The final publication is available at Journal of Environmental Planning and Management, DOI: 10.1080/09640568.2020.1766427.

Cite this article as: Ferrero-Ferrero, I., León, R., & Muñoz-Torres, M. J. (2020), Sustainability materiality matrices in doubt: may prioritizations of aspects overestimate environmental performance? *Journal of Environmental Planning and Management, doi.org/10.1080/09640568.2020.1766427*

Sustainability materiality matrices in doubt: May prioritizations of aspects overestimate environmental performance?

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Abstract

This study builds on the research gap that arises from the consistency analysis of GRI-materiality approach with other prioritization approaches. The main objective is to explore to what extent corporate environmental performance is consistent using two different prioritization approaches. This study employs a novel quantitative approach to assess environmental performance through the prioritization of environmental aspects by using companies' materiality analysis and independent expert knowledge. The empirical analysis focuses on the environmental performance analysis of wearing apparel companies. The main finding reveals that companies with better environmental performance could be using materiality analysis to further embellish the positive performance or for greenwashing purposes. This study could serve as a starting point to improve the understanding of how companies could identify, from an objective and comparable basis, those environmental aspects that are essential to their business strategy and that are necessary to help stakeholders to make fully informed decisions.

Keywords: environmental performance, sustainability accounting; sustainability reporting; materiality analysis; wearing apparel industry

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1. Introduction

Sustainable Development Goals (SDGs) have promoted sustainability on a global-scale, which call for a global response and action by all countries. Accordingly, it is expected that private sector contributes to the implementation of the Agenda 2030 and to foster sustainable development. Sustainability is understood as a situation in which human activity is conducted in a way that safeguards Earth's life-support system and protects the welfare of current and future generations (Griggs et al. 2013). However, this situation depicts a broad context, vague, complex and difficult to operationalize at corporate level (Muñoz-Torres et al. 2018), which requires further developments to make significant progress in the field of corporate sustainability.

A crucial factor for improving corporate sustainability is to advance in measuring and monitoring sustainability performance. In this context, one of the weaknesses of the current measurement frameworks that needs to be addressed is their limited ability to identify those issues that should be measured and how to respond to them (Whitehead 2017). Another main obstacle to understand the integration of sustainability at corporate level (Witjes et al. 2017) is the disconnection among the sustainability assessment, reporting, accounting, and management control fields in both literature and practice. In this vein, improvements in the measurement and management of sustainability performance are clearly needed to achieve high-quality decision-making and high-quality sustainability reporting. At the same time, and in order to increase sustainability performance, sustainability reporting should be effective, since it is considered as an important tool for communication and stakeholder engagement in the management process.

Despite sustainability reporting is important to assess, manage and communicate internally and externally, current reporting practices still have significant gaps which have come to light in numerous studies and surveys (e.g. Kitsikopoulos et al. 2018; Eurosif and ACCA 2013; EYGM 2014). A stream of literature highlights the discretionary nature of sustainability reporting and the possibility of using the sustainability reports in an opportunistic way for greenwashing purposes (Kim and Lyon et al. 2014; Laufer 2003). In parallel, other critical works put the lens on sustainability reports showing how irrelevant and incomplete (too generic) the information for stakeholders is; highlighting the lack of detailed and quantifiable measures and heterogeneous indicators, which are difficult to compare (Bradley and Botchway et al. 2018; Dubbink et al. 2008; Hess 2007; Michelon et al. 2015). All these important weaknesses on the quality (Hahn and Kühnen 2013) of sustainability reporting affect directly to the content of reports and their credibility (Lock and Seele 2016; 2017).

Building on these gaps, this study focuses on the connection between sustainability reporting and performance assessment, paying special attention to the prioritization process, in order to identify those aspects that are essential to business strategy and stakeholder management. In this respect, a key concept is materiality, a fundamental principle of financial reporting that has been incorporated into sustainable reporting. Materiality in financial reporting is defined by Financial Accounting Standards Board (FASB, Statement of Financial Accounting Concept No. 2) as: *'The magnitude of an omission or misstatement of accounting information that, in*

the light of surrounding circumstances, makes it probable that the judgement of a reasonable person relying on the information would have been changed or influenced by the omission or misstatement'. The main message of this definition is that materiality establishes the threshold between what is important and what is trivial. Recently this concept has been adopted as a principle by the main non-financial reporting standards (Global Reporting Initiative - GRI, International Integrated Reporting Council -IIRC, and Sustainability Accounting Standards Boards - SASB) in order to decide the issues and indicators to include, omit, and emphasize in sustainability reporting. However, each different reporting initiative involves a different subjective process to assess materiality, what could be considered to be too much flexible and to lead to selective reporting and a loss of credibility in sustainability reporting. Despite the relevance of the materiality principle for reporting standards, in the academia, the quality of the materiality assessment process is a question that requires further developments (Kitsikopoulos et al. 2018; Messier et al. 2005).

Sustainability aspects prioritization differs substantially across industries. For that reason, an approach focused on a limited number of the most relevant aspects for a specific industry can contribute to improve comparability and practicability for stakeholders. This study adopts an industry-based approach and attempts to advance the materiality framework in the wearing apparel industry. The wearing apparel industry is considered as one of the most unsustainable industries in the world from an environmental dimension (Choudhury 2014) due to several reasons: use of harmful chemicals, high consumption of water and energy, generation of large quantities of solid and gaseous wastes, spillages, huge fuel consumption for transportation to remote places where textile units are located, and use of non-biodegradable packaging materials. In addition, wearing apparel industry is one of the most global industries in the world with huge environmental impacts along the supply chain (Escrig-Olmedo et al. 2017; Fransson and Molander 2013; Muñoz-Torres et al. 2018). Given the relevance of environmental impacts of this industry and their large scope, this paper provides a first analysis focused on the environmental dimension.

In this context, this study aims to explore to what extent corporate environmental performance is consistent using two different prioritization approaches. To this end, this study develops a process to assess environmental performance through the prioritization of environmental aspects by using company materiality analysis on the one hand, and independent expert knowledge on the other. This study contributes to the current discussions on environmental reporting and environmental performance assessment in two directions. First, this study provides a novel quantitative approach to compare prioritization methods. Second, this study digs deeper into the materiality assessment for defining reports content, and highlights the necessity to involve expert judgements to complement the materiality analysis.

This work is divided into five sections. After this introduction this study presents the theoretical background. The third section includes information on the methodology used in the empirical analysis. Section four presents the empirical results and discussion. Finally, section five offers the main conclusion.

2. Theoretical background

This study reviews theoretical arguments that support stakeholder engagement and sustainability reporting, and considers the prominent empirical studies and international standards in this field.

2.1. Stakeholder theory and sustainability reporting

Stakeholder theory (Freeman, 1984) is one of the most dominant theories used in sustainability reporting and environmental management research (e.g. Bellantuono et al., 2016; Gallego-Álvarez and Ortas 2017; Herremans et al. 2016; Jones et al. 2017; Manetti and Bellucci 2016; Reed et al. 2009). Stakeholder theory states that companies must bear in mind the different needs and expectations of those groups or individuals who can affect or be affected by the business activities, i.e. the stakeholders. In literature, stakeholder theory has been justified from different perspectives, becoming the instrumental one (Donaldson and Preston 1995; Jones 1995) a recurrent approach to explain the relationship between stakeholder management and favorable corporate performance. In this regard, Instrumental Stakeholder Theory (Jones 1995), which integrates Freeman's Stakeholder Theory (1984) with economic, behavioral science and ethics concepts, states that the relationship of cooperation, trust and non-opportunistic behavior provides companies with competitive advantage.

