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Sustainability performance measurement – a framework for context-specific applications

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Abstract

Purpose – Researchers and practitioners have recently been interested in corporate sustainability performance (CSP). However, knowledge on measuring CSP is limited. Many CSP-measurements are eclectic, without guidance for contextual applications. This paper aims to develop a conceptual framework that categorizes, explains and evaluates measurements based on their accuracy and precision and provides a guideline for their context-specific application.

Design/methodology/approach – The authors conducted a systematic literature review of an initial sample of 1,415 papers.

Findings – The final sample of 74 papers suggested four measurement categories: isolated indicators, indicator frameworks, Sustainability Balanced Scorecards (SBSC) and Sustainability Performance Measurement Systems (SPMS). The analysis reveals that isolated indicators are inaccurate and imprecise, limiting their application to organizations with delimited, specific measurements of parts of CSP due to the risk of a GIGO-effect (i.e. low-quality input will always produce low-quality output). CSP-indicator frameworks are imprecise but accurate, making them applicable to organizations that handle a more significant amount of CSP data. They have a risk of greensplashing, i.e. many indicators not connected to the industry, organization or strategy. In contrast, SBSCs are precise but inaccurate and valuable for organizations desiring a comprehensive strategic management tool with limited capacity to handle sustainability issues. They pose a risk of the streetlight effect, where organisations do not measure relevant indicators but what is easy to measure.

Originality/value – The ideal CSP-measurement was identified as SPMSs, which are both precise and accurate. SPMSs are useful for organizations with complex, comprehensive, connected and tailored indicators but are methodologically challenging.

Keywords ESG, Sustainability, Sustainability performance, Measurement, Balanced scorecard, Systematic literature review

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1. Introduction

Corporate sustainability performance (CSP) has grown in importance, especially in the past decade or two (Grewal and Serafeim, 2020). Increasing pressure from both external and internal stakeholders, forces organizations to actively manage and account for their activities' sustainability (O'Dwyer *et al.*, 2005). Therefore, precise and accurate CSP-measurements are important. A plethora of standards, guidelines and measurement approaches for measuring CSP have emerged, including ISO 26000 (Antolín-López *et al.*, 2016), SA8000 (Schrippe and Ribeiro, 2018), Global Reporting Initiative (GRI) (Siew, 2015) and other indicator frameworks (Schneider and Meins, 2012), such as standards of the International Sustainability Standards Board (ISSB), the Task Force for Climate-related Financial Disclosures (TCFD) and the European Sustainability Reporting Standards (ESRS), sustainability balanced scorecards (SBSC) (Hubbard, 2009) and sustainability performance measurement systems (SPMS) (Pryshlakivsky and Searcy, 2017). These CSP-measurements are also used by academic research to represent actual organizational sustainability practices (Venkatesh *et al.*, 2021) or sustainability performance (Grewatsch and Kleindienst, 2017).

Problematically, CSP-measurements can easily misrepresent organizational practices (and thus performance) and result in biased conclusions if they lack precision and accuracy (Adams and Frost, 2008). Precision can be defined as whether a CSP-measurement can be repeated with the same result (Rukmana, 2012). In contrast, accuracy can be defined as how conclusions drawn from a CSP-measurement reflect reality (Shiu *et al.*, 2009). Measurement bias may relate not only to the nature and number of indicators representing CSP (e.g. Adams and Frost, 2008; Keeble *et al.*, 2003; Sureeyatanapas *et al.*, 2015) but also to the appropriateness of the data proxies used (e.g. Jasiński *et al.*, 2016). Environmental, social and governance (ESG) scores from large data providers are widely used in practice and research as proxies for sustainability, even though they can be highly problematic in terms of precision and accuracy. ESG scores are also imprecise because of the sheer variety, inconsistency and differences in methods used to deal with data gaps (Grewal and Serafeim, 2020).

This study conducted a systematic literature review of CSP to answer the research question:

RQ1. What are the trade-off effects of different corporate sustainability performance measurements on precision and accuracy?

The aim is to provide a conceptual framework for CSP measurements that guides future research at the organizational level in choosing appropriate CSP-proxies and assessing their accuracy and precision. We identified four CSP-measurements by reducing the initial 1,415 CSP papers to 74 seminal papers published in 28 journals between 1987 and 2021. Each consecutive measurement incorporated the previous method:

- isolated sustainability indicators;
- sustainability indicator frameworks;
- SBSC; and
- SPMS.

We identified different trade-offs in precision and accuracy for these four CSP-measurements and potentials for bias. Trade-offs exist in the selection of indicators, the number of indicators, the specification of indicators and the contextual fit of indicators. We also identified four bias effects related to the types of CSP-measurements: a potential

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Garbage-In-Garbage-Out (GIGO)-Effect, a Greensplashing Effect, a Streetlight Effect and a methodological challenge. Finally, we provide context-specific applications of different CSP-measurements.

The remainder of the paper is organized as follows. In Section 2, theoretical foundations are provided, while Section 3 describes the methodology on which this paper is based. Subsequently, a systematic literature review is conducted in Section 4, and a content analysis of the papers is presented. In Section 5, the precision and accuracy of the identified CSP-measurements and their corresponding risk for bias are discussed, resulting in a conceptual framework. This paper discusses and concludes in Section 6 with implications for theory and practice, limitations and opportunities for future research.

2. Theoretical foundations

2.1 Defining corporate sustainability

Concepts, definitions and delimitations between the concepts of sustainability and corporate social responsibility have been discussed for more than 70 years. Where sustainability originated on the green, environmental side (Caradonna, 2014), focusing on for example eco-justice and eco-efficiency, CSR originated more on the social, human side (Strand *et al.*, 2015), focusing on ethics, philanthropy and social responsiveness. Nowadays both incorporate both sides, focusing on value and costs for all material stakeholders. Even though CSR is used widely, it seems that in a corporate context, most companies focus on corporate sustainability, as also can be seen in the new EU Sustainable Finance Framework, the EU Corporate Sustainability Directive and European Sustainability Reporting Standards (ESRS). This might be because corporate managers prefer the more rational language of sustainability over more normative CSR language (Strand *et al.*, 2015).

The Brundtland Commision (1987, p. 15) defined sustainable development as the development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". This widely accepted definition requires operationalization for specific sustainability fields (Seuring *et al.*, 2003). When incorporated by a company, sustainable development is referred to as Corporate Sustainability (CS), which can be defined as "demonstrating the inclusion of social and environmental concerns in business operations and interactions with stakeholders" (van Marrewijk, 2003, p. 102) and having "an intentional strategy to create long-term financial value through measurable societal impact" (Grewal and Serafeim, 2020, p. 2). As with stakeholder theory (Freeman, 2010), this concerns the total value and cost of doing business for all stakeholders, and not just focusing on shareholders and profit. However, no widely agreed definition of CS exists (Chen *et al.*, 2017).

2.2 Defining corporate sustainability performance

The literature often sees CS as a three-dimensional construct composed of economic, social and environmental sustainability. Performance on these dimensions has to be managed and measured. Corporate sustainability performance (CSP) [1] can be defined as how well organizations contribute to the Triple Bottom Line (Elkington, 1997) of environmental stewardship and social responsibility while maintaining an economically viable business (Wagner, 2010). CSP reflects how a company contributes to the intention and principles of sustainable development, that is, the impact on society and the natural environment (Hillman and Keim, 2001; Xiao *et al.*, 2018). Since CSP reflects practices, it focuses on the organizational level.

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2.3 Corporate sustainability performance measurement

Measuring CSP is not easy. General methodological concerns about CSP-measurement include that the identified indicators should reflect the characteristics of the industry and organization (Hubbard, 2009; Sureeyatanapas *et al.*, 2015) and strategy (Adams and Frost, 2008). Additionally, indicators should be flexible and change over time (Keeble *et al.*, 2003). To foster this, data should be collected continuously by involving managers, experts and relevant stakeholders (Adams and Frost, 2008). The team should consider the organization's internal processes and surroundings and emphasize the selection and specification of KPIs, design, indicator weights and results evaluation phase (Wicher *et al.*, 2019).

Common CSP-measurements rely on indicators companies developed internally or extracted from the plethora of guidelines that exist right now. Guidelines are made by national governments and accounting bodies, supranational governments, like the EU ESRS, international non-profits like the ISSB, or NGO-standards like the ISO-standards, SA8000, and the GRI. Consolidation is starting in that for example the ISSB now incorporates the Sustainability Accounting Standards Board and the TCFD, while the EU ESRS state they a.o. take account of the SDGs, the UN Global Compact, the UN PRI, the OECD Guidelines for MNEs, the ILO Principles and ISO 26000 (EU, 2022).

CSP measurements extend from simple isolated indicators that are not holistic, through connected indicators that add more features and complexity, toward comprehensive measurements tailored to and integrating other performance measurement systems in the organization. We use this preliminary framework to conduct a literature review.

3. Methodology

We conducted a systematic literature review of CSP measurements. We followed the systematic approach of Tranfield *et al.* (2003) for the literature search and applied the PRISMA - guidelines for structured and transparent reporting (Moher *et al.*, 2009). We refer to the Appendix for a detailed description of the three stages.

4. Systematic literature review

4.1 Descriptive results

Figure A1 (Panels A–D) in the Appendix provides information on the systematic literature review, including a descriptive analysis of the number of papers published each year, affiliation of the first author and categorization of journals. Panel A shows that CSP measurements represent a relatively new area of research with 65% of the papers published within the past six years. According to Panel B, 26 countries are represented, which shows that it is a topic of global interest. Most studies stem from European researchers, which could imply some form of Eurocentrism and/or Europe having significantly more focus on sustainability. Panel C shows that 43% of the sample were cited less than 50 times, with the average number of citations per paper being 183 and the median 56.5. Panel D reveals that 62% of the papers were published in the sustainability, business and ethics areas, while accounting is grossly underrepresented with only two papers. This is surprising since performance measurement is a central management accounting topic (Lueg and Radlach, 2016).

