The Evolution of Sustainability Measurement Research

Summary

Research in sustainability measurement has been growing at a very high pace over the past years, and it has explored a variety of issues, from sustainability disclosure to measurement in green supply chains, from the diffusion of environmental standards to the political use of sustainability metrics. This study is the first to report and discuss the results of a comprehensive review of the sustainability measurement literature. In particular, we adopt a wide conceptualization of the measurement process, and analyze data through a bibliometric method - bibliographic coupling. Our results show that the literature is divided into eight distinct areas of inquiry and 12 sub-fields, some of which have expanded significantly over recent years, and others appear to be waning. Furthermore, the lack of a comprehensive view of sustainability measurement has led to the development of many separate communities, resulting in duplications of effort, incomplete framing of the problem, and the proposal of partial solutions. However, findings drawn in sustainability measurement research could inform current debates in performance measurement and management in three main ways: by emphasizing stakeholders' roles in the design, implementation and use of measures; by indicating ways to establish common measures and sharing data between organizations; and by adopting novel theoretical perspectives. Equally, future sustainability measurement studies could benefit from consideration of extant research on strategic performance measurement and on the behavioral effects of measurement practices.

Introduction

Environmental sustainability is a major area of interest for governments, businesses and society (Carroll and Shabana 2010). Many organizations have introduced a wide range of sustainability programs and practices to reduce their consumption of natural resources, and to diminish their impact on the natural environment (Nidomolu *et al.* 2009; Delmas *et al.* 2013; Eccles and Serafeim 2013; Comyns and Figge 2015). As interest in sustainability "has moved from ideology to reality" (Lindgreen and Swaen 2010, p. 1), organizations have also started to make considerable investments in the measurement of sustainability-related aspects (Wood 2010; Hansen and Schaltegger 2016; O'Dwyer and Unerman 2016).

Research in sustainability measurement has been growing at a very high pace and exploring a variety of issues (Searcy 2012). For example, scholars have investigated the introduction of sustainability indicators within organizations and supply chains (Henri and Journeault 2010; Brandenburg and Rebs 2015), the roles of sustainability reporting (Burritt and Schaltegger 2010; Gray 2010), and the disclosure of information to a variety of external stakeholders (Roca and Searcy 2012). These studies have enabled us to gain a much deeper understanding of both technical and behavioral aspects of sustainability measurement.

However, several issues remain. For example, organizations have struggled to increase the dimensionality of performance (Richard *et al.* 2009) to include environmental sustainability along with financial aspects (Chen *et al.* 2014). This is reflected in academic studies where scholars have highlighted the need for sustainability measures to be integrated in organizational performance measurement systems (Henri and Journeault 2010; Hansen and Schaltegger 2016). As Bititci *et al.* (2012, p. 317) argued, "the sustainability agenda needs to be explored as part of the whole rather than as a standalone, exclusive and independent performance-measurement system within the organization or the value chain."

Despite calls for a comprehensive view of sustainability measurement, most studies have tended to consider only selected aspects of the measurement process and to concentrate on specific issues (e.g., sustainability reporting, carbon accounting, eco-efficiency, introduction of specific measures within organizations and supply chains) (Searcy 2012; Henri *et al.* 2016; Passetti and Tenucci 2016). This has led to a quickly expanding, but very fragmented field, with different theoretical perspectives, conceptualizations of the measurement process, and contributions to practice.

This paper reports and discusses the results of a comprehensive and quantitative review of the literature in sustainability measurement. This study has three main aims: (1) to understand the intellectual structure of the current literature, and identify main conceptualizations and theoretical approaches; (2) to examine whether and how research in sustainability measurement could contribute to the development of the wider field of performance measurement and management; (3) to identify how the literature is evolving, detail future developments, and propose an agenda for further research.

In this paper, to capture the richness of sustainability measurement research, we conceptualize performance measurement as an empirical and formal process aimed at obtaining and expressing descriptive information about the property of an object (e.g. process, activity or people) (Micheli and Mari 2014). Such process consists of three main phases: acquisition, analysis and representation of information (Mari 2007). Therefore, performance measurement is seen as encompassing various activities such as the design and implementation of performance indicators, collection and analysis of data, and reporting of performance information to internal and external stakeholders (Bourne *et al.* 2000). We also define sustainability as "company activities demonstrating the inclusion of social and environmental concerns in business operations and in interactions with stakeholders" (van Marrewijk 2003, p. 102). The concept of sustainability

measurement is rooted in these definitions and its practice is often aimed at improving and providing information over one or more organizations' social and environmental impacts.

In this review we employ a bibliometric method based on citation data - bibliographic coupling - which comprises the collection, handling, and mathematical and statistical analysis of quantitative bibliographic data derived from scientific publications (for a review, see Verbeek *et al.* 2002). Bibliographic coupling consists in the analysis of the publications having at least two references in common (Kessler 1963), and points to the intellectual structure of current and emerging literature (Cobo *et al.* 2011; Vogel and Güttel 2013). Because this bibliometric methods adopts a quantitative approach to the mapping and analysis of science, it presents a more systematic, transparent, and reproducible process than narrative literature reviews (Zupic and Čater 2015).

Our findings suggest that the literature on sustainability measurement is characterized by various research strands that can be grouped into eight main areas of research. Although sustainability measurement researchers belong to various academic communities and often adopt different approaches and terminology, they have tended to reach similar conclusions. Our results also show the evolution of this literature and highlight current developments in sustainability measurement research. Finally, our findings contribute to the advancement of the wider field of performance measurement and management by: (i) detailing whether and how stakeholders should be included in the measurement process; (ii) investigating how measurement practices could be extended across organizations, particularly in supply chains, rather than within organizations, as in most performance measurement and management studies; (iii) exploring how stakeholder and legitimacy theories could bring different perspectives to performance measurement theory and practice.

The paper is organized as follows. Firstly, we present the research design, describing the process of data collection and the bibliometric method used for the analysis. Subsequently, we discuss our findings, which include descriptive evidence regarding the sample, and detailed findings of the

bibliographic coupling. Thirdly, we connect and compare the findings with research in the wider field of performance measurement and management. In the last section we propose several avenues for future research and conclude by highlighting the main implications.

Research design

Given the breadth and rapid growth of the sustainability measurement literature over the last two decades, there is a vast body of research available for synthesis (Deegan 2002; Searcy 2012; Hahn and Kühnen 2013). Also, articles have been published in a variety of journals and authors have utilized different terms, methods and theoretical frameworks. We thus conduct a bibliometric analysis with the aims of bringing together different strands of literature, identifying main contributions and unanswered questions, and mapping the evolution of sustainability measurement research by highlighting current and emerging trends (Jones and Gatrell 2014).

Data

Data were retrieved from the Social Science Citation Index Web of Science (SSCI WOS), which is recognized as an authoritative and most commonly used source of bibliographic data (Verbeek *et al.* 2002; Zupic and Čater 2015). In order to define which documents to include in our search, three of the authors and an additional panel of five scholars experts on the topic (for a similar procedure, see Chabowski *et al.* 2013) developed a list of keywords which characterize the field of interest. We chose two sets of keywords to be used for the retrieval of documents (see Table 1 for details). The first set of nineteen keywords relates to various aspects of sustainability (e.g., sustainab*, Corporate Social Responsibil*, CSR, green, circular economy, triple bottom line), while the second set of fifteen keywords relates to performance measurement (e.g., measur*, metric, performance indicator*, PI, account*, assess*, Balanced Scorecard).

Table 1. Keywords used for retrieving data

SET 1 – "sustainability"	**SET 2 – "measurement"**
Circular economy	Account*
Carbon	Assess*
Carbon disclosure project	Assurance
Climate	Balanced scorecard
CO2	Disclos*
Corporate Social Responsibil*	GRI
CSR	KPI
Ecol*	Management control
Emission*	Meas*
Environment*	Metric*
Footprint	Performance indicator*
"Global Engagement Services"	PI
Green	Rating
KLD	Report*
LCA	Transparency
Life cycle	
Sustainab*	
TBL	
Triple bottom line	

We coupled each keyword of the first set with each keyword of the second set, thus obtaining 285 combinations. We searched these combinations of keywords into the string "topic" of SSCI WOS considering journal articles published all years until June 22nd 2016. These queries resulted in the retrieval of 1,463,523 documents.

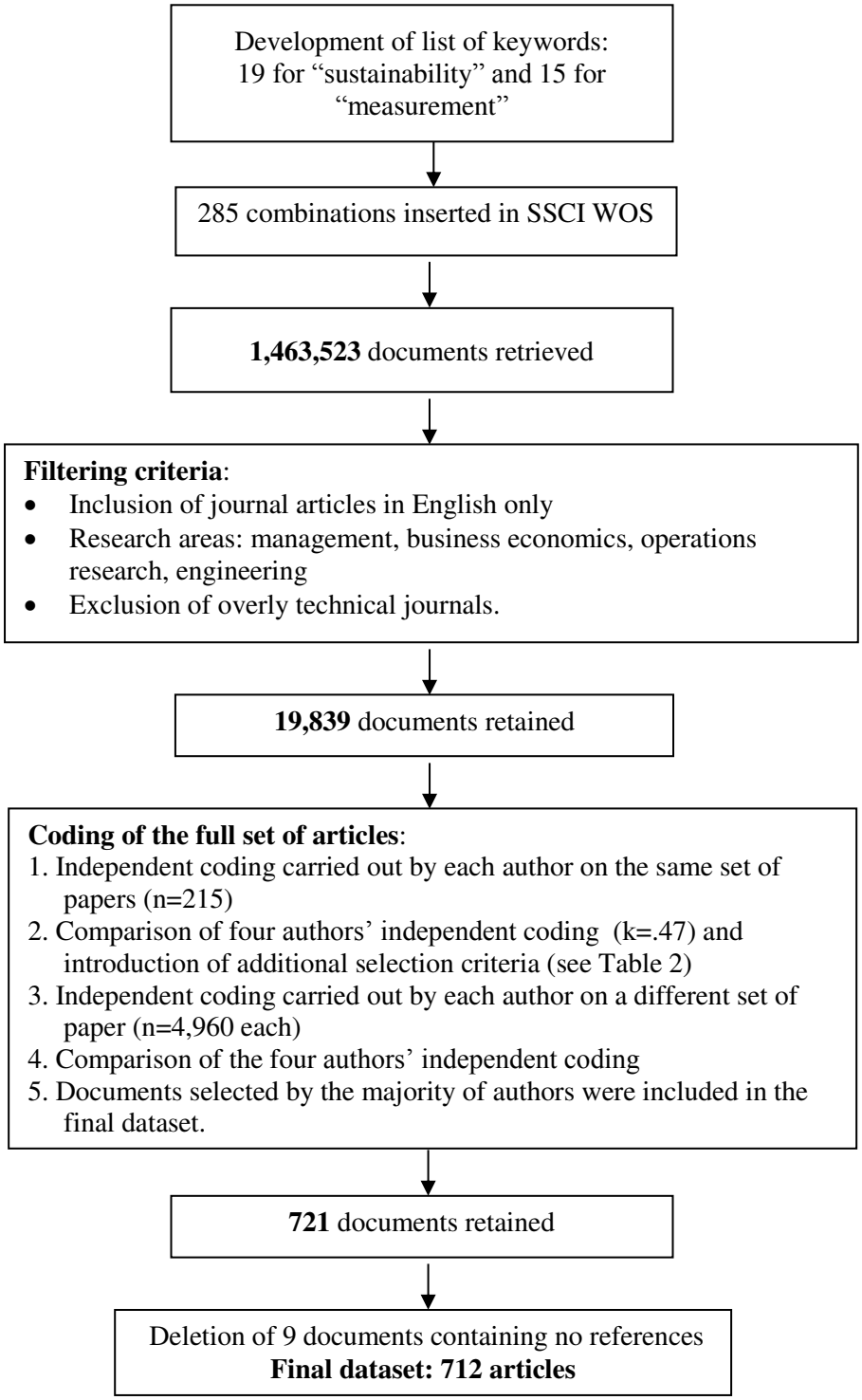
Not all documents were relevant for this review, thus we refined our search by keeping only journal articles written in English, in the fields of management, business economics, operations research and engineering, and excluding publications in overly technical journals (e.g., in the field of energy, environment or construction engineering[i]). This filtering stage resulted in retaining 19,839 documents. These articles were divided among the four authors for manual screening to determine which documents to include in the final sample. Given the large number of documents, the coding procedure followed five steps to ensure reliability and consistency: (1) the first 215 papers were assigned to each author for independent coding based on title, journal, author, and abstract; (2) raters' results were compared (Fleiss Kappa for inter-rater agreement = .47) (Fleiss 1971), and disagreements resolved through discussion – this process allowed us to determine further selection criteria as detailed in Table 2; (3) each author individually reviewed around 4,960 articles, considering titles and abstracts; (4) the documents selected were reciprocally evaluated (i.e., each author received the potential list of selected articles by the other three authors and reviewed the selected articles); and (5) documents that were selected by the majority of authors were included in the final list. This accurate coding procedure significantly reduced the risk of either including articles with low or no relevance to the topic, or excluding significant ones.

Table 2. Selection criteria

Inclusion criteria
Articles focusing on the topic of: • sustainability reporting / measurement in organizations, rather than about the measurement of a construct; sustainability management; sustainability benchmarking • Life Cycle Assessment (LCA), but including management aspects rather than simply technical ones • sustainability measurement tools in both management and technical journals • environmental ratings • corporate social responsibility (CSR), when including environmental sustainability aspects.
Exclusion criteria
Articles focusing on: • sustainability and/or CSR in general, rather than on measurement aspects • human resource management practices only • the broad relationship between sustainability or CSR and financial performance, but that do not refer to any measurement aspect. Articles included in journals not relevant for this search (see Table A2 in on-line Appendix A).