In this context, sustainability reporting is understood as an effective practice of stakeholder management whether the information reported forms the basis for meaningful interaction between the company and its stakeholders (Barkemeyer et al. 2015). However, the prioritization of the stakeholders' demands and needs and the interaction process between the company and the stakeholders are central issues that have not yet been sufficiently addressed in the business strategic management in general, and in the sustainability reporting design and implementation in particular (Ferrero-Ferrero et al. 2018). In this regard, an important question that arises in sustainability reporting is how their contents respond to "sustainability of what" and "sustainability for whom". Sustainability reporting, as a sustainable business practices, has been criticized (Mahsud et al. 2018) to meet only the expectation of primary stakeholders (Freeman 2017) given their role to support the viability of business. Note that although stakeholder's expectations about sustainability could be sometimes aligned (e.g. improving the efficiency with respect the resource use), they could also be contradictory (e.g. profit maximization at expenses of cultural heritage) (Mahsud et al. 2018; Schaltegger et al. 2017). Based on these arguments, the model of organizational hypocrisy (Brunsson 2002) and the impression management perspective (Leary and Kowalski 1990) emerge to explain the misaligned or non-aligned organizational management practices.

The model of organizational hypocrisy states that an inconsistency between organization's talk, actions and decisions may be deliberated with the aim of satisfying multiple demands in an organization, even when the interests of stakeholders are contradictory, and maintaining the legitimacy of organizations. As Brunsson (1993 p. 490) highlights "what can be talked about cannot always be translated into action, and what can be done cannot always be talked about". In this vein, Nickell and Roberts (2014 p. 218) illustrate the model of organization hypocrisy with the example that "a mining company can talk about its commitment to protecting the

environment in its sustainability report and increase its invasive techniques for strip mining in pristine wildfire areas".

The impression management perspective (Leary and Kowalski 1990) can contribute to the explanation regarding the possibility to meet only a group of powerful stakeholders. Although, this theoretical perspective was initially focused on individual behavior, it has been extended to explain how companies can strategically disclose information to manage the perceptions of stakeholders in order to increase their reputation or to handle legitimacy threats (Hooghiemstra 2000). Different authors have highlighted that companies have used the management of perceptions to give answer to different stakeholder's behavior and attitudes toward corporate social responsibility (Cho et al. 2009) and environmental information disclosure. Cormier et al. (2004) show how company managers perceive different stakeholders' attitudes towards environmental issues and how the firm disclosure is tailored to fulfill the most valued stakeholders to get firm legitimacy.

Consistent with this perspective, sustainability reporting could be seen as a form of impression management when companies attempt to influence their reputation selecting only good environmental and social strategies and actions (Adams 2008; Bebbington et al. 2008). Therefore, companies can avoid publishing those aspects that negatively influence corporate brands. In this context, the principle of materiality in non-financial information, which allows companies to determine and prioritize the relevant aspects and topics, underlies to limit the room for discretion in the selection content of sustainability reporting. However, the lack of earnestness in the application of the materiality principle (e.g. Beske et al. 2020, Calabrese et al. 2019; Guix et al. 2019) leads to call into question whether companies tend to select topics strategically in terms of reputation. The impression management perspective is related to greenwashing practices when there is an intentionally misleading environmental communication (Torelli et al. 2019a). In this case, a company can create confusion and deceptively posture its objectives, commitments and accomplishments (Laufer, 2003) to generate a positive but totally misleading impression of the company's performance. In this regard, Torelli et al. (2019a) show how greenwashing influences stakeholder perceptions about company environmental behavior in different contexts of misleading communications.

Building on this research stream, this paper uses the stakeholder theory jointly with the impression management perspective, which support the main findings of a large number of empirical studies, like biases in the quantity of disclosure (e.g. Hahn and Kühnen 2013; Reimsbach and Hahn 2015) or in the choice of thematic content of disclosure (e.g. Clarkson et al. 2008). From the stakeholder theory, if a company adopts a shareholder primacy approach in a "business case of sustainability" (Schaltegger et al. 2017) context, it could use subjective process to identify those stakeholders (or representatives) and to meet those of their needs that contribute to maximize the economic performance. This opportunistic approach of the stakeholder theory could be used to justify positive bias in the sustainability performance disclosure. However, as pointed out by Kim and Lyon (2014), a company may not always want to exaggerate favorable environmental performance. They find that under a deregulated environment, where a higher power of shareholders is more evident, companies show a less friendly environmental behavior than the one they really have, and this result is exacerbated in those cases where companies obtain lower profits. In this case, this behavior may be

explained due to shareholders could punish companies if they consider that companies are reducing their profits at expenses of protecting the environment. This is consistent with the results provided by Chen et al. (2017), who find that mandatory disclosure impacts a firm's activities because the increased transparency can make it easier for governments and interest groups to pressure firms to engage in more CSR activities, and that may lead to a decrease in firm performance. In addition, companies with lower environmental performance will have fewer incentives to greenwash since they will assume high reputational risks. By contrast, companies with good environmental performance will adopt impression management strategies by paying special attention to the public reporting in those aspects where they present the highest results. This strategy will enable companies to gain a competitive advantage (Mahsud et al. 2018).

Accordingly, this study suggests that as the companies' results get better their decision will appear more subjective regarding stakeholder engagement and sustainability reporting. This can be understood due to their interest to generate favorable impressions of corporate sustainability performance, preserve the support of their primary stakeholders and gain superior environmental performance over its competitors.

2.2. Studies in sustainability reporting: stakeholder engagement and materiality

Sustainability reporting has been criticized for presenting opacity and disclosing incomplete and irrelevant information, which is too generic, vague and hardly comparable (Boiral and Henri 2017; Dubbink et al. 2008; Hess 2007). This is in contrast to the initiatives of international standards which have paid special attention in principles and good practices that help companies to define the report content based on relevant topics. In this regard, the most globally used disclosure framework (Landrum and Ohsowski 2018; Park and Ravenel 2015), that is GRI, proposes two noteworthy principles i.e., 'stakeholder inclusiveness principle' which is related to the identification of stakeholders and the explanation of how the company responds to the stakeholders' expectations, and 'materiality principle' which aims that sustainability report covers those topics important for reflecting the organization's economic, environmental, and social impacts, or influencing the decisions of stakeholders (GRI 2016). Likewise, the Integrated Report also includes materiality principle in the guidance for the preparation of reports. In this case, a material matter is understood as a matter that 'could substantively affect the organization's ability to create value in the short, medium and long term' and industry factors and multi-stakeholders perspectives should be included in the process of determining (IRRC 2015: 4). Other standards have addressed similar principles but with different lens. For instance, the Sustainability Accounting Standards Board identifies sector-specific material topics for investors based on the Lydenberg et al. (2010) proposal (Eccles et al. 2012).

The application of materiality principle by different international initiatives shows a growing interest in this topic. In addition, the sustainability reporting is encouraged by the European directive on nonfinancial disclosure (Directive 2014/95/EU), which requires large companies to disclose on social and environmental aspects. Directive 2014/95/EU gives companies flexibility to choose the guidelines for nonfinancial information disclosure. In this respect, both

Integrated Reporting and GRI standards are allowed, among others. However, it is different the logic behind each standard to determine whether information is material or not. GRI is inspired by a stakeholder logic (Mio et al. 2020) and Integrated Reporting is driven mainly by a finance-centric market logic (Cerbone and Maroun 2019; Mio et al. 2020). Therefore, depending on the used standard, the identification of material topics could be different (Mio et al. 2020) and consequently, it makes it more difficult the comparison between nonfinancial reports.