4.2 Content analysis

The following section analyses the theories, research methods and CSP measurement approaches used in the study's sample.

4.2.1 Theories. Some researchers use traditional theory like stakeholder theory or institutional theory. In contrast, others are phenomena-driven and fact-centred and do not

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apply any specific theory, which is in line with previous observations (Montiel and Delgado-Ceballos, 2014). The choice of theory reflects assumptions regarding the phenomenon and Table A2 in the Appendix provides an overview of the theories applied in the sample [2]. We found that 65% of the papers were phenomena-driven without applying a specific theory. Among the papers applying traditional theory, stakeholder theory was used most, either as an isolated theory or through TBL or the balanced scorecard (BSC). Other theories include agency theory ($n = 1$), the resource-based view ($n = 5$) and institutional theory ($n = 3$). Stakeholder theory focuses on CSP-measurement and value for all stakeholders, while institutional theory relates CSP-measurement to what is legitimate (Glover *et al.*, 2014) and focuses on social aspects. RBV-theory is related to strategic choices and decision-making (Aragón-Correa and Sharma, 2003; Bowen, 2007), which could be argued to affect the scope of measurements.

4.2.2 Methods and research objectives. Research in this field often has one of two objectives:

(1) to develop new CSP-measurements; or

(2) to explore theoretical study subjects and existing frameworks related to CSP-measurement.

The latter focuses on similarities and differences between CSP measurements (Antolín-López *et al.*, 2016) and the decision-making effect of CSP measurement (Adams and Frost, 2008) or deepens insights into applications (e.g. Montiel and Delgado-Ceballos, 2014). More than half of the papers in the sample are attempts to develop new CSP measurements, which suggests that research in this area is not saturated, and that an accurate and precise CSP measurement probably still is unavailable.

4.2.3 Research methodology. Methodologically, research on CSP measurements has focused on three different streams. The first and most essential track (51% or $n = 38$) is where researchers seek insight into CSP-measurements by making baseline conclusions on existing literature, such as extracting general KPIs (Adams and Frost, 2008) or increasing understanding in the field (Montiel and Delgado-Ceballos, 2014). In the second track (35%), researchers use archival data to conclude multiple settings, for example, extracting KPIs based on guidelines and standards (Engida *et al.*, 2018; Sartori *et al.*, 2017) or by testing conditions that can later be generalized (Bodhanwala and Bodhanwala, 2018). In the third, most specialized track, researchers analyse a specific organization or industry by collecting primary data through surveys and interviews. However, surveys and interviews remain underrepresented (see Table A3 in Appendix). Further research using these methods could potentially contribute new knowledge. The lack of methodological variety could be why the field of CSP measurement partially still is immature.

4.2.4 Measurement approaches (instruments). While our pilot study initially pointed toward isolated, connected and comprehensive CSP-measurements, we identified one more category after thoroughly examining the 74 papers. This category consists of measurement approaches tailored to other management systems in the organization, providing comprehensive financial and non-financial information measures. We identified two different measurements integrated into the other systems: Sustainable Balanced Scorecards (SBSC) and Sustainable Performance Measurement Systems (SPMS). An SBSC has the same philosophy as a BSC, and therefore argues for the 80/20 Pareto principle (i.e. 80% of the consequences come from 20% of the causes). An SPMS builds on many input indicators and is anchored to other management systems. This yields four categories of CSP measurements:

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(1) isolated indicators;
(2) indicator frameworks;
(3) SBSC; and
(4) SPMS.

64% of the papers argue that CSP should be measured using sustainability indicators integrated into a specific framework or model. In comparison, 22% argue using indicators in an isolated manner. Only a few studies claim that CSP-measurement entails integrating indicators within an SPMS (7%) or SBSC (7%). As most studies apply secondary data with a theoretical focus (see Table A3 in the Appendix), it is not surprising that the literature focuses on developing isolated indicators and indicator frameworks, as these are more isolated and narrower, and therefore do not necessarily require a more profound analysis in a specific organization. On the other hand, SPMS and SBSC are connected to other systems within organizations. We argue that researchers should emphasize SPMS and SBSC research because of precision and accuracy issues in frameworks and isolated indicators. The following sections provide information on the four different categories of measurement approaches.

4.2.4.1 Isolated indicators – description and context-specific application. Firstly, we identified CSP measurements using indicators that are not part of a framework, system or model. Organizations individually collect sustainability indicators without applying a structured method of collecting, weighing or measuring them. This leads to an unstructured overall CSP measurement tailored to the organization. It is the simplest and fastest CSP measurement method. However, there are limitations regarding precision and accuracy because they do not allow the handling of a large amount of data. The purpose is often delimited and theoretical, including a specific investigation of how KPIs can be used in CSP measurement (Adams and Frost, 2008), the development of a standardized list of possible KPIs (Antolín-López *et al.*, 2016), and an investigation of CSP measurements related to decision-making (Epstein and Widener, 2010). However, it might not capture the entire construct of CSP measurement because it can be (too) complex to measure all relevant indicators without a strategy. Gianni *et al.* (2017, p. 1298) argue that when relying on indicators, "organizations seem often failing to prove that internal operations deal with sustainability issues yielding results that come out as improvement in sustainability indicators." Isolated indicators may not be able to accurately measure sustainability if they do not include key event details, time or space dimensions (Lodhia and Martin, 2014).

We argue that KPIs can measure specific and delimited areas of CSP and assist managers in decision-making but cannot be used for an overall CSP measurement. International standards and guidelines can be used in CSP measurements but remain helpful only in the lowest category of measurements, namely, for isolated indicators. CSP measurement using isolated indicators is helpful for simple, large-scale research and organizations with low complexity related to sustainability issues owing to low precision and accuracy. Isolated indicators are helpful for organizations that know exactly what to measure, either through *ad hoc* or regular monitoring. An example of isolated indicators are the 79 indicators suggested by the GRI.

4.2.4.2 Indicator frameworks and models – description and context-specific application. Secondly, we identified CSP-measurements based on a framework or model (e.g. Ahmad and Wong, 2019; Engida *et al.*, 2018; Jasiński *et al.*, 2016; Krajnc and Glavič, 2005). These include all aspects of the first category of CSP measurements and other features. The new features include being causal, data-driven and comprehensive, and involve a process from collecting data to weighting indicators (Jiang *et al.*, 2018). As frameworks often include a recipe that

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includes both preparatory steps and the execution of the measurement, it is possible to handle a more significant amount of data.

Numerous methodological approaches have been suggested when using indicator frameworks, including fuzzy expert systems (Islam *et al.*, 2019; Venturelli *et al.*, 2017), data envelopment analysis (DEA) (Lee and Farzipoor Saen, 2012; Mahdiloo *et al.*, 2016; Sartori *et al.*, 2017; Tajbakhsh and Hassini, 2018), principal component analysis (PCA) (Jiang *et al.*, 2018) and decision-making trial and evaluation laboratories (Ou, 2016) [3].

Even though frameworks represent a more complex CSP measurement than isolated indicators, they are not integrated with other management systems in the organization, as they can be used separately. Frameworks allow the use of more indicators without the same risk of information overload (Jasiński *et al.*, 2016) but serve mainly to understand and visualize the measurement process. They are most beneficial to complex organizations because structured measurement allows for a more significant number of indicators and structuring of the data collection process.

4.2.4.3 Sustainability balanced scorecard – description and context-specific application. Thirdly, we classified SBSCs as a category of CSP measurements. An SBSC is a performance measurement and management framework based on Kaplan and Norton (1992) BSC. The BSC was initially organized with four performance perspectives to balance financial and non-financial, short-term and long-term and qualitative and quantitative measures (Kaplan and Norton, 1992). The SBSC expands beyond this by explicitly focusing on the organization's environmental, social and ethical aspects (Hubbard, 2009). There is a broad consensus that an SBSC can be used to measure CSP in different ways, including, but not limited to, integrating social and environmental measures within the four perspectives of the BSC and adding specific social and environmental dimensions to the traditional BSC (Hubbard, 2009; Journeault, 2016; Vieira *et al.*, 2017). Consequently, an SBSC is a strategic management approach with a high level of integration, as CSP measurement is integrated into a system that does not require parallel systems such as separate environmental, social and financial management systems (Hansen and Schaltegger, 2016). SBSCs are more complex and can be integrated into systems other than isolated indicators and frameworks. Researchers argue that the number of indicators must remain low when using SBSCs for CSP measurements, following an 80 / 20 Pareto principle (Hubbard, 2009). SBSCs require sustainability strategies; therefore, they are valuable for organizations that formulate these strategies (Hubbard, 2009b).

SBSCs are appropriate for organizations that already use a BSC because it is easier to build on an already recognized tool (Hubbard, 2009). To avoid compromising the validity of this CSP-measurement, vital insights into the relevant sustainability indicators are crucial. This is important because the number of indicators used was low; therefore, the selected indicators must be relevant. Moreover, because it contains a high degree of integration with other systems, this tool is especially appropriate for organizations that wish to integrate sustainability into their strategy (Pádua and Jabbour, 2015; Pryshlakivsky and Searcy, 2017). In addition, an SBSC can be helpful for organizations that wish to report on their sustainability performance, as the SBSC, if handled correctly, adopts the necessary stakeholder view going beyond shareholder value (Hansen and Schaltegger, 2016; Hubbard, 2009).

4.2.4.4 Sustainability performance measurement systems – description and context-specific application. Performance measurement systems go beyond a performance indicator catalogue, as they need the integration of indicators with the infrastructure required to use and interpret these data. An SPMS can be defined as a:

> *system of indicators that, in short- and long-term, provides the corporation with information necessary to assist in the management, control, planning and performance of its economic, environmental and social activities* (Searcy, 2012, p. 240).