721 documents were retained at the end of this coding phase. Additionally, we had to delete 9 articles containing no references, therefore resulting in a final sample of 712 documents over the 1992-2016 period (see Table A1 in on-line Appendix A for the full list of retrieved papers). We cross-checked whether this list of papers was inclusive of all relevant manuscripts discussed in available literature reviews, and consulted scholars active in this field through personal communications and presentation at a conference. The 712 chosen articles contain 43,514 citations to 27,261 sources. Figure 1 summarizes the data gathering process.

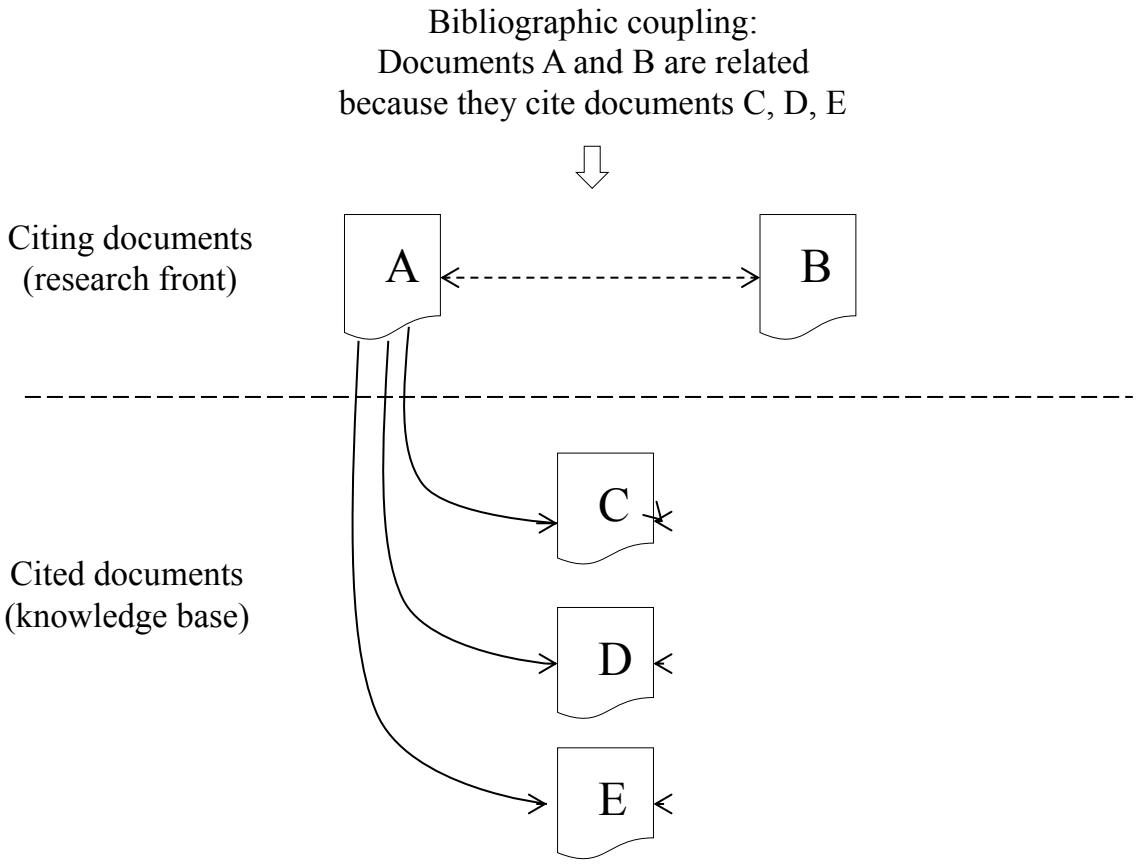
Figure 1. The data gathering process



Method

Given our aim to map sustainability measurement research, but also to identify main findings and to understand its evolution, the data analysis was conducted using bibliographic coupling. This method is considered to be the most appropriate one to capture the evolution and current developments of a specific research domain (Zupic and Čater 2015). Bibliographic coupling measures similarity between couples of documents by using the number of citations shared by the documents (Kessler 1963). Hence, the more the references used in two articles overlap, the stronger their similarity (see Figure 2).

Figure 2. Bibliographic coupling



Source: adapted from Garfield (2001); Vogel and Güttel (2013)

In bibliographic coupling, the connection between cited documents is made by the authors of the retrieved articles, who intentionally cite documents which are relevant to them. Because

bibliographic coupling is carried out by analyzing citing documents, which are more recent than the cited literature, and because the number of references shared by two documents does not change over time, this method is useful to map a current research front (Small 1999; Boyack and Klavans 2010). As such, and despite being a relatively neglected method in management research (Zupic and Čater 2015), we considered it as particularly suitable to uncover emerging and future trends in the field of sustainability measurement.

Because bibliographic coupling refers to the number of references shared by at least two documents, the first step in this analysis is the construction of a matrix that displays, for all document pairs, the co-occurrences of references in their bibliographies. The greater the number of references shared by two citing texts, the greater the similarity between them. To do so, we started by cleaning all the references by ensuring that the same document was cited in the same way in different articles (e.g., consistent reference to authors' names and journal spellings; merger of books with the same title but different editions and publication years). This issue was particularly relevant for corporate reports: for example, the so-called 'Brundtland Report' was cited in as much as 12 different ways. Then, we imported the cleaned citation data into BibExcel bibliometric software (Persson *et al.* 2009) to produce a co-occurrence matrix. In order to identify clusters of papers exploring similar research sub-fields within the sustainability measurement literature, we processed the co-occurrence matrix using network analysis, which is an increasingly used method in bibliometric studies (e.g., Pilkington and Chai 2008; Ma *et al.* 2012; Vogel and Güttel 2013) in lieu of other more traditional clustering and visualization methods such as multidimensional scaling or hierarchical cluster analysis (Zupic and Čater 2015). We used the network analysis software Pajek (Batagelj and Mrvar 1998) to produce partitions using the Louvain-community finder algorithm (Blondel *et al.* 2008). This accurate community-detection algorithm optimizes the modularity of partitions, i.e., the density inside communities as compared to links between communities, and thus the meaningfulness of network division into separate groups (Zupic and Čater 2015). The algorithm is divided into two phases that are repeated iteratively, first finding the natural partition of the

network (i.e., assigning each node to a community by executing several trials of replacement in different communities, until no individual move can improve the modularity), and then identifying the global maximum of modularity (i.e., building and iteratively improving meta-communities) (Blondel et al. 2008). In this phase, in order to produce complete yet parsimonious results, we interactively worked on the identification of the appropriate thresholds for coupling (i.e., the number of common references between two papers) by exploring different results obtained adopting different thresholds (Zupic and Čater 2015). Subsequently, we visualized the identified network structures by employing the Kamada-Kawai layout algorithm, which is a spring-embedder algorithm that works to minimize the difference between geometric distances, approximated by the path length between every pair of nodes (Zupic and Čater 2015). Finally, we interpreted the results by engaging in an in-depth analysis of the documents contained in each cluster, the relationships between clusters, and the evolution of the network in the period 1992-2016. For each identified subgroup we calculated its density, i.e., the number of lines in the considered network, expressed as a proportion of the maximum possible number of lines, and its structural cohesion through measuring the average degree of nodes, i.e. the average number of ties in which group nodes are involved (de Nooy *et al.* 2005).

Findings

The results of this study reveal the breadth and diversity of research on sustainability measurement. In the following sections, we first present descriptive findings in relation to the selected documents, and then examine the bibliographic network obtained through the bibliographical coupling showing the mapping and evolution of the field.

Sample description

The number of articles published on the topic has grown exponentially since 1992 (Figure 3). In particular, the field has experienced an impressive growth over the last three years, since half of the papers in our sample were published in 2013-2016. The top 20 journals cover 67.7% of the scientific production on the topic and comprise of journals in general management (e.g., *Journal of Business Ethics*, *Business & Society*), accounting (e.g., *Accounting Auditing & Accountability Journal*, *Accounting Organizations and Society*), operations management (*International Journal of Production Economics*), and engineering (e.g., *Journal of Cleaner Production*) (Figure 4). The most productive authors in our sample are Roger Burritt (12 articles), Dennis Patten (11 articles), Stefan Schaltegger (10 articles), Joseph Sarkis (9 articles), and Charl de Villiers (8 articles).

Figure 3. Year of publication of retrieved articles

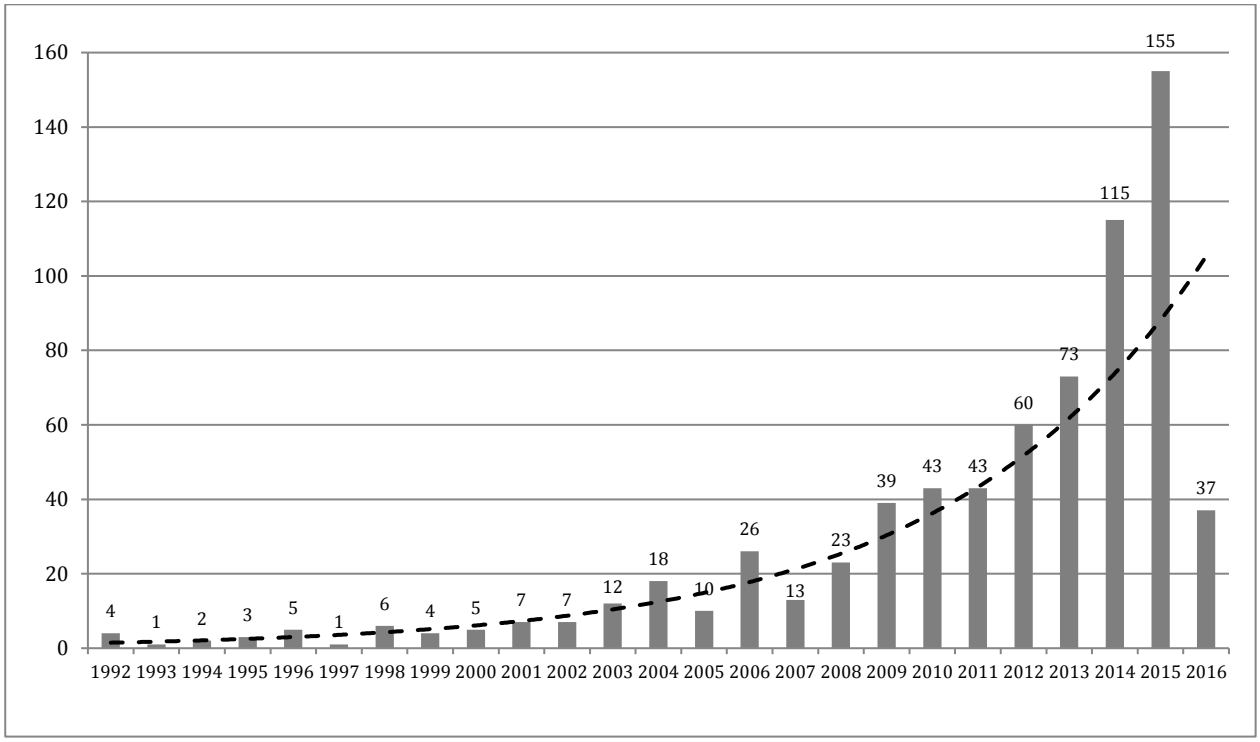
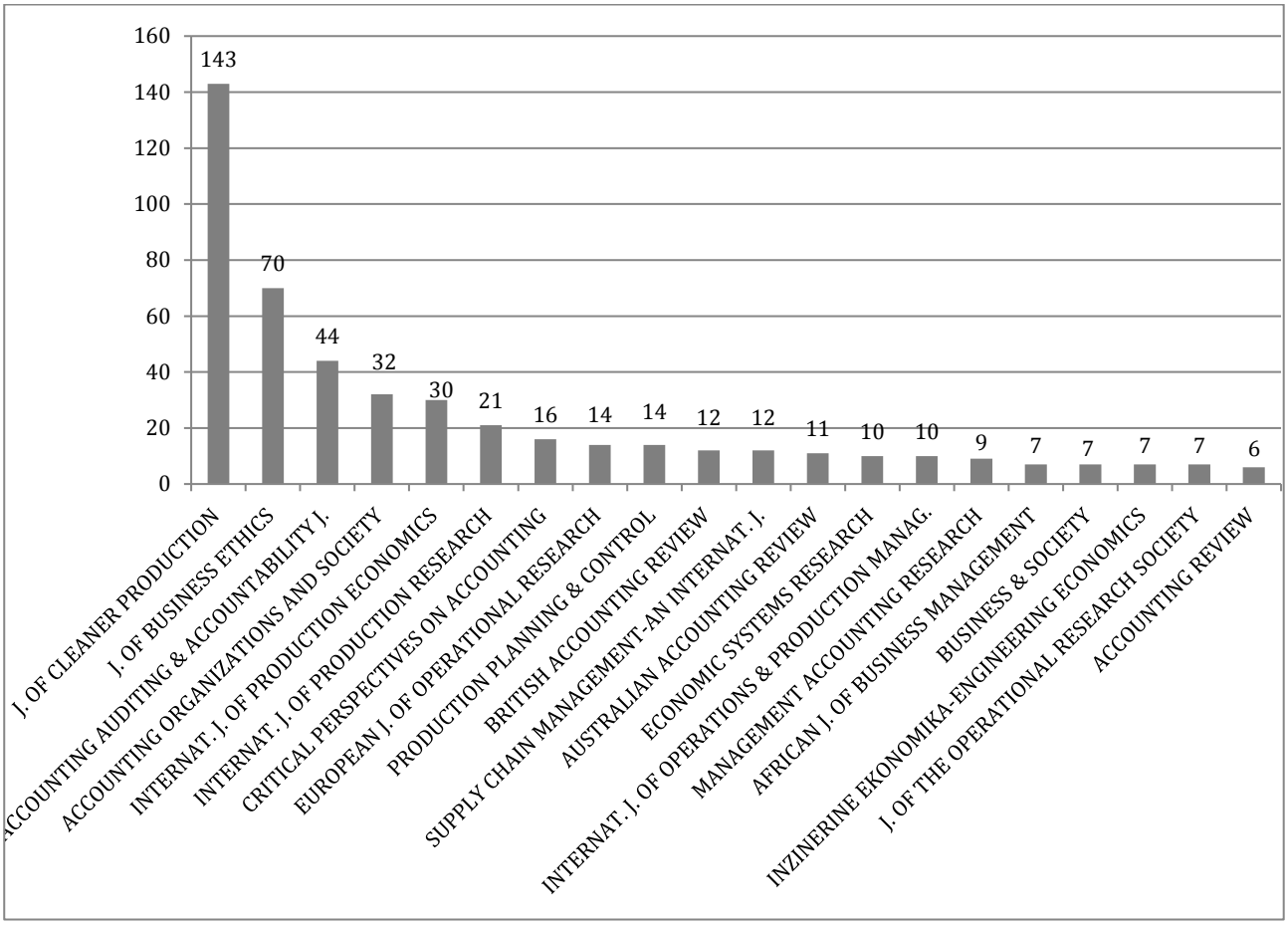


Figure 4. Top twenty publishing journals



In order to further describe our sample and better understand the citing patterns, we analyzed the most cited documents in the retrieved articles by means of citation analysis. Citation analysis is particularly useful to map and describe a research field, and as a preparatory step to bibliographical coupling (Zupic and Čater 2015). Specifically, a large proportion of papers (51.3%) was only cited once. In the total list of references, the most cited researchers are Rob Gray (502 citations), Craig Deegan (360 citations) and Ans Kolk (214 citations); the most cited practitioner reports were by the Global Reporting Initiative (238 citations), KPMG (214 citations), and various branches of the United Nations (210 citations).