In academia, an increasing number of empirical studies address stakeholder engagement and materiality practices in sustainability reporting. In these studies, three of the most common characteristics that arise are: (i) a sector-specific approach (e.g. Ceulemans et al. 2015; Ferrero-Ferrero et al. 2018; Jones et al. 2015a; 2015b; 2016a; 2016b), (ii) the use of GRI reports[1] as the main source of information (e.g. Barkemeyer et al. 2015; Boiral and Henri 2017; Domingues et al. 2017; Moratis and Brand 2017) and (iii) a clear evidence of opacity or a lack of rigorous process of determining the sustainability report content as a result (e.g. Beske et al. 2020; Boiral and Henri 2017; Boiral et al. 2017; Diouf and Boiral 2017; Guix et al. 2019).

Focusing on stakeholder engagement, numerous studies that have explored the quality of stakeholder engagement in sustainability reporting (Diouf and Boiral 2017; Manetti 2011; Moratis and Brand 2017), find that companies usually engage with stakeholders; although they fail to provide full disclosure on how stakeholders have been engaged in defining the report content and how companies have responded to the stakeholder concerns. In this vein, Manetti (2011) highlights that, in a large number of companies, reports show a management stakeholder approach rather than a stakeholder engagement, what implies a low participation of stakeholder in defining the content of reports. Likewise, Diouf and Boiral (2017) examine the perceptions of the quality of GRI reports held by socially responsible investment practitioners and conclude that sustainability reports reflect the impression management strategies to remark aspects associated with favorable performance and obfuscate negative outcomes. By analyzing other tools for supporting stakeholder engagement, Manetti and Bellucci (2016) reveal that only a small number of organizations use the online interaction through social media as a stakeholder engagement mechanism in order to define the contents of sustainability reports.

Regarding materiality, a broad range of studies show that, in practice, companies do not comply with this principle or there is a lack of a systematic approach to determine material issues (Barkemeyer et al. 2015; Beske et al. 2020; Guix et al. 2019; Hsu et al. 2013). In this regard, Beske et al. (2020) after examining 132 reports of the German 110 HDAX stock market index between 2014 and 2017, find that, regardless of the reporting framework followed (integrated reporting or GRI), companies provide a small amount of information which is hard

[1]As exceptions, Lai et al. (2017) explore how the materiality principle is implemented in the Integrated Reporting, highlighting a clear strategic orientation and a significant role of the chief financial officer and Fasan and Mio (2017) identify the determinants of materiality disclosure based on the adoption of Integrated Reporting, concluding industry and some firm-level characteristics as significant factors.

to verify and, in most cases, a lack of information regarding how they have identified stakeholder and material topics. Likewise, Guix et al. (2019), based on semi-structured interviews with sustainability managers in hotels, explain the unsystematic and opaque materiality analysis in reports as a consequence of the limited resources, time, knowledge and skills to adopt materiality assessments without an impact on the core business practices.

At international level, Barkemeyer et al. (2015), after examining 933 GRI reports by companies from 30 countries and 7 industries, find that sustainability reports do not reflect context-specific materiality considerations. In this respect, Hossein Rahdari and Braendle (2016) underline that companies should pay more attention to the material aspects and not just disclosing more indicators. Jones et al. (2015a; 2015b; 2016b) and Bellantuono et al. (2018) carry out different studies for specific-sector regarding materiality. A common conclusion of the Jones et al. studies is that less than 50 per cent of the companies analyzed address materiality in their reports, and they adopt different approaches on how they determine and identify material aspects, making it difficult comparisons. In this regard, Bellantuono et al. (2018) criticizes the GRI guidelines materiality approach given the subjectivity of the analysis and propose an approach to identify a list of mandatory material topics for agri-food sector based on expert knowledge. Regarding the importance of industry for the materiality principle, Torelly et al. (2019b) find that companies that belong to environmentally sensitive industries tend to apply the principle of materiality less seriously. Although the authors justify the results due to the irrelevancy of a materiality analysis for these companies, since they are under pressure to show environmental information, an alternative explanation could be that they do not elaborate detailed materiality analysis to avoid controversial issues. Concerning textile and wearing apparel sector, García-Torres et al. (2017) explore the materiality matrices of the two leading fast-fashion companies (Inditex and H&M) and find only 56 per cent of common material issues and an absent of issues not reported but key for the fast-fashion industry ecosystem.

Considering stakeholder engagement jointly with materiality, Fasan and Mio (2017: 302) find evidence of a conflicting vision of the materiality "in which different stakeholder groups compete to have their issues classified as material, at the expense of other stakeholders". Focusing on the user-oriented perspective on materiality, Reimsbach et al. (2019) conclude that materiality of non-financial information is an ambiguous concept that depends on the user. In particular, they find that potential employees consider nonfinancial information more material than capital market participants, who choose as material topics those that can be translated into financial terms (performance or risk).

Other articles propose new methods for supporting materiality and stakeholder engagement analyses and, consequently, improving sustainability reporting. Accordingly, Bellantuono et al. (2016) highlight as a weakness of GRI-G4 guidelines the lack of specific recommendations or tools to actually engage stakeholders for materiality analysis. Filling this gap, these authors propose a structured quantitative approach to support materiality assessment in sustainability reporting, which is applied to Italian SMEs from several sectors. Hsu et al. (2013) offer a new model to identify material issues based on stakeholder concerns according to occurrence, detection and severity criteria. Calabrese et al., (2019) propose a method that attempts to handle the subjectivity of the materiality analysis and overcome the critical issue of

discrepancies in judgements, including a consistency test. Whitehead (2017) prioritizes sustainability indicators for the New Zealand wine industry using materiality analysis based on the salience of each issue across multiple stakeholders' groups and the risk posed given the country-industry context. García-Torres et al. (2017) propose a 'Fast-Fashion Sustainability Scorecard' based on an action-oriented disclosure tool for industry-specific concerns which help companies to disclosure information on their actions to address key concerns.

With the aim of improving the credibility of sustainability reporting some authors (Manetti 2011; Jones et al. 2016a) suggest that a stronger focus should be placed on the external assurance and it is necessary that auditors clarify the criteria used to assess the quality of sustainability reports. In line with this, Boiral et al. (2017) examine the opinions of assurance providers regarding the GRI sustainability reports in the mining and energy sectors. They show that the materiality principle is one of the most frequently assessed principles in the statements although it is not clear the verification process of the principle in practice. Surprisingly, they find a lower explicit reference of the stakeholder inclusiveness principle, which is mainly addressed using internal procedures rather than external stakeholders.

Consequently, recent studies have paid much attention to the weaknesses in the implementation of GRI-materiality principle and stakeholder engagement, remaining unexplored the consistency of GRI-materiality approach with other materiality approaches in quantitative terms. The robustness of materiality analysis requires further attention since it could affect the reported indicators and, consequently, the sustainability performance. In this respect, the lack of consistency in the materiality analysis could be a possible explanation for the findings that suggest that evaluation of sustainability performance is subjective and differently measured depending on particular needs (Büyüközkan and Karabulut 2018).

This study contributes to this research gap through a comparative analysis using two different approaches of materiality: GRI-materiality matrices analysis developed by textile companies vs. materiality analysis proposed by Lydenberg et al. (2010) and conducted by sectoral experts. This study compares the performance derived from both materiality analyses. On the basis of the previous theoretical framework and above-mentioned finding, this study expects that those companies with good environmental performance will adopt imprecise materiality analysis with the aim of adopting impression management strategies to enhance those aspects associated with favorable performance in the sustainability report instead of key sectoral aspects. This practice involves the overestimation of own environmental performance, measured as the difference between assessment results using materiality matrices and expert knowledge, and it is defined in this paper as a self-laudatory environmental practice.

Accordingly, the following hypothesis is developed and empirically tested:

Hypothesis: A higher environmental performance leads to a higher overestimation of performance.