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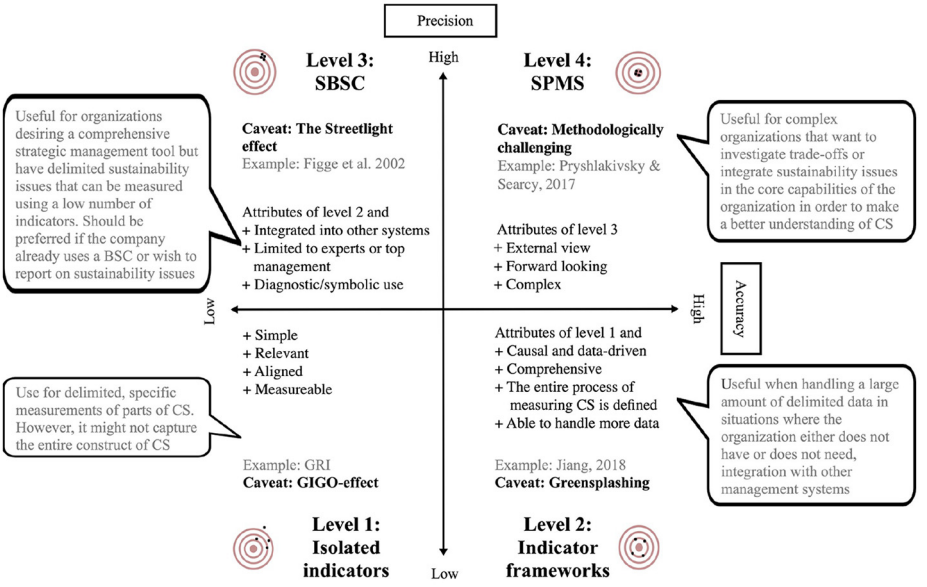
Even though many different SPMSs exist, their main principles are essentially the same: the measurement is conducted based on the vision and strategy of the organization (Nawaz and Koç, 2018; Pádua and Jabbour, 2015), indicators are chosen from a broad range of perspectives to create a holistic and balanced view and a list of critical indicators such as success factors is developed when the system is designed (Vieira *et al.*, 2017).

SPMS differs from SBSC in that it includes individual and composite indicators. In contrast, SBSC is a "performance measurement package" that integrates multidimensional performance measurement and management models (Hansen and Schaltegger, 2016, p. 195). Moreover, it incorporates a more significant number of indicators, whereas SBSCs facilitate the identification of a smaller number of successful drivers to focus only on essential indicators (Vieira *et al.*, 2017). Thus, although SPMS and SBSC are both PMSs, they are at the opposite end of the scale when evaluated by the number of indicators and the amount of information involved. In addition, a SPMS has a more external view and is forward-looking as it also contains a strategic purpose (Silvi *et al.*, 2015). Compared with SBSCs, SPMSs rely on a more significant number of indicators, making them especially appealing for complex organizations. SPMSs can also help investigate trade-offs, integrate them into the organization's core capabilities and better understand how sustainability-related issues can affect the organization and what decisions need to be taken to achieve sustainability (Pryshlakivsky and Searcy, 2017, Figure 1 on p. 329).



Notes: Target illustrations: based on BIPM (2021). Bubbles: Suggestions for context-specific use of each of the four categories of CSP measurements Middle: Attributes of each of the four categories of CSP-measurements. Level 1 contains the essential attributes, and the following levels have the characteristics of the levels below and new and extra features, as indicated in the figure

Source: Authors' own work

Figure 1.
CSP measurement categories and issues related to accuracy and precision

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5. Synthesis

In the following, CSP measurement issues related to accuracy and precision are discussed.

5.1 Analysis of precision

Precision can be defined as whether a CSP measurement can be repeated with the same result (Rukmana, 2012). Explicitly related to CSP measurement, a precise measure would provide the same effect when repeating the measurement. Still, they do not necessarily show the "true" or the actual state of CSP. This depends on accuracy, as illustrated in Figure 1.

Repeatability and reproducibility are closely related to precision (McAlinden *et al.*, 2015). Threats to measurement precision are factors that cause errors such as human error, changes in the environment or data collection processes (Haase *et al.*, 2010). The repeatability of measurements concerns the variation in repeat measurements completed under identical conditions (i.e. the same instrument, same observer and a short period). Variations in these measurements can only be described according to errors in the measurement process itself (Bartlett and Frost, 2008). On the other hand, reproducibility concerns a deviation in measurements completed on a subject under changing conditions (i.e. different instruments used, different observers or a long period) (Bartlett and Frost, 2008). Surprisingly, precision is rarely discussed or tested in the CSP-literature, even though researchers argue that precision is a problem (Jiang *et al.*, 2018; Morioka and Carvalho, 2016a, 2016b; Vieira *et al.*, 2017).

Trade-offs exist in the selection of indicators, which range from simple (isolated indicators, SBSC) to complex (indicator frameworks, SPMS); the number of indicators that vary from few (isolated indicators, SBSC) to comprehensive (indicator frameworks, SPMS); the specification of indicators, which range from isolated (isolated indicators, indicator frameworks) to connected (SBSC, SPMS); and the contextual fit of indicators, which vary from generic (isolated indicators, indicator frameworks) to tailored to the specific industry, the organization and its strategy and culture (SBSC, SPMS). These trade-offs affect the precision of CSP measurements, and we argue that SBSC and SPMSs are more precise than isolated indicators and indicator frameworks for several reasons. Firstly, the specification of indicators in the measurement is connected to the organization or industry. Secondly, the contextual fit of the measurement is tailored to the organization. The structure and design of the measurements secured a high level of precision, as they were carefully developed for predefined purposes, with little subjectivity involved when carrying out the measurement.

A threat towards reproducibility, and thus to precision, is human error. The risk of human error increases as the amount of data to be handled increases. SBSCs include the fewest indicators of all measurements, limiting the risk of human error and enhancing reproducibility and precision. SPMSs involve a large amount of data, which increases the risk of human error. However, SPMSs are often standardized as part of a more extensive system, which lowers the risk of human error. Although isolated indicators can only handle a lower amount of data due to a lack of structure, the precision remains low, as there is no structured approach to select either indicators or data for these.

5.2 Analysis of accuracy

Accuracy is how the conclusion drawn from CSP measurement reflects reality (Shiu *et al.*, 2009), and concerns questions about the validity and relevance of the measure. Accurate indicators should represent the phenomenon intended to be measured (Rusticus, 2014) and should be able to measure the given hypothesis (Ginty, 2013). Jiang *et al.* (2018) addressed the accuracy problem by testing validity and found that almost 33% of the measurement indicators did not meet the criteria to pass the analysis and were therefore excluded. This

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shows that accuracy is a substantial threat to CSP measurement, yet fewer than a dozen papers in the sample assess this risk.

Relying on a low (high) number of indicators results in less (more) accurate measurement of the CSP-construct. Relying on fewer indicators increases the risk that what is being measured is not necessarily CSP but only a small part of the construct. This is a substantial risk as organizations can "score" high on some features of CSP but low on others (Hubbard, 2009). Thus, we argue that CSP-measurements with a significant number of indicators (indicator frameworks and SPMS) are more accurate than isolated indicators and SBSC. If only a few indicators are used, the risk of reaching inaccurate conclusions increases. Frameworks and SPMS have better opportunities to incorporate indicators, as they have established a systematic method for collecting data and measurement.

Another threat to the accuracy of CSP measurements is the potential collection of non-representative data. For example, using ESG scores without carefully investigating what they actually measure. ESG scores are being criticized for having low validity, due to convergent scores between different rating providers (Berg *et al.*, 2020; Chatterji *et al.*, 2009; Crifo *et al.*, 2016). In addition, too much focus on readily available data can also threaten the accuracy of the measure. Using readily available data risks a streetlight effect, as researchers may search for measurements where it is easiest to see and not where it would be most accurate. In other words, the streetlight effect occurs when researchers study what is easy to learn (Hendrix, 2017) and managers measure what is easy to measure.

Another threat is the Garbage-In-Garbage-Out (GIGO)-effect, which generally refers to the idea that the quality of output is determined by the quality of the input [4]. If researchers or managers rely on low quality, inappropriate or nonsensical data, the output will be similar. Even in situations where good input data are used, accuracy can still be an issue, as the weighting of the indicators must be accurate. With a low number of indicators (e.g. isolated indicators or SBSC), an inappropriate weighting scheme affects the overall accuracy of the measurement more than CSP measurements with more indicators. We argue that CSP measurements related to indicator frameworks and SPMS are more accurate than those of isolated indicators and SBSC.

5.3 Precision and accuracy effects of the measurement

Issues related to the precision and accuracy of CSP measurements resulted in four different situations, as illustrated in Figure 1. CSP-measurements can be accurate and precise; the ideal setting we call "the green bullseye." These CSP-measurements measure CSP accurately, reflecting actual practices as all the bullets hit the same spot every time and the spot is in the middle. This illustrates that what is measured is actually CSP, i.e. it has high construct validity. CSP-measurements can be precise, but inaccurate. This is an example of the streetlight effect, in which researchers or managers measure what is easy to measure without concerns about the accuracy or appropriateness of the data. An SBSC can be precise but inaccurate. SBSCs ensure structure but often comprise only a small number of indicators. Organizations can potentially be high performers in some areas of CSP (e.g. human rights, training and safety, or reducing emissions) but low performers in other places that are not being measured. Thus, SBSC risks measuring only a minor part of the construct, as it is built on limited input, i.e. construct validity is low.

Next, CSP measurements can be accurate, but imprecise. In this greensplashing-effect, the "bullets" hit close to the center, which is the accurate reflection of CSP but are spread out widely. This can occur when indicator frameworks or models are used. They allow more isolated indicators, which increase accuracy but can be imprecise. The fourth and last setting is when CSP-measurement is neither precise nor accurate. In this situation, we do not

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hit close to the target (i.e. CSP), and the results could be different each time the measurement is completed. This is an example of the GIGO-effect: the lack of integration into other systems and the lack of structure in the data collection could affect the appropriateness of input data.