Details of the top 25 cited manuscripts in our dataset are provided in Table 3. Overall, these documents were cited 1,367 times (about 3.1% of overall citations). The most cited one is the so-called 'Brundtland report' (World Commission on Environment and Development 1987). The

majority of cited works are articles in international peer reviewed journals in the field of accounting (e.g., *Accounting, Organizations and Society* and *Accounting, Auditing, and Accountability Journal*), general management (e.g., *Academy of Management Review* and *Harvard Business Review*), and engineering (e.g., *Journal of Cleaner Production*). In addition, two specialist books (Elkington 1997; Gray *et al.* 1996), one general management book (Freeman 1984), one methodological book (Yin 1984) and reports on corporate sustainability practices (e.g., KPMG 2011) were also extensively cited.

Table 3. Top 20 cited documents

Rank	Times cited	Authors	Year	Document title	Type of document	Journal title
1	93	World Commission On Environment And Development	1987	Our Common Future	Report	
2	89	Gray, R., Kouhy, R., & Lavers, S.	1995	Corporate social and environmental reporting: a review of the literature and a longitudinal study of UK disclosure.	Article	Accounting, Auditing & Accountability Journal
3	69	Elkington, J.	1997	Cannibals with forks. The triple bottom line of 21st century.	Book	
4	66	Deegan, C.	2002	Corporate social and environmental reporting: a review of the literature and a longitudinal study of UK disclosure.	Article	Accounting, Auditing & Accountability Journal
5	64	Freeman, R. E.	1984	Strategic management: A stakeholder perspective	Book	
6	62	Neu, D., Warsame, H., & Pedwell, K.	1998	Managing public impressions: environmental disclosures in annual reports	Article	Accounting, Organizations and Society
7	58	Clarkson, P. M., Li, Y., Richardson, G. D., & Vasvari, F.P.	2008	Revisiting the relation between environmental performance and environmental disclosure: An empirical analysis.	Article	Accounting, Organizations and Society
8	57	Hackston, D. & Milne, M. J.	1996	Some determinants of social and environmental disclosures in New Zealand companies	Article	Accounting, Auditing & Accountability Journal
9	55	DiMaggio, P., & Powell, W. W.	1983	The iron cage revisited. Institutional isomorphism and collective rationality in organizational fields	Article	American Sociological Review
9	55	KPMG	2011	KPMG International Survey of Corporate Social Responsibility Reporting 2011	Report	
10	54	Roberts, R. W.	1992	Determinants of corporate social responsibility disclosure: An application of stakeholder theory	Article	Accounting, Organizations and Society
11	53	Deegan, C., & Gordon, B.	1996	A study of the environmental disclosure practices of Australian corporations	Article	Accounting and Business Research
12	52	Patten, D. M.	1992	Intra-industry environmental disclosures in response to the Alaskan oil spill: A note on legitimacy theory	Article	Accounting, Organizations and Society
13	50	Patten, D. M.	2002	The relation between environmental performance and environmental disclosure: a research note	Article	Accounting, Organizations and Society
14	49	Seuring, S., & Mueller, M.	2008	From a literature review to a conceptual framework for sustainable supply chain management	Article	Journal of Cleaner Production

14	49	Cho, C. H., & Patten, D. M.	2007	The role of environmental disclosures as tools of legitimacy: A research note	Article	Accounting, Organizations and Society
15	47	Mitchell, R. K., Agle, B. R., & Wood, D. J.	1997	Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts.	Article	Academy of Management Review
16	46	Global Reporting Initiative	2006	Sustainability Reporting Guidelines – Version 3.0	Report	
17	44	Al-Tuwairi, S. A., Christensen, T. E., & Hughes, K. E.	2004	The relations among environmental disclosure, environmental performance, and economic performance: a simultaneous equations approach	Article	Accounting, Organizations and Society
17	44	Yin, R.	1984	Case study research	Book	
17	44	Gray, R.	2010	Is accounting for sustainability actually accounting for sustainability… and how would we know? An exploration of narratives of organisations and the planet	Article	Accounting, Organizations and Society
18	43	Patten, D. M.	1991	Exposure, legitimacy, and social disclosure	Article	Journal of Accounting and Public Policy
19	42	Gray, R., Owen, D., & Adams, C.	1996	Accounting & accountability: changes and challenges in corporate social and environmental reporting	Book	
20	41	Suchman, M. C.	1995	Managing legitimacy: Strategic and institutional approaches	Article	Academy of Management Review
20	41	Porter, M.	1995	The competitive advantage of the inner city	Article	Harvard Business Review

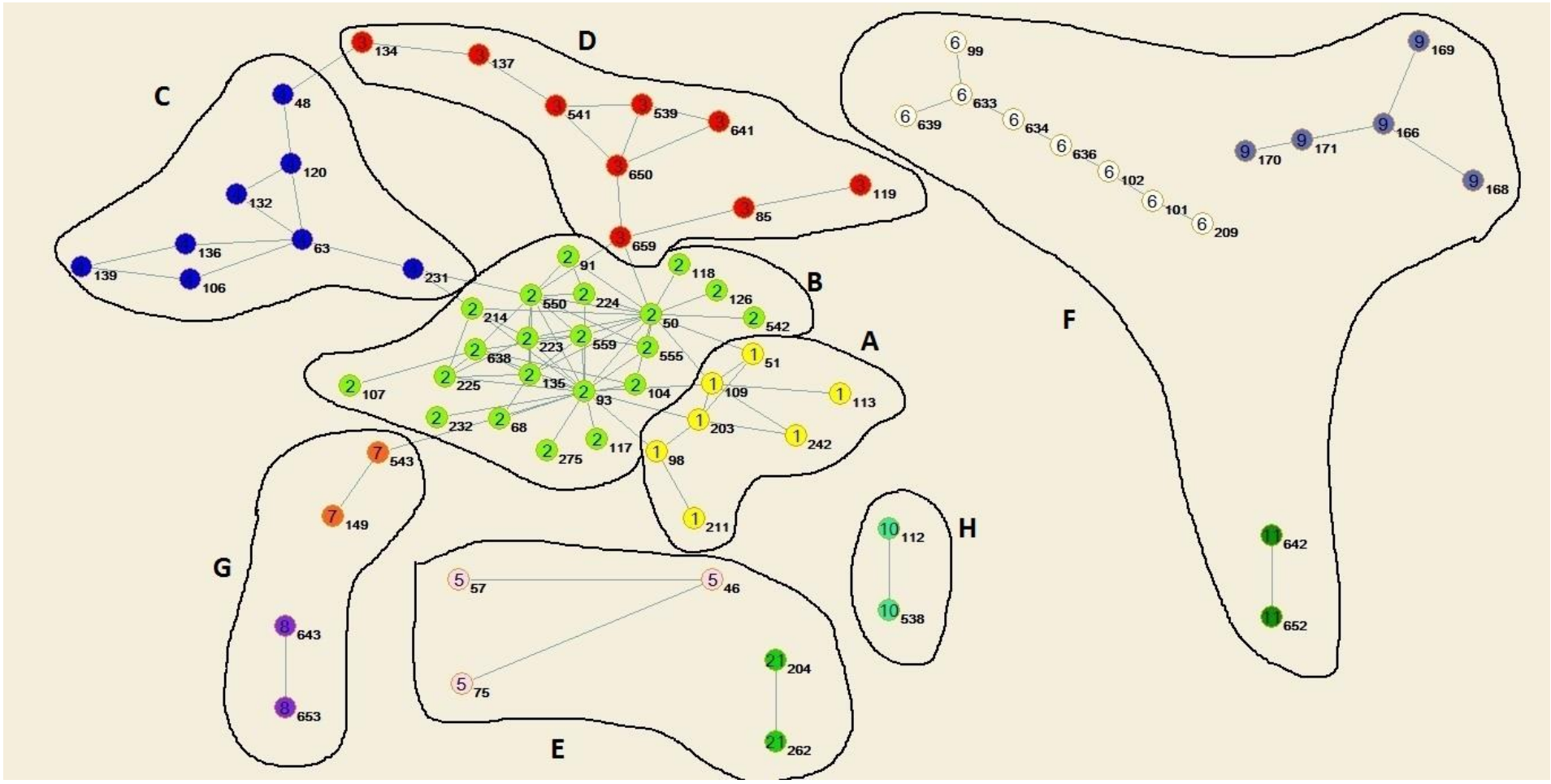
Bibliographic coupling results

As explained in the sample description, the literature on sustainability measurement has grown dramatically. Bibliographic coupling is a suitable method to analyze our sample because the considered timeframe (i.e., 1992-2016) is sufficiently short to avoid significant changes in citation habits (Glaenzel and Thijs 2012). In order to map and capture the evolution of the field, we divided the sample in two parts with roughly equal numbers of papers (332 and 380) (for a similar approach, see Vogel and Güttel 2013). We firstly analyzed the 332 papers published between 1992 and 2012, and then we repeated the bibliographic coupling analysis for the whole sample (712 papers published between 1992 and 2016), by adding to the previous sub-sample the 380 papers published between 2013 and 2016. Given that bibliographic coupling maps the front of a research domain, by comparing the results from the two groups of papers (1992-2012 vs. 1992-2016), we were able to track how the most recent publications have shaped the bibliographic network and to identify in which directions research on sustainability measurement is developing. This comparison is crucial as it enables us to show the dynamic evolution of the field, and thus to identify emerging and future research trends. As explained in greater detail in the research design section, the clusters in each sample of papers (1992-2012 vs. 1992-2016) were identified and visualized by employing network analysis. To decide upon a final cluster structure for the two samples, we interactively worked to identify appropriate thresholds, aiming at obtaining a complete yet parsimonious network representation. In particular, we conducted a sensitivity analysis to assess whether applying different thresholds would result in different cluster structures, particularly in relation to two aspects: (1) the robustness of the cluster structures, i.e., the number of clusters retained by applying different thresholds; (2) the completeness and parsimony of the highlighted cluster structure, i.e., the clarity of visualization for the maximum number of representative nodes. For the period 1992-2012 we decided to consider only those articles having 10 or more couplings with another document (n=96), whereas for the period 1992-2016 we included articles having 13 or more

couplings with another document (n=166) (for an overview of the results of our sensitivity analysis through the application of lower and higher thresholds, see Figures A1-A4 in on-line Appendix B).

The network of papers published in 1992-2012 is shown in Figure 5 (for a detailed list of papers, see Table 4). Network nodes represent citing documents, while network edges (i.e., the lines that connect the nodes) indicate coupling between papers, i.e., common references (Zupic and Cater 2015). 24 clusters emerge from the analysis (density of the entire network = 0.026; average degree = 2.48). However, a preliminary analysis revealed that 12 clusters consisted only of two papers written by the same authors; that is, citations were common as the same researchers utilized similar references in two separate articles. We therefore decided to exclude these clusters from subsequent analyses; this resulted in 12 clusters for a total of 71 papers. Additionally, by following an in-depth examination of the content of the papers in each cluster, certain clusters with a small number of papers were brought together into a single area dealing with similar research topics. For example, area G consists of two small clusters that discuss similar issues: diffusion of sustainability standards (cluster 7), and diffusion of sustainability standards over time (cluster 8). This process led to the identification of eight areas of research that were internally consistent, and different from one another in terms of content (see Figure 5).