3. Method

This study employs Analytical Hierarchy Process (AHP) (Saaty 1980) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Hwang and Yoon 1981), to calculate two environmental performance scores for a sample of companies in the industry. The two scores differ mainly in the environmental aspects used, and the relative importance they are given, which have been determined separately by using a set of materiality matrices for the first score, and by a group of experts for the second one.

Bi et al. (2015) review existing techniques for measuring environmental performance at different economic levels, and they identify that literature on this topic uses life cycle analysis, multiple criteria decision making, stochastic frontier analysis, distance function, data envelopment analysis and other integrated approaches. AHP and TOPSIS may be considered specific methods for multicriteria decision making, and they share some similarities with methods in the other categories. Furthermore, both techniques are two of the most used in Multicriteria Decision Making Method literature, and have been recently applied in materiality and sustainability reporting research (e.g. Calabrese et al. 2016).

The rest of this section provides information explaining how the empirical analysis has been carried out, including: (i) research design to describe the approaches of prioritization (ii) sample of wearing apparel companies, (iii) assessment method and (iv) linear regression model.

3.1. Research design to prioritize aspects using materiality matrices

This study applies two different approaches to prioritize environmental aspects in the wearing apparel industry using, on the one hand, the company materiality analysis and, on the other hand, exogenous expert knowledge.

The first approach is based on the materiality analysis addressed by wearing apparel companies and published in their GRI sustainability reports. After examining the reports listed in the GRI-Sustainability Disclosure Database from 2013 to 2015 in the wearing apparel industry, this study selected those reports that present a clear analysis of materiality with a materiality matrix. In particular, the reports that comply with this requirement were: Dudalina, Kering, Lindström, Puma, Zeeman, Hennes & Mauritz (H&M), Inditex, Lojas Renner, and DBL Group. To the purpose of this research, this study identified 12 environmental aspects proposed by GRI and 3 additional aspects related to product responsibility, due to their close linkage to product environmental management. These aspects were prioritized based on the following information: (i) whether each environmental aspect was material or not, and (ii) the position of each aspect in the materiality matrix (when it was included).

The employed materiality matrices corresponded to 2013 reports, since it was the reporting year when sample companies presented in more detail the materiality analysis. Nonetheless, in 2015, the data remained substantially unchanged. Note that in a broad range of companies the materiality analysis has a validity for two or three years, and therefore the analysis of one single year is expected to provide a solid evidence of the reporting practices of the companies in the sample due to the following reasons. On the one hand, because as in any other industry,

companies must be able to measure and assess their sustainability performance and to demonstrate continuous improvements over long term. Furthermore, both medium and long-term impacts may need to be reviewed when assessing what is material (Jones, 2016a), so it is expected that few changes are included in the reported information in the short term. On the other, because companies' main activities are also expected to remain unchanged, like so their usage of social and environmental capitals and their main social and environmental impacts.

The prioritization of the identified environmental aspects on the basis of selected materiality matrices was done following to the process described by León et al. (2016). According this method, AHP was used to calculate the relative weight of the different aspects prioritized by companies' materiality analysis, and later with TOPSIS to calculate the overall assessment of a sample of companies in each of those aspects.

The AHP method involves generating a weight for each evaluation criterion (aspects in our case) according to the expert's pairwise comparisons of the decision criteria. In our case, instead of interviewing experts, the pairwise comparisons of the aspects have been done on the basis of the materiality matrices that companies in the sector disclose.

These matrices are included in sustainability reports in the form of scatter plot figures, where the two axes represent respectively the significance of economic, environmental and social impacts; and the influence on stakeholder's assessment and decisions. Dots represent sustainability aspects, so the more in top-rigth corner an aspect is located, the more material is considered by the company.

Using these figures, the position of aspects in the matrix has been used to rank the different aspects within each materiality matrix according to their Euclidean distance to the origin. Then, the comparison values have been defined by rating the relative distance of the aspects within the rank by using a scale based in the one scale proposed by Saaty (1980). All the aspects in the matrix have been rated *extremely important* in relation to those not included in the matrix, which at the same time have been rated *equally important* between them. These assumptions are based on the fact that as far as an aspect is material for a company, it should appear in its materiality matrix. As far as a company recognizes some aspects as material and others as not material, it clearly stablishes an important distinction among them in qualitative terms Therefore, we consider that missing aspects are not material at all for companies, being those included extremely important in relation to them. Moreover, as not material aspects are not represented in the matrix, it is not possible to compare the relative importance among them, being therefore considered equally not material. More concretely, the comparison values have been defined as described in Table 1

Insert Table 1 here

Consistency tests are then conducted as required by AHP. To this end, the consistency index (CI) and the consistency ratio (CR) are calculated for each matrix in order to test the consistency of the judgments extracted from materiality matrices.

The individual comparison matrices of the companies in the sample are then aggregated to create a collective matrix. The Aggregation of Individual Judgments (AIJ) method is used in this

process, which is one of the methods that have been found to be the most useful in AHP group decision making judgments (AIJ) (Dong et al., 2010). According to AIJ, individual judgement matrices are aggregated by means of geometric mean to obtain a collective judgement matrix.

Let $D=\{d_1,d_2,...,d_m\}$ be the set of materiality matrices collected from sustainability reports, $C=\{c_1,c_2,...,\ c_n\}$ the set of sustainability aspects used as assessment criteria, and $A^{(k)} = \left(a_{ij}^{(k)}\right)_{n*n}$ the judgment matrix constructed by the process described above from the materiality matrix d_k ($k=1,2,...,m$). AIJ can be used to calculate a collective judgement matrix $A^{(c)} = \left(a_{ij}^{(c)}\right)_{n*n}$ where

$$A^{(k)} = \left(a_{ij}^{(k)}\right)_{n*n}$$

After assessing consistency of the collective matrixthe next step entailed using a prioritization method to derive a collective priority vector. The prioritization method refers to the process of calculating a priority vector $w=(w_1,...,w_n)^T$, where $w_i \leq 1$ and $\sum_{i=1}^{n} w_i = 1$ from a judgement matrix A. To this end this paper follows Saaty's proposal, which is based on the eigenvalue method (Saaty, 2003). Let λ be the principal eigenvalue of A, and e^T the unique positive eigenvector of A that is normalised. Then, the priority vector w can be obtained by solving the linear system:

$$\begin{cases} Aw = \lambda w \\ e^T w = 1 \end{cases}$$

As a result of this process, it is obtained a priority vector with the relative importance—or materiality—of each GRI aspect considered as criteria for the assessing the environmental performance of corporations

3.2. Research design to prioritize aspects using expert knowledge

The second approach for environmental aspects priorization was developed in accordance with Lydenberg et al. (2010) proposal and was carried out by a group of experts of environmental concerns in the wearing apparel industry. In this case, the research was structured in three phases. The first phase consisted in identifying the environmental issues regardless the industry selected. To this end, this study used RAND method, which combines scientific evidence and expert knowledge (Muñoz Torres et al. 2013), by carrying out an analysis of the literature on sustainability tools to create an initial set of environmental issues and a subsequent proposal and discussion of a group of experts on corporate sustainability to reach a consensus on the final list of relevant environmental issues. The second phase focused on the questions of interviews to prioritize the environmental issues of the wearing apparel industry according to five dimensions[2] (Lydenberg et at. 2010): Financial impact/risk; peer-

[2] In the prioritization of aspects, this study calculates an average by issue of the results obtained in the five dimensions.

based norms; stakeholder concerns; legal/regulatory/political drivers; and opportunity for innovation. In the prioritization of aspects this study calculates an average by issue, using the individual results obtained in the five dimensions. To validate this process, three experts on environmental dimension in wearing apparel industry evaluated the questions with the aims to ensure that they captured the purpose of the research. The third phase comprised informal interviews with some of the experts which were carried out from March to June 2015. The interviews were supported with a questionnaire to obtain the numerical measures used in the prioritization method. The numerical answers were discussed also with those experts to validate the results. The pool of experts in environmental aspects and wearing apparel industry was 12 belonging to European organisations and regulators, national and local regulators; NGOs; companies; business organisation; investors; media; academia; and trade unions.

