Logistics Research (2020) 13:6
DOI_10.23773/2020_6

Supply chain sustainability performance indicators - A systematic literature review

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Received: 11 July 2018 / Accepted: 20 April 2020 / Published online: 12 May 2020

ABSTRACT

This research article aims to identify sustainability performance indicators (SPIs) and provide practical guidance for assessing organizations and their supply chains' sustainability-related performances. We conducted a systematic literature review to analyze scientific journal articles related to sustainable supply chains and performance measurement. We assessed sustainability performance by identifying 1054 indicators from selected scientific journal articles. In addition, in-depth analyses of selected journal articles, predefined attribute categories, and the text restructuring resulted in a unique and coherent list of 68 SPIs. Of these SPIs, 47% originated from the environmental sustainability dimension, 31% from the social sustainability dimension, and 22% from the economic sustainability dimension. The systematic literature review's results identified a complete lack of agreement on how to measure organizations and their supply chains' sustainability performances.

KEYWORDS: sustainable supply chain management; systematic literature review; sustainability; performance measurement; key performance indicators

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1. INTRODUCTION

Over the past few decades, the literature has increasingly discussed the interdisciplinary and inter-organizational concept of sustainable supply chain management (SSCM). These discussions include research across environmental, social, and economic sustainability areas in the supply chain management (SCM) context [42]. Academics have also emphasized building relationships between different sustainability dimensions and between supply chain partners [3, 12, 26, 32, 46]. Seuring and Müller [46] 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." They emphasize the importance of integrating the three-dimensional sustainability concept (also known as the triple bottom line (TBL)) into business processes throughout the supply chain, which is also in line with Carter and Rogers's [13] definition. In addition, Seuring and Müller [46] highlight customers and other stakeholders' needs in terms of achieving sustainability goals within the supply chain. This SSCM conceptualization lends itself to evaluate supply chains' sustainability performance [11] and serves as a basis for the supply chain sustainability performance assessment in this study and its related purposes.

Organizations face enormous external and internal pressure to adopt sustainability practices throughout their supply chains [10, 13, 41, 45] in order to increase their products and services' overall sustainability performance, as well as that of the associated processes [1, 11]. Consequently, a fundamental need has arisen for a multidisciplinary and balanced performance measurement approach for supply chains [9, 16, 26, 34]. Such an approach could improve the actions within the supply chain and achieve a better performance in terms of the economic and non-economic (i.e., environmental and social) sustainability dimensions. However, measuring supply chains' sustainability performance is a challenging task given sustainability's multi-disciplinary concept and SCM's inter-organizational nature [4, 11, 22, 31, 48, 50].

Furthermore, characteristics such as the required industry-specific, sustainability-related indicators (i.e., expectations regarding ensuring a balanced resource usage for future generations) make sustainable supply chains' performance assessment different from the conventional supply chain performance measurement [9]. On the one hand, an effective sustainable supply chain performance measurement system should assess progress based on the supply chain's defined strategic goals and communicate this to the stakeholders for the better management of internal and external sustainability-related issues [24, 38]. On the other hand, such a sustainable supply chain performance measurement system should allow organizations to evaluate or benchmark their sustainability performance. However, sustainable supply chains' performance assessment is relative at an early stage in their development [4, 9, 11, 22]. In addition, the majority of the published articles are either conceptual and focused on the focal organization, or address individual sustainability dimensions with a strong emphasis on the environmental sustainability dimension [4, 5, 11, 34]. Consequently, there is a strong need for a systematic performance measurement approach to assess organizations and their supply chains' overall sustainability performance [16, 31, 34].

Research into the sustainability performance measurement field has recently expanded and academics are endeavoring to incorporate financial and non-financial sustainability dimensions into supply chain performance measurement. Erol et al. [18] have proposed a framework for evaluating grocery retailing's industrial sustainability performance in terms of three sustainability aspects: social, environmental, and economic. Cetinkaya et al. [15] adapted the balanced scorecard concept and have divided the performance indicators in line with three sustainability dimensions. Hassini et al. [26] have suggested an SSCM framework comprised of six supply chain functions: sourcing, transformation, delivery, value proposition, customers, and recycling. They have also proposed composite indicators to summarize complex and multidimensional SSCM performance indicators. Tajbakhsh and Hassini [48] have categorized sustainability into seven dimensions: economic, social, environmental, valuable, reputable, equitable, and sustainable. In addition, they have synthesized the available performance measures in accordance with these seven sustainability dimensions. Based on sustainability's triple bottom line concept, Saeed and Kersten [42] have proposed a performance assessment framework for evaluating supply chain's sustainability performance on five hierarchical levels: the overall supply chain, the supply chain participants, the sustainability dimension, the attribute category, and the sustainability performance indicator (SPI). Academics have therefore clearly discussed a number of key sustainability issues in SSCM. Nevertheless, sustainable supply chain performance assessment tools are diverse and, as yet, there is no universally accepted framework [11, 42, 48]. In order to provide a foundation for future work, the current state of the research in this area needs to be better understood and consolidated.

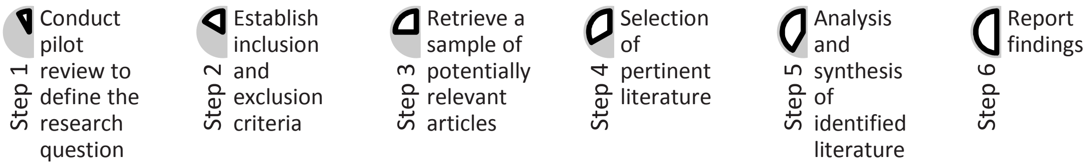
The contemporary understanding of SSCM identifies performance indicators as an integral part of its performance measurement and the selection of appropriate performance indicators as one of the crucial steps for sustainability performance evaluation [9, 11, 18, 19]. Performance indicators are basic tools for monitoring the situation being managed and can be used to convert complex information into units that are easy to understand for decision making at all levels [9, 18]. However, various researchers' use of different SSCM terms may lead to confusion, although the underlying practices are associated with the same activities [32]. In addition, different authors' interpretation and integration of various terms differ, with some using, for example, the term "business indicators" instead of "economic indicators," which poses a big challenge for practitioners as they might find it difficult to implement these concepts directly [48]. Furthermore, subtle differences between the multitude of SPIs [11] have made it difficult to extract a standardized set of indicators with a common terminology to use in order to assess sustainable supply chain performance [4].

Owing to the topic's complexity, there is an already established need to develop a set of key performance indicators for assessing organizations' performance across three sustainability dimensions [4, 11, 16, 34, 48]. Conventional indicators mainly focus on economic issues and cannot assess sustainable supply chain's interdisciplinary performance sufficiently [11]. Despite all efforts to date, there is still a clear gap in terms of a standardized set of SPIs, a standardized or well-accepted performance assessment methodology, and sustainability reporting. Consequently, this research paper's fundamental research question is: What are the sustainability-related indicators identified in the scientific literature regarding sustainable supply chain's performance assessment?

We will address the main research question by means of a systematic literature review. The goals of our systematic analysis of the scientific literature are: i) evaluating and providing a clear understanding of the current SPIs landscape regarding assessing the supply chain sustainability performance, and ii) providing an integrated and coherent set of SPIs that address the three sustainability dimensions, which can subsequently be used to develop sustainability performance measurement systems for organizations and their supply chains.

The remainder of the paper is structured as follows: Section 2 presents the research methodology used for the systematic literature review and section 3 provides

Figure 1: Overview of the six literature review steps adapted from Durach et a. [17]



a detailed analysis of the results and findings. Section 4 presents the conclusions and future outlook.

2. RESEARCH METHODOLOGY

We followed a systematic literature review methodology by Durach et al. [17] to address the research question (see Figure 1). This methodology enabled us to analyze the current state of the scientific literature published in the SSCM field and, more specifically, in the SPI research area.

First, we undertook a pilot review of the sustainable supply chain performance measurement's research area to identify the research gap and define the research question. Next, we defined the selection criteria in order to identify scientific literature articles in the field of sustainable supply chain performance measurement. We only selected peer-reviewed journal articles, excluding all other literature sources such as conference papers, books, magazine articles, and working papers. Furthermore, since the majority of the academic journals are published in English, we only included manuscripts in English [30]. However, we did not limit the time of publication, also considering scientific articles published very recently (i.e., January 2019).

Third, given our focus on the identification of SPIs, we started reviewing scientific articles (related to both SSCM and sustainable supply chain performance measurement). The pilot literature review clarified that the terms "parameter," "measure," and "metric" are used synonymously for performance indicators, while the terms "sustainable supply chain" and "supply chain sustainability" were the most commonly used for SSCM. This led to two keyword combinations, as shown in Table 1. The keywords search of the "abstract, title, keywords" search fields of two well-renowned electronic databases, namely *Science Direct* and *Ebsco Host*, allowed us to identify 228 articles. However, after removing duplications (37), we selected and downloaded 191 unique journal articles for the initial review.

Fourth, we undertook the initial review by means of a detailed reading of each article's title, abstract, and keywords, including the articles themselves, if they were related to a) SSCM and its b) performance assessment. To fulfill the first criterion, the articles' title, abstract, and keywords had to suggest that they addressed one or more sustainability dimensions. An article had to encompass the performance assessment of supply chains, as well as mention, define or explain SPIs, rather than merely using these as input for another purpose, to meet the second criterion. Consequently, we identified 72 articles providing indicators of organizations and their supply chains' sustainability-related performance assessment that we could use for further analysis. The appendix (Table 8) provides a complete list of the selected journal articles.