Figure 5. Bibliographic network 1992-2012



Area	Clusters	Cluster n. of papers	Cluster representative paper	Cluster density	Cluster average degree
A - Sustainability disclosure and performance	1- Environmental reporting and environmental performance	7	109	0.38	2.29
B - Determinants of sustainable disclosure	2- Determinants and outcomes of environmental disclosure	21	50	0.23	4.70
D - Sustainability metrics	3- Sustainability measurement	9	641	0.28	2.22
C - Critical environmental accounting	4- Critical environmental accounting	8	136	0.32	2.25
E - Sustainable operations and supply chain management	5- Sustainable operations	3	46	0.67	1.33
	21- Environmental management systems used in OM	2	204	1.00	1.00
F - Carbon accounting	6- Carbon accounting	8	102	0.25	1.75
	9- Carbon footprint	5	166	0.40	1.60
	11- Carbon accounting indicators	2	642	1.00	1.00
G - Diffusion of sustainability standards	7- Diffusion of sustainability standards	2	543	1.00	1.00
	8- Diffusion of sustainability standards over time	2	643	1.00	1.00
H - Assurance of sustainability reporting	10- Assurance of sustainability reporting	2	112	1.00	1.00

Table 4. Summary list of the analyzed papers, ordered by paper ID number

PAPER ID	AUTHOR	YEAR
2	Li et al.	2016
8	Chan et al.	2016
19	Soobaroyen and Mehedeo	2016
23	Nurhayati et al.	2016
26	Kamal and Deegan	2013
38	Rimmel and Jonall	2013
39	Siddiqui	2013
46	Gimenez et al.	2012
48	Gond et al.	2012
50	Bouten et al.	2012
51	Luo et al.	2012
57	Caniato et al.	2012
63	Gray and Laughlin	2012
68	Hrasky	2012
75	De Giovanni	2012
85	Fortanier et al.	2011
91	Gamerschlag et al.	2011
93	Cowan and Deegan	2011
98	Clarkson et al.	2011
99	Burritt et al.	2011
101	Milne and Grubnic	2011
102	Ascui and Lovell	2011
104	Rankin et al.	2011
106	Solomon et al.	2011
107	Qian et al.	2011
109	Cormier et al.	2011
112	O'Dwyer et al.	2011
113	Dhaliwal et al.	2011
117	Haque and Deegan	2010
118	Papaspyropoulos et al.	2010
119	Kolk	2010
120	Schaltegger and Burritt	2010
126	Cho et al.	2010
132	Burritt and Schaltegger	2010
134	Ferreira et al.	2010
135	Elijido-Ten et al.	2010
136	Gray	2010
137	Henri and Journeault	2010
139	Laine	2010

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PAPER ID	AUTHOR	YEAR
149	Reid and Toffel	2009
166	Minx et al.	2009
168	Wood et al.	2009
169	Nansai et al.	2009
170	Wilting and Vringer	2009
171	Andrew et al.	2009
176	Bouten and Everaert	2015
178	Michelon et al.	2015
180	Contrafatto et al.	2015
182	Chen et al.	2015
184	Fernandez-Feijooet al.	2015
185	Liao et al.	2015
187	Lisi	2015
189	Kumar et al.	2015
190	Lake et al.	2015
193	Alon and Vidovic	2015
203	Clarkson et al.	2008
204	Wu et al.	2008
209	Bebbington and Larrinaga-Gonzales	2008
211	Cho and Patten	2007
214	Gibson and O'Donovan	2007
223	de Villiers and Van Staden	2006
224	Brammer and Pavelin	2006
225	Deegan and Blomquist	2006
231	Herbohn	2005
232	Patten	2005
242	Cormier and Magnan	2004
262	de Burgos-Jimenez and Céspedes Lorente	2001
275	Neu et al.	1998
279	Loh et al.	2015
284	Chithambaranathan et al.	2015
290	Marshall et al.	2015
291	Segui-Mas et al.	2015
294	Brandenburg and Rebs	2015
295	Subramanian and Gunasekaran	2015
297	Acquaye et al.	2015
338	Peters and Romi	2015~~5~~
353	Liesen et al.	2015
354	Thoradeniya et al.	2015

(continues in the next page)

PAPER ID	AUTHOR	YEAR
362	Huang et al.	2015
366	Gomes et al.	2015
376	Comyns and Figge	2015
377	Touboulic and Walker	2015
379	Baker and Schaltegger	2015
380	Cho et al.	2015
381	Cho et al.	2015
383	Hashemi et al.	2015
386	Burritt and Schaltegger	2014
388	Lee and Wu	2014
394	Dobos and Vörösmarty	2014
397	Genovese et al.	2014
399	Henri et al.	2014
403	Passetti et al.	2014
408	Bebbington and Larrinaga	2014
409	Contrafatto	2014
410	Spence and Rinaldi	2014
411	Thomson et al.	2014
412	Tregidga et al.	2014
416	de Villiers and Alexander	2014
432	Mathiyazhagan et al.	2014
438	Blome et al.	2014
443	Varsei et al.	2014
446	Beske and Seuring	2014
447	Ortas et al.	2014
453	van Bommel	2014
456	Garcia-Sanchez et al.	2014
464	Rodrigue	2014
474	Rodrigue et al.	2013
475	Pondeville et al.	2013
497	Cho and Patten	2013
499	Gray	2013
508	Depoers et al.	2016
510	Thijssen et al.	2015
512	Vigneau et al.	2015
513	Chauvey et al.	2015
514	Campopiano and De Massis	2015
518	Chiu and Wang	2015
519	Higgins et al.	2015
524	Peters and Romi	2014
525	Chen et al.	2014
527	Chan et al.	2014

(continues in next upper column)

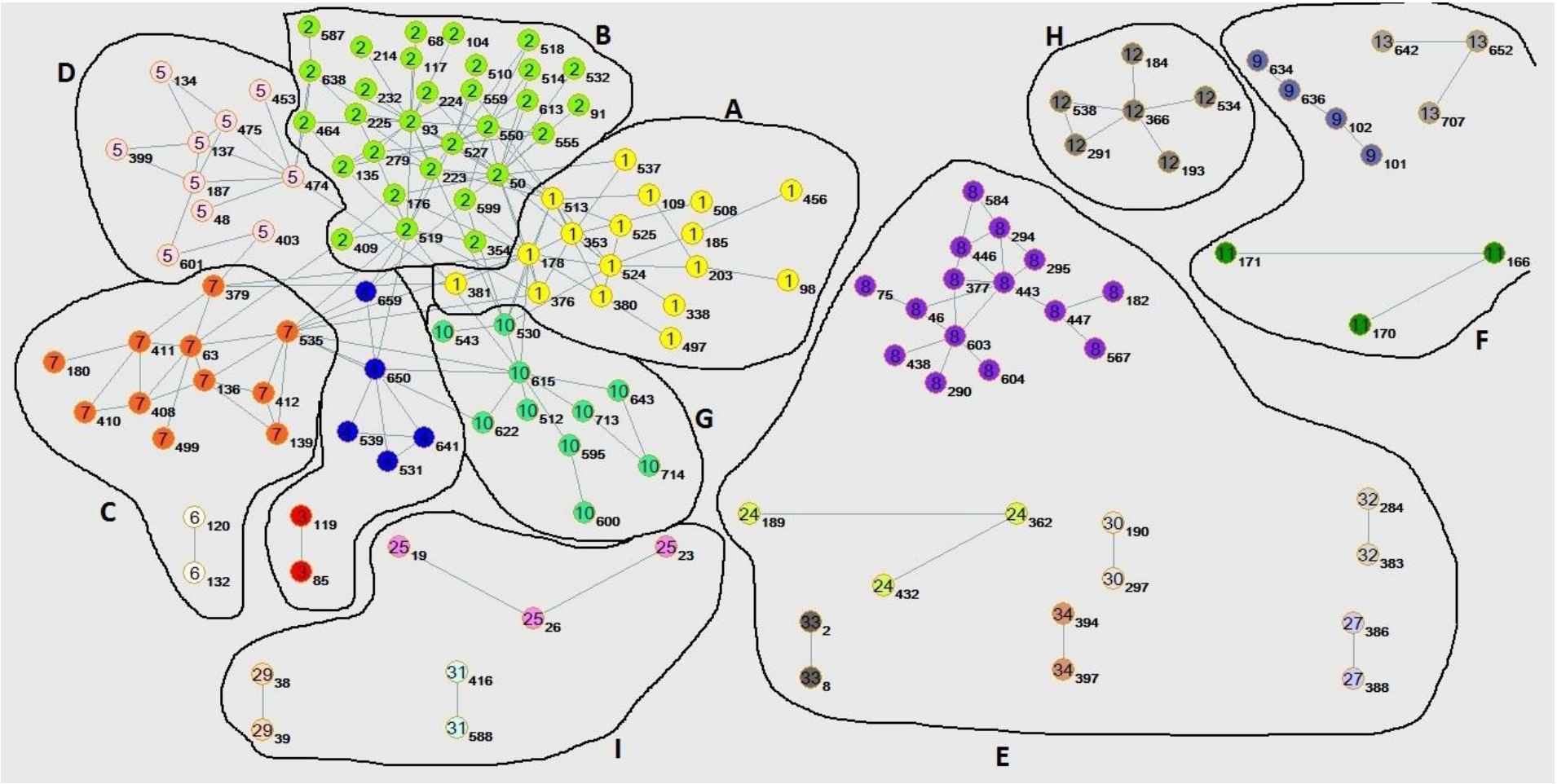
PAPER ID	AUTHOR	YEAR
530	Hahn and Luelfs	2014
531	Searcy and Buslovich	2014
532	Albertini	2014
534	Junior et al.	2014
535	Milne and Gray	2013
537	Mallin et al.	2013
538	Perego and Kolk	2012
539	Searcy	2012
541	Chow and Chen	2012
542	Mahadeo et al.	2011
543	Dawkins and Fraas	2011
550	Reverte	2009
555	Holder-Webb et al.	2009
559	Criado-Jimenez et al.	2008
567	Igalens and Gond	2005
584	Ahi and Searcy, 2015	2015
587	Hess and Lodhia	2014
588	Depoers et al.	2016
595	Fernandez-Feijoo et al.	2014
599	Skouloudis et al.	2014
600	Lock and Seele	2016
601	Passetti and Tenucci	2016
603	Sancha et al.	2016
604	Grimm et al.	2016
613	Lu and Abeysekera	2014
615	Hahn and Kuehnen	2013
622	Ramos et al.	2013
633	Schaltegger and Csutora	2012
634	Stechemesser and Guenther	2012
636	Ascui and Lovell, 2012	2012
638	Pellegrino and Lodhia	2012
639	Lee	2012
641	Searcy and Elkhawas	2012
642	Čuček et al.	2012
643	Marimon et al.	2012
650	Roca and Searcy	2012
652	Herva et al.	2011
653	Marimon et al.	2011
659	Evangelinos et al.	2010
707	Angelakoglou and Gaidajis	2015
713	Ceulemans et al.	2015
714	Alonso-Almeida et al.	2015

Note: In order to connect the presentation and discussion of tables and figures to areas of thematic development, we ordered the papers listed in this table by paper ID. The paper IDs were automatically assigned to documents by BibExcel software and it was not possible to recode them manually.

In relation to the period 1992-2016, 34 clusters, comprising a total of 156 papers, emerge from the analysis (density of the entire network = 0.017; average degree = 2.77) (see Figure 6). Because 12 clusters consisted only of two papers written by the same authors, they were excluded from subsequent analyses, resulting in 22 clusters comprising 138 papers. An in-depth examination of the content of the papers in each cluster allowed us to group the 22 clusters into 9 areas of research dealing with similar content. For example, area C consists of two small clusters that discuss the issue of critical environmental accounting (cluster 6) and beyond critical environmental accounting (cluster 7) (see Figure 6 for further details).

Table A3 in the on-line Appendix shows the relationships between the clusters obtained considering the 1992-2012 and the 1992-2016 samples. The next section describes results in relation to clusters retained in the first sample, grouped into eight areas of inquiry, and then compares it to findings drawn when accounting for the full sample. The main findings are summarized in Table 5, and the list of 162 papers retained after the bibliographic analyses is reported in Table 4.

Figure 6. Bibliographic network 1992-2016



Area	Cluster	Cluster n. of papers	Cluster representative paper	Cluster density	Cluster average degree
A - Sustainability disclosure and performance	1- Revisiting the relation between sustainability reporting and environmental performance	17	338	0.17	2.71
B - Determinants of sustainable disclosure	2- Determinants and outcomes of environmental disclosure	31	50	0.13	3.80
D - Sustainable metrics	3- Sustainability metrics in multi-national companies	2	119	1.00	1.00
	4- Use of sustainability metrics	4	641	0.60	2.40
	5- EMA and SPMS	10	137	0.31	2.80
C - Critical environmental accounting	6- Critical environmental accounting	2	120	1.00	1.00
	7- Beyond critical environmental accounting	11	136	0.33	3.27
E - Sustainable operations and supply chain management (SCM)	8- Sustainable supply chain management	15	294	0.19	2.67
	32- Evaluation of green suppliers	2	284	1.00	1.00
	24- Drivers to adopt sustainable practices in SCM	3	362	0.66	1.33
	27- Sustainability accounting in SCM	2	386	1.00	1.00
	30- LCA in sustainable supply chains	2	190	1.00	1.00
	33- Role of sustainable supply chains in product design	2	2	1.00	1.00
	34- DEA-type indicators for green supplier selection	2	394	1.00	1.00
F - Carbon accounting	9- Carbon accounting	4	102	0.50	1.50
	11- Carbon footprint	3	166	0.66	1.33
	13- Sustainability indicators: outcome measures	3	652	0.66	1.33
G - Diffusion of sustainability standards	10- Diffusion of sustainability standards	10	530	0.22	2.00
H - Assurance of sustainability reporting	12- Assurance of sustainability reporting	6	291	0.40	2.00
I - Emerging themes	25- Greenwashing	3	23	0.66	1.33
	29- Biodiversity accounting and reporting	2	38	1.00	1.00
	31- Institutionalisation of sustainability standards	2	416	1.00	1.00