5.4 Conceptual framework of CSP measurements

We developed a conceptual framework based on a systematic literature review of CSP-measurements. Figure 1 presents different categories of CSP-measurement, elaborates on their specific attributes and provides suggestions for their context-specific applications.

The conceptual framework highlights the findings in our review, including the categorization of CSP-measurements available, related issues with accuracy and precision and suggestions for their context-specific use. The framework provides a comprehensive overview of the essential aspects to be considered in CSP-measurements. See Table A4 in the Appendix for an overview of the papers related to each category.

6. Discussion

This study analysed different CSP-measurements by providing a conceptual framework that guides future research in assessing the context, accuracy and precision of proxies for the CSP construct at the organizational level. Our systematic literature review of 74 papers dealing with CSP-measurements from 1987 to September 2021 found that CSP has drawn increasing interest during the decade. This study makes several contributions to research and practice.

6.1 Implications for research

Our review's main theoretical contribution is the development of a conceptual framework for CSP-measurements to be used in future research. Firstly, the four identified categories of CSP-measurement:

(1) isolated sustainability indicators;
(2) sustainability frameworks;
(3) SBSC; and
(4) SPMS.

Guide future research with this more nuanced picture to position and develop theories and contributions in CSP-measurement (also for example to investigate links to external reporting models, such as integrated reporting). Secondly, our suggestions for context-specific applications develop CSP-measurement theory by demonstrating trade-offs in the application of the four different categories and showing context-specific situations where each category is suitable. Studying context-fitting CSP-measurements is also vital for being able to report CSP-performance, for example through an integrated report. Thirdly, our conceptual framework contributes to theory by identifying problems with CSP measurement precision and accuracy, constructing four challenges with respect to the categories: the GIGO-effect, the streetlight effect, greensplashing and a methodological challenge. Methodologically, researchers should take these challenges into account when doing research.

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6.2 Implications for practice

This systematic review has several practical implications. Firstly, managers should be aware of the different practices and difficulties of CSP measurement. These pitfalls include CSP-measurements that are susceptible to GIGO-, greensplashing and streetlight effects. Secondly, we identify and structure four levels of CSP measurements and discuss them according to their accuracy and precision. This will help managers and regulators improve their understanding of CSP measurements. By suggesting appropriate, context-specific applications, this study advances the process of identifying CSP measurements that are both appropriate for a specific organization and sufficiently accurate and precise in the given context. In general, this study can help organizations to address the evolution of CSP measurements.

6.3 Limitations

Despite the systematic approach, the transparency of the findings in this review is limited by our inherent values and beliefs, which can be difficult to express fully (Lueg and Radlach, 2016). In sampling papers, there is a risk of excluding studies in progress or published in other languages. By requiring specific terms to be listed in the title, abstract, or keywords of the paper, we may have excluded other relevant papers. However, we are confident that analysing the references of the 71 initially identified papers minimized this risk. Additionally, relevant papers were excluded because they were not published in a 1–4* journal, as this study aimed to review papers of the highest quality. Sustainability is a broad concept currently being explored from many different perspectives, such as in economics, policy, engineering, law and science-based fields. This study only focuses on the business perspective at the organizational level.

6.4 Future research opportunities

Our review of CSP measurements shows several research shortcomings. As European researchers are overrepresented (Eurocentrism), research should shed light on drivers of CS and CSP measurement on national and regional levels to account for this. In addition, American and Chinese samples were more prevalent. Future research should be more inclusive and develop different cultural contexts. There is ample opportunity, specifically in accounting and management, as these remain underrepresented. Accounting and management researchers can contribute by making the picture of CSP measurement more nuanced, as the principles of performance measurement are rooted in accounting and management principles. One specific area that needs more investigation is the link between CSP measurements and their external reporting, for instance through integrated reporting.

Many studies have not applied a specific theory in their analyses, and future research should not continue this trend, as the lack of academic background hinders further development of research analysis and consistent argumentation. Also, CSP research often relies on ESG-scores as data input. We argue that this should be performed only after careful investigation of the data.

In addition, researchers have not fully exploited available data. Instead of manually coding or relying on publicly available data such as ESG-scores, they could analyse annual reports and websites using modern big data and AI-tools such as computer-aided text analysis (CATA). CATA can measure individuals' beliefs, perceptions and feelings imitated in written texts. It is specifically appealing because of its reliability and ability to process a large amount of data quickly (Short *et al.*, 2010). Especially compared to proxy ESG-scores, we argue that CATA can lessen the streetlight effect, in that it focuses on actual performance data, the GIGO-effect, in that CATA-input is more reliable and less prone to human error, and the black box methodological challenge, in that CATA-dictionaries, if shared, make coding and results transparent.

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Several practical gaps remain, including how general business-specific aspects, such as industry, country and organizational size, affect selected indicators or type of CSP-measurement. This includes research on best practices for collecting valid and reliable data, including transforming qualitative data into quantitative data, and interpreting, evaluating and communicating related information. Additionally, researchers should seek to answer how sustainability accounting, management control and sustainability reporting are linked, and whether this affects CSP measurement. In general, sector-specific research and field studies are lacking. Many CSP measurements are still not tested in case studies or are only tested across one or a few organizations in isolated industries.

6.5 Conclusion

In conclusion, this article provides a conceptual framework for measuring corporate sustainability performance (CSP) and evaluates different measurement approaches based on their accuracy and precision. The study conducts a systematic literature review of 74 papers and identifies four categories of CSP measurements: isolated indicators, indicator frameworks, sustainability balanced scorecards (SBSC) and sustainable performance measurement systems (SPMS). The analysis reveals trade-offs between accuracy and precision for each category, with SPMS identified as the ideal measurement approach. The article offers context-specific suggestions for the use of these measurements and discusses their implications for research and practice, highlighting the challenges and opportunities in the field of CSP measurement.

Notes

1. For brevity's sake, we use CSP; not to be confused with corporate social performance (Wood, 1991), which focuses on corporate social responsibility, corporate social responsiveness and social impacts, programs and policies.
2. For further information on the methodology, research questions and data collection, see Table 4 in Appendix.
3. Figure 1 in Jiang *et al.* (2018) provides an example of many best-practice approaches.
4. Coined in 1957 about US Army mathematicians, the GIGO effect is now also widely used in business, IT, computer science and data science (Hanson *et al.*, 2023).

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Appendix. Systematic literature review

As described in the methodology section, we conducted a systematic literature review in three stages. In Stage 1, we planned the review by following a non-structured snowball approach (Morioka and Carvalho, 2016a; Nawaz and Koç, 2018) to better understand the topic keywords in relevant databases. The search revealed an essential difference between "assessment" and "measurement." Maas *et al.* (2016) state that the keyword "measurement" mainly depicts an internal and managerial perspective of the decision-making process, while "assessment" focuses on external reporting. However, not all studies have consistently used these terms. Researchers argue that external assessments require internal systems to provide information, so both measurement and assessment approaches require internal and external elements (Maas *et al.*, 2016; Silva *et al.*, 2019). Hence, we included both terms in the search string.

In Stage 2, we conducted the literature review based on a seven-step approach (Tranfield *et al.*, 2003). Keywords were selected based on the initial search in Stage 1. We searched the following string in either title, abstract or keywords: (*corporate sustainab* measur* OR corporate sustainab* assess* OR sustainab* performance measur* OR sustainab* performance assess* OR sustainab** management *measur* OR sustainab* management assess*).* We searched two separate databases (EBSCO Business Source Complete and Scopus), which initially yielded a sample of 1,415 papers. The search was conducted in September 2021.

In the second step of Stage 2, we set research boundaries by setting the language to English only and the timeline to 1987-September 2021 (the Brundtland Commission report was released in 1987). As we focus on the most impactful journals with the highest quality, we only included the journals rated 1–4* in the 2021 Association of Business Schools (ABS) Academic Journal Guide (AJG). The AJG is stable, widely-used, focuses on business, rather than all sciences (Walker *et al.*, 2019), and scores journals similar to other well-known rankings, such as the Harzing-list (Harzing, 2023). This reduced the number of studies to 664.

In the third step of Stage 2, we performed a cursory analysis of the titles of the 664 papers. We only included papers that specifically dealt with CSP-measurements and viewed CSP as a three-dimensional construct. Research often examines smaller parts of CSP by focusing on only one of the three dimensions (economic, social or environmental), with the risk that the internal relationships between the dimensions are overlooked. Additionally, the measurement must contain an organization-level view. This step reduced the number of papers to 140.

In Step 4, we screened the 140 papers by reading abstracts to include papers that met the mentioned inclusion criteria. This reduced the number of studies to 87. We excluded several papers that did not focus on CSP measurements or elaborated on intra-organizational relationships and unidimensional measures. We also excluded studies on non-organization-level measures related to national, project or product-level measures. We also eliminated studies on investments, reporting, lifecycle sustainability and not-for-profit organizations because they do not balance or prioritize financial objectives. In Step 5, we eliminated six duplicates as two separate databases were used. We performed full-text reading of the remaining 81 papers in the sixth step. Ten of these papers were excluded because they did not meet the inclusion criteria, primarily because of a lack of focus on CSP measurements. A total of 71 papers were included in the sample. We investigated all their references, which helped identify three additional relevant papers. We analysed the resulting 74 papers using quantitative and qualitative content analyses of the research questions. Specifically, we read all the articles more than once to become immersed in the data. As we applied deductive content analysis, we developed a structured categorization matrix (Elo and Kyngäs, 2008) and coded data according to the following categories: measurement approach proposed, research objective, research methodology, data sources and data processing. We also gathered information about the validity and reliability of the tests and data related to the systematic literature review.

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In Stage 3, the final stage, we reported the results based on the PRISMA-framework. Table A1 displays our processes across all three stages.