The fifth step comprised an analysis and synthesis of the identified scientific literature. In order to identify SPIs from the selected sample, we selected sentences and phrases as the unit of analysis. We subsequently undertook a content analysis of the selected articles and identified the SPIs, presented in tables, figures, appendices, and/or anywhere else in the articles' content. We also documented the exact wording of each SPI as mentioned in the source article, along with the relevant page numbers in order to ensure transparency and replicability. This process resulted in a total of 1959 indicators. Nevertheless, we only considered these SPIs eligible for further categorization and analysis if they exhibited characteristics such as sustainability relevance [18, 20, 37], stakeholder relevance [18, 37],

Table 1: Sustainability performance indicators' (SPIs) related keyword combinations.

Data source	Keyword 1		Keyword 2	With repetition	Without repetition	Relevant (R)/ Irrelevant (IR)
Science-direct	"sustain* supply	AND	Indicator* OR	119	82	36 (R), 46 (IR)
EBSCO-host	chain" OR		Metric* OR	109	72	20 (R), 52 (IR)
Science-direct /EBSCO-host	"supply chain sustain*"		Measure* OR Parameter*		37 (repeated)	16 (R), 21 (IR)
				228	191	72 (R), 119 (IR)

Table 2: Attribute categories of sustainable supply chain management (SSCM).

Environmental sustainability			Social sustainability			Economic sustainability		
Attribute category		**Sources**	**Attribute category**		**Sources**	**Attribute category**		**Sources**
E_1	Energy efficiency	[6, 7, 10, 27, 35, 47, 52]	S_1	Human rights and anti-corruption	[6, 7, 14, 33, 35, 36, 40]	Ec_1	Stability and profitability	[6, 7, 35, 36, 40]
E_2	Material efficiency	[7, 8, 10, 23, 27, 35, 47, 52]						
E_3	Water management	[6, 7, 35, 36, 47]	S_2	Human resource	[7, 23, 27, 36, 40]	Ec_2	Income distribution	[6, 8, 27, 40]
E_4	Waste management	[7, 8, 10, 25, 35, 36]	S_3	Health and safety	[6, 7, 14, 23, 33, 35, 36, 40]			
E_5	Emissions	[6, 7, 27, 35, 36, 47]	S_4	Training and education	[6, 7, 35]	Ec_3	Market competitiveness	[7, 14, 36, 47]
E_6	Land use	[7, 27, 35, 36, 47]						
E_7	Environmental compliance	[8, 23, 25, 35, 40, 47]	S_5	Consumer issues	[6, 14, 40]	Ec_4	Sustainability expenditures	[6–8, 21, 33, 35, 36]
E_8	Supplier assessment	[8, 25, 40]	S_6	Social compliance	[7, 8, 14, 25, 35, 40, 47, 52]			

were practically measurable [2, 37, 42], reflected factually correct and unbiased information [2, 29], were clear to the audience [18, 29, 49], timely, and their data were available [18, 37]. A final total of 1054 indicators met these characteristics.

The data collection involved a two-step coding process: an initial coding and a focused coding. In the initial coding process, we consolidated indicators with similar meanings, for example, "reduction in the use of energy," "decrease in the use of energy," and "decreasing in the energy use." In the focused coding, we reviewed the indicators coded initially and classified them according to the 18 attribute categories presented in Table 2. For the systematic coding and categorization, we first identified and coded SPIs from *Science Direct* journal articles, subsequently adopting a similar approach for the *Ebsco Host* journal articles. Including journal articles from the second database in the analysis led to a few incremental improvements. The data collection resulted in a consolidated list of 68 SPIs. In the final step, we synthesized the findings and reported on the systematic literature review's results.

3. RESULTS AND DISCUSSION

The first subsection presents the selected sample's relevant descriptive features, such as the development of sustainable supply chain performance assessment over the years, SSCM-related journals, and the authors of the publications. Subsection 3.2 discusses the different sustainability dimensions as mentioned in the literature and in current issues of importance for sustainability performance measurement. Subsection 3.3 presents an analysis of the SPIs identified by means of the content analysis, while subsection 3.4 presents an analysis of the number of SPI occurrences in the scientific literature. Subsection 3.5 provides an analysis of each sustainability dimension's and attribute category's development over time.

3.1. Descriptive analysis of the systematic literature review

The first descriptive analysis of the selected journal articles identified from two scientific databases presents the development of SPIs over time. Figure 2 presents the yearly distribution of the selected publications that discussed at least one of the sustainability dimensions and its performance assessment. In this research, the cutoff date was January 2019, but more articles should be published during the rest of the year. Consequently, in Figure 2, the number of publications in 2019 is indicated with an asterisk (*). The literature review revealed that the research area of sustainable supply chain performance assessment is growing and gaining increasing attention from the scientific community. There was a sudden rise in the number of publications after 2013, with more than 80% of the identified articles published subsequently. This development was significant, because the scientific community recognizes a research field if its number of articles doubles over a span of ten to 20 years [11]. During the past five years, the number of publications on the research area of sustainable supply chain performance assessment has increased more than twofold.

In addition, we analyzed the scientific articles' distribution in the different journals to assess how these journals prioritize a particular research area [44]. Table 3 provides a summary of the frequency with which the selected scientific articles are published in a journal. Our literature review identified that 36 journals had published articles related to sustainable supply chain

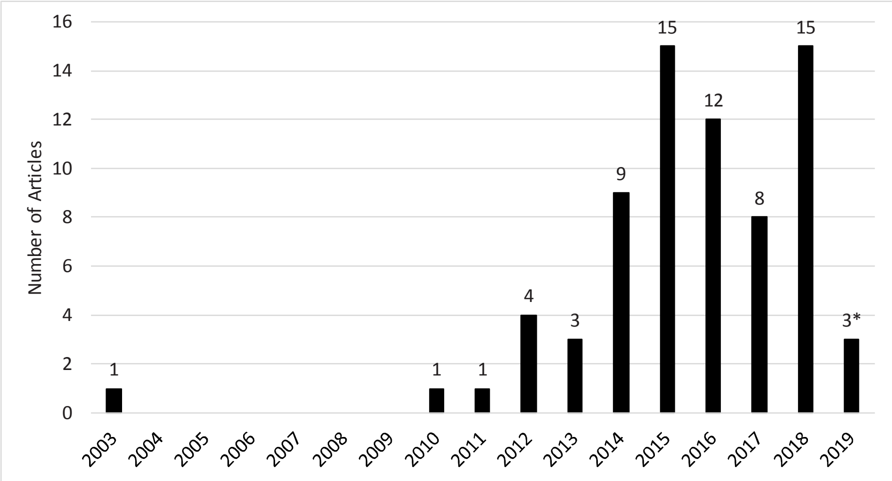


Figure 2: Distribution of SPI-related identified research articles by publication per year.

performance assessment, with 11 journals publishing more than two articles. The *Journal of Cleaner Production; Computer & Operations Research; International Journal of Production Economics; Resources, Conservation and Recycling; Journal of Environmental Management; and Supply Chain Management: An International Journal* are the top three journals in terms of the number of publications and are considered core journals in the field of sustainable supply chain performance measurement. These top three journals contributed 51% (37 out of 72) of the selected scientific articles. Besides the *Journal of Cleaner Production*, all the other journals in the selected sample had published fewer than five articles. However, our systematic literature review's findings imply that authors might find it difficult to publish their research, since not many journals are dedicated to sustainable supply chain performance assessment and most of the journals in the selected sample are related to the SCM research area.

Table 3: Distribution of SPI-related identified research articles per journal.

Journal name	#	Journal name	#
Journal of Cleaner Production	19	*Resources, Conservation and Recycling*	4
Computers & Operations Research	4	*Journal of Environmental Management*	3
International Journal of Production Economics	4	*Supply Chain Management: An International Journal*	3
Total number of publications in top 3 journal			**37**
Production Planning & Control	2	*Benchmarking: An International Journal*	2
International Journal of Productivity & Performance Management	2	*Transportation Research Part D: Transport and Environment*	2
Sustainable Production and Consumption	2	*International Journal of Product Development*	1
Applied Mathematical Modelling	1	*International Strategic Management Review*	1
Computers & Industrial Engineering	1	*Journal of Business Logistics*	1
Ecological Economics	1	*Logistics Research*	1
Ecological Indicators	1	*Management Research Review*	1
Energy Conversion and Management	1	*Measurement*	1
European Journal of Operational Research	1	*Greener Management International*	1
Omega	1	*Procedia - Social and Behavioral Sciences*	1
Industrial Management & Data Systems	1	*Procedia CIRP*	1
Intelligent Systems in Accounting, Finance & Management	1	*International Journal of Operations & Production Management*	1
International Journal of Logistics Management	1	*Supply Chain Forum: International Journal*	1
Renewable and Sustainable Energy Reviews	1	*Waste Management*	1
International Journal of Physical Distribution & Logistics Management	1	*Transportation Research Part E: Logistics and Transportation Review*	1
Total number of publications in other journals			**35**
Total			**72**

Table 4: Distribution of authors published in more than one SPI-related scientific journal article.