In this approach, the priority vector was obtained by aggregating and normalizing the responses of the independent experts, as they already offered quantitative measures of importance for the diverse aspects.

On an initial step, the responses of the experts in relation to the importance they confer to the five dimensions of Lydenberg et al. (2010) are aggregated by calculating the row geometric mean method (RGMM) (Crawford and Williams, 1985). The five dimensions priority vector is then used to calculate the priority vector for aspects by aggregating the responses to the survey. To this end, it is used the row weighted geometric mean method (RWGMM).

3.3. Sample of wearing apparel companies

The two assessment methods above-mentioned have been applied to estimate the corporate environmental performance of a sample of companies according to the different importance that materiality matrices and experts confer to the diverse environmental aspects. The sample consists of 53 companies belonging to the wearing apparel industry. The sample has been selected according the information available in Thomson Reuters Datastream database and the filter 'industry', including the following: apparel retailers, broadline retailers, clothing & accessory, and footwear. Environmental, social and governance (*ESG*) data from Thomson Reuters Datastream (former Asset-4) is obtained from publicly available information and offers a comprehensive platform for assessing corporate performance in environmental, social and governance terms (Ferrero-Ferrero et al. 2015).

Our sample comprises companies from 15 countries around the world, being United States the one more represented, with 15 companies. By regions, North America and Asia have 32% companies each, followed by Europe with 22.65%. Oceania has 7.55% of the companies, Africa 3.85%, and only 1.95% of the companies have their headquarters located in South America. On average for the three years, companies in the sample—for which data is available in the database—employ over 46,000 employees each, having the smallest one 2,372 employees. Regarding total assets indicator, the average value is almost 61.5 billion dollars, having the smallest company a total assets value over 6.5 million dollars. Several of the companies are listed on more than one international stock exchange.

For each company in the sample, a set environmental key performance indicators (KPIs) corresponding to years 2013, 2014 and 2015 was extracted. In the database, each of these

indicators are scored from 0 (the lowest performance) to 1 (the highest performance). This study has selected the environmental indicators due to their relation to the environmental aspects of the materiality analysis (47 environmental KPIs) and issues of the expert knowledge (43 environmental KPIs), which are mainly common in both cases (36 environmental KPIs). With this KPIs' process selection the objective is to directly connect assessment with sectoral activity.

Scores within the same aspect are aggregated by calculating the geometric mean. Note that whether a company does not report a particular indicator in the database, it could be supposed that the company, or does not have the capacity to assess this impact or has such a low performance that does not to declare intentionally. Accordingly, as Thomson Reuters Datastream obtains extra-financial information from public sources and this study has allocated, the minimum score to those indicators that have presented a lack of data. Moreover, one of the GRI aspects and four of the expert knowledge aspects have been excluded from the analysis, as any of the KPIs included in Asset-4 were considered by the authors to fit those aspects. Table 2 provides details of the indicators used for each aspect in the two approaches.

Insert Table 2 here

The environmental scores, calculated as explained in the following section with the closeness coefficient provided by TOPSIS, provide robust results even when some of the aspects in the prioritization vector are not included in the analysis.

3.4. Assessment method for environmental performance estimation

Using the normalized priority vectors and the set of performance indicators associated to the different sustainability aspects, defined as explained above, the performance of companies operating in the sample was scored using the TOPSIS method.

On an initial step, performance indicators associated to each criterion were synthetized in a single and normalized measure—value from 0 to 1—to be used as input for TOPSIS method. To simplify the use of TOPSIS, all the synthetic indicators where generated to represent a benefit criterion, standing 0 for the worst performance and 1 for the best. After synthetizing indicator by related aspects, the application of the TOPIS method followed next steps, and it was executed for both of the materiality matrices and the experts' knowledge approaches

Let $S=\{s_1,s_2,...,s_p\}$ be the companies to be ranked and $R = \left(r_{ij}\right)_{p*n}$ the decision matrix with the measures previously calculated for each company s_i(*i=1,2,...,p*) and criteria c_j(j=*1,2,...,n*). The TOPSIS method starts by calculating the normalized decision matrix $R^{(N)} = \left(r_{ij}^{(N)}\right)_{p*n}$

$$r_{ij}^{(N)} = \frac{r_{ij}}{\sqrt{\sum_{i=1}^{p} {r_{ij}}^2}}, \qquad i = 1,2,\dots p; j = 1,2,\dots n$$

By using the priority vector w, we calculated the weighted normalized decision matrix $T = (t_{ij}) = \left(r_{ij}^{(N)} w_j\right)_{p*n}$, and then we determined the ideal positive candidate $T^+ = (t_1^+, t_2^+, \dots t_n^+)$and negative ideal candidate $T^- = (t_1^-, t_2^-, \dots t_n^-)$, where $t_j^+ = \max\left(t_{ij}^+\right)$ and $t_j^- = min\left(t_{ij}^-\right)$, *i=1,2,...,p;* j*=1,2,...,n.* The distance of each company in the sample from the ideal positive and negative candidates are then calculated as:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} \left(t_{ij} - t_j^+\right)^2}, \qquad i = 1,2, \dots p$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} \left(t_{ij} - t_j^-\right)^2}, \qquad i = 1,2, \dots p$$

The next step involves calculating the relative closeness to the ideal candidate, the one which is the nearest to the positive ideal candidate and the farthest from the positive ideal candidate. A closeness coefficient (CC) is defined to determine the relative distance the ideal solution, and it is calculated as

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-}, \qquad i = 1,2, \dots p$$

According to the latter expression, company s_i is closer to d_i^+ and farther from d_i^- as CC_i approaches to 1. Therefore, according the CC value, it is possible to assess the relative environmental performance of a company calculated on the basis of the materiality of the selected criteria and the companies on the sample. This value will be named environmental score in the rest of this paper, and it may be different depending on which of the two approaches is employed in its calculation.

3.5. Linear Regression Model

In order to test the hypothesis, this study estimates the linear regression model showed in Equation 1 using data panel from 2013 to 2015. In addition to the variables justified by the theoretical background (FAVORABLE PERFORMANCE and PERFORMANCE) and consistent with previous research (Hussain et al. 2018; Karaman et al. 2018; Martínez-Ferrero et al. 2015; Nazari et al. 2015), this study includes SIZE, LEVERAGE, and PROFITABILITY variables as well as geographical regions dummies as control variables. Note that Europe has been the dummy variable omitted.

The variables and proxies are displayed in Table 3.

(1)

$$FAVORABLE\ PERFORMANCE_{i,t} = \beta_0 + \beta_1 \cdot PERFORMANCE_{i,t} + \beta_2 \cdot SIZE_{i,t} + \beta_3 \cdot LEVERAGE_{i,t} + \beta_4 \cdot PROFITABILITY_{i,t} + \beta_5 \cdot NORTH\ AMERICA_{i,t} + \beta_6 \cdot LATIN\ AMERICA_{i,t} + \beta_7 \cdot OCEANIA_{i,t} + \beta_8 \cdot ASIA_{i,t} + \beta_9 \cdot AFRICA_{i,t} + \eta_i + \upsilon_{i,t}$$

With the aim of addressing the presence of unobserved heterogeneity, this study applies the generalized least square (GLS) random effect (RE) Swamy-Arora estimator which is typically used for small samples. The potential problem of multicollinearity has been explored by means of the variance inflation factors (VIF). The VIF values are below 3, therefore, multicollinearity is not a concern.