Stages	Main activity
Stage 1– planning the review	We followed the non-structured snowball approach to obtain a better understanding of the topic, keywords and relevant databases. The search revealed an important difference between the keywords assessment and measurement
Stage 2– Conducting the review	Step 1: Identification of keywords, search string and relevant databases *Databases: EBSCO business source complete and scopus* – "Corporate sustainab*" measure* – "Corporate sustainab*" assess* – Sustainab* performance assess* – Sustainab* performance measure* – Sustainab* management assess* – Sustainab* management measure* – Sustainab* performance evaluation → Result: 1,415 papers Step 2: Development of research boundaries – Language: English – Timeline: 1987–september 2021 – Only 1–4* journals according to the ABS Journal Guide → Result: 664 papers Step 3: Cursory analysis by reading titles Inclusion of papers based on their relevance by reading title → Result: 140 papers Step 4: Including papers meeting the inclusion criteria by reading abstracts – Deal with SPM measurement – Three-dimensional view of SPM – Corporate level analysis → Result: 87 papers Step 5: Removal of duplicates – Removing 6 duplicates → Result: 81 papers Step 6: Full-text screening – Including papers based on inclusion criteria from step 4 → Result: 71 papers Step 7: Investigating references – Inclusion based on inclusion criteria from step 4 → Result: 74 papers
Stage 3 - Reporting	Reporting of the literature review based on PRISMA framework

Table A1.
Three-stage approach used in the literature review

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Theory	Papers
Agency theory	Hussain *et al.* (2018)
Balanced scorecard	Figge *et al.* (2002); Hansen and Schaltegger (2016); Hubbard (2009); Journeault (2016); Vieira *et al.* (2017); Nicoletti Junior *et al.* (2018)
Institutional theory	Gianni *et al.* (2017); Küçükbay and Sürücü (2019)
Legitimacy theory	Küçükbay and Sürücü (2019)
Other	Ahi *et al.* (2018); Figge and Hahn (2004); Maas *et al.* (2016); Pryshlakivsky and Searcy (2017)
Phenomena-driven	Adams and Frost (2008); Antolín-López *et al.* (2016); Bodhanwala and Bodhanwala (2018); Caiado *et al.* (2019); Castro and Chousa (2006); Crifo *et al.* (2016); Cui *et al.* (2019); Deng (2015); Ding (2005); Dubey *et al.* (2015); Engida *et al.* (2018); Epstein and Widener (2010); Eslami (2021); Garbie (2014); Gómez-Bezares *et al.* (2017); Gupta and Singh (2020); Isaksson and Steimle (2009); Islam *et al.* (2019); Jasiński *et al.* (2016); Jiang *et al.* (2018); Keeble *et al.* (2003); Kocmanová and Šimberová (2014); Krajnc and Glavič (2005); Labuschagne *et al.* (2005); Lee and Farzipoor Saen (2012); Lodhia and Martin (2014); Lu *et al.* (2021); Mahdiloo *et al.* (2016); Malesios *et al.* (2018); Marcis *et al.* (2019); Montiel and Delgado-Ceballos (2014); Morioka and Carvalho (2016b); Morioka and Carvalho (2016a); Nantee and Sureeyatanapas (2021); Nawaz and Koç (2018); Pádua and Jabbour (2015); Pislaru *et al.* (2019); Sartori *et al.* (2017); Schneider and Meins (2012); Schrippe and Ribeiro (2018); Searcy (2012); Sureeyatanapas *et al.* (2015); Tagliari *et al.* (2020); Tajbakhsh and Hassini (2018); Venturelli *et al.* (2017); Wagner (2010); Yeh (2021); Zhou *et al.* (2018)
Resource based view	Gianni *et al.* (2017); Sangwan *et al.* (2018); Sangwan *et al.*, 2019); Tseng *et al.* (2018)
Stakeholder theory or TBL	Ahmad and Wong (2019); Cagno *et al.* (2019); Garcia *et al.* (2016); Gianni *et al.* (2017); Hussain *et al.*, 2018); Küçükbay and Sürücü (2019); McElroy and Thomas (2015); Ou (2016); Perrini and Tencati (2006); Pryshlakivsky and Searcy (2017); Rahdari *et al.* (2015); Tamimi and Sebastianelli (2017); Vieira *et al.* (2017); Wicher *et al.* (2019)

Note: Some papers apply more than one theory
Source: Authors' own work

Table A2. Theoretical applications

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Methodology	Papers
Archival	Bodhanwala and Bodhanwala (2018); Cagno *et al.* (2019); Crifo *et al.* (2016); Engida *et al.* (2018); Epstein and Widener (2010); Garcia *et al.* (2016); Gómez-Bezares *et al.* (2017); Hussain *et al.* (2018); Isaksson and Steimle (2009); Krajnc and Glavič (2005); Küçükbay and Sürücü (2019); Labuschagne *et al.* (2005); Lee and Farzipoor Saen (2012); Lodhia and Martin (2014); Lu *et al.* (2021); Mahdiloo *et al.* (2016); Morioka and Carvalho (2016b); Ou (2016); Pislaru *et al.* (2019); Rahdari *et al.* (2015); Sartori *et al.* (2017); Schneider and Meins (2012); Tajbakhsh and Hassini (2018); Tamimi and Sebastianelli (2017); Wagner (2010); Venturelli *et al.* (2017)
Interview	Adams and Frost (2008); Ahmad and Wong (2019); Cagno *et al.* (2019); Caiado *et al.* (2019); Epstein and Widener (2010); Jasiński *et al.* (2016); Journeault (2016); Keeble *et al.* (2003); Kocmanová and Šimberová (2014); Lodhia and Martin (2014); Marcis *et al.* (2019); Morioka and Carvalho (2016b); Nantee and Sureeyatanapas (2021); Nicoletti Junior *et al.* (2018); Sureeyatanapas *et al.* (2015); Tagliari *et al.* (2020); Vieira *et al.* (2017); Wicher *et al.* (2019); Yeh (2021)
Literature review (as a primary methodology)	Ahi *et al.* (2018); Antolín-López *et al.* (2016); Castro and Chousa (2006); Cui *et al.* (2019); Deng (2015); Eslami (2021); Figge *et al.* (2002); Figge and Hahn (2004); Garbie (2014); Gianni *et al.* (2017); Gupta and Singh (2020); Hansen and Schaltegger (2016); Hubbard (2009); Islam *et al.* (2019); Journeault (2016); Keeble *et al.* (2003); Lu *et al.* (2021); Maas *et al.* (2016); Mahdiloo *et al.* (2016); Malesios *et al.* (2018); McElroy and Thomas (2015); Morioka and Carvalho (2016a); Montiel and Delgado-Ceballos (2014); Nawaz and Koç (2018); Nicoletti Junior *et al.* (2018); Pádua and Jabbour (2015); Perrini and Tencati (2006); Pryshlakivsky and Searcy (2017); Sangwan *et al.* (2019); Sangwan *et al.* (2018); Searcy (2012); Tagliari *et al.* (2020); Zhou *et al.* (2018); Tseng *et al.* (2019); Tseng *et al.* (2018); Venturelli *et al.* (2017); Vieira *et al.* (2017); Wicher *et al.* (2019); Zhou *et al.* (2018)
Survey	Ahmad and Wong (2019); Cagno *et al.* (2019); Caiado *et al.* (2019); Ding (2005); Dubey *et al.* (2015); Gupta and Singh (2020); Islam *et al.* (2019); Jiang *et al.* (2018); Kocmanová and Šimberová (2014); Labuschagne *et al.* (2005); Marcis *et al.* (2019); Sangwan *et al.* (2019); Schrippe and Ribeiro (2018); Sureeyatanapas *et al.* (2015); Tseng *et al.* (2019)

Table A3.
Research methodologies of papers

Note: Some papers apply more than one method and are therefore mentioned more than once
Source: Authors' own work

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Table A4. Studies included in the literature review

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
					Indicators			
Adams and Frost (2008)	*Accounting Forum*	492	Phenomena-driven	Australia	To investigate how to develop KPIs and how they can be used to measure SPM and affect decisions of the management	Interviews and literature review	Three Australian and four British companies	Minimum time spent with an organization was one and a half hours and the maximum a full day. The data was processed through evaluation of interviews
Antolín-López *et al.* (2016)	*Journal of Cleaner Production*	68	Phenomena-driven	Europe	To investigate SPM measurement tools and compare them according to their similarities and differences, with the aim of advancing towards a more standardized list of sub-dimensions	Literature review	Several academic management journals, environmental management journals and practitioner management journals	Manual coding, including Cohen-Kappa statistic between pair of researchers
Caiado *et al.* (2019)	*Production Planning and Control*	12	Phenomena - driven	South America	To investigate the degree of importance of SP measures as well as proposing guidelines	Literature review, questionnaire survey, semi - structured interviews	Survey with industry professionals in August 2016	The software "R", reliability assessments (Cronbach's alpha coefficient), Lilliefors (LF) and Anderson–Darling (AD) normality tests
Crifo *et al.* (2016)	*International Journal of Production Economics*	55	Phenomena-driven	Europe	To investigate how different mixtures of CSR dimensions can affect corporate economic performance	Archival	French Organizational Changes and Computerization (COI) 2006 survey (contains information on more than 13,790 French companies)	Simultaneous Equations Model (SEM) to account for possible double relationships
Epstein and Widener (2010)	*Journal of Corporate Citizenship*	35	Phenomena - driven	America	The goal is to provide insights that can be used in decision - making to facilitate decisions that are more informed, as well as identifying feasible	Interviews, archival and observational data	Archival data from several sources including governmental organizations, local businesses, and non-profits, as well as data from Bureau of Land	Manual coding and interpretation

(*continued*)

Table A4.