Author Name	Article as 1st Author	Article as 2nd Author	Article as 3rd Author	Total articles	Author Name	Article as 1st Author	Article as 2nd Author	Article as 3rd Author	Total articles
Saen, R. F.	0	3	2	5	*Hassini, E.*	1	1	0	2
Searcy, C.	0	3	2	5	*Azadi, M.*	1	0	0	2
Ahi, P.	3	0	0	3	*Germani, M.*	1	0	0	2
Kumar, D.	3	0	0	3	*Papetti, A.*	1	0	0	2
Genovese, A.	2	0	0	3	*Rahman, Z.*	0	2	0	2
Sarkis, J.	0	2	0	3	*Gunasekaran, A.*	0	1	1	2
Bai, C.	2	0	0	2	*Torabi, S.A.*	0	1	1	2
Mani, V.	2	0	0	2	*Jaber, M.Y.*	0	1	1	2
Izadikhah, M.	2	0	0	2	*Marconi, M.*	0	1	1	2
Acquaye, A.	1	1	0	2					

Furthermore, our co-authorship analysis investigated the authors' contribution to the research field of sustainable supply chain performance measurement, because their contributions help define the development and shape of a research area. As shown in Table 4, our systematic literature review revealed that *Cory Searcy* and *Reza Farzipoor Saen* published five journal articles each. However, they were not mentioned as the primary (first) authors in any of their selected publications, whereas, the authors *Payman Ahi* and *Divesh Kumar* published three articles each as a first author. In total, 19 authors published more than two scientific journal articles in the area of SPIs for sustainable supply chain performance assessment. Our analysis revealed that 65% of the identified articles in this systematic literature review were published by at least three authors. Moreover, our co-authorship analysis revealed that, until 2013, the average number of authors per scientific journal article in the selected sample was 2.4 and 3.19 subsequently. This analysis shows that the average number of authors increased with the increase in the number of publications per year. However, in respect of the whole sample, the average number of authors was 3.08, which is above the average in the environmental management accounting literature (i.e., 1.75) [44] and across all other research disciplines (i.e., 1.45) [28]. The higher number of co-authors could mean that, as an interdisciplinary research area, sustainable supply chain performance assessment requires different research groups' involvement and interaction.

3.2. Sustainability dimensions and issues of importance

The sustainable supply chain performance assessment includes measuring the extent of environmental, social, and economic factors' incorporation into organizational activities, i.e., measuring the impacts of organizations' activities on their internal and external environment [19]. Figure 3 presents selected journal articles' distribution across the TBL's three sustainability dimensions. Our systematic literature review of the scientific literature revealed that 65 scientific journal articles addressed the environmental sustainability dimension's performance assessment, 57 journal articles the social sustainability dimension, and 47 journal articles the economic sustainability dimension. Furthermore, we identified that half of the selected journal articles addressed the three sustainability dimensions (i.e., 38 of 72). The other half discussed just one or two sustainability dimensions, with 29% (i.e., 10 of 34) discussing only the environmental sustainability dimension, 6% (i.e., 2 of 34) the social sustainability dimension, and only 3% (i.e., 1 of 34) the economic sustainability dimension. Moreover, 38% (i.e., 13 of 34) of the selected journal articles discussed the environmental and the social sustainability dimensions jointly, with 12% (i.e., 4 out of 34) jointly discussing the environmental and the economic sustainability dimensions, and the remaining 12% (i.e., 4 of 34) addressing the economic and social sustainability dimensions.

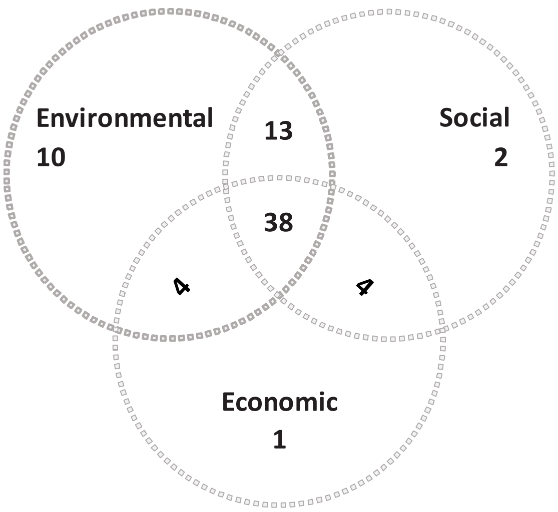


Figure 3: Distribution of relevant journal articles across the triple bottom line (TBL).

Furthermore, our findings of the selected journal articles' content analysis allowed us to analyze the distribution of each sustainable supply chain's attribute category (sustainability issues of importance) addressed in each article. This analysis helped us understand the degree of importance that the authors assigned to each attribute category, as well as identify areas of future development. Table 5, which is based on our content analysis's findings, presents the distribution of each attribute category in respect of each selected journal article. In accordance with previous research [12, 22, 43, 45, 46, 51], this literature review's findings could indicate that the scientific literature mostly addresses environmental sustainability-related issues and performance assessment. However, Table 5 also shows that the majority of the research articles addressing three sustainability dimensions were only published recently, which, in turn, indicates an increasing interest in the holistic assessment of supply chain's sustainability performance.

In order to develop a clear understanding of the sustainability performance assessment landscape, we assigned the three sustainability dimensions to seven groups, either alone or together with other sustainability dimensions. Of these groups, three groups were standalone sustainability dimensions: environmental (E), social (S), and economic (Ec). In addition, three groups were combinations of environmental and social sustainability (E+S), environmental and economic sustainability (E+Ec), and social and economic sustainability (S+Ec). The seventh group is a combination of all three sustainability dimensions (TBL). Our analysis revealed that 65 of the 72 selected articles addressed the environmental sustainability dimension 275 times in total – either standalone (i.e., E) or together with other sustainability dimensions (i.e., E+S, E+Ec, and TBL). *Land use* was the least addressed (18%, or 12 of 65) and *emission* the most addressed (72%, or 47 of 65) attribute categories in the environmental sustainability performance assessment. Furthermore, 57 of the 72 selected articles addressed the social sustainability performance 150 times in total – standalone (i.e., S) and together with other sustainability dimensions (i.e., E+S, S+Ec, and TBL). Social sustainability performance emerged as the second most addressed sustainability dimension in sustainable supply chain performance assessment. *Social compliance* was the least addressed attribute category (21%, or 12 of 57) and *human resource* the most addressed (58%, or 33 of 57) attribute category in the social sustainability performance assessment. Moreover, 47 of the 72 selected articles addressed the economic sustainability performance 94 times in total – standalone (i.e., Ec) and together with other sustainability dimensions (i.e., E+Ec, S+Ec, and TBL). *Income distribution* was the most addressed (79%, or 37 of 47) and *market competitiveness* the least assessed (32%, or 15 of 47) attribute categories for the performance assessment of the economic sustainability dimension.

Table 5 Sustainability attribute categories and their relation to selected SPI-related research articles.

	Sustainability attribute categories																	
	Environmental (275)								**Social (150)**						**Economic (94)**			
Source	E_1 **(44)**	E_2 **(46)**	E_3 **(33)**	E_4 **(41)**	E_5 **(47)**	E_6 **(12)**	E_7 **(32)**	E_8 **(20)**	S_1 **(22)**	S_2 **(36)**	S_3 **(33)**	S_4 **(21)**	S_5 **(26)**	S_6 **(12)**	Ec_1 **(22)**	Ec_2 **(37)**	Ec_3 **(15)**	Ec_4 **(20)**
Courville (2003)	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	x	-	-
Hall and Matos (2010)	x	-	-	x	x	x	-	-	-	-	x	-	-	-	-	x	-	-
Erol et al. (2011)	x	x	x	x	-	x	x	x	x	x	x	x	x	-	x	x	-	-
Caniato et al. (2012)	x	x	x	x	x	-	x	-	-	-	-	-	-	-	-	-	-	-
Hassini et al. (2012)	x	x	x	x	x	-	x	x	-	-	-	-	-	-	-	x	-	-
Styles et al. (2012)	-	-	-	-	-	x	x	-	-	-	-	-	-	-	-	-	-	-
Uysal (2012)	x	x	x	x	-	x	x	x	x	x	x	x	x	-	x	x	-	-
Cucchiella and D'Adamo (2013)	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
Govindan et al. (2013)	-	x	x	x	x	-	x	x	x	x	x	-	-	x	-	x	-	-
Reefke and Trocchi (2013)	x	x	x	x	-	x	x	x	-	x	x	x	x	-	x	x	x	-
Bai and Sarkis (2014)	x	x	-	x	-	-	x	x	-	-	-	-	-	-	-	-	-	x
Blome et al. (2014)	-	x	-	x	x	-	x	-	-	-	-	-	x	-	-	-	x	-
Egilmez et al. (2014)	x	-	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-
Genovese et al. (2014)	x	x	x	x	x	x	x	-	-	-	-	-	-	-	x	-	-	-
Hong et al. (2014)	-	-	-	-	-	-	-	-	-	-	-	-	x	-	x	x	x	-
Ortas et al. (2014)	-	-	-	-	-	-	x	x	-	-	-	-	-	-	x	x	-	x
Pishvaee et al. (2014)	-	x	-	-	-	-	-	-	-	x	x	-	x	-	-	x	-	-
Varsei et al. (2014)	x	x	x	x	x	-	-	-	-	x	-	-	x	x	-	-	-	-