Insert Table 3 here

4. Empirical results

First, this section shows the results of the prioritization approaches used (Materiality Matrices vs. Expert Knowledge). Second, it includes an exploratory analysis of the main variables of the study. Third, it reports the results of the multivariate analysis carried out to test the hypothesis.

4.1. Results of the prioritization approaches

The assessment methods have been applied to the sample previously described. Table 4 shows the weighting criteria (priority vectors) obtained from the results of the materiality matrices published by companies and the expert knowledge from independent sectorial experts. This study finds differences between both prioritization approaches which may influence the final environmental scores.

Insert Table 4 here

In the case of the first approach, the collective judgment matrix derived from individual companies' materiality matrices has proven to be consistent, presenting a consistency index of 0.93% and a consistency ratio of 0.59%. The random index (RI) value used to calculate the consistency ratio has been set to 1.59, as we use 15 environmental aspects as assessment criteria (Saaty, 1980). In relation to individual judgment matrices, all CR values, as shown in Table 5, are lower than 0.1, therefore individual matrices can be considered consistent.

Insert Table 5 here

The results reveal that 'Effluent and Waste', 'Materials', 'Water', 'Energy', and 'Emissions' aspects are the five most relevant aspects. It is important to note that the weights of these five aspects represent almost the 60% of total relevance, and therefore they play a crucial role in the assessment of companies according to the materiality matrices. On the other side, aspects such as 'Product and Service Labeling', 'Compliance' and 'Environmental Grievance Mechanisms' have the lowest weights in the priority vector since they are not considered as material aspects by a large number of companies in the wearing apparel industry.

Regarding the expert judgments, the priority vector calculated by the row geometric mean reveals that financial performance and/or economic financial risks, and the opportunity for innovation as the most important dimensions of materiality for our experts Table 6 summarizes the weights of the five dimensions.

Insert Table 6 here

All the issues included in the semi-structured interviews have been scored above 3 out of 5 in average, which means that the expert consider the 22 environmental aspects to be relevant for the wearing apparel industry. Moreover, in relative terms there not exist large differences in the priority vector between aspects. Nonetheless, the most relevant aspects for the experts are 'Investment in environmental R&D&I and technologies' (clean technologies and eco-efficiency), mainly due to the importance for strategic reasons and the competitive position of the company, and 'Compliance with the more restrictive legal framework', what could be justified by the high negative consequences that it could have on the financial performance of the company, or with respect to the difficulties to meet the stakeholder expectations if the company does not comply with.

This study calculates two environmental scores depending on the prioritization approach to analyze whether a specific approach provides a more favorable environmental performance for companies.

4.2. Univariate Analysis

Table 7 displays the descriptive statistics of the environmental scores using the materiality matrices and the independent expert knowledge as well as company specific variables. At this level, a descriptive result is the fact that the performance obtained using materiality matrices in the 25th percentile is lower than using expert knowledge (except for 2013), although from the 50th percentile the relationship is reversed. This result may suggest the existence of asymmetries in the definition of what is important in relation to the environmental performance.

Insert Table 7 here

With the aim of exploring whether there are differences in the scores between the two prioritization approaches, this study carries out a non-parametric test. Table 8 shows the results of the non-parametric Kolmogorov-Smirnov test, which reject the null hypothesis that the distribution from the scores calculated using the materiality matrices are equal than using expert knowledge.

Insert Table 8 here

Given the hypothesis of this study, which expects that a higher (lower) environmental performance is associated to a more favorable (unfavorable) performance, and with the

objective of deepening in the exploratory analysis, this study has divided the companies into two subsamples depending on whether their environmental scores are higher or lower than the industry median, as a proxy of the result of the peer companies group.

Figure 1 illustrates graphically the results. In particular, the companies are ranked according their environmental performance and for each company the spider chart shows both environmental scores, i.e. calculated according to materiality matrices and according to expert knowledge. In this regard, when the blue line is above the red line means that using materiality matrices prioritization, the companies obtain a more favorable performance, which occurs mainly in the subsample that includes those companies that get a performance higher than the industry median. By contrast, in the other subsample when the performance obtained is lower than the industry median, the red line predominantly is above the blue line which implies that companies obtain an unfavorable performance using materiality matrices prioritization.

These results are consistent with the non-parametric Kolmogorov-Smirnov test for subsamples showed in Table 7. Concerning those companies with higher environmental scores than industry median (Figure 1 – Subsample 1), the results of non-parametric Kolmogorov-Smirnov test reveal that the environmental scores using expert knowledge are less favorable than using the materiality matrices developed by companies. In this context, the companies with good environmental performance adopt impression management strategies by paying special attention to the public reporting in those aspects where they present the highest performance. Consequently, these companies improve the opinion of their stakeholders about their behavior in order to increase their reputation in the market. An alternative explanation is connected to the lack of life-cycle thinking in the definition of aspects in GRI, that have arisen as relevant in the expert knowledge; as an example, 'Product life-cycle management' and 'Product management at the end of its useful life' achieved a high level of consensus of their importance among experts. When the environmental performance is lower than industry median (Figure 1 – Subsample 2), the performance from materiality matrices are lower than from experts. This finding is in line with the idea that those companies less environmental friendly do not have any incentive to greenwash their environmental results. Another possible explanation is that companies presenting low environmental performance lack of proper assessment systems for measuring environmental impacts, focusing on the management of general practices regarding compliance. This fact could justify the results since these aspects have received greater relevance in the case of the expert knowledge than in the materiality matrices one.

Insert Figure 1 here

4.3. Multivariate Analysis

The results of the previous exploratory analysis support the hypothesis developed in the theoretical framework. Nonetheless, in this section, this study examines how the environmental performance may affect the favorable performance measured by the difference between the two prioritization approaches, considering control variables in this relationship. Table 9 summarizes the results of the regression analysis. The results reveal the

level of the environmental performance as a significant variable that affects positively the difference between approaches, which is consistent with the results and explanations included in the univariate analysis. This finding remains unchanged regardless the environmental score used as proxy of environmental performance (Model A and Model B). Therefore, this study finds evidence to support the hypothesis presented, i.e., a higher (lower) environmental performance leads to a more favorable (unfavorable) environmental performance using company materiality matrix analysis than using expert knowledge.

Insert Table 9 here

5. Discussion and future studies

This study finds discrepancies between two different approaches of prioritization: expert knowledge and companies' materiality matrices. These discrepancies involve an overestimation of the environmental performance (self-laudatory) when companies use materiality matrices as a prioritization measure for assessing the performance in those cases where their performance is higher than the industry median. In this regard, the results reveal that the environmental performance increases the likelihood of positive bias in the performance based on the prioritization approach that uses reporting practices. This finding is consistent with previous studies that put in doubt the integrity and reliability of the sustainability reports as well as the objectivity of the reporting process to define material issues from a real stakeholder approach (Boiral and Henri, 2017; Dubbink et al., 2008; Hess, 2007). Based on the findings, this study suggests a set of implications for research and practice.

Contributing to the literature, this research offers a novel quantitative approach to compare different prioritization methods. In sustainability reporting literature, recent studies (Beske et al. 2020; Cerbone et al. 2019; Mio et al. 2020) explore the materiality in different frameworks for sustainability, mainly between integrated reporting, which is dominated by a market logic, and sustainability reporting, which is inspired by a stakeholder logic. This study adds to the literature a new perspective of prioritization defined by expert logic, and compares in quantitative terms whether it exists differences between the environmental performance adjusted with the prioritization analysis defined by matrices of materiality (stakeholder logic according to Mio et al., 2020).