Table 5. Summary of the findings

Area	Main arguments (articles 1992-2012)	Emerging topics (articles 1992-2016)
A- Sustainability disclosure and performance	Impact of environmental disclosure on environmental performance is inconclusive (Cho and Patten 2007). Firms disclose little sustainability-related information, particularly small firms and companies in non-carbon intensive sectors (Cormier and Magnan 2004). Firms with greater emissions (often in industries such as mining, and oil and gas) tend to disclose more (Cormier *et al.* 2011) and to use more verifiable information (Clarkson *et al.* 2011). Main theoretical approaches: Legitimacy theory and other socio-political theories: environmental disclosure as a function of social and political pressures and a way to gain legitimacy towards stakeholders (Luo *et al.* 2012; Cormier *et al.* 2011). Signaling theory and voluntary disclosure theory: social and environmental disclosure used to signal commitment to external stakeholders (Clarkson *et al.* 2011).	Significant gap between sustainability disclosure and its practice. Emphasis on measures and indices used for enhancing disclosure's credibility (Delmas and Montes-Sancho 2011; Comyns and Figge 2015) and breadth of disclosure (Chauvey *et al.* 2015). Need for standardization of reporting (CDP- and GRI-like frameworks) (Cho *et al.* 2015b). Dual role of regulation: when metrics are fuzzy, regulation stimulates opportunistic disclosure (Comyns and Figge 2015). When reporting is based on output measures, then regulation enhances the quality of the information disclosed (Chauvey *et al.* 2015). Behavioural effects: Managers adopt selective disclosure techniques to address the information needs of different stakeholder groups (Delmas *et al.* 2013). Governance characteristics affect content and quality of disclosure. Additional theories: Institutional theory: sustainability disclosure is taken for granted and is institutionalized into companies' activities (Cho *et al.* 2015b). Agency theory, to focus on governance and board dynamics and their influence on sustainability disclosure (Mallin *et al.* 2013)
B- Determinants of sustainability disclosure	Drivers of voluntary disclosure: Studies confirm previously identified determinants of voluntary environmental and social disclosure: company size, strategic approach, board composition and ownership, country, industry membership, media exposure (Reverte 2009; Bouten *et al.* 2012). New motivations to disclose are proposed: pressures by external stakeholders, and a way to better manage climate change-related risks and opportunities (Pellegrino and Lodhia 2012). Environmental regulation positively affects environmental disclosure, it allows external stakeholders to put pressures on companies, and provides an opportunity to identify inefficiencies in internal processes (Cho *et al.* 2010; Cowan and Deegan 2011). Main theoretical approaches:	Partly extend previous findings on determinants of disclosure by using new data (surveys and case studies), focusing on developing countries, and on family firms (Skouloudis *et al.* 2014; Higgins *et al.* 2015). Analysis of behavioral aspects of sustainability disclosure (Thoradeniya *et al.* 2015). Detailed analyses of types of stakeholders putting pressures on companies (Thijssens *et al.* 2015). Additional theories: Institutional theory (Contraffatto, 2014), and the theory of planned behavior (Thoradeniya *et al.* 2015) to understand managers' attitudes towards sustainability reporting.

	Legitimacy theory (Holder-Webb *et al.* 2009), and stakeholder theory (Elijido-Ten *et al.* 2010).	
C - Critical environmental accounting	A fully reliable set of indicators that measure sustainability at corporate level can never be developed. Problems relate to: (i) unit of analysis; (ii) scope of analysis; (iii) the impossibility to adopt a really systemic view (Herbohn 2005; Schaltegger and Burritt 2010). Companies have integrated sustainability into the business rhetoric through accounting information, but betrayed the initial reasons for sustainability accounting (Laine 2010). Main theoretical approaches: Critical theory: accounting conventions cannot enable organizations to record and disclose information about corporate social and environmental impacts. Sustainability accounting is a fad and it will disappear in time (Burritt and Schaltegger 2010).	Further development of the critical perspective: (i) inability of accounting systems to ever capture sustainability-related information; (ii) profound disconnection between sustainability reporting and current ecological issues (Milne and Gray 2013; Tregidga *et al.* 2014). Beyond the critical perspective: management tools and approaches have to address the decision and control needs of managers, and environmental accounting should move in this direction. Case studies are used to examine the implementation of environmental accounting frameworks (Bebbington and Larrinaga 2014; Spence and Rinaldi 2014). No additional theory used.
D - Sustainability metrics	Use of environmental and social indicators for external reporting through either international sustainability standards (Roca and Searcy 2012) or rating indices (Searcy and Elkhawas 2012). Lack of standardization is found in measurement practices, and very many indicators are disclosed, however the GRI is the most established reporting standard (Roca and Searcy 2012). Stricter enforcement mechanisms by different standards do not result in greater harmonization of indicators. Sustainability indicators for internal management are more used when integrated in companies' management control and performance measurement systems. Importance of connecting indicators to organizational strategy (Ferreira *et al.* 2010; Henri and Journeault 2010). Emphasis on the design, implementation, use, and evolution of corporate sustainability PMS (Searcy 2012). Main theoretical approaches: Stakeholder theory and legitimacy theory (Searcy 2012; Roca and Searcy 2012).	Integration of sustainability indicators into organizational processes such as resource planning, capital allocation and performance evaluation (Passetti *et al.* 2014). Development and use of eco-efficiency indicators, and exploration of ways to track environmental costs (Henri *et al.* 2014). Key role of top management's environmental commitment for sustainability PMS implementation (Lisi 2015). Additional theories: Simons' Levers of Control framework (Gond *et al.* 2012).

E - Sustainable operations and supply chain management	Aspects related to measurement are not central, but they are related to wider themes of sustainability of production processes and supply chains (Caniato *et al.* 2012). Measurement is considered principally as a means to quantify environmental impacts. While no direct impact of sustainability measurement is found on the triple bottom line (Gimenez *et al.* 2012), sustainability indicators can be used to influence the behaviors of suppliers (Caniato *et al.* 2012). <u>No particular theory used.</u>	Investigate organizations' use of measures to quantify environmental impacts (Brandenburg and Rebs 2015) and to monitor suppliers' behaviors (Marshall *et al.* 2015). Link measurement practices to standards or certification schemes (Beske and Seuring 2014). How to incorporate environmental and social measures into broader PMS is marginally explored (Varsei *et al.* 2014). Use of operations research methods to: assess suppliers; identify factors that influence the adoption of sustainability practices; quantify the life-cycle of products. Explore the role of environmental accounting in supply chains. <u>No particular theory used.</u>
F - Carbon accounting (CA)	CA differs in uses according to the level of analysis: national, supply chain, corporate, and product (Stechemesser and Guenther 2012). Focus on metrics: monetary and physical, backward and forward looking, short-term and long-term oriented (Schaltegger and Csutora 2012). Role of environmental legislation and political pressures: (i) making corporations accountable for their carbon impacts; (ii) responding to companies' need for generally accepted methods of CA (Schaltegger and Csutora 2012). <u>No particular theory used.</u>	No evolution in this stream of literature.
G – Diffusion of sustainability standards	How political context and stakeholder pressures affect companies' decisions to adopt sustainability standards (Reid and Toffel 2009). Analysis of the diffusion of standards over time (Marimon *et al.* 2012). <u>No particular theory used.</u>	Additional exploration of the diffusion of standards by country, region, and industrial sector (Ramos *et al.* 2013). Literature reviews propose frameworks on the determinants and outcomes of sustainability disclosure (Ceulemans *et al.* 2015). Consequences of sustainability reporting within organizations (Vigneau *et al.* 2015). <u>No particular theory used.</u>

H - Assurance of sustainability reporting	Prominent role of auditing and third-party assurance practices in developing sustainability reporting (Perego and Kolk 2012). Diversity of assurance standards and type of assurance providers shape the quality of sustainability assurance statements. <u>No particular theory used.</u>	Use and diffusion of assurance practices in different types of organizations or industrial sectors (Segui-Mas *et al.* 2015). Link assurance practices to environmental performance, company reputation and other contextual factors (Alon and Vidovic 2015). <u>Additional theories:</u> Signaling theory and legitimacy theory, but only to a limited extent.
I - Emerging clusters		Greenwashing: firms use sustainability reports to portray themselves as "good" corporate citizens even though they do not have strong social and environmental records (Mahoney *et al.* 2013). Diffusion of biodiversity reporting (Rimmel and Jonall 2013). Institutionalization of sustainability reporting within organizations (De Villiers and Alexander 2014). <u>Main theoretical approaches:</u> Institutional theory.

Area A – Sustainability disclosure and performance - Sample 1992-2012

The first group of papers, *"sustainability disclosure and performance",* consists of articles concerned with the outcomes of environmental and social disclosure. Overall, the relation between sustainability disclosure and environmental performance is not conclusive, with some studies suggesting it to be positive (Clarkson *et al.* 2011), while others proposing negative (Cho and Patten 2007) or non-significant relationships (Luo *et al.* 2012).

Articles mainly focus on different types of sustainability information disclosed by companies, ranging from pure environmental data that include pollution information or greenhouse gas (GHG) emissions (Clarkson *et al.* 2008; Luo *et al.* 2012), to social information that mainly include employee- and community-related metrics. A considerable number of documents also focus on the characteristics of the companies disclosing social and environmental information. Overall, firms appear to disclose little environmental information (Clarkson *et al.* 2011). In particular, SMEs and organizations operating in non-carbon intensive sectors (Cormier and Magnan 2004; Luo *et al.* 2012) seem to disclose the least. In contrast, firms with greater emissions (often in industries such as mining, and oil and gas) tend to disclose more (Cormier and Magnan 2004; Cho and Patten 2007; Cormier *et al.* 2011) and to use more verifiable information (Clarkson *et al.* 2011).

When examining reasons for disclosure, scholars draw conflicting conclusions, depending on the theoretical perspectives taken. Authors who adopt either legitimacy theory (Cho and Patten 2007; Luo *et al.* 2012) or other socio-political theories argue that environmental disclosure is a function of social and political pressures, and a way to gain legitimacy towards stakeholders. Therefore, somewhat paradoxically, firms with poor environmental performance are predicted to have a greater incentive to disclose environmental information in an attempt to change society's perceptions. However, poor environmental performers will also tend to rely on soft or unverifiable information in their attempt to alter their public image. On the other hand, researchers drawing on signaling theory (Cormier *et al.* 2011) and voluntary disclosure theory (Clarkson *et al.* 2011) suggest that firms use social and environmental disclosure to signal their commitment to external

parties – including capital markets – and that, therefore, firms with superior environmental performance will have a stronger incentive to disclose environmental information to differentiate themselves from competitors.

Evolution of area A - Sustainability disclosure and performance - Sample 1992-2016

When the full sample of papers is considered, this literature appears to evolve by exploring further the findings reached in previous research. The effect of social and environmental disclosure on performance remains unclear, and authors find that there is a significant gap between corporate sustainability disclosure and actual sustainability practices. Recent studies have tended to focus more on measures and indices used for enhancing disclosure's *credibility* – both non-financial (Comyns and Figge 2015) and financial (Chen *et al.* 2014). The scope of sustainability disclosure has also increased, with respect to both environmental and social information (Cho *et al.* 2015; Chauvey *et al.* 2015). Nevertheless greater emphasis on environmental rather than social measures has been highlighted (Mallin *et al.* 2013), as the "people" dimension is characterized by fuzziness both in terms of which issues are to be considered important and which measures better capture the performance of firms.

Greater emphasis has also been given to the standardization of reporting (Cho *et al.* 2015b) and to the content of disclosure in order to enhance precision and replicability in reporting. The effect that sustainability measurement has on individuals is also explored, as managers seem to adopt selective disclosure techniques (Gibassier and Journeault 2014) to adapt their disclosure strategy to the information needs of different stakeholder groups (Depoers et al. 2016). Additional scrutiny is given to the analysis of the antecedents and moderators of environmental disclosure (Mallin *et al.* 2013; Garcia-Sanchez *et al.* 2014; Peters and Romi 2014; Cho *et al.* 2015b; Liao *et al.* 2015).

Moreover, regulation is found to play a complicated role in disclosing environmental information. When metrics are ambiguous, as in the case of social indicators, regulation appears to

stimulate opportunistic disclosure practices (Comyns and Figge 2015); however, when reporting standards are based on clearer indicators and output measures (e.g., CDP reporting standard), then regulation enhances the quality of the information disclosed (Chauvey *et al.* 2015; Comyns and Figge 2015).

Considering theoretical approaches, although legitimacy and signaling theory still remain widely used (Mallin *et al.* 2013; Chauvey *et al.* 2015; Comyns and Figge 2015), other theories have been adopted, including agency theory (Mallin *et al.* 2013), stakeholder theory (Liao *et al.* 2015; Depoers *et al.* 2016), and institutional theory (Cho *et al.* 2015b). Studies adopting an agency theory lens tend to focus on governance issues, for example in relation to board of directors' composition and dynamics. A stakeholder theory perspective emphasizes managers' voluntary disclosure of sustainability-related information to inform stakeholders and to address their concerns. Instead, institutional theory enables authors to shed light on isomorphic pressures and mechanisms. For example, Cho *et al.* (2015a) draw on the concepts of organized hypocrisy and organizational façades to suggest that contradictory societal and institutional pressures are seen as irreconcilable by organizations, which end up developing 'façades' and identical practices, which hinder the capacity for sustainability reports to ever evolve into genuine disclosures.

Area B – Determinants of sustainability disclosure - Sample 1992-2012

In this area, most papers focus on the motivations to disclose social and environmental information. Although all articles belong to the same cluster, two large groups emerge. The first one – revolving around (Reverte 2009) – explores the determinants of voluntary sustainability disclosure – organizational characteristics and contextual factors – (Brammer and Pavelin 2006; Gamerschlag *et al.* 2011; Rankin *et al.* 2011; Bouten *et al.* 2012; Hrasky 2012), thus supporting findings drawn in papers belonging to cluster A. However, new determinants are proposed and disclosure emerges as a means to respond to pressures by external stakeholders (for example in relation to climate change). In some cases, pressures are considerable and could threaten a company's license to

operate (Deegan and Blomquist 2006; Pellegrino and Lodhia 2012), and therefore can be a way to better manage risks and opportunities, although sometimes only to a limited extent (Haque and Deegan 2010). Additionally, factors contributing to enhance the *quality* of disclosure are explored (Brammer and Pavelin 2006; Bouten *et al.* 2012).