Source	Sustainability attribute categories																	
	Environmental (275)								Social (150)						Economic (94)			
	E_1 (44)	E_2 (46)	E_3 (33)	E_4 (41)	E_5 (47)	E_6 (12)	E_7 (32)	E_8 (20)	S_1 (22)	S_2 (36)	S_3 (33)	S_4 (21)	S_5 (26)	S_6 (12)	Ec_1 (22)	Ec_2 (37)	Ec_3 (15)	Ec_4 (20)
Zhang et al. (2014)	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	x	-	-
Ahi and Searcy (2015)	x	x	x	x	x	-	x	x	x	x	x	-	x	-	x	x	x	x
Azadi et al. (2015)	x	x	x		x	-	x	-	-	-	x	-	-	x	-	x	-	x
de Sousa Jabbour et al. (2015)	x	x	x	x	x	-	x	-	-	-	-	-	-	-	-	-	-	-
Germani et al. (2015)	x	x	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-
Jakhar (2015)	x	x	-	-	x	-	-	-	-	-	-	-	-	-	-	x	-	-
Khodakarami et al. (2015)	-	-	-	-	-	-	-	-	-	x	-	x	-	-	x	x	-	x
Kozlowski et al. (2015)	x	x	x	x	x	-	x	x	x	-	-	x	x	-	-	-	-	-
Kumar and Rahman (2015)	x	x		x	x	-	-	-	x	x	-	x	-	-	-	x	x	x
Marshall et al. (2015)	x	x		x		-	-	-	x	x	-	-	-	-	-	-	-	-
Morana and Gonzalez-Feliu (2015)	-	-	-	-	x	-	-	-	-	x	-	x	x	-	x	x	-	-
Mota et al. (2015)	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	x	-	-
Santiteerakul et al. (2015)	x	x	-	-	x	-	x	-	x	x	x	x	-	-	x	x	x	-
Tajbakhsh and Hassini (2015)	-	x	-	-	x	-	-	x	-	-	-	-	x	-	-	x	-	x
Tseng et al. (2015)	x	x	x	x	x	-	x	x	x	x	x	-	x	x	x	x	x	x
Vance et al. (2015)	x	-	-	-	x	-	-	-	-	-	-	-	-	-	-	x	-	-
Ahi et al. (2016a)	x	x	-	x	x	-	-	-	-	x	x	-	x	-	x	x	x	x
Ahi et al. (2016b)	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blanco et al. (2016)	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
Haghighi et al. (2016)	-	x	-	-	x	-	x	-	-	-	-	-	x	-	-	-	-	x
Hussain et al. (2016)	-	-	-	-	-	-	x	-	-	-	-	x	x	x	-	-	-	-
Izadikhah and Saen (2016)	x	x	x	x	x	-	x	-	-	-	x	-	-	-	-	x	-	x
Kumar and Rahman (2016)	x	-	-	x	x	-	-	x	-	-	-	-	-	-	-	-	-	-
Mani et al. (2016)	-	-	-	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Sgarbossa and Russo (2016)	x	-	-	-	-	-	-	-	-	x	-	-	-	-	x	x	-	-
Wan Ahmad et al. (2016)	-	x	x	x	-	x	x	x	-	-	x	x	x	-	-	-	-	-
Willersinn et al. (2016)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	x	-	-
Zhang et al. (2016)	-	-	-	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-
Acquaye et al. (2017)	-	-	x	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
Chen and Kitsis (2017)	x	x	-	x	x	-	x	x	-	x	x	-	x	-	x	x	-	x
Das (2017)	x	x	-	-	-	-	x	-	-	x	x	-	-	-	-	x	-	-
Fritz et al. (2017)	x	x	x	x	x	-	x	x	x	-	x	x	x	x	-	-	x	x
Genovese et al. (2017)	-	x	-	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-
Kumar and Garg (2017)	x	x	-	x	x	-	-	-	-	-	x	x	-	-	-	x	x	-
Saeed and Kersten (2017)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Stindt (2017)	x	x	x	x	x	x	x	-	x	x	x	x	-	x	-	-	-	-
Allaoui et al. (2018)	-	x	x	x	x	x	-	-	-	x	x	x	-	-	x	-	-	x
Bai and Sarkis (2018)	x	x	x	x	x	-	x	-	x	x	x	-	-	-	-	-	-	x
Castillo et al. (2018)	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-
Farkavcova et al. (2018)	x	-	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-
Gómez-Luciano et al. (2018)	-	-	-	x	x	-	-	-	-	x	x	-	x	-	-	-	-	-
Gong et al. (2018)	x	x	-	x	x	-	-	x	x	x	x	x	-	-	x	x	-	-
Izadikhah and Saen (2018)	x	x	x	x	x	x	x	-	x	x	x	-	x	-	-	x	-	x
Kolotzek et al. (2018)	-	x	-	-	-	-	-	-	x	x	x	-	-	-	-	-	x	-
Li and Mathiyazhagan (2018)	-	-	x	-	x	-	-	-	x	x	-	x	x	-	-	-	-	-
Mani et al. (2018)	-	x	-	-	-	-	-	x	x	x	x	x	-	x	-	-	-	-
Osiro et al. (2018)	x	x	x	x	x	-	x	-	x	x	x	x	x	-	x	-	x	x
Pourjavad and Shahin (2018)	x	x	x	x	x	-	x	x	-	x	x	x	x	-	-	x	-	-
Raj and Srivastava (2018)	x	x	x	x	x	-	-	x	x	x	x	x	x	x	x	x	x	x
Rashidi and Saen (2018)	x	x	x	x	x	-	x	-	-	x	x	-	-	x	x	x	-	x

Source	Environmental (275)								Social (150)						Economic (94)			
	E_1 (44)	E_2 (46)	E_3 (33)	E_4 (41)	E_5 (47)	E_6 (12)	E_7 (32)	E_8 (20)	S_1 (22)	S_2 (36)	S_3 (33)	S_4 (21)	S_5 (26)	S_6 (12)	Ec_1 (22)	Ec_2 (37)	Ec_3 (15)	Ec_4 (20)
Zhou et al. (2018)	x	x	-	x	-	-	x	-	-	x	-	-	x	-	x	x	-	-
Papetti et al. (2019)	x	x	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-
Rohmer et al. (2019)	-	-	x	-	-	x	-	-	-	-	-	-	-	-	-	x	-	-
Taleizadeh et al. (2019)	x	-	x	-	x	-	-	-	-	-	x	-	-	-	-	-	x	-

Sustainability attribute categories

() parenthesis in the header represents the number of times each attribute category was mentioned in the literature

3.3. SPIs identification in the scientific literature

Organizations measure their sustainability efforts by using different SPIs [18], which Saeed and Kersten [42] define as "indicators that help to measure the performance of an organization at least in one of the three dimensions of sustainability." The selected journal articles' content analysis identified 1054 indicators related to sustainable supply chain performance assessment. We classified the identified indicators further according to their attribute categories. Each attribute category characterizes a set of SSCM goals that an organization and its supply chain need to achieve. Based on the attribute category level's performance, an organization's sustainability performance was evaluated in respect of each sustainability dimension. The restructuring, standardizing, and coding of the identified indicators from our systematic literature review of scientific journal articles resulted in a consolidated list of 68 SPIs.

In respect of the environmental sustainability dimension, we identified 32 SPIs from the selected journal articles to assess the environmental sustainability performance, as shown in Table 6. Of the 32 SPIs, we identified four for the *energy efficiency* attribute category, five for the *material efficiency*, seven for the *water management,* five for the *waste management*, four for the *emissions*, two for the *land use*, three for the *environmental compliance,* and two for the *supplier assessment* attribute categories.

Furthermore, we identified 21 SPIs for the social sustainability dimension through our scientific journal articles' review to assess organizations' social sustainability performance. We identified 21 SPIs, seven for the *human resource* attribute category, four for the *human rights and anti-corruption*, three for the *health and safety,* two for the *training and education,* three for the *consumer issues,* and two SPIs for the *social compliance* attribute categories. Similarly, for the economic sustainability dimension, we identified 15 SPIs through our literature review. Of the 15 SPIs, we identified five for the *stability and profitability*, five for the *income distribution,* two for the *market competitiveness,* and three for the *sustainability expenditures* attribute categories.

3.4. Number of SPI occurrences in scientific journal articles

As shown in Table 7, this subsection discusses the frequency with which SPIs occurred in the selected journal articles. This frequency analysis also indicates the total number of times the selected literature mentioned an SPI for a particular attribute category, which Table 7 shows as the *total number of SPI citations*. However, if an SPI was mentioned more than once in the same article, we counted all the occurrences related to that SPI only once, which Table 7 shows as the *number of unique SPI citations.* Furthermore, the analysis provided the frequency with which the

Table 6: Number of SPIs identified for each attribute category from the selected articles.

Attribute categories	Sustainability dimensions (68)					
	Environmental (32)		**Social** (21)		**Economic** (15)	
	E_1	Energy efficiency **(4)**	S_1	Human rights and anti-corruption **(4)**	Ec_1	Stability and profitability **(5)**
	E_2	Material efficiency **(5)**			Ec_2	Income distribution **(5)**
	E_3	Water management **(7)**	S_2	Human resource **(7)**	Ec_3	Market competitiveness **(2)**
	E_4	Waste management **(5)**	S_3	Health and safety **(3)**	Ec_4	Sustainability expenditures **(3)**
	E_5	Emissions **(4)**	S_4	Training and education **(2)**		
	E_6	Land use **(2)**				
	E_7	Environmental compliance **(3)**	S_5	Consumer issues **(3)**		
	E_8	Supplier assessment **(2)**	S_6	Social compliance **(2)**		

(#) is the total number of SPIs identified for each attribute category

SPIs were mentioned regarding each sustainability dimension, i.e., the number of times in total that the selected journal articles mentioned a sustainability dimension.

The number of times an SPI was mentioned can be interpreted as the importance that academics assign to a particular sustainability issue. The internal distribution of each SPI within the sample has revealed that the literature did not mention all of the indicators equally. Of the 68 identified SPIs, the selected sample mentioned 22% less than five times and only mentioned 7% more than 30 times. SPI-22, which refers to the total greenhouse gases emission (Scope-1, Scope-2, and Scope-3), was mentioned most often (i.e., 40 times) in terms of the environmental sustainability performance. Furthermore, SPI-44, which refers to the total number of health and safety incidents and occupational injury or illness arising from, associated with, or occurring in the course of work, was mentioned most often (i.e., 31 times) in terms of the social sustainability dimension. In respect of the economic sustainability dimension, SPI-60 (operating cost) was mentioned very often (i.e., 32 times) in the selected sample. Although some SPIs were mentioned less often in the selected sample, our literature review considered them equally important for building sustainability-related awareness and performance assessment.

