltegger and Burritt, 2014).

Furthermore, some authors have started to analyze whether implementing sustainability into SCM is economically viable and leads to a competitive advantage. This third research stream seeks to measure the impact of SSCM practices on conventional performance (Dam and Petkova, 2014). A particular challenge for sustainability performance measurement and management research is to develop procedures and methods to control for side effects of improvement measures. How can sustainability improvements for supply chains be created and checked to ensure that no undesired negative impacts are caused in another dimension and how can the identification of potential trade-offs be used as a starting point to innovate and develop triple-win solutions? This leads to another suggestion for future research and application: practitioners and researchers alike could start to concentrate more on win-win situations when implementing sustainability (Sarkis *et al.*, 2011), that is on the positive impacts that sustainability can have. Of course, this also calls for different performance measures than those which are commonly applied today. Instead of measuring the negative impacts and their reduction, an approach that measures positive impacts can help to boost the acceptance of sustainability in society.

In addition, more detailed definitions of what the research is about and what is understood by sustainability performance, for example by including specifications of performance and not only discussing unspecified "high performance", is necessary to enhance the scientific discourse and possible knowledge transfer into practice. Here, the GRI could be considered as a common guideline and baseline. It would need some adaptations considering a broader set of sustainability-related performance measures (e.g. on biodiversity) and reporting norms. However, the GRI already provides a more comprehensive view on the matter than most performance measurement systems seem to cover in the current supply chain literature. Hence, even practitioners might consider adopting the structure of the GRI for their performance management systems on a wider scale too. Using the GRI as a common approach could also help to structure the performance metrics in a way to include a larger part of the supply chain, and not only focus on the first-tier suppliers, which is still common in SCM and SSCM. Another possibility is the aforementioned founding of third party auditors.

Finally, a surprising fact becomes apparent when considering the link between practical implementation of performance measurement and management systems and related research. With the exception of several well-established instruments like the SBSC or LCA, relatively few approaches proposed and analyzed in research seem to find their way into corporate practice. Even more startling is that major initiatives such as the Higg Index developed by the sustainable apparel coalition which has been founded by leading apparel and textile companies or the Environmental Profit and Loss Account published by Puma in 2011 (Puma, 2011) and its parent holding company (Kering, 2015) have not been the topic of scientific research on sustainability performance

measurement and management of supply chains. While we cannot comment on the quality of such initiatives here, precisely because they have not been assessed yet, studying these practical examples might provide interesting insights for the future development of measurement methods.

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