A second group of papers – with (Cowan and Deegan 2011) at their core – addresses the issue of environmental regulation. Overall, environmental regulation is seen to positively affect companies' decisions to disclose sustainability-related information (Gibson and O'Donovan 2007). Firstly, disclosure can be a way to comply with mandatory environmental regulation (Criado-Jiménez *et al.* 2008); secondly, it can enable external stakeholders to put pressure on companies to disclose information (Cowan and Deegan 2011).

Concerning theoretical approaches, legitimacy theory (Holder-Webb *et al.* 2009; Reverte 2009) and stakeholder theory (Elijido-Ten *et al.* 2010) are the most commonly used to explain the reasons why companies disclose social and environmental information.

Evolution of area B - Determinants of sustainability disclosure - Sample 1992-2016

This literature stream evolves by further investigating existing findings (half of the papers in this cluster come from the previous one). Additional evidence is provided in relation to the factors influencing voluntary disclosure, mostly by means of empirical analyses (Higgins *et al.* 2014; Skouloudis *et al.* 2014; Campopiano and De Massis 2015).

Findings reveal major gaps in disclosing practices, and stakeholders' influence on sustainability disclosure is found to be generally weak, except for shareholders and creditors (Lu and Abeysekera 2014), buyers in global supply chains, and social rating agencies (Chiu and Wang 2015), which positively influence sustainability disclosure. Additionally, using the theory of planned behavior (Ajzen 1991), behavioral aspects of sustainability reporting are explored. Managers' attitudes towards sustainability reporting, beliefs about stakeholder pressures, and ability

to control sustainability reporting are found to influence managers' intention to engage in reporting practices and, indirectly, in actual reporting behavior (Thoradeniya *et al.* 2015).

Overall, this group of papers builds on previous evidence in the field and marginally extends it by either applying previously explored models to different context (e.g., developing countries), or adding new factors that determine the level and the quality of disclosure (e.g., family firms vs. public ones; managers' attitude towards disclosure; and governance characteristics).

Area C – Critical environmental accounting - Sample 1992-2012

Papers in this area focus on sustainability accounting and offer a critical perspective on the role accounting plays in both business and society. Sustainability accounting can be regarded as a subset of accounting tools that deal with activities, methods and systems to record, analyze and report social and environmental information (Herbohn 2005; Schaltegger and Burritt 2010). Most articles in this cluster put forward theoretical arguments and engage critically with the sustainability accounting literature, by examining its origins and outlining ways it should develop. Various questions and challenges are posed concerning (i) sustainability measurement studies' unit of analysis – sustainability is an ecological and societal concept which only rarely coincides with organizational boundaries; (ii) the scope of sustainability measurement studies – sustainability can potentially be achieved in many different ways and considering innumerable factors; and (iii) the need, but difficulty to apply systemic reasoning –an organization may clearly operate in an 'unsustainable' manner, but do so within a sustainable system that compensates for this in some way (Gray 2010; Gray and Laughlin 2012). Additionally, Laine (2010) empirically shows that, over the years, sustainability has transformed from a 'revolutionary' concept into one merely concerned with preserving the status quo. For authors in this cluster, sustainability has been subsumed in mainstream business logics and practices, and has lost its original purpose.

Authors in this group tend to adopt two main perspectives. One group of scholars, drawing on critical theory (e.g., Gray 2010; Gray and Laughlin 2012), argues that sustainability accounting

is a cause of corporate sustainability problems, because conventions are not – and will never be – fit for the purpose of recording and disclosing information about corporate social and environmental impacts. From a critical perspective, sustainability accounting is seen a fad that will disappear in time (Burritt and Schaltegger 2010). The second approach in sustainability accounting recognizes the importance of managerial decision-making and views corporate sustainability accounting as capable of offering managers a set of tools when dealing with social and environmental issues (Burritt and Schaltegger 2010; Schaltegger and Burritt 2010).

Evolution of area C – Critical environmental accounting - Sample 1992-2016

This literature evolves in two separate clusters. The first one comprises only two papers coming from the previous cluster. The second, that we labeled *"beyond critical environmental accounting",* advances this body of research in two main ways.

First, some studies embrace the critical perspective as proposed by Gray (2010) and Gray and Laughlin (2012) and extend it through deeper theoretical reasoning (Gray 2013; Milne and Gray 2013) and empirical analysis (Tregidga *et al.* 2014). Moreover, the critique of environmental accounting is extended to financial accounting (Gray 2013) and to sustainability reporting (Milne and Gray 2013; Tregidga *et al.* 2014). On one hand, this highlights the inability of traditional financial accounting systems to ever capture sustainability-related information. On the other hand, authors emphasize the profound disconnection between the practice of sustainability reporting and urgent issues of our times – i.e., "sustaining the life-supporting ecological systems on which humanity and other species depend" (Milne and Gray 2013, p. 13). From this point of view, mainstream financial accounting, the triple bottom line and the GRI "are insufficient conditions for organizations contributing to the sustaining of the Earth's ecology [as] they may reinforce business-as-usual and greater levels of un-sustainability" (Milne and Gray 2013, p. 13).

Second, other authors also embrace the critical perspective, but propose the use of pragmatism within the sustainability accounting literature (Baker and Schaltegger 2015). Despite

the limitations of sustainability accounting, these researchers explore situations in which sustainability accounting has been positively implemented, and propose theoretical frameworks (Bebbington and Larrinaga 2014; Thomson *et al.* 2014) as well as practical recommendations (Spence and Rinaldi 2014; Thomson *et al.* 2014; Contrafatto *et al.* 2015) on how to implement social and environmental accounting in organizations.

Area D – Sustainability metrics - Sample 1992-2012

In this area two main research topics emerge. The majority of papers focus on the development of environmental and social indicators (Chow and Chen 2012), and on the extent to which companies use these indicators for *external reporting* through the implementation of sustainability standards (Kolk 2010; Fortanier *et al.* 2011; Roca and Searcy 2012), or rating indices (Searcy and Elkhawas 2012). A general lack of standardization in measurement practices emerges as a key problem in this literature (Roca and Searcy 2012). However, despite the various indicators used, new metrics that explore the multi-dimensional nature of corporate sustainability have been proposed and empirically validated (Chow and Chen 2012). Some authors also focus on sustainability indicators specifically used by multi-national companies (Kolk 2010; Fortanier *et al.* 2011; Searcy and Elkhawas 2012). In this context, several factors are found to motivate the introduction of sustainability ratings: the need to differentiate from competitors on the basis of sustainability aspects, investors' increasing recognition of the importance of sustainability, the company's acknowledgement of sustainability as a means to improve performance and manage risks, and the diffusion of stakeholder analysis alongside other approaches to strategy development (Searcy and Elkhawas 2012).

A second stream of research in this cluster concentrates on sustainability indicators used for *internal management* purposes through their integration in companies' management control and performance measurement systems. Great emphasis is given to the association between environmental management accounting and eco-control (Henri and Journeault 2010), and

companies' strategy and innovation processes (Ferreira *et al.* 2010). Particular attention is paid to the design, implementation, use, and evolution of corporate sustainability performance measurement systems, defined as a system of indicators that provides an organization with information that can help management plan, control and execute economic, environmental, and social activities, in both the short- and the long-term (Searcy 2012).

Most papers in this cluster are empirical and based on either surveys (Ferreira *et al.* 2010; Henri and Journeault 2010; Chow and Chen 2012) or archival analyses (Fortanier *et al.* 2011; Kolk 2010; Roca and Searcy 2012). Only Searcy (2012) provides a literature review on the development of sustainable performance measurement systems. Stakeholder theory (Searcy 2012) and legitimacy theory (Roca and Searcy 2012) are the two main theoretical lenses adopted.

Evolution of area D - Sustainability metrics - Sample 1992-2016

The literature on "sustainability metrics" evolves into three main clusters that we labeled: *"sustainability metrics in multi-nationals companies (MNCs)"*, *"use of sustainability metrics"*, and *"environmental management accounting (EMA) and sustainability performance measurement systems (SPMS)"*. While the literature on EMA and SPMS significantly expands in terms of number of papers published and content of research findings, the other two streams of research show either a marginal increase or no increase at all. Therefore we will focus on the evolution of the literature on "EMA and sustainability PMS".

This stream of research develops by providing greater focus on the integration of environmental and social indicators into organizational processes such as resource planning, capital allocation and performance evaluation (Passetti *et al.* 2014). Studies in this cluster explore the concept of eco-efficiency (Henri *et al.* 2016; Passetti and Tenucci 2016), conceptualized as a set of indicators that show how efficiently companies use limited natural resources such as water, oil and carbon (Figge *et al.* 2014). Additionally, the tracking of environmental costs – i.e., the extent to which cost accounting systems make firms' environmental costs visible – is found to be strongly

related to environmental performance although not directly linked to economic performance (Henri *et al.* 2016). Authors also examine the role of contextual and strategic factors in the development of environmental management control systems and sustainability accounting (Pondeville *et al.* 2013; Passetti *et al.* 2014). Furthermore, a few studies explore the interplay of management control systems and sustainability control systems, and its effect on the integration of a sustainability perspective within organizational strategy (Gond *et al.* 2012; Rodrigue *et al.* 2013).

This stream of research adopts more sophisticated quantitative modeling based on surveys or archival data (Pondeville *et al.* 2013; Lisi 2015; Henri *et al.* 2014) and, at the same time, provides a more fine-grained analysis through case studies and interviews with managers (Rodrigue *et al.* 2013; Passetti *et al.* 2014; Searcy and Buslovich 2014). Simons' "levers of control" (Simons 1995), widely used in the management accounting literature, emerges as a core theoretical framework. Studies drawing on the "levers of control" show that environmental indicators can be used as both interactive and diagnostic controls (Simons 1995), i.e., to monitor and control performance, but also to trigger future-looking conversations and stimulate innovation. Also, stakeholders' influences are integrated in the organization's sustainability control system through its values, credos and mission and vision statements (the so-called 'belief system'). Overall, this strand of research takes a predominantly managerial perspective to sustainability measurement (Henri and Journeault 2010; Searcy and Elkhawas 2012) and, by adopting a pragmatic approach, it affirms the importance of linking sustainability measurement with business objectives by integrating sustainability metrics into decision-making processes.

Area E – Sustainable operations and supply chain management - 1992-2012

The initial group of articles in this area is relatively small and it is divided in two clusters: *'sustainable operations'* and *'environmental management systems (EMS)'*. In both cases, aspects related to measurement are not central, but they are related to wider themes of sustainability of production processes and of supply chains more broadly. Measurement is considered principally as

a means to quantify environmental impacts. In these articles, no management theory is explicitly utilized and contributions appear to be mainly technical. Most authors review measures of sustainability from water pollution to energy consumption (de Burgos Jimenez and Céspedes Lorente 2001; Caniato *et al.* 2012), and emphasize the importance of certifications and standards in ensuring sustainable practices are adopted along the supply chain.

Considering empirical results, Gimenez *et al.* (2012) and Caniato *et al.* (2012) study the impact of sustainability measurement on the triple bottom line: Gimenez *et al.* (2012) finds no direct effect, whereas Caniato *et al.* (2012) concludes that key performance indicators (KPIs) could be used to influence the behaviors of suppliers. Looking at EMS, Wu *et al.* (2008) find that these systems can be a strategic asset for organizations. However, their effectiveness depends on cross-functional cooperation, top management team's strategic perception, and the existence of environmentally responsible suppliers. In this area, authors appear to develop similar arguments, but they tend to conceptualize and describe the measurement process somewhat differently, ranging from "assessment" or "evaluation" (Gimenez *et al.* 2012) to the use of specific KPIs and measures (de Burgos Jimenez and Céspedes Lorente 2001; Caniato *et al.* 2012), to regarding measures as key components of wider EMS.

Evolution of area E - Sustainable operations and supply chain management -1992-2016

This literature expands dramatically in the second period considered. In particular, it evolves into a much larger *"sustainable supply chain management (SCM)"* group, and into six smaller sets. The former consists of articles that mainly expand arguments reviewed above. Authors investigate organizations' use of measures to quantify environmental impacts (Brandenburg and Rebs 2015) and to monitor suppliers' behaviors (Marshall *et al.* 2015), and they often link measurement practices to the existence of standards and certification schemes (Beske and Seuring 2014). Moreover, they provide suggestions over which indicators to introduce to capture specific environmental aspects (Ahi and Searcy 2015; Subramanian and Gunasekaran 2015), and review

existing sustainability ratings (Igalens and Gond 2005). However, only in few cases do they extend their findings to suggest ways to incorporate environmental and social measures into broader PMS (Varsei *et al.* 2014) or investigate in-depth the actual usage of sustainability measures.

The other clusters identified in this review comprise: *"evaluation of green suppliers"*, *"drivers to adopt sustainable practices in SCM", "life-cycle assessment in sustainable supply chains", "role of sustainable supply chains in product design", "Data Envelopment Analysis (DEA)-type indicators for green supplier selection",* and *"sustainability accounting in SCM"*. The first five all utilize operations research methods, but consider separate roles of measurement: (i) to provide an assessment of suppliers; (ii) to identify internal and external factors that influence the adoption of sustainability practices, one of which is measurement; (iii) to quantify the life-cycle of products; (iv) to support new product development; and (v) to select suppliers using DEA-type indicators. The sixth cluster consists of accounting articles that propose a more influential role of accounting at the supply chain level, rather than within single organizations. Across these small clusters, perspectives over measurement are various and the terminology adopted quite diverse (e.g., "evaluation", "reporting", "environmental accounting"). However, all authors are concerned with different ways of quantifying and reporting on environmental aspects, and, similarly to most scholars in the "sustainable SCM" cluster, they tend to not to adopt any theoretical perspective and to consider measurement as a technical aspect.