This study also proposes a new variable to measure the overestimated performance as a proxy of self-laudatory. This variable could be useful to explore the relationship between this new variable and the level of application of the materiality principles proposed by Torelli et al. (2019b). This could help researchers to explore whether those companies that describe in detail the materiality analysis present a materiality assessment more aligned with the expert knowledge than with the companies matrices. Moreover, the dependent variable of this study also allows researchers to go in depth in the greenwashing analysis, using the materiality matrix of each company for building the dependent variable, which opens new avenues for future studies.

Another interesting result of this study is the impact of company's location on overestimated performance. In this respect, corporations located in Asia and Africa seem to overestimate

their performance in a higher degree than other countries. This study only has considered as control variables the possible effect of different geographical areas, but future studies could explore in depth how to explain these differences. In this respect, two key variables could be the level of corruption and transparency of a specific region. The future studies could explore how these variables, using for example the Corruption Perceptions Index, can impact on corporate greenwashing practices.

In addition, the fact that the materiality matrices lead to overestimate the environmental performance, call into question the accuracy of the materiality analysis and the real process of stakeholder engagement. In this respect, future studies could propose new methods to handle the subjectivity of the materiality assessment, including the prioritization process based on expert knowledge applied in this study. This research opens up a new line of work to test the quality of materiality analysis in sustainability reporting reports. Although this study is focused on the environmental dimension, future research may replicate this study in all sustainability dimensions and in other industries to examine the authenticity of sustainability in the reporting.

With respect to the practical implications, this study calls the companies' materiality analysis into question given the subjectivity associated to the questions: Who are the stakeholders that decide the environmental material aspects? And who decide the stakeholders of a company? In this regard, it is expected that a company that identifies and engages with the stakeholders will prioritize primary stakeholders (e.g. owners, employees, suppliers or customers), being secondary stakeholders (e.g. society or future generations) considered less important. This implies that when the interests of the different stakeholders do not overlap, the interests of the dominant stakeholders will be the interests safeguarded. For this reason, given the material aspects are defined and prioritized by the stakeholders and this process could be done only for window-dressing reasons, this study suggests to decide the core material aspects for reporting at industry level by experts. For instance, this study shows in Table 4 the core environmental material aspects that from a normative perspective could be required for the wearing apparel industry.

An additional practical implication is connected with the environmental terms used for the empirical analysis (see Table 4). This study uses, on the one hand, the environmental aspects defined by GRI to explore the materiality matrices and, on the other hand, the environmental issues agreed upon by a group of experts after applying the RAND method. The results show that, although there is a set of common terms like "biodiversity", "emissions" or "water" which is assumed that the meaning is the same in both cases, this study finds a broad range of environmental issues that can be related but they do not share the same meaning like "effluents and waste" and "waste management". This fact limits the possibility to compare the information between different prioritization approaches, or even different environmental reporting standards. For this reason, it is necessary that European directive on nonfinancial disclosure (Directive 2014/95/EU) advances in the requirement of information defining clearly the environmental (and social) issues that companies should report, with specific sectorial information.

Another practical implication derived from this study is that the methodological framework presented could be used by auditors to check the robustness of materiality analysis from different prioritization approaches and sources of information. This proposal combines qualitative (expert knowledge) and quantitative methods that explores whether the discrepancies between the different approaches are significant. In this regard, this study could contribute to the uncovered assurance technologies for addressing the materiality of non-financial data (Canning et al., 2019).

6. Conclusion

The main source of information for assessing the environmental performance of organizations is the sustainability reports they periodically disclose. However, sustainability reports have been widely criticized because of showing incomplete, vague, irrelevant and biased information, without a clear external assurance process. In this context, one of the challenges of sustainability reporting is to identify real material aspects for both internal and external stakeholders under an accurate prioritization process. In spite of the importance of materiality principle in generating high quality sustainability reports, the consistency between the most used materiality approach (GRI) and other prioritization approaches remains unexplored in the academic and practitioner literature. Building on this research gap, this study aims to explore to what extent corporate environmental performance is consistent using two different prioritization approaches. To this end, this study develops a process to assess environmental performance through the prioritization of environmental aspects by using company materiality analysis and independent expert knowledge, and adopts an industry-based approach in the empirical analysis.

The main finding shows that companies with better environmental performance adopt impression management strategies by paying special attention to the public reporting in those aspects where they present the highest performance. This fact could be explained by the high degree of subjectivity of the materiality analysis (Calabrese et al. 2019), although it is unknown the degree of the intentionality of creating misleading information. Therefore, the explanation of these results could be diverse. Perhaps, companies only want to further embellish their positive performance or they use materiality analysis in an opportunistic way for greenwashing purposes.

The conducted empirical research evidences that there are still several limitations related to materiality assessment in sustainability reporting. The first limitation is that materiality analysis and the material aspects strongly depend on the individual company decisions, making it difficult to compare the aspects with their peers. Furthermore, it is heterogeneous the clarity with which companies define materiality, remaining unclear the criteria used to establish the threshold at which the aspects become sufficiently important to be reported. This study reveals that there is still considerable room for improvement in the application of the materiality principle in sustainability. In this vein, this study suggests to advance this field proposing a set of core environmental material aspects required for all the companies of a particular industry, being this set defined on the basis of the knowledge from independent experts. From a methodological point of view, this study offers a flexible framework that could

be useful for different purposes: (i) to test in quantitative terms the robustness of materiality analysis from different prioritization approaches; (ii) to extract the knowledge from diverse sources, such us experts, stakeholders' opinion, or a collection of materiality matrices; and (iii) to generate rankings of companies to compare them according to their sustainability performance assessment.

One of the limitations of the study is that empirical analysis has been carried out using the small number of available materiality matrices, a limited number of environmental sectoral experts and a small sample of companies considering, only 3 years. Another limitation is linked to the fact that this paper does not address the possible effects that mandatory disclosure regulation in some countries may have on the reporting quality. This study could be replicated in future research extending the number of observations (number of companies, matrices, experts including more years) to test the robustness and the validity of the results in other samples. Moreover, this research has been applied only in one sector, which may not represent the whole panorama of companies dealing with business problems and it limits the generalizability of results. The empirical analysis could be extrapolated in other industries, including the social and economic dimensions of sustainability to establish comparisons among them. In addition, this study could serve as a starting point in the literature and practice to improve the understanding of how companies could identify the environmental core aspects to their business strategy from an objective and comparable basis, what is also necessary to help stakeholders to make fully informed decisions, and what is expected to positively influence the long-term business performance.

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Acknowledgements

This research was supported by the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 693642, project SMART (Sustainable Market Actors for Responsible Trade) and the Spanish Ministry of Economy, Industry and Competitiveness, Project "ECO-CIRCULAR" – Ref. ECO2016-74920-C2-1-R. In addition, this research was partially financed by Nils Science and Sustainability Programme (ES07), ABEL – Coordinated Mobility of Researchers (ABEL-CM-2014A), and supported by a grant from Iceland, Liechtenstein and Norway through the EEA Financial Mechanism. Operated by Universidad Complutense de Madrid.