Furthermore, our frequency analysis helped us identify 756 unique SPIs mentions, 399 of 32 environmental SPIs, 224 of 21 social SPIs, and 133 of 15 economic SPIs. Moreover, our detailed analysis of the total number of SPI occurrences in the selected sample revealed that 53% (562 mentions) of the identified SPIs addressed the environmental sustainability dimension, 28% (298 mentions) the social sustainability dimension, and only 18% (194 mentions) the economic sustainability dimension. In this respect, one could argue that environmental sustainability performance evaluation is still a leading topic in the literature, since more than half of the existing SPIs were related to the environmental sustainability dimension. There is scant research on social sustainability performance assessment. Our frequency analysis also reinforces the needs that the literature highlights [4, 11, 32, 35, 48]; that is, to emphasizing the social sustainability dimension in general and social sustainability performance assessment in particular. However, holistic sustainability performance assessment, which includes the social dimension, has been gaining in importance in recent years.

Table 7 also shows that, in terms of the total number of mentions in the scientific literature, the *material efficiency* (115 mentions) and *energy efficiency* (114 mentions) attribute categories primarily drive the environmental sustainability performance assessment. In the performance assessment related to *material efficiency*, SPI-5 (i.e., total material input) was the most discussed sustainability issue and, in *energy*

Table 7: Number of occurrences of SPIs in the systematic literature review.

	Attribute category (68)		**# of unique SPI citations**	**Total # of SPI citations**	
Environmental Sustainability	E_1	Energy efficiency **(4)**	68	114	562
	E_2	Material efficiency **(5)**	83	115	
	E_3	Water management **(7)**	48	53	
	E_4	Waste management **(5)**	54	73	
	E_5	Emissions **(4)**	66	90	
	E_6	Land use **(2)**	13	14	
	E_7	Environmental compliance **(3)**	40	56	
	E_8	Supplier assessment **(2)**	27	47	
Social Sustainability	S_1	Human rights and anti-corruption **(4)**	39	45	298
	S_2	Human resource **(7)**	70	93	
	S_3	Health and safety **(3)**	42	60	
	S_4	Training and education **(2)**	24	31	
	S_5	Consumer issues **(3)**	34	49	
	S_6	Social compliance **(2)**	15	20	
Economic Sustainability	Ec_1	Stability and profitability **(5)**	33	46	194
	Ec_2	Income distribution **(5)**	57	93	
	Ec_3	Market competitiveness **(2)**	16	22	
	Ec_4	Sustainability expenditures **(3)**	27	33	
	Total		**756**	**1054**	

(#) in parenthesis represents the total number of SPIs in each attribute category *efficiency,* SPI-1 (i.e., total energy consumption) was the most discussed sustainability issue. In respect of the social sustainability performance assessment, academics mainly mentioned the *human resource* (93 mentions) and the *health and safety* (60 mentions) attribute categories. Sustainability issues related to the total number of employees are highlighted in the performance assessment related to *human resource*. *Health and safety*-related performance assessment focused mainly on the total number of health and safety incidents during the course of the work. The economic sustainability performance assessment mostly addressed the *income distribution* (93 mentions) and *stability and profitability* (46 mentions) attribute categories. In the case of *income distribution* performance assessment, the existing literature emphasized issues related to operating costs and issues related to the total sales/revenue in the case of *stability and profitability* performance assessment. Consequently, in keeping with the previous subsections' findings, the majority of the scientific literature addressed environmental SPIs, which means that, specifically, more focus is required on social SPIs' development.

3.5. Analysis of SPI development

Our literature review has revealed that there is no agreement on an ideal number of SPIs. However, the selected SPIs must meet the purposes for which they were developed [19]. Our detailed analysis of the scientific literature regarding the development of SPIs helped provide a clear understanding of the latest findings on SPIs used for organizations and their supply chains' sustainability-related performance assessment. In order to achieve this understanding, we first analyzed the development of sustainability dimensions between 2010 and 2018. As shown in Figure 4, there has been a continuous increase in all three-sustainability dimensions' performance measurement since 2010. However, SPIs related to the environmental sustainability dimension were mentioned more often than other sustainability dimensions and followed by the social and economic sustainability dimensions. This might be due to the difficulties associated with sustainability performance's measurement in general [26] and, more specifically, with the social sustainability dimension [11].

Furthermore, our analysis of SPIs' development and supply chains' sustainability performance assessment over five years (between 2014 and 2018) revealed that 11 journal articles addressed SPIs in respect of just one sustainability dimension, while 48 (81%) scientific journal articles addressed SPIs in respect of more than one sustainability dimension. A total of 31 (53%) journal articles addressed the SPIs of all three sustainability dimensions. Consequently, this analysis confirms that, in recent years, sustainable supply chain performance assessment has not only remained an issue related to the environmental dimension. Sustainable supply chain's three-dimensional performance evaluation has gained considerable importance and its focus has shifted to reducing the existing gap in developing SPIs related to social sustainability performance.

Figure 5 provides the internal distribution of the consolidated list of 68 SPIs for each sustainability dimension in terms of the total number of mentions in the selected journals. Our analysis of SPIs over a ten-year period (2010 to 2018) revealed that SPIs are not evenly distributed with regard to each sustainability dimension. However, 2019 was excluded from the analysis as we only identified articles until January 2019. The analysis revealed that the scientific literature

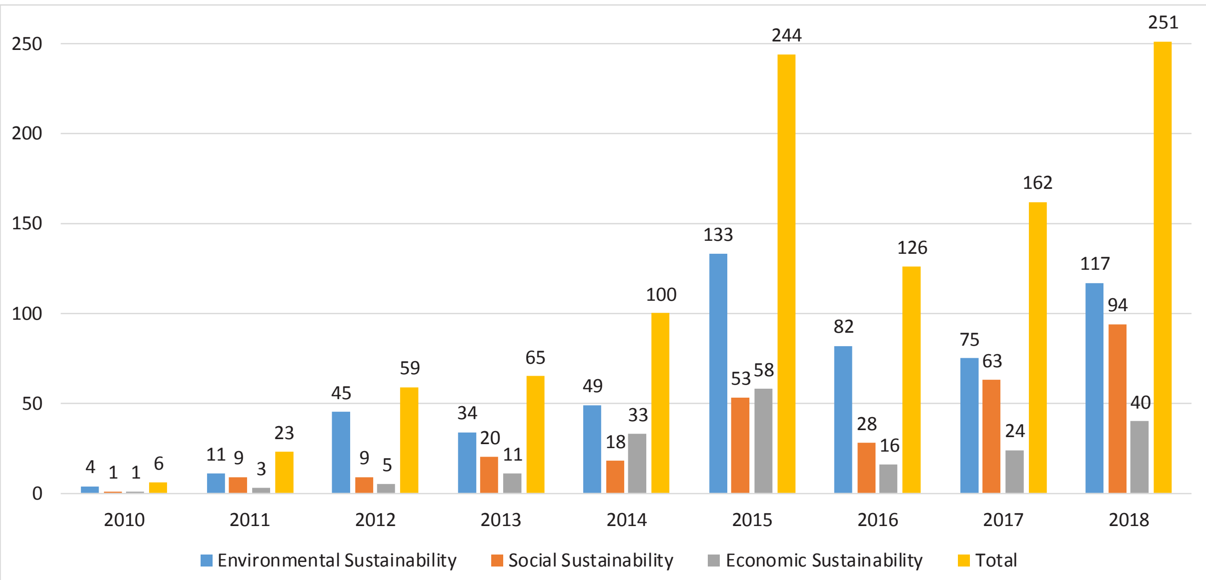


Figure 4: Development of SPIs across each sustainability dimension between 2010 and 2018.

Sustainability erformance		Attribute category	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total S citations
	Environmental	Energy efficiency	1	2	7	6	8	20	41	9	18	**112**
		Material efficiency	0	1	6	4	7	46	9	18	23	**114**
		Water management	0	1	7	2	5	10	2	9	13	**49**
		Waste management	1	1	7	5	7	12	9	10	20	**72**
		Emissions	1	0	5	4	9	25	9	14	20	**87**
		Land use	1	2	2	1	1	0	1	3	2	**13**
		Environmental compliance	0	1	7	8	6	10	5	8	11	**56**
		Supplier assessment	0	3	4	4	6	10	6	4	10	**47**
	Social	Human rights and anti-corruption	0	1	1	1	0	9	3	14	16	**45**
		Human resource	0	5	5	8	8	12	4	20	30	**92**
		Health and safety	1	1	1	7	4	8	7	10	19	**58**
		Training and education	0	1	1	1	0	5	4	8	11	**31**
		Consumer issues	0	1	1	2	4	17	8	5	11	**49**
		Social compliance	0	0	0	1	2	2	2	6	7	**20**
	Economic	Stability and profitability	0	1	1	1	11	11	4	6	11	**46**
		Income distribution	1	2	4	9	17	31	7	8	12	**91**
		Market presence	0	0	0	1	2	7	1	4	6	**21**
		Sustainability expenditures	0	0	0	0	3	9	4	6	11	**33**

Figure 5: Development of SPIs across each attribute category between 2010 and 2018.

mentioned both general and specific SPIs for sustainable supply chain performance assessment. Specific SPIs were used to assess the relative sustainability performance and general SPIs to assess an organization or a supply chain's general sustainability performance.