Area F – Carbon accounting - 1992-2012

Three clusters in our sample focus on the area of *"carbon accounting"*, defined as the recognition, evaluation and monitoring of greenhouse gas emissions at all levels of the value chain, and of the effects of these emissions on the carbon cycle of ecosystems (Lee 2012). The first cluster on *'carbon accounting'* comprises eight papers published in either accounting or engineering journals; the second cluster on *'carbon footprint'* consists of six papers published in the September 2009 issue of *Economic System Research*; the third – *'carbon accounting indicators'* – comprises two

papers published in the *Journal of Cleaner Production.* These articles provide interesting nuances on the topic of carbon accounting and footprint.

Firstly, carbon accounting differs in uses according to the level of analysis (Milne and Grubnic 2011; Stechemesser and Guenther 2012). International and political institutions have introduced different metrics in order to measure the carbon emissions of countries and regions (Nansai *et al.* 2009; Wilting and Vringer 2009; Wood and Dey 2009; Stechemesser and Guenther 2012). Within supply chains, carbon accounting helps to quantify carbon emissions and to reduce them across the value chain (Stechemesser and Guenther 2012). At corporate level, carbon accounting has been used as a diagnostic tool to track improvements in companies' environmental performance (Schaltegger and Csutora 2012), but also as an enabling tool by linking carbon indicators with responsibilities and activities within the organization (Schaltegger and Burritt 2010; Lee 2012). Additionally, new methods such as hybrid accounting (i.e., the combination of physical and monetary carbon indicators) and input-output models have been proposed to track the carbon footprint of product life-cycles (Minx *et al.* 2009; Schaltegger and Csutora 2012).

Secondly, different metrics and indices have been suggested to account for carbon-related information, ranging from monetary and physical indicators, to backward and forward looking ones, to short-term and long-term oriented measures (Schaltegger and Csutora 2012). The different "scopes" of carbon-related measures as defined by the Greenhouse Gas Protocol (GHG Protocol 2004, 2011) detail the accounting boundaries and the organizational areas covered by carbon management information (Schaltegger and Csutora 2012; Lee 2012).

Finally, the roles of environmental legislation and political pressure are considered. The Kyoto protocol, emissions trading scheme in the EU, carbon taxes in Australia, and carbon footprint standards like ISO 14000 are found to make corporations more accountable for their carbon impacts, but can be also considered responses to companies' need for generally accepted methods of carbon accounting (Bebbington and Larrinaga-González 2008; Schaltegger and Csutora 2012; Stechemesser and Guenther 2012). Indeed, carbon intensive products are losing competitiveness,

and the identification of the accumulated costs and risks related to carbon emissions is therefore becoming increasingly relevant also from a financial point of view (Johnston *et al.* 2008). Papers in this cluster rarely draw on any specific theoretical lens.

Evolution of area F – Carbon accounting - 1992-2016

When the full sample of papers is considered, results show a reduction in the debate around carbon accounting, as all three clusters appear to shrink and no new paper is added to the group. Different motivations can be proposed. Firstly, optimism and enthusiasm in relation to climate change issues expressed by the international community – e.g., COP 15 Conference on Climate Change in Copenhagen in late 2009 – may have turned into indifference, despite the (apparently) positive results of the recent COP 21Conference on Climate Change in Paris. Things have cooled down – at least politically – and more pressing needs such as economic recessions, bank failures, and the current EU crisis may have taken precedence (Angelakoglou and Gaidajis, 2015 ; Milne and Grubnic 2011). Furthermore, from a scientific point of view, carbon accounting remains conceptually contested, as doubts have been expressed about the reliability and validity of carbon assessment methodologies (Ascui and Lovell 2011).

Area G – Diffusion of sustainability standards - 1992-2012

The area focusing on reporting standards is small and divided into two clusters. The first cluster, *"diffusion of sustainability standards",* focuses on how political context and stakeholder pressures affect companies' decisions to disclose sustainability information by adopting an international standard (Reid and Toffel 2009), and also detail the effect of media pressure as a moderating variable (Dawkins and Fraas 2011). The second cluster, *"diffusion of sustainability standards over time"*, concentrates on the diffusion of international sustainability standards through longitudinal

archival data analysis and details similarities and differences among countries and industrial sectors (Marimon *et al.* 2011; Marimon *et al.* 2012).

Evolution of area G – Diffusion of sustainability standards - 1992-2016

The literature on "sustainability standards" expands significantly and it evolves into a larger group of papers. While a few studies continue to explore the diffusion of sustainability standards worldwide (Ramos *et al.* 2013; Fernandez-Feijoo *et al.* 2014; Alonso-Almeida *et al.* 2015), most of them appear to contribute to two major streams of literature. One group provides, through literature reviews, overarching frameworks over the determinants and outcomes of sustainability reporting and disclosure (Ceulemans *et al.* 2015), by detailing the level, extent, and quality of disclosure (Hahn and Kühnen 2013). A second group of papers focuses on the consequences of sustainability reporting within organizations. Findings show different communication strategies developed by managers to gain stakeholder legitimization (Hahn and Luelfs 2014) and reporting credibility (Lock and Seele 2016), and also detail unintended consequences of sustainability reporting within companies (Vigneau *et al.* 2015).

Considering the terminology used, emphasis is given to 'reporting' rather than to 'disclosure', and authors highlight the differences between sustainability reporting standards (e.g., GRI and CDP) and environmental management standards (e.g., ISO 14000 and ISO 26000).

Area H – Assurance of sustainability reporting - 1992-2012

This group of two papers explores the prominent role of auditing and third-party assurance practices in developing and assessing sustainability reporting. These papers mainly analyze how different assurance standards shape the quality of sustainability reporting (Perego and Kolk 2012; Peters and Romi, 2015; O'Dwyer *et al.* 2011).

Evolution of area H – Assurance of sustainability reporting - 1992-2016

This literature significantly expands in the second period considered. One group of studies explores the use and diffusion of assurance practices in different organizations (e.g., cooperatives, and listed companies) or industry sectors (Segui-Mas *et al.* 2015). Another group links assurance practices with other organizational variables such as environmental performance and company reputation (Alon and Vidovic 2015), or contextual factors like the recent economic crisis (Gomes *et al.* 2015). Overall, no particular theoretical contribution is made, and researchers tend to adopt either legitimacy theory or signaling theory, similarly to authors in areas A and B.

Area I – Emerging clusters - 1992-2016

Three small clusters, not present in the first period considered, emerge when considering all selected articles. These clusters may represent emerging trends in sustainability measurement research. The first focuses on companies' motivations to disclose sustainability information, and adds to the debate on *"greenwashing"* (Nurhayati *et al.* 2016), i.e., firms use sustainability reports to portray themselves as "good" corporate citizens, despite not having any particular social or environmental credentials. The second cluster focuses on *"biodiversity accounting and reporting"*, by exploring the level of diffusion of this form of environmental reporting in different countries (Rimmel and Jonall 2013; Siddiqui 2013). Finally, the third cluster, *"institutionalization of sustainability standards"*, investigates the structure of sustainability reports through the lens of institutional theory. By comparing companies from different countries, and of different sectors and sizes, results suggest that the structures of sustainability reports are remarkably similar. This is probably due to normative and mimetic isomorphism, which tend to become very influential when a field or practice reaches maturity, as in the case of corporate environmental disclosures (De Villiers and Alexander 2014; Depoers *et al.* 2016).

Discussion

Sustainability measurement: A rapidly expanding but fragmented field

Interest in sustainability measurement has grown exponentially over the past years, and the topic is becoming established in different areas of research, including: management accounting and control (Barry and Otley 2009), operations and supply chain management (Gualandris *et al.* 2015), reporting (O'Dwyer and Unerman 2016), and industrial engineering (Alblas *et al.* 2014). Such expansion has led to the examination of a wide variety of issues. Our review shows that eight distinct areas of inquiry can be identified: sustainability disclosure and performance; determinants of sustainability disclosure; critical environmental accounting; sustainability metrics; sustainable operations and supply chain management; carbon accounting; diffusion of sustainability standards; and assurance of sustainability reporting. As the field has started to mature, several literature reviews have been published on specific aspects (see, e.g., Burritt 2012; Hahn and Kühnen 2013; Chen *et al.* 2014; Hansen and Schaltegger 2016).

Our findings provide an overview of the development and evolution of the sustainability measurement literature, and help identify emerging issues. In particular, some sub-fields have expanded significantly over the years by proposing new insights and compelling findings; for example, the integration of sustainability-related information in management control and performance measurement systems, and the assessment and management of green supply chains. In contrast, other strands have expanded, but only through marginal contributions. For instance, the literature on the determinants and outcomes of sustainability disclosure shows an increasing number of studies that either simply apply existing models and approaches to new contexts (industry or country), or merely include new variables (different measures of GHG emissions, or different governance characteristics). A few sub-fields also appear to be waning, as in the case of carbon

accounting, whereas others are emerging such as sustainability measurement and greenwashing, and biodiversity accounting and reporting.

Considering the different streams of literature together, it is clear how the cross-disciplinary nature of the subject and the lack of a sufficiently comprehensive conceptualization of sustainability measurement have led to the creation of many separate communities. Indeed, research in sustainability measurement feels like the moral of the blind men and the elephant—authors from different areas offer important insights into particular aspects, but exclusive reliance on any single viewpoint results in incomplete framing of the problem and in partial (and often repetitive) solutions. Our analyses show the emergence of 12 different sub-fields over the 1992-2012 period and to the creation of further, sometimes unconnected, clusters over the following three years. While adopting different viewpoints could be beneficial, our findings show that studies conducted by authors belonging to different academic communities tend to considerably overlap. Also, despite inconsistencies in terminology and premises, studies have tended to draw very similar conclusions both empirically and theoretically. For example, similar findings have been reached at different points in time and by different authors in relation to the antecedents and motivations for environmental disclosure (areas A, B, C, G and H – see Table 5); the difficulty to create a comprehensive and reliable set of indicators for measuring sustainability at corporate level (areas D and E); and the need to identify appropriate measures related to the eco-efficiency of processes and products and link them to company strategy (areas C, D and E).

From a theoretical point of view, the use of various lenses has certainly helped this field evolve and shine light on many relevant aspects. Two very popular theories in sustainability measurement are legitimacy theory and signalling theory. The former derives from the notion of social contract and has traditionally focused on symbolic types of actions that could guarantee legitimacy to an organizational entity (Patten 1992; Suchman 1995). The latter is an economic theory that refers to stakeholders' search for 'signals' that could help them better understand

something in relation to an uncertain or ambiguous attribute. For example, in presence of information asymmetry, the party who owns better information sends 'signals' to the less informed party to improve their understanding or influence their choice (Micheli and Gemser, 2016). Other commonly used theories are stakeholder theory, which postulates that managers provide environmental information in response to stakeholder pressures (Depoers *et al.* 2016), and institutional theory, which proposes that sustainability measurement is shaped by mimetic and coercive pressures, and predicts that practices converge over time (Hahn and Kuhnen 2013). More recently, some authors have adopted agency theory and Simons' levers of control, particularly in Areas A and D respectively.

In a broad sense, the most frequently used theories in sustainability measurement studies can be grouped in two categories: (1) socio-political theories, such as legitimacy theory and institutional theory, which adopt an external perspective on organizations and portray them as predominantly reacting to external stimuli such as regulation, institutional pressures and societal expectations (Patten 1992; Cho *et al.* 2015b); (2) managerial theories, such as agency theory and Simon's levers of control, which focus on the organization's governance and strategy, and regard sustainability measurement as an enabler of pro-active communication to external parties and, eventually, of performance improvement (Gond *et al.* 2012; Mallin et al. 2013). While socio-political and managerial theories conceptually complement each other, their separate use has led to fragmentation of this field of research and to drawing conflicting findings. In the context of sustainability disclosure, for instance, research adopting the former type of theory typically concludes that disclosure is inevitably selective and utilized mainly for legitimation purposes, eventually making organizations less transparent and accountable, whereas studies drawing on managerial theories regard disclosure and reporting as positive forces that help address the information needs of different stakeholder groups. Aware of such discrepancies, authors have recently attempted to reconcile opposing findings by drawing on multiple theoretical approaches. For example, Hummel and Schlick (2016, p. 455) distinguished between quality and quantity of

sustainability reporting and found that "consistent with voluntary disclosure theory, superior sustainability performers choose high-quality sustainability disclosure to signal their superior performance to the market. In addition, based on legitimacy theory, poor sustainability performers prefer low-quality sustainability disclosure to disguise their true performance and to simultaneously protect their legitimacy." Nonetheless, several scholars have called for the application of richer and more nuanced theoretical frameworks in this field of research (Cho *et al.* 2015).

Another reason for the fragmentation of the sustainability measurement literature is the lack of recognized seminal publications across the different sub-fields, beyond key sources on sustainability itself (e.g., the report on *"Our common future"*) or on theoretical perspectives (e.g., Di Maggio and Powell 1983; Freeman 1984). Highly cited authors and publications certainly exist (see Table 3), but they are mainly known and referred to within single clusters. A revealing finding in this regard is also the lack of consideration of the general performance measurement and management literature. Indeed, there are only two authors who have written about performance measurement and management [ii], but not specifically on sustainability, within the top 100 cited scholars in the selected papers: Robert Kaplan (56th) for his articles and books on the Balanced Scorecard, and Angappa Gunasekaran (98th) for his research on performance measurement in supply chains [iii].