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
					measures of sustainability performance		Management, the Pinedale school district, Wyoming Game and Fish, crime reports, the Sublette Country Chamber of Commerce, organizations on the environmental sector, newspapers and several gas companies. Interviews with the vice-president of external relation of Shell Oil Company and 24 stakeholders and representatives of local organizations and personal observations	
Figge and Hahn (2004)	*Ecological economics*	649	Strong sustainability	Europe	To develop a new approach called Sustainable Value Added to measure SPM	Literature review	Existing literature	Manual coding, evaluation and calculation of theoretical aspects related to sustainable value added
Gómez-Bezares *et al.* (2017)	*Journal of Business Ethics*	33	Phenomena-driven	Europe	To examine how the integration of sustainability into corporate strategy affects shareholder value creation and financial performance in the British capital market	Archival	FTSE350 listed companies with a total of 2,450 firm-year and 29,400 firm-month observations from 2006 to 2012	Based on the work by (Tagesson *et al.*, 2009)
Hussain *et al.* (2018)	*Journal of Business Ethics*	103	Agency theory and stakeholder theory	Europe	To empirically study how corporate governance, affect the TBL and sustainability performance	Archival	152 company reports from 2007-2011 from Global Fortune 2013 list	Coding according to GRI based on a two-stage manual content analysis technique and regression model estimation

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Table A4.

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
Isaksson and Steimle (2009)	*The TQM journal*	271	Phenomena-driven	Europe	The purpose is to investigate what the contribution of businesses to sustainability is and to investigate the measurement of corporate sustainability. The measurement criteria are then applied for the analysis of GRI reports of five companies	Literature review, theoretical development of main criteria in the measurement, case studies	World Business Council for Sustainable Development, Global Company and The Natural Step	Manual evaluation and Structuring Content Analysis
Keeble *et al.* (2003)	*Journal of Business Ethics*	378	Phenomena-driven	Europe	To investigate how the proper use of indicators can be a dominant tool in measuring and adopting sustainability	Case study with interviews and observation	Two case studies. Case study 1 collected data through peers, leaders in sustainability, standards, and dialogue with the company. Case study 2 collected data through consultation with internal and external stakeholders	Manual evaluation and company engagement
Lodhia and Martin (2014)	*Journal of Cleaner Production*	44	Phenomena-driven	Australia	To develop KPI's for Corporate Sustainability and determine the value of these indicators for the company and its stakeholders	Literature review, interview, archival	Literature, a large, diversified resources company and its reported sustainability data and interviewing managers and stakeholders	The value and explanatory capacity of the indicators and the trend was determined by interviewing managers and stakeholders
Montiel and Delgado-Ceballos (2014)	*Organization and Environment*	292	Phenomena-driven	North America	To increase the insight in the field of CS researched by management scholars with the aim of defining and measuring SPM	Literature review	Literature search by searching among specific top academic management journals	Manual coding and Cohen's kappa statistics
Sartori *et al.* (2017)	*Energy Policy*	14	Phenomena-driven	South America	To measure sustainability of electricity power industry in Brazil	Archival	GRI indicators for the energy sector	Data Envelopment Analysis (DEA) specified with a directional distance function (DDF)

(*continued*)

Table A4.

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
Searcy (2012)	*Journal of Business Ethics*	346	Phenomena-driven	North America	To identify future directions for research in the design, implementation, use, and evolution of corporate SPMS (Searcy, 2012, p. 239)	Literature review	Literature from the following sources: Springer Link, Wiley Interscience, Science Direct, Emerald Insight, Inderscience, Compendex, ABI Inform, JSTOR, Scholars Portal, EconLit, IEEE Explore, EBSCO, and Google Scholar	Manual and theoretical evaluation
Tamimi and Sebastianelli (2017)	*Management Decision*	20	Stakeholder theory	North America	"To explore the state of S&P 500 companies' transparency by analysing their Bloomberg ESG scores (Podsakoff *et al.*, 2005) (Tamimi and Sebastianelli, 2017, p. 1660)	Archival	Bloomberg ESG scores	Non-parametric methods. Data was processed by using the Kolmorgorov-Smirnov goodness of fit test to establish marked deviations from normality and the Friedman procedure for matched sample to compare more than two groups. Additionally, the Wilcoxon Signed Rank Test was used for comparing two groups. Lastly, data was processed through the Kruskal–Wallis test and the Mann–Whitney test
Wagner (2010)	*Ecological Economics*	249	Phenomena-driven	Europe	To review the literature on how DEA can be used in measurement of SPM by using a citation-based approaches	Archival	Panel data for a set of US firms in the Standard and Poor's 500 index as of 2003. Main data sources were Compustat, Worldscope Disclosure, BankerOne and	Radom effects panel model

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Table A4.

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
Zhou *et al.* (2018)	*European Journal of Operational Research*	68	Phenomena-driven	Asia	To review the literature on DEA applications in sustainability	Literature review	KLD for the period of 1992-2003 Literature, ISI Web of Science (WOS) and Kamada–Kawai algorithm	Citation based review methods, assigning an importance index (search path count) to all the links in the citations path work
					Frameworks/models			
Ahi *et al.* (2018)	*Ecological Economics*	6	Strong sustainability	North America	To propose a probabilistic model for measuring CSP	Literature review	Literature review and theory	Model based on the work by Ahi and Searcy, 2014
Ahmad and Wong (2019)	*Journal of Cleaner Production*	3	TBL/ Stakeholder	Asia	To develop a comprehensive measurement by using weighted indicators for the Malaysian food manufacturing industry	Survey and interviews	Academic experts, experts from a research center and the industry	Delphi method and calculated the weighting based on applicability scores that were assigned by the experts
Bodhanwala and Bodhanwala (2018)	*Management Decisions*	10	Phenomena-driven	Asia	The goal is to investigate whether corporate sustainability affects profitability of the company	Archival	Thomson Reuters Asset 4 ESG database of 58 Indian companies with data from 2010-2015	Empirical multivariate panel data model
Castro and Chousa (2006)	*Business Strategy and the Environment*	73	Phenomena-driven	Europe	To develop an integrated model, that takes into accounting the TBL of a company and analyse the sustainability-oriented value in companies, by investigating the financial analysis of sustainability	Literature review	Literature and theory including the DuPont ratio pyramid, SBSC and shareholder value	The ratios identified in the model are linked by mathematical expressions t
Cui *et al.* (2019)	*Industrial Management and Data Systems*	0	Phenomena-driven	Asia	The purpose is to develop a hybrid approach to measure sustainability in high-tech firms by integrating quantitative and qualitative research methods	Literature review and word frequency analysis	Literature review and expert opinions	Word frequency analysis, cluster analysis, grey heory, decision-making and trial evaluation laboratory

(*continued*)

Table A4.

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
Ding (2005)	*Building Research and Information*	176	Phenomena-driven	Australia	To develop a model that incorporates environmental and social information into decision-making	Surveys and literature review	Literature and industry survey from the construction industry	Multi criteria evaluation and the sustainability index
Deng (2015)	*Benchmarking: An international Journal*	27	Phenomena-driven	Australia	To develop a benchmark for sustainability performance in the context of multi-criteria analysis	Literature review and theoretical development	Literature review and theory	Information entropy
Dubey *et al.* (2015)	*International Journal of Production Research*	111	Phenomena-driven	Asia	To develop a sustainable manufacturing framework	Survey	A modified version of Dillman's total design method	Confirmatory factor analysis and multiple regression analysis
Engida *et al.* (2018)	*Journal of Cleaner Production*	16	Phenomena-driven	Europe	To develop a composite indicator that evaluate issues in regard to measurement of SPM	Archival	Sustainalytics	DEA and Principal Component Analysis (PCA)
Eslami (2021)	*International Journal of Production Research*	9	Phenomena-driven	Europe	To understand how to measure SPM in manufacturing companies and to propose a new framework	Literature review	Literature review from several databases	Formal Concept Analysis (FCA)
(Garbie, 2014)	*International Journal of Production Research*	106	Phenomena-driven	Asia	To investigate how to model components in a measurement of SD as well as how to measure SD at the microlevel	Literature review, theoretical development, and survey	Survey of the case company and interviewing the stakeholders and experts	Manual coding
Garcia *et al.* (2016)	*Journal of Cleaner Production*	68	Stakeholder theory	South America	To develop a model that helps managers in decisions-making and measurement of SPM by considering the TBL framework and a stakeholder view	Archival and illustrative case study	Integrated Environmental Evaluation of Water Resources Development (IEE) model developed by the United Nations Environment Program and the United Nations Educational, Scientific and Cultural Organization in	Multicriteria decision aid methods

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Table A4.

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
							1987 as well as a case study on Brazilian Electricity Corporation	
Gianni *et al.* (2017)	*Journal of Cleaner Production*	34	Stakeholder, RBV and institutional theory	Europe	To address two gaps in literature: 1) integrated management systems are managed yet not measured and, 2) sustainability is measured yet not managed	Literature review	Literature reviews from Scopus, Google Scholar, EBSCO, ProQuest, Web of Science, and the journal electronic depositories of Elsevier, JSTOR, Emerald, Wiley, Taylor and Francis, Springer and Sage Publications	Manual coding based on theory
Gupta and Singh (2020)	*International Journal of Productivity and Performance Management*	1	Phenomena-driven	Asia	To find practices related to sustainability and propose a framework for measuring sustainability	Literature review, survey	Literature and a case study Literature review and experts from the leather industry in Bangladesh	Manual coding
Islam *et al.* (2019)	*Journal of Cleaner production*	3	Phenomena-driven	Asia	To investigate corporate culture attributes and form them as a measurement tool for measuring corporate sustainability performance	Literature review, interview with industry experts		Fuzzy synthetic evaluation, a decision-making trial and evaluation laboratory (DEMATEL) method
Jasiński *et al.* (2016)	*Journal of Cleaner Production*	26	Phenomena-driven	Europe	To develop a comprehensive sustainability measurement framework	Interviews and literature review	Literature review and qualitative interviews with 24 experts	Thematic analysis and content analysis
Jiang *et al.* (2018)	*Journal of Cleaner Production*	21	Phenomena-driven	Asia	To develop a measurement model to measure sustainability based on the three dimensions of TBL	Interviews, case studies and literature review	Questionnaires from 49 companies with a total of 284 samples	PCA analysis
Kocmanová and Šimberová (2014)	*Journal of Business Economics and Management*	48	Phenomena-driven	Europe	To determine on indicators of sustainability performance	Interview, surveys	International sources and deep interviews with experts	Multi-dimensional and multi-factor analyses, PCA method with CARIMAX rotation

(*continued*)

Table A4.