Initially, the literature emphasized the environmental sustainability performance strongly, with the majority of the identified SPIs related to environmental sustainability performance, as shown in Figure 5. However, during the past five years, the three-dimensional focus has increased and academics are making efforts to address social sustainability performance evaluation. In respect of environmental sustainability, the literature covers SPIs related to energy, material, emissions, supplier assessment, and compliance-related sustainability issues. In respect of social sustainability, the literature discusses SPIs related to human resource, human rights, health and safety, and consumer-related sustainability issues. In the case of economic sustainability, the SPIs addressed stability and profitability, income distribution, and sustainability expenditure-related issues.

3.6. SPI-Grid for sustainable supply chain management

Based on the consolidated list of 68 SPIs, we provide a conceptual SPI-Grid (see Figure 6) to monitor and evaluate standalone sustainability performance of organizations within a supply chain as well as to benchmark their sustainability performance with other supply chain participants from the same or different supply chains. It will help organizations to identify potential improvements of their business processes and their business models by collecting and analyzing data that are related to achieve of their sustainability targets.

The SPI-Grid evaluates sustainability performance of each dimension of the TBL, i.e. environmental sustainability (Env.), social sustainability (Soc.), and economic sustainability (Econ.). The sustainability performance of each SPI (e.g., E_{ij} in case of environmental sustainability, S_{ij} in case of social sustainability, Ec_{ij} in case of economic sustainability) leads to the sustainability performance at the attribute category level, i.e., E_i in case of environmental sustainability, S_i in case of social sustainability, Ec_i in case of economic sustainability. Subsequently, the average performance score of each attribute category level leads to the performance evaluation at the sustainability dimension level by using Formulas from equation 1 to 3. The final performance scores of each sustainability dimension can be represented on an equilateral triangle in which each corner comprises of one dimension of the triple bottom line.

$$Env. = \frac{1}{N}\sum_{i=1}^{N}\frac{1}{n}\sum_{j=1}^{n} E_{ij} \;\ldots\ldots (1)$$

$$Soc. = \frac{1}{N}\sum_{i=1}^{N}\frac{1}{n}\sum_{j=1}^{n} S_{ij} \;\ldots\ldots (2)$$

$$Econ. = \frac{1}{N}\sum_{i=1}^{N}\frac{1}{n}\sum_{j=1}^{n} Ec_{ij} \;\ldots\ldots (3)$$

E_i = environmental sustainability attribute category
E_{ij} = environmental sustainability indicator
S_i = social sustainability attribute category
S_{ij} = social sustainability indicator
Ec_i = economic sustainability attribute category
Ec_{ij} = economic sustainability indicator
i = attribute category number

N = total number of attribute categories
j = performance indicator number in an attribute category

n = total number of performance indicator in an attribute category

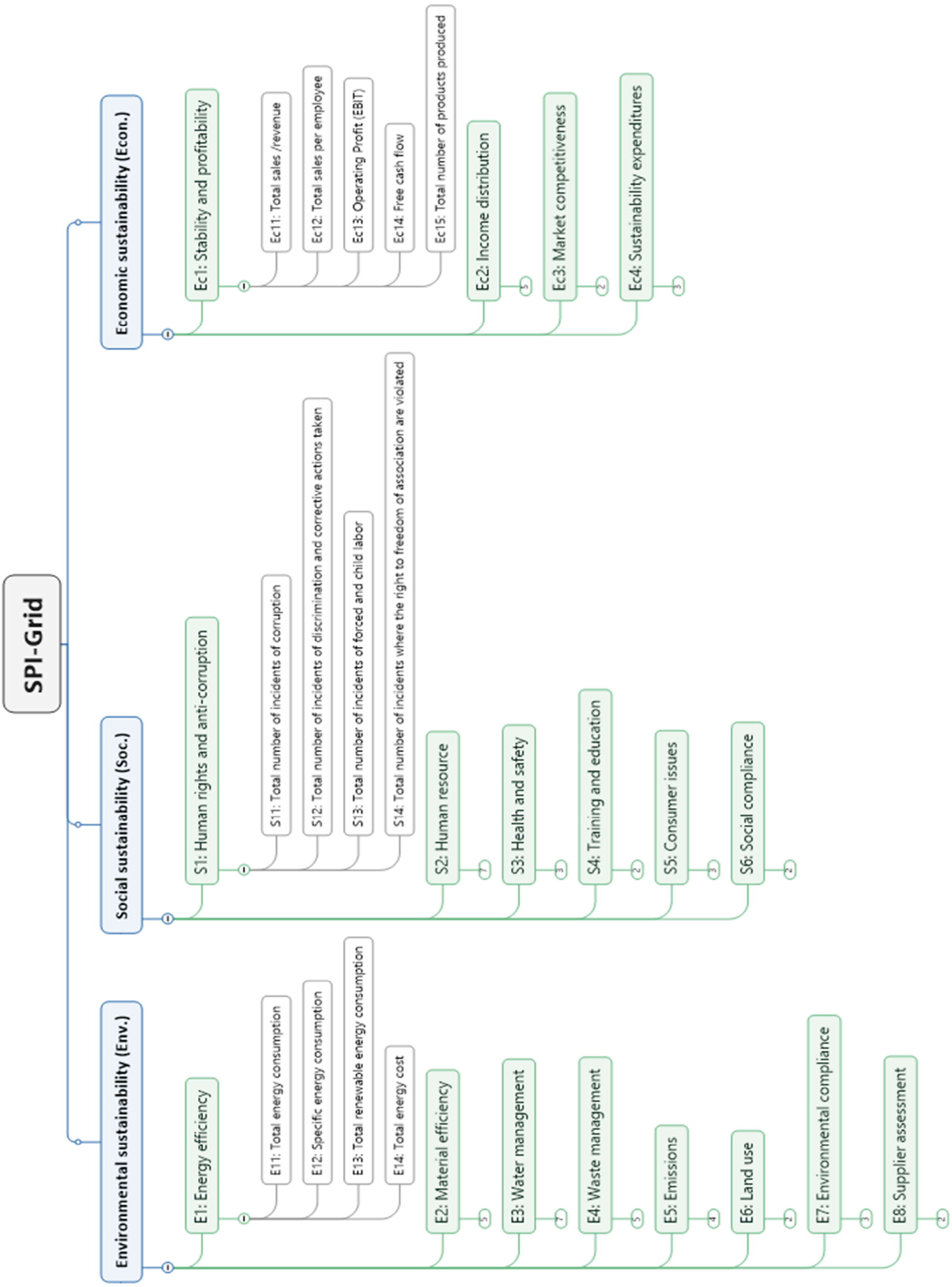


Figure 6: SPI-Grid for sustainable supply chain management

4. CONCLUSIONS AND OUTLOOK

The primary objective of this research article was to provide a clear understanding of the current SPI landscape for a sustainable supply chain performance assessment, as well as to provide a consistent and consolidated list of SPIs for this assessment. Consequently, we identified SPIs from the scientific literature. After a precise interpretation, restructuring, and standardizing, we had a consolidated list of 68 SPIs and developed a conceptual SPI-Grid. The integration of the consolidated list of SPIs into SPI-Grid will help monitor and report on organizations' efforts to implement sustainability-related initiatives.

In this systematic literature review, we have seen a continuous growth in the number of scientific articles related to sustainable supply chain performance assessment. In turn, the increasing number of scientific articles is an indication of the research field's growing maturity and authors' keen interests in developing a well-accepted performance measurement system. Although environmental sustainability still dominates the scientific literature, research articles addressing all three sustainability dimensions are increasing rapidly. In keeping with the literature's earlier findings [5, 12, 39, 43, 45, 51], research on social sustainability performance assessment is still fragmented, with social SPIs enjoying very little attention [4, 11, 32, 35, 48]. In the literature, social sustainability performance is usually addressed with the other two sustainability dimensions. However, the majority of the identified articles discussed the assessment of sustainability performance in terms of its past impacts and with no future orientation. Nevertheless, our systematic literature review identified an increasing emphasis on developing a holistic approach to assess organizations and their supply chains' sustainability performance. However, the review also revealed that, during an overall supply chain sustainability performance assessment, organizations might face tradeoffs situations regarding simultaneously improving their performance in several areas [11].

Despite the reasonable efforts identified in the scientific literature, we observed that a standardized set of SPIs and a performance measurement system for the assessment of organizations and their supply chains' sustainability performance are still lacking. The literature review also identified many unclear and ambiguous indicators that cannot help identify when an organization is close to or far from its sustainability goals. For example, indicators related to an organization's total energy cost are dependent on the production volume, country of operation, and any other benefits or subsidies that the organization may receive.

This research's findings have numerous implications for organizations and their supply chains' sustainability performance assessment. On the one hand, to help organizations achieve their sustainability goals, this research offers them and their supply chain partners essential knowledge on the use of SPIs in the implementation and evaluation of their sustainability actions. On the other hand, the consolidated list of 68 SPIs provides a reasonable basis for comparing and evaluating different supply chains and different supply chain participants' sustainability performance. In addition, practitioners can use the SPIs identified in our systematic literature review to develop a performance measurement system, which will allow them to evaluate a supply chain's sustainability performance across different supply chain functions. Furthermore, in the future, the consolidated list of SPIs can be updated by developing new multidimensional SPIs. Nevertheless, the consolidated list of SPIs identified in this research is another right step in the development of a comprehensive framework for a sustainable supply chain performance assessment and more research is needed to address the research gap between theory and implementation.