While the decoupling of the sustainability measurement and the performance measurement literatures has led to further duplication of efforts and missed opportunities in bringing together findings from the two areas, it has also created interesting developments, as authors have approached similar issues in different ways. We first review the contributions sustainability measurement research could make to performance measurement and management, and then consider the reverse.

Contributions to the performance measurement and management literature

This review of the sustainability measurement literature contributes in three main ways to the development of performance measurement and management (PMM) theory and practice. First of all, while the role of stakeholders has been discussed in performance measurement studies (Atkinson *et al.* 1997; Neely *et al.* 2002), whether and how stakeholders should be included in the measurement process has been a point of contention, as scholars have juxtaposed resource-based and stakeholder-based arguments (see, e.g., Kaplan 2008). Sustainability measurement research appears to adopt a more uniform but different starting point: stakeholders play such an important role in the design, implementation and use of sustainability measures that they should be considered an integral part of the measurement process, or even the focal point of studies. This is evident when considering research on the roles and effects of regulators and institutions that introduce standards and award certifications, as well as external auditors, rating agencies, and firms that assess suppliers' environmental practices and reporting. Various articles in area A and B, for example, focus on the roles that regulation and political pressure play in sustainability measurement. In the sustainable operations and supply chain management literature (area E), great attention has been paid to how certifications and standards are created, and how these could encourage the uptake of environment-related measures and practices. In so doing, various sustainability measurement researchers have conceptualized measurement as a dialectical process involving two or more stakeholders, at times considering measurement as a way to inform decisions and provide accountability and assurance; at times as external representation and a pure legitimation mechanism (Burritt and Schaltegger 2010; Gray 2010). Such an emphasis on stakeholders' role in the measurement process could also contribute to the shift in the PMM literature from a focus on measurement to one on management of performance (Bititci *et al.* 2012). Moreover, specific aspects of PMM could be interpreted more from a multi-stakeholder perspective, e.g., the design of performance indicators and targets may be considered less as an intentional management decision and more as the result of interactions with stakeholders.

Secondly, research in sustainability measurement offers both technical and social perspectives of measurement (Bititci *et al.* 2012; Chenhall *et al.* 2014). This is particularly important, as recent contributions in PMM have explicitly called for the consideration of social and behavioural aspects of measurement, and not only of technical ones (Smith and Bititci 2017). Some of the areas identified in this review, such as the one on determinants of sustainability disclosure, tend to be more concerned with social and behavioural issues. Others, such as carbon accounting and sustainable operations, focus mainly on technical aspects of sustainability measurement. Others again, such as the one on the development and use of sustainability metrics (area D), tend to encompass both. Furthermore, while commonly adopted theories in the PMM literature are virtually absent (e.g., contingency theory, the resource-based view of the firm), and in some of the areas identified in this review there is very little use of theory at all (see Table 5), various philosophical stances and theoretical perspectives can be found in the sustainability measurement literature In particular, legitimacy theory and signaling theory emerge as prominent, and these could be considered in future PMM research. Importantly, both theories emphasize the links between the organization and its environment in a much more explicit way than normally done in PMM studies. In the case of legitimacy theory, organizations are regarded as attempting to legitimate their operations by creating a generalized perception that their actions are "desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman, 1995, p.574). Using this lens could shed light on several areas besides sustainability such as safety, employee diversity and social outcomes where PMM practices and tools may be introduced for symbolic rather than substantive reasons. Signaling theory could help highlight the importance of influencing internal and external actors by providing specific information that is relevant to them. This perspective could contribute, for example, to the burgeoning literature on accountability and uses of performance information (Bryson, 2012), as well as more technical studies on data presentation and visualization (Berinato 2016).

Thirdly, rather than adopting a typical organizational point of view (Kaplan and Norton 2008; Bititci *et al.* 2012), many authors have studied sustainability measurement practices across organizations. For example, the area on sustainable operations and supply chain management (E) is mainly formed by articles on the assessment and evaluation of suppliers, and on the introduction of common sustainability measures by buyers and suppliers. In the area of carbon accounting (F), various authors discuss how carbon accounting could be used not only within but also between organizations. In this case, the sustainability measurement literature has implications for research and practice in the wider PMM field in relation to how common measures could be established and how data could be effectively shared.

Contributions to the sustainability measurement literature

Our review shows that performance measurement and management research could inform sustainability measurement studies too. Great advancements could be made by adopting a more comprehensive conceptualization of the measurement process (see, e.g., Franco-Santos *et al.* 2007; Bititci *et al.* 2012; Melnyk *et al.* 2014; Micheli and Mari 2014) – thus bringing together different strands in the sustainability measurement literature - and by building on existing findings in PMM. Firstly, sustainability measurement authors have tended to consider separately different activities that are integral to the measurement process - e.g., design and introduction of performance indicators; use of standards; reporting and disclosure. Moreover, they have concentrated on either internal or external sustainability measurement practices, including type and use of metrics, and have separated managerial concerns from external reporting ones. In relation to stakeholders, most researchers have considered either internal (especially senior management) or external ones, and focused on either decision-making or legitimacy-seeking arguments (see, for example, areas C and D). The authors' different perspectives, terminology and fields of provenance (e.g., accounting, operations management, strategic management, industrial engineering) have also exacerbated this

fragmentation. The adoption of a comprehensive view of measurement, which includes various activities – such as gathering, analysis and communication of information – and involves both internal and external stakeholders, could greatly reduce duplications and overlaps in future studies, and lead to further identification and understanding of interrelated phenomena.

Considering extant research in PMM, findings from two large and established groups of studies could inform developments in sustainability measurement research. The first is 'strategic performance measurement', i.e., the relationship between strategy and performance measurement systems (Chenhall 2005; Kaplan and Norton 2008; Micheli and Manzoni 2010; Bisbe and Malagueño 2012; Melnyk *et al.* 2014). While some authors dealing with sustainability PMS have considered the links between strategy and sustainability measurement, and the importance to integrate sustainability measures in performance measurement systems, the vast majority of authors have considered sustainability measurement as rather detached from either strategy or measurement systems, and often dictated by external parties. Given the importance of these links, it is recommended that a wider and more interconnected perspective be adopted.

The second area that has attracted much attention in the performance measurement literature - since its inception (see, e.g., Ridgway 1956) - regards the behavioral consequences of measurement. While sustainability measurement research has aptly discussed the roles of stakeholders, it has done very little to examine the behavioral consequences (at individual, team and organizational levels) of data collection, analysis and reporting. Somewhat surprisingly, even though the sustainability measurement literature is quite advanced in its consideration of stakeholders and the social aspects of measurement (Smith and Bititci 2017), specific behavioural consequences of measurement are rarely investigated. For example, managers have been found to adopt selective disclosure techniques – internally and externally - to address the information needs of different stakeholder groups and to gain legitimacy. However, little is known about specific behavioral effects, either positive (e.g., learning, improvement and innovation) or negative (e.g.,

misinterpretation, tunnel vision, gaming) (Smith 1995; Franco-Santos *et al.* 2012). Similarly, despite considerable research on goal setting (see, e.g., Latham and Locke 2007), very few authors have considered the behavioral effects of sustainability targets and goals.

Limitations

This research is not without limitations. Several ones concern the methodological approach used in this study. While bibliometric analysis has been an increasingly used and effective method to map the structure and development of a scientific field, it also has some inherent shortcomings. Firstly, as a quantitative method based on citation analysis, it is not able to capture the reason that a particular publication was cited (Zupic and Čater 2015). For example, references to a certain publication may be made to refute it (negative citation); to self-legitimize the author or his/her team through practices of self-citation; and to strategically influence the review process or apply other kinds of micro-politics strategies – even if these motives have turned out to be less important than reviewing earlier literature, recognizing priorities, and substantiating assumptions (for a discussion, see Bornmann and Daniel 2008). Secondly, bibliographic coupling tends to give more weight to publications with comparatively long reference lists (Vogel and Güttel 2013). Therefore, literature reviews, for example, tend to have higher network centrality than empirical articles, and papers with few or no references tend to be excluded. Thirdly, as a method based on the reduction of large amount of data into a more parsimonious set of information, the results of bibliographic coupling depend on the thresholds defined in the coupling and clustering procedures. In addition, specifically with regard to data selection, our study does not consider the influence of book and book chapters – similarly to other published studies employing bibliometric methods (Di Stefano *et al.* 2010; Ma *et al.* 2012; Vogel and Güttel 2013). Nonetheless, we have attempted to address some of these limitations in our research design and data analyses. For example, we limited self-citation bias by excluding from our analysis the clusters that were only populated by papers published by the same

authors or groups of authors. In addition, we tried different thresholds to test the resilience of our findings - and indeed observed no significant changes in the network structures.

A final limitation concerns the scope of our analysis. As detailed in the introductory section, this study focuses on sustainability measurement mainly from a management point of view; therefore all the papers analyzed revolve around the management, business economics, operations research and engineering management fields. However, sustainability measurement is a vast research area, with other academic communities that focus on more technical topics (e.g., energy, environment, chemistry or construction engineering) and which could provide other insightful contributions.

Despite these methodological and scope-related limitations, we believe that this study provides a useful, replicable and in-depth review of sustainability measurement research through the implementation of an accurate research design, in line with up-to-date best practices and methodological guidelines.

Avenues for future research

This review of the literature indicates various opportunities for further research and practical developments in both the wider field of PMM and specifically in relation to sustainability measurement. First of all, the stakeholder-based, dialectical perspective adopted in many sustainability measurement studies could illuminate various issues in PMM, including the design and implementation of performance indicators in networks (Bititci *et al.* 2012) and the roles of performance measures in multi-stakeholder environments, such as not-for-profit organizations (Moxham 2009). For example, stakeholder involvement in the design, implementation and use of measures could lead to more informed decisions as well as enhanced accountability and assurance. Indeed, it would be appropriate to use stakeholder theory when investigating how pressures from

external parties affect the design of PMM tools, as well as the use of performance measures within and between organizations.

Legitimacy theory and signaling theory could also be utilized to shed light on the PMM process. For example, legitimacy theory would suggest a clear link between PMM and organizational reputation, which is currently under-explored in the PMM literature. Moreover, authors could examine whether an organization, or network of organizations, engages with stakeholders proactively or reactively, and whether such engagement is mainly ceremonial (Di Maggio and Powell 1983) and purely aimed at acquiring greater legitimacy (Suchman 1995) or intended to, for example, gain stakeholders' support in specific initiatives or strengthen collaboration between organizations. Moreover, how measurement tools are developed and introduced could significantly influence their use and people's perceptions over what such tools are intended to achieve. Drawing on signaling theory, future studies could also investigate how organizations disclose performance information (e.g., content and visualization formats) in different ways to different parties, and how different disclosure techniques affect the other parties' decisions.

At the level of the network or supply chain, future studies could investigate the development of common measures (e.g., by dominant firms, in collaboration between different stakeholders, or by third parties) and the sharing of data across organizations. To do so, research could focus more explicitly on social and behavioural issues (Smith and Bititci 2017), perhaps adopting a social constructivist perspective. In this case, the measurement process – of gathering, analysing and communicating performance information – would be studied at the level of the network, rather than the organization. The design of performance indicators, for example, would be regarded less as a declination of the strategic objectives of a single organization (Kaplan and Norton 2008), but rather as shaped by a variety of factors, often outside of the organization's control. Performance measures may also be owned by several individuals operating in various firms, and 'good performance' could be judged quite differently depending on the different actors' points of view. Key questions would

relate to the appropriateness of adopting standard measures of performance as well as individuals' reactions to these; for example, would these be perceived as compliance mechanisms? How could they be effectively incorporated in the organizational PMM system?

Future studies on sustainability measurement, rather than focusing on specific and distinct measurement activities, could adopt a more comprehensive view of the measurement process by jointly considering the gathering, analysis and communication of information, and also relating measurement to various stakeholders' agendas.

Finally, further research could explore the links between strategy and measurement, by developing a wider and more holistic perspective of the sustainability measurement process, and also investigate the behavioral consequences of measurement by examining the effects that sustainability measurement has on individuals and teams.

Conclusions

This review of the sustainability measurement literature demonstrates the salience and evolution of this area of inquiry. While important findings have been reached in relation to several aspects, diverse and unrelated approaches, and limited connections to performance measurement and management research, have hindered its progression.

This paper makes three main contributions to PMM. First, several PMM scholars have discussed whether and how stakeholders should be explicitly considered in the measurement process. Sustainability measurement research proposes that, since stakeholders play a fundamental role in the design, implementation and use of measures, they should be explicitly considered, and measurement be conceptualized as a dialectical process between two or more actors. This argument is connected to the research agenda of understanding and promoting the interplay between technical-controls and social-controls in PMM. Second, many authors have studied sustainability measurement practices across organizations, particularly in supply chains. Therefore, the

sustainability measurement literature also has implications in relation to how common measures could be established and how data could be effectively shared. Third, research in sustainability measurement provides both technical and social perspectives of measurement. For example, environmental disclosure is considered in some cases as a means to address the information needs of different stakeholders, whereas in others it is regarded as a way to construct 'organizational façades'.

This review also makes a substantial contribution to the sustainability measurement literature itself, by mapping existing studies, identifying current developments, and proposing avenues for further research. In particular, future studies in sustainability measurement could greatly benefit by adopting a wider conceptualization of the measurement process, and by drawing on existing literature on the links between strategy and performance measurement, and on the behavioral effects of measurement practices.

Endnotes

[i] For example, the following journals were not included: "Applied Catalysis B-Environmental" in the field of environmental engineering; "Fuel" in the field of chemical engineering; "IEEE Transactions on Electromagnetic Compatibility" in the field of electrical and electronic engineering; "Energy and Buildings" in the field of civil engineering.

[ii] The list of most cited authors in performance measurement and management was compiled through Scopus and by drawing also on existing reviews of main publications and authors in this field (e.g., Neely 2005).

[iii] Gunasekaran has also written about sustainable supply chain management, but only in recent years.

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