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
Krajnc and Glavič (2005)	*Ecological economies*	382	Phenomena-driven	Europe	To develop a framework with a composite indicator index that can measure SPM.	Archival	GRI framework and data from two case companies' sustainability reports	Pair-wise comparison Analytic Hierarchy Process and mathematical model development
Küçükbay and Sürücü (2019)	*Corporate Social Responsibility and Environment al Management*	1	Legitimacy theory, stakeholder theory, institutional theory, dependency theory	Europe	To develop a new measurement method called Multimoora Sort, that can measure corporate sustainability performance	Archival	Empirical case studies with 25 companies listed in Fortune 500 USA and Thomson Reuters Eikon database	Multicriteria sorting method, the Multimoor Sort method
Labuschagne *et al.* (2005)	*Journal of Cleaner Production*	955	Phenomena-driven	South Africa	To develop a comprehensive model to measure SPM	Survey, archival	Review of various frameworks and guidelines and a pre-survey at a large petrochemical company in South Africa with 23 participants	Manual and theoretical evaluation
Lee and Farzipoor Saen (2012)	*International Journal of Production Economics*	227	Phenomena-driven	Australia	To develop a model for measuring SPMby using DEA	Archival	AccountAbility 1000, ISO 14000 and 26000, Dow Jones Sustainability Index (DJSI), OECD Multinational Enterprises, Social Accountability (SA) 8000, Global Reporting Initiatives (GRI) guidelines, United Nations Global Compact, and World Business Council for Sustainable Development initiatives as well as case studies of 10 Korean electronics manufacturing companies during the period May to July 2010	DEA and a combined approach of cross-efficiency and dual-role factors

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Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
Lu *et al.* (2021)	*Corporate Social Responsibility and Environmental Management*	8	Phenomena-driven	Asia	To discuss and develop a model to measure sustainability by taking SDGs into account	Archival	Literature and the 17 Sustainable Development Goals with more than 500 indicators	Manual and theoretical evaluation
Maas *et al.* (2016)	*Journal of Cleaner Production*	127	Transparency perspective and performance improvement perspective	Europe	To review literature related to CSP-measurement, management accounting, control and reporting	Literature review	Literature	Manual and theoretical evaluation
Mahdiloo *et al.* (2016)	*Transportation Research part D*	8	Phenomena-driven	Australia	To develop a two-stage DEA model to measure sustainability with more realistic weights than the usual DEA-model	Archival	A dataset from (Chen *et al.*, 2012) published by the US Environmental Protection Agency	Multiple criteria DEA method to develop a multiple criteria two-stage DEA model
Malesios *et al.* (2018)	*Socio-Economic Planning Sciences*	3	Phenomena-driven	Europe	To review the current state of SPM and develop a framework for measuring and improving performance	Literature review	Various literature databases	Word cloud method and manual content analysis
Marcis *et al.* (2019)	*Journal of Cleaner Production*	0	Phenomena-driven	South America	To develop a model for the measurement of sustainability performance that is applied to agricultural cooperatives. They aim at assessing the adherence of an indicator set to develop a model called SAAC	Literature review, refinement with specialists and case studies	Literature review and multiple case studies. The organizations are all members of OCEPAR (2017)	Manual coding, process approach

(*continued*)

Table A4.

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
McElroy and Thomas (2015)	*Sustainability Accounting, Management and Policy Journal*	23	TBL and multicapitalism	America	To disclose a new method on performance accounting called the Multi Capital Scorecard, that makes it possible to measure, manage and report the TBL performance relative to norm for impacts on multiple capitals	Theoretical development based on hypothetical case	Theory and a hypothetical case	Expansion of the multiple capital accounting system Context-Based Sustainability to the Multi Capital Scorecard based on theory
Morioka and Carvalho (2016a, 2016b)	*Journal of Cleaner Production*	104	Phenomena-driven	South America	To review literature with the aim of developing a comprehensive framework for measuring and integrating SPM into business	Literature review	Literature review from ISI Web of Knowledge (Web of Science) and Scopus databases in June 2015	Manual and theoretical evaluation
Nantee and Sureeyatanapas (2021)	*Benchmarking: An International Journal*	1	Phenomena-driven	Asia	To obtain an understanding of the Logistic 4.0 impact on sustainability and develop a framework for measure SPM	Interviews with industry experts and data identified in literature	Literature and evaluation by industry experts	The item-objective congruence index, Q-sort method and the IOC method for content validity testing
Nicoletti Junior *et al.* (2018)	*Journal of Cleaner Production*	10	BSC/ Stakeholder/ TBL	South America	To develop a model to measure sustainability based on a correlation matrix between the dimensions of the TBL and the balanced scorecard	Literature review and interviews	Literature and data from a Brazilian manufacturer in the food sector	Manual and theoretical evaluation
Ou (2016)	*Journal of Business Economics and Management*	11	TBL	Asia	To develop an integrated model to measure sustainable development performance of High-Tec companies	Archival	Data from Taiwanese High-Tec companies disclosed CSR reports, financial statements and annual reports in 2013. Data sources include the Taiwan Economic Journal (TEJ) Data Bank, eco-efficiency indexes, environmental and CSR disclosures and RAROC values provided by the TEJ VaR system v2.1	Grey relational analysis, decision-making trial, evaluation laboratory and analytic network process

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Table A4.

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
Perrini and Tencati (2006)	*Business Strategy and the Environment*	578	Stakeholder theory	Europe	To develop a sustainability evaluation and reporting system to track sustainability performance	Literature review	Un-structured in a literature review	Manual and theoretical evaluation and empirical experiences
Pislaru *et al.* (2019)	*Journal of Cleaner Production*	23	Phenomena-driven	Europe	To develop a methodology to improve corporate sustainability management and assess the corporate sustainability performance of a specific company	Archival	An automotive company ranked by Forbes	PCA and fuzzy logic
Rahdari *et al.* (2015)	*Journal of Cleaner Production*	117	Stakeholder theory	Asia	To provide a general set of the most common indicators and to develop a hierarchical normative framework	Archival	Sustainability normative frameworks, management systems, guidelines, and rating systems	Theoretical evaluation of the findings, processed by using a comprehensive four-pronged approach
Sangwan *et al.* (2019)	*Benchmarking: An International Journal*	0	RBV	Asia	To develop a framework and KPIs to measure sustainability in manufacturing companies in the cement sector	Literature review, survey	Systematic literature review	Frequency analysis, factor analysis, Cronbach's alfa method, item-to-total correlation, Barlett's test of sphericity and Kaiser-Meyer-Oklin measure
Sangwan *et al.* (2018)	*Benchmarking: An International Journal*	8	RBV	Asia	To develop a model that can assess sustainability for manufacturing organizations	Literature review and case study	Literature review and tested on a case study through personal visits. They also use the work of Dyllick and Hockerts, 2002	Manual evaluation based on frequency analysis
(Schneider and Meins, 2012)	*Business Strategy and the Environment*	112	Phenomena-driven	Europe	To investigate different dimensions of CSR and develop a comprehensive Framework for measuring SPM	Archival	Standards including GRI and ISO 26000 as well as rating agencies (DJSI, KLD; FTSE4Good)	Manual and theoretical evaluation

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Table A4.

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
Schrippe and Ribeiro (2018)	*Journal of Cleaner Production*	6	Phenomena-driven	South America	To develop a measurement model of SPM, based on the Corporate Sustainability Index (ISE) of the B3 in Brazil	Surveys	Semi-structured and structured surveys with 5 sustainability experts	Weighted Sum as well as Minimum Performance on Mandatory Items (MPMI) approach
Sureeyatanapas *et al.* (2015)	*Production Planning and Control*	34	Phenomena-driven	Asia	To empirically develop a framework for measuring CS within the Thai sugar industry	Interviews, surveys	Multiple case studies of 4 companies. 14 managers from the four companies agreed to take part and the interviews were conducted in May 2012	Manual evaluation of the questionnaires based on rankings
Tagliari *et al.* (2020)	*Journal of Cleaner Production*	0	Phenomena-driven	South America	To develop a procedure for measuring sustainability performance of manufacturing processes	Literature review, interviews	Systematic literature review and interviews with professionals and researchers from the field	Manual and theoretical evaluation
Tajbakhsh and Hassini (2018)	*Energy Economics*	5	Phenomena-driven	North America	To develop performance measures for sustainability of the U.S fossil-fuel power stations	Survey	418 electricity generations plants, EIA, Federal Regulatory Commission, Clean Air Task Force	DEA and nonparametric statistical analysis
Tseng *et al.* (2019)	*Technological Forecasting and Social Change*	16	RBV	Asia	To develop a valid and reliable hierarchical framework to measure corporate sustainability performance	Literature review, Survey	Literature, Taiwanese textile industry	Integrating the decision-making trial and evaluation laboratory method, exploratory factor analysis and the fuzzy synthetic method
Tseng *et al.* (2018)	*Business Strategy and the Environment*	7	RBV	Asia	To propose a method to measure the CSR identity of a firm	Survey	Case study of a company specialized in printing circuit board manufacturer in Taiwan. 42 staff members and 8 academics were included	Fuzzy logic and exploratory factor analysis

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Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
Venturelli *et al.* (2017)	*Journal of Cleaner Production*	19	Phenomena-driven	Europe	To develop a model to measure SPM based on a Fuzzy expert system	Survey, archival	Literature, rating agencies and survey information from CSR managers	Manual content analysis and evaluation of experts on fuzzy expert systems models
Wicher *et al.* (2019)	*Journal of Cleaner Production*	0	TBL	Europe	To goal is to develop and verify a model for measuring sustainability performance as an aggregated assessment of an industrial company by using the FANP method	Literature review and an explanatory case study	Literature	Fuzzy Analytic Network Process (FANP), logarithmic fuzzy preference programming methodology, and an action matrix
Yeh (2021)	*Annals of Operations Research*	0	Phenomena-driven	Asia	To develop a new measurement approach to measure sustainability performance based on corporate image of CSR activities, stock price crash risk and profitability	Theoretical development based on literature	Derived from theory and applied empirically to Taiwanese listed companies who have won a Corporate Citizen Award	DEA-SBM model and learning-curve model
					Sustainability balanced scorecard			
Figge *et al.* (2002)	*Business Strategy and the Environment*	1329	BSC	Europe	To formulate a SBSC that can measure sustainability management	Literature review	Theoretically collected based on literature and knowledge by the authors	Theoretical evaluation
Hansen and Schaltegger (2016)	*Journal of Business Ethics*	157	BSC	Europe	To investigate SBSC and its use in measuring and managing SPM	Literature Review	Systematic literature review	Theoretical evaluation
Hubbard (2009)	*Business Strategy and the Environment*	905	Stakeholder theory	Australia	To develop SBSC for measuring organizational performance related to sustainability	Literature review	The development of the SBSC is based on literature and knowledge of the authors as a hypothetical BSC and organizational sustainable performance index is developed	Theoretical evaluation

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Table A4.

Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
Journeault (2016)	*Journal of Environment al Management*	24	Stakeholder theory	North America	To develop a completer and more comprehensive SBSC that can support corporate sustainability strategies by developing an Integrated Scorecard		Literature and expert evaluation by 5 academics and 4 practical experts and then tested through practical experimentation	Theoretical and practical evaluation
Vieira *et al.* (2017)	*Organization and Environment*	13	BSC	Europe	To analyse the link between sustainability management and economic performance by analysing the framework of (Ferreira and Otley, 2009)	Interviews, archival	A case study from October2007 to March 2008 at a wind farm company where one of the authors was working in the finance and control department. Three different collection methods were applied: participant observation, semi structured interviews, and documentary analysis. Five managers and three staff members were included	Theoretical and practical Examination of the issues and possibilities by using a SPMS based on the framework of (Ferreira and Otley, 2009)
					Sustainability performance measurement systems			
Cagno *et al.* (2019)	*Journal of Cleaner Production*	17	TBL	Europe	To develop a system for measuring industrial sustainability that is scalable and featured with different levels of application and suitable in different contexts	Literature review, interviews, survey, archival	Literature by searching Scopus, explanatory case studies with semi-structured interviews, questionnaires, and secondary material. The sample was selected from the AIDA database	Theoretical and practical content analysis. The empirical research was carried out on 5 Italian manufacturing firms where they tested the model's heterogeneity by sector and size
Morioka and Carvalho (2016a, 2016b)	*Journal of Cleaner Production*	64	Phenomena-driven	South America	To investigate the incorporation of sustainability in SPMS as well as investigate which factors affect the interaction between indicators and their relative priority for decision making	Interviews, archival	Cross-sector case studies at five Brazilian companies based on semi-structured interviews and triangulated with published reports and internal documents	Iterative coding and document analysis

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Author	Journal	Google Scholar citation	Theory	Region	Research objective	Research methodology	Data sources	Processing of data
Nawaz and Koç (2018)	*Journal of Cleaner Production*	34	Stakeholder theory	Asia	To investigate sustainability in management systems and develop a SPMS	Literature review	Systematic literature review based on Tranfield *et al.* (2003).	Theoretical evaluation
Pádua and Jabbour (2015)	*Business Process Management Journal*	26	Phenomena-driven	South America	To create a SPMS from a perspective of business process management	Literature review	Web of Science and Scopus	Theoretical evaluation
Pryshlakivsky and Searcy (2017)	*Journal of Business Ethics*	22	Contingency, institutional, stakeholder theory	North America	To present a model that consider the trade-offs associated with corporate SPMSs	Literature review	Un-structured literature search	Theoretical evaluation

Source: Authors' own work

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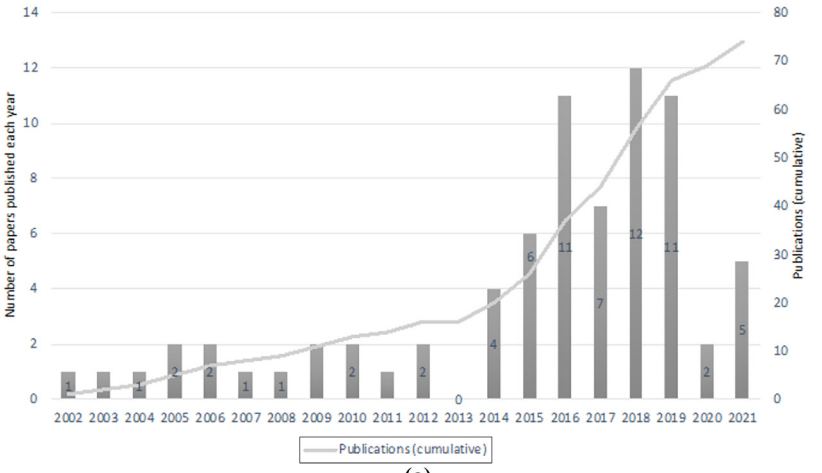

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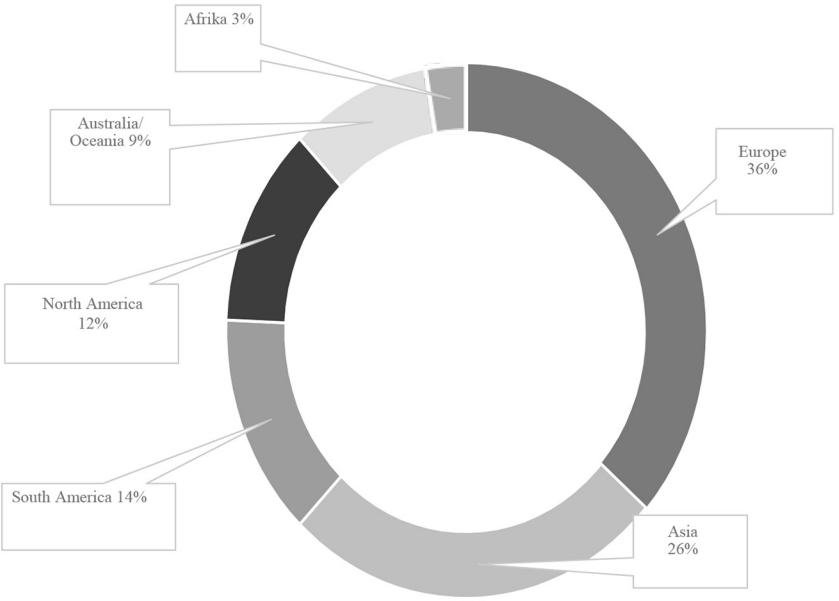

(b)

Figure A1.
Descriptive analysis of materials

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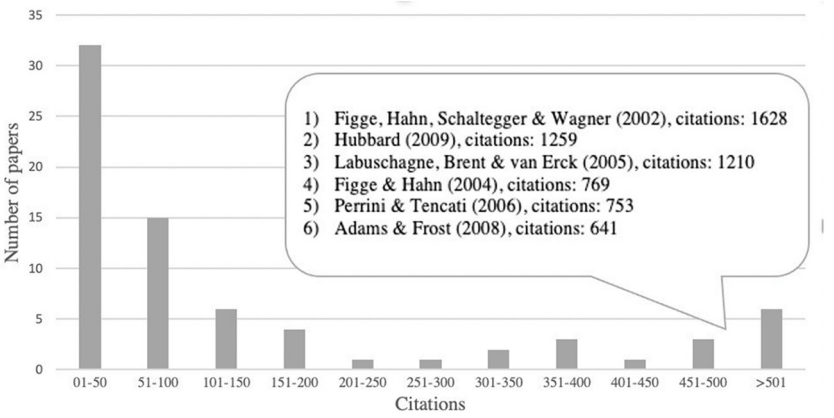

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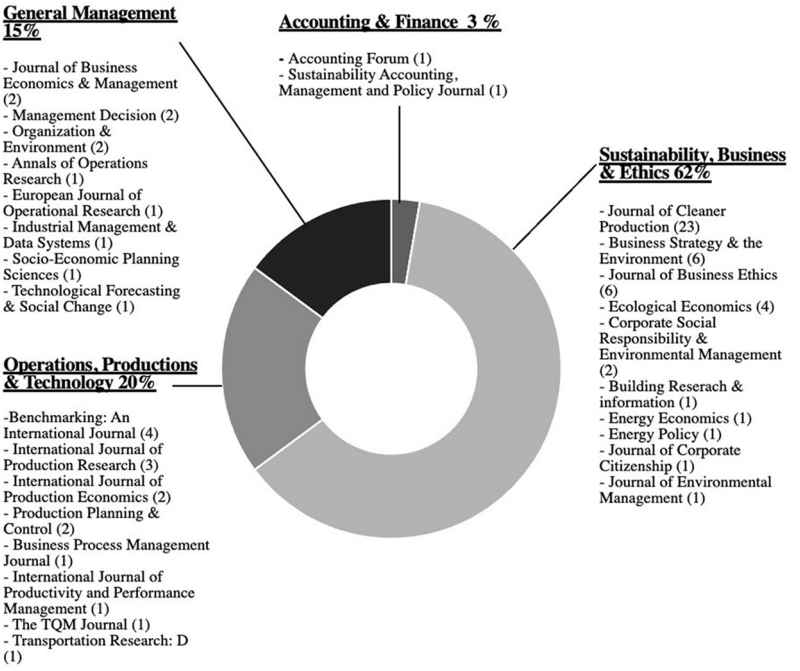

(d)

Notes:(a) Number of papers published each year;(b) Affiliation of the first author; (c) Number of citations; (d) Categorization of journal groups
Source: Authors' own work

Figure A1.

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