Although our systematic literature review has provided a consolidated and coherent list of SPIs, our research can be extended by analyzing the current development regarding the sustainable supply chain performance assessment in the industry, since the industry SPIs may not be fully disclosed in the literature. Researchers can achieve this updating by analyzing and evaluating companies' efforts regarding implementing sustainability practices. For this purpose, researchers can, for example, investigate annual industrial sustainability and corporate social responsibility reports to identify and analyze industry SPIs. The results can subsequently be cross-referenced with the list of SPIs identified in this research. Furthermore, future areas of research in the field of sustainable supply chain performance assessment could be the need for crosscutting and industry-specific SPIs, as well as developing an interrelation between the three sustainability dimensions.

We selected scientific journal articles published in English for our systematic literature review, because the peer review system contributes to their high quality. However, researchers could also analyze articles from other data sources, such as conference proceedings, books, dissertations, and magazines, to verify the results of this research. Considering articles in languages other than English could also add value to the identified list of SPIs. Moreover, the inclusion of more scientific databases in the analysis could affect the results obtained in our research. However, the selection of just two scientific databases within the scope of this study is justified, as we noticed no drastic changes in the list of SPIs when integrating those SPIs obtained from the *Ebsco Host* into the SPIs obtained from the *Science Direct* database, indicating a state of probable data saturation.

Furthermore, researchers can increase the number of research publications in the sample by incorporating fewer specific keyword combinations when using keywords to search the databases or using supply chain function-related keywords instead of using supply chain as a single keyword. This could identify more scientific publications and offer additional value for a systematic literature review.

5. APPENDIX

Table 8: List of selected journal articles for the systematic literature review.

#	Publication's Authors	Publication's title
1	*Courville (2003)*	Use of Indicators to Compare Supply Chains in the Coffee Industry
2	*Hall and Matos (2010)*	Incorporating impoverished communities in sustainable supply chains
3	*Erol et al. (2011)*	A new fuzzy multi-criteria framework for measuring sustainability performance of a supply chain
4	*Caniato et al. (2012)*	Environmental sustainability in fashion supply chains: An exploratory case based research
5	*Hassini et al. (2012)*	A literature review and a case study of sustainable supply chains with a focus on metrics
6	*Styles et al. (2012)*	Environmental improvement of product supply chains: Proposed best practice techniques, quantitative indicators and benchmarks of excellence for retailers
7	*Uysal (2012)*	An Integrated Model for Sustainable Performance Measurement in Supply Chain
8	*Cucchiella and D'Adamo (2013)*	Issue on supply chain of renewable energy
9	*Govindan et al. (2013)*	A fuzzy multi criteria approach for measuring sustainability performance of a supplier based on triple bottom line approach
10	*Reefke and Trocchi (2013)*	Balanced scorecard for sustainable supply chains: design and development guidelines
11	*Bai and Sarkis (2014)*	Determining and applying sustainable supplier key performance indicators
12	Blome et al. (2014)	Supply chain collaboration and sustainability: a profile deviation analysis
13	*Egilmez et al. (2014)*	Supply chain sustainability assessment of the U.S. food manufacturing sectors: A life cycle-based frontier approach
14	*Genovese et al. (2014)*	Exploring the challenges in implementing supplier environmental performance measurement models: a case study
15	*Hong et al. (2014)*	Assessing the Perception of Supply Chain Risk and Partnerships Using Importance-Performance Analysis Model: A Case Study of SMEs in China and Korea
16	*Ortas et al. (2014)*	Sustainable supply chain and company performance A global examination
17	*Pishvaee et al. (2014)*	An accelerated Benders decomposition algorithm for sustainable supply chain network design under uncertainty: A case study of medical needle and syringe supply chain
18	*Varsei et al. (2014)*	Framing sustainability performance of supply chains with multidimensional indicators
19	*Zhang et al. (2014)*	Sustainable supply chain optimisation: An industrial case study
20	*Ahi and Searcy (2015)*	An analysis of metrics used to measure performance in green and sustainable supply chains
21	*Azadi et al. (2015)*	A new fuzzy DEA model for evaluation of efficiency and effectiveness of suppliers in sustainable supply chain management context
22	*de Sousa Jabbour et al. (2015)*	Green supply chain management and firms performance: Understanding potential relationships and the role of green sourcing and some other green practices
23	*Germani et al. (2015)*	A System to Increase the Sustainability and Traceability of Supply Chains
24	*Jakhar (2015)*	Performance evaluation and a flow allocation decision model for a sustainable supply chain of an apparel industry
25	*Khodakarami et al. (2015)*	Developing distinctive two-stage data envelopment analysis models: An application in evaluating the sustainability of supply chain management
26	*Kozlowski et al. (2015)*	Corporate sustainability reporting in the apparel industry
27	*Kumar and Rahman (2015)*	Sustainability adoption through buyer supplier relationship across supply chain: A literature review and conceptual framework

#	Publication's Authors	Publication's title
28	*Marshall et al. (2015)*	Environmental and social supply chain management sustainability practices: construct development and measurement
29	*Morana and Gonzalez-Feliu (2015)*	A sustainable urban logistics dashboard from the perspective of a group of operational managers
30	*Mota et al. (2015)*	Towards supply chain sustainability: economic, environmental and social design and planning
31	*Santiteerakul et al. (2015)*	Sustainability performance measurement framework for supply chain management
32	Tajbakhsh and Hassini (2015)	A data envelopment analysis approach to evaluate sustainability in supply chain networks
33	*Tseng et al. (2015)*	Sustainable supply chain management: A closed-loop network hierarchical approach
34	*Vance et al. (2015)*	Designing sustainable energy supply chains by the P-graph method for minimal cost, environmental burden, energy resources input
35	*Ahi et al. (2016a)*	A comprehensive multidimensional framework for assessing the performance of sustainable supply chains
36	*Ahi et al. (2016b)*	Energy-related performance measures employed in sustainable supply chains: A bibliometric analysis
37	*Blanco et al. (2016)*	The state of supply chain carbon foot printing: analysis of CDP disclosures by US firms
38	*Haghighi et al. (2016)*	An integrated approach for performance evaluation in sustainable supply chain networks (with a case study)
39	*Hussain et al. (2016)*	A framework for supply chain sustainability in service industry with Confirmatory Factor Analysis
40	*Izadikhah and Saen (2016)*	Evaluating sustainability of supply chains by two-stage range directional measure in the presence of negative data
41	*Kumar and Rahman (2016)*	Buyer supplier relationship and supply chain sustainability: empirical study of Indian automobile industry
42	*Mani et al. (2016)*	Social sustainability in the supply chain: Construct development and measurement validation
43	*Sgarbossa and Russo (2016)*	A proactive model in sustainable food supply chain: Insight from a case study
44	*Wan Ahmad et al. (2016)*	Commitment to and preparedness for sustainable supply chain management in the oil and gas industry
45	*Willersinn et al. (2016)*	Food loss reduction from an environmental, socio-economic and consumer perspective – The case of the Swiss potato market
46	*Zhang et al. (2016)*	Sustainable supply chain management: Confirmation of a higher-order model
47	*Acquaye et al. (2017)*	Measuring the environmental sustainability performance of global supply chains: A multi-regional input-output analysis for carbon, Sulphur oxide and water footprints
48	*Chen and Kitsis (2017)*	A research framework of sustainable supply chain management
49	*Das (2017)*	Development and validation of a scale for measuring Sustainable Supply Chain Management practices and performance
50	*Fritz et al. (2017)*	Selected sustainability aspects for supply chain data exchange: Towards a supply chain-wide sustainability assessment
51	*Genovese et al. (2017)*	Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications
52	Kumar and Garg (2017)	Evaluating sustainable supply chain indicators using fuzzy AHP
53	*Saeed and Kersten (2017)*	Supply chain sustainability performance indicators - a content analysis based on published standards and guidelines
54	*Stindt (2017)*	A generic planning approach for sustainable supply chain management - How to integrate concepts and methods to address the issues of sustainability?
55	*Allaoui et al. (2018)*	Sustainable agro-food supply chain design using two-stage hybrid multi-objective decision-making approach
56	*Bai and Sarkis (2018)*	Integrating and extending data and decision tools for sustainable third-party reverse logistics provider selection
57	*Castillo et al. (2018)*	Supply Chain Integrity: A Key to Sustainable Supply Chain Management

58	*Farkavcova et al. (2018)*	Expanding knowledge on environmental impacts of transport processes for more sustainable supply chain decisions: A case study using life cycle assessment
59	*Gómez-Luciano et al. (2018)*	Sustainable supply chain management: Contributions of supplies markets
60	*Gong et al. (2018)*	Inside out: The interrelationships of sustainable performance metrics and its effect on business decision making: Theory and practice
61	*Izadikhah and Saen (2018)*	Assessing sustainability of supply chains by chance-constrained two-stage DEA model in the presence of undesirable factors
62	*Kolotzek et al. (2018)*	A company-oriented model for the assessment of raw material supply risks, environmental impact and social implications
63	*Li and Mathiyazhagan (2018)*	Application of DEMATEL approach to identify the influential indicators towards sustainable supply chain adoption in the auto components manufacturing sector
64	*Mani et al. (2018)*	Enhancing supply chain performance through supplier social sustainability: An emerging economy perspective
65	*Osiro et al. (2018)*	A group decision model based on quality function deployment and hesitant fuzzy for selecting supply chain sustainability metrics
66	*Pourjavad and Shahin (2018)*	Hybrid performance evaluation of sustainable service and manufacturing supply chain management: An integrated approach of fuzzy DEMATEL and fuzzy inference system
67	*Raj and Srivastava (2018)*	Sustainability performance assessment of an aircraft manufacturing firm
68	*Rashidi and Saen (2018)*	Incorporating dynamic concept into gradual efficiency: Improving suppliers in sustainable supplier development
69	*Zhou et al. (2018)*	Sustainable recycling partner selection using fuzzy DEMATEL-AEW-FVIKOR: A case study in small-and-medium enterprises (SMEs)
70	*Papetti et al. (2019)*	Web-based platform for eco-sustainable supply chain management
71	*Rohmer et al. (2019)*	Sustainable supply chain design in the food system with dietary considerations: A multi-objective analysis
72	*Taleizadeh et al. (2019)*	Modeling and solving a sustainable closed loop supply chain problem with pricing decisions and discounts on returned products

6. REFERENCES

1. Acquaye A, Ibn-Mohammed T, Genovese A, Afrifa GA, Yamoah FA, Oppon E (2018) A quantitative model for environmentally sustainable supply chain performance measurement. European Journal of Operational Research 269/1(1):188–205.
2. Agami N, Saleh M, Rasmy M (2012) Supply chain performance measurement approaches: Review and classification. The Journal of Organizational Management Studies:1–20.
3. Ahi P, Searcy C (2013) A comparative literature analysis of definitions for green and sustainable supply chain management. Journal of Cleaner Production 52:329–341.
4. Ahi P, Searcy C (2015) Measuring social issues in sustainable supply chains. Measuring Business Excellence 19/1(1):33–45.
5. Ashby A, Leat M, Hudson-Smith M (2012) Making connections: A review of supply chain management and sustainability literature. Supply Chain Management: An International Journal 17/5(5):497–516.
6. Azapagic A (2003) Systems Approach to Corporate Sustainability. Process Safety and Environmental Protection 81/5(5):303–316.
7. Azapagic A (2004) Developing a framework for sustainable development indicators for the mining and minerals industry. Journal of Cleaner Production 12/6(6):639–662.
8. Azapagic A, Perdan S (2000) Indicators of Sustainable Development for Industry. Process Safety and Environmental Protection 78/4(4):243–261.
9. Bai C, Sarkis J (2014) Determining and applying sustainable supplier key performance indicators. Supply Chain Management 19/3(3):275–291.
10. Beamon BM (1999) Designing the green supply chain. Logistics Information Management 12:332–342.
11. Beske-Janssen P, Johnson MP, Schaltegger S (2015) 20 years of performance measurement in sustainable supply chain management - what has been achieved? Supply Chain Management: An International Journal 20:664–680.
12. Carter CR, Easton PL (2011) Sustainable supply chain management: Evolution and future directions. International Journal of Physical Distribution & Logistics Management 41:46–62.
13. Carter CR, Rogers DS (2008) A framework of sustainable supply chain management: Moving

toward new theory. International Journal of Physical Distribution & Logistics Management 38:360–387.
14. Castka P, Balzarova MA (2008) ISO 26000 and supply chains – On the diffusion of the social responsibility standard. International Journal of Production Economics 111/2(2):274–286.
15. Cetinkaya B, Cuthbertson R, Ewer G, Klaas-Wissing T, Piotrowicz W, Tyssen C (2011) Sustainable supply chain management: Practical ideas for moving towards best practice. Springer, Berlin, Heidelberg.
16. Chen D, Thiede S, Schudeleit T, Herrmann C (2014) A holistic and rapid sustainability assessment tool for manufacturing SMEs. CIRP Annals 63/1(1):437–440.
17. Durach CF, Kembro J, Wieland A (2017) A New Paradigm for Systematic Literature Reviews in Supply Chain Management. J Supply Chain Manag 53/4(4):67–85.
18. Erol I, Cakar N, Erel D, Sari R (2009) Sustainability in the Turkish retailing industry. Sustainable Development 17:49–67.
19. Feil A, Schreiber D, Haetinger C, Strasburg V, Barkert C (2019) Sustainability Indicators for Industrial Organizations. Systematic Review of Literature. Sustainability 11/3(3):854.
20. Foxon TJ, Mcilkenny G, Gilmour D, Oltean-Dumbrava C, Souter N, Ashley R, Butler D, Pearson P, Jowitt P, Moir J (2010) Sustainability criteria for decision support in the UK water industry. Journal of Environmental Planning and Management 45:285–301.
21. Glavič P, Lukman R (2007) Review of sustainability terms and their definitions. Journal of Cleaner Production 15/18(18):1875–1885.
22. Gold S, Seuring S, Beske P (2010) The constructs of sustainable supply chain management – a content analysis based on published case studies. Progress in Industrial Ecology, An International Journal 7:114–137.
23. Govindan K, Khodaverdi R, Jafarian A (2013) A fuzzy multi criteria approach for measuring sustainability performance of a supplier based on triple bottom line approach. Journal of Cleaner Production 47:345–354.
24. Gunasekaran A, Patel C, McGaughey RE (2004) A framework for supply chain performance measurement. International Journal of Production Economics 87:333–347.
25. Handfield R, Walton SV, Sroufe R, Melnyk SA (2002) Applying environmental criteria to supplier assessment: A study in the application of the Analytical Hierarchy Process. European Journal of Operational Research 141:70–87.
26. Hassini E, Surti C, Searcy C (2012) A literature review and a case study of sustainable supply chains with a focus on metrics. International Journal of Production Economics 140:69–82.
27. Hutchins MJ, Sutherland JW (2008) An exploration of measures of social sustainability and their application to supply chain decisions. Journal of Cleaner Production 16:1688–1698.
28. Jokić M, Ball R (2006) Qualität und Quantität wissenschaftlicher Veröffentlichungen. Bibliometrische Aspekte der Wissenschaftskommunikation. Forschungszentrum Jülich, Zentralbibliothek, Jülich.
29. Keeble JJ, Topiol S, Berkeley S (2003) Using indicators to measure sustainability performance at a corporate and project level. Journal of Business Ethics 44:149–158.
30. Kersten W, Saeed MA (2014) A SCOR based analysis of simulation in supply chain management. In: Squazzoni F, Baronio F, Archetti C, Castellani M (eds) 28th European Conference on Modelling and Simulation, Brescia, Italy, 461–469.
31. Koberg E, Longoni A (2019) A systematic review of sustainable supply chain management in global supply chains. Journal of Cleaner Production 207:1084–1098.
32. Köksal D, Strähle J, Müller M, Freise M (2017) Social sustainable supply chain management in the textile and apparel industry – A literature review. Sustainability 9:1–32.
33. Kolk A (2003) Trends in sustainability reporting by the Fortune Global 250. Business Strategy and the Environment 12:279–291.
34. Lee K-H, Farzipoor Saen R (2012) Measuring corporate sustainability management. A data envelopment analysis approach. International Journal of Production Economics 140/1(1):219–226.
35. Lozano R, Huisingh D (2011) Inter-linking issues and dimensions in sustainability reporting. Journal of Cleaner Production 19:99–107.
36. Matos S, Hall J (2007) Integrating sustainable development in the supply chain: The case of life cycle assessment in oil and gas and agricultural biotechnology. Journal of Operations Management 25/6(6):1083–1102.
37. Nordheim E, Barrasso G (2007) Sustainable development indicators of the European aluminium industry. Journal of Cleaner Production 15:275–279.
38. Öztayşi B, Sürer Ö (2014) Supply chain performance measurement using a SCOR based fuzzy VIKOR approach. In: Kahraman C, Öztayşi B (eds) Supply chain management under fuzziness. Springer, Berlin, Heidelberg, 199–224.
39. Pagell M, Wu Z (2009) Building a more complete theory of sustainable supply chain management using case studies of 10 examplars. Journal of Supply Chain Management 45:37–56.
40. Pojasek RB (2011) ISO 26000 guidance on social responsibility. Environmental Quality Management 20/3(3):85–93.

41. Saeed M, Kersten W (2019) Drivers of Sustainable Supply Chain Management. Identification and Classification. Sustainability 11/4(4):1137.
42. Saeed MA, Kersten W (2017) Supply chain sustainability performance indicators – a content analysis based on published standards and guidelines. Logistics Research 10/1(1):1–19.
43. Sarkis J, Gonzalez-Torre P, Adenso-Diaz B (2010) Stakeholder pressure and the adoption of environmental practices: The mediating effect of training. Journal of Operations Management 28:163–176.
44. Schaltegger S, Gibassier D, Zvezdov D (2013) Is environmental management accounting a discipline? A bibliometric literature review. Meditari Accountancy Research 21/1(1):4–31.
45. Seuring S (2013) A review of modeling approaches for sustainable supply chain management. Decision Support Systems 54:1513–1520.
46. Seuring S, Müller M (2008) From a literature review to a conceptual framework for sustainable supply chain management. Journal of Cleaner Production 16:1699–1710.
47. Sloan TW (2010) Measuring the sustainability of global supply chains: current practices and future directions. Journal of Global Business Management 6/1(1):92–107.
48. Tajbakhsh A, Hassini E (2015) Performance measurement of sustainable supply chains: A review and research questions. International Journal of Productivity and Performance Management 64:744–783.
49. Tanzil D, Beloff BR (2006) Assessing impacts: Overview on sustainability indicators and metrics. Environmental Quality Management 15:41–56.
50. Tseng M-L, Lim MK, Wong W-P, Chen Y-C, Zhan Y (2018) A framework for evaluating the performance of sustainable service supply chain management under uncertainty. International Journal of Production Economics 195:359–372.
51. Varsei M, Soosay C, Fahimnia B, Sarkis J (2014) Framing sustainability performance of supply chains with multidimensional indicators. Supply Chain Management: An International Journal 19:242–257.
52. Veleva V, Ellenbecker M (2001) Indicators of sustainable production. Framework and methodology. Journal of Cleaner Production 9/6(6):519–549.