TABLES

Table 1: Assessment values for comparisons according to aspects distance in the rank

Distance	Value	Meaning
0	1	Equally important
1 to 3	2	Very weakly important
4 to 6	3	Weakly important
7 to 12	5	Strongly important
13 to 14	7	Very strongly important
Aspect not included in the matrix	9	Extremly important

Source: Self defined based on Saaty (1980)

Table 2. Relationship Analysis between the aspects from both prioritization approaches (materiality matrices and expert knowledge) and the ESG scores

Materiality Matrices approach

Aspects	Score
Biodiversity	EnERO01S
	EnPIO10S
	EnERO02S
Compliance	EnERO23S
Customer Health and Safety	SoPRD01S
	SoPRO15S
	SoCoO09S
Effluents and Waste	EnERO10S
	EnERO11S
	EnERO12S
	EnERO14S
	EnERO20S
	EnERO21S
Emissions	EnERD01S
	EnERO03S
	EnERO08S
	EnERO13S
	EnERO06S
Energy	EnPIO11S
	EnRRO04S
	EnRRO06S
	EnRRO08S
	EnPIO02S
Environmental Grievance Mechanisms	-
Marketing Communications	SoPRO09S
Materials	EnRRO01S
	EnRRO02S
Overal	EnERO24S
	EnPIO03S
Product and Service Labeling	EcCLD01S
	EcCLD03S
	EcCLD04S
	EcCLO09S
	EnPIO20S
Products and services	EcCLO12S
	EnERO15S
	EnPIO05S
	EnPIO13S
	EnPID01S
	EnPID04S
	EnPIO04S
	EnPIO21S
Supplier Environmental Assessment	EnRRD01S
	EnRRO11S
	SoTDO06S
Transport	EnERO19S
Water	EnRRO09S
	EnRRO10S

Expert Knowledge approach

Aspects	Score
Compliance with the more restrictive legal framework	EnERO23S
	EnRRO13S
Consumption of raw materials (fibers)	EnRRD02S
	EnRRD03S
	EnRRO01S
	EnRRO02S
Consumption of chemicals for dyeing, finishing and printing	EnRRD02S
	EnRRD03S
	EnRRO01S
	EnRRO02S
Eco-design	EnPIO01S
	EnPIO07S
	EnPIO13S
	EnPID01S
Education, training and environmental awareness of employees	-
Energy consumption	EnPIO02S
	EnPIO11S
	EnPIO18S
	EnPIO20S
	EnRRO04S
	EnRRO06S
	EnRRO08S
Environmental assessment of suppliers	EnRRO11S
	SoTDO06S
Environmental information on the labeling of products	-
Environmental management systems	EnERO17S
	EnERD01S
Grievance mechanisms for environmental issues	-
Investment in environmental R&D&I / clean technologies / eco-efficiency	EnERO05S
	EnERO24S
	EnPID02S
	EnPID03S
	EnPID04S
	EnPIO03S
	EnPIO04S
Management of effluents	EnERO20S
	EnERO21S
Management of emissions	EnERD02S
	EnERD03S
	EnERD04S
	EnERO03S
	EnERO06S
	EnERO07S

	EnERO08S
	EnERO09S
	EnERO13S
Nature and biodiversity	EnERO01S
	EnERO02S
	EnERO18S
	EnPIO10S
	EnERD01S
Product lifecycle management	EnRRD01S
	EnPID01S
Product management at the end of its useful life (end waste)	EnPIO16S
Product responsibility	EnPIO15S
	EnPIO21S
	SoPRO04S
	SoPRO05S
Promotion of the responsible and sustainable consumption	SoPRO07S
Sustainable management of packaging	-
Sustainable management of the logistics process	EnERO19S
Waste management	EnERO10S
	EnERO11S
	EnERO12S
	EnERO14S
Water consumption	EnPIO08S
	EnRRO09S
	EnRRO10S

The ESG scores follow the Thomson Reuters DataStream score codes.
The first two letters refer to ESG pillars: “En” means Environmental, “So” means Social and “Ec” means Economic
The second two letters refer to ESG categories: “RR” means resource reduction, “ER” means emission reduction, “PI” means product innovation; “TD” means training and development, “PR” means product responsibility, “Co” means society and community, “CL” means client loyalty.

Table 3. Variables and proxies

Variable	Proxy
FAVORABLE PERFORMANCE	Environmental score using company materiality matrices minus Environmental score using expert knowledge
PERFORMANCE MM	Environmental score using company materiality matrices
PERFORMANCE EK	Environmental score using company expert knowledge
SIZE	Natural logarithm of total assets of a firm
LEVERAGE	Ratio of total debt to total assets
PROFITABILITY	Return on assets (ROA)
NORTH AMERICA	1 if company is registered in North America, 0 otherwise
LATIN AMERICA	1 if company is registered in Latin America, 0 otherwise
OCEANIA	1 if company is registered in Oceania, 0 otherwise
ASIA	1 if company is registered in Asia, 0 otherwise
AFRICA	1 if company is registered in Africa, 0 otherwise

Table 4. Priority vectors from both prioritization approaches: materiality matrices and expert knowledge

Materiality Matrices approach		Expert Knowledge approach	
Aspects	**Priority vector**	**Aspects**	**Priority vector**
Effluents and Waste	16.56%	Investment in environmental R&D&I and technologies	5.05%
Materials	14.42%	Compliance with the more restrictive legal framework	5.03%
Water	10.62%	Consumption of chemicals	4.85%
Energy	9.65%	Waste management	4.79%
Emissions	8.44%	Environmental assessment of suppliers	4.78%
Customer Health and Safety	6.98%	Environmental information on the labeling of products	4.74%
Supplier Environmental Assessment	5.50%	Effluents	4.73%
Products and services	5.46%	Eco-design	4.70%
Biodiversity	4.71%	Emissions	4.66%
Marketing Communications	4.02%	Promotion of responsible and sustainable consumption	4.59%
Overall	3.56%	Product responsibility	4.54%
Transport	3.13%	Energy	4.52%
Product and service labeling	2.78%	Raw materials	4.51%
Compliance	2.34%	Product management at the end of its useful life	4.51%
Environmental Grievance Mechanisms	1.83%	Packaging	4.44%
		Product lifecycle management	4.42%
		Environmental management systems	4.40%
		Biodiversity	4.34%
		Environmental Grievance Mechanisms	4.22%
		Water	4.18%
		Sustainable Logistics process	4.10%
		Environmental Education and training of employees	3.96%

Source: Self calculated

Table 5: Consistency indexes and consistency ratios

	Matrix									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Collective**
CI	0,078	0,101	0,112	0,106	0,066	0,131	0,101	0,083	0,048	0,009
CR	0,049	0,064	0,070	0,066	0,042	0,082	0,064	0,052	0,031	0,006

Source: Self calculated

Table 6: Weights vector for the five dimensions of Lydenberg et al

Lyndenberg et al. criteria	Weight
1. Financial performance and/or economic-financial risks	21,33%
2. Competitive position and strategic expectations	20,38%
3. Stakeholder concerns	17,54%
4. Future regulations	19,43%
5. Opportunity for innovation	21,33%

Source: Self calculated

Table 7. Descriptive statistics of environmental scores according to prioritization approach

Variables	Year	Obs.	Mean	SD	25th Percentile	50th Percentile	75th Percentile
Performance MM	2015	53	0.3257	0.2628	0.1278	0.2913	0.5684
Performance EK	2015	53	0.2830	0.2087	0.1428	0.2499	0.4246
Favorable performance	2015	53	0.0426	0.1160	-0.0140	-0.0015	0.0822
Size	2015	53	15.9483	2.0487	14.4140	15.9190	16.8074
Leverage	2015	42	16.6607	13.6189	6.3491	14.0700	24.7142
Profitability	2015	52	9.7545	9.9875	3.2700	7.3900	14.9400
Performance MM	2014	53	0.3152	0.2677	0.1091	0.1984	0.5158
Performance EK	2014	53	0.2830	0.2087	0.1274	0.2161	0.4323
Favorable performance	2014	53	0.0480	0.1239	-0.0190	-0.0095	0.1085
Size	2014	53	15.9311	2.0537	14.4049	15.8828	16.7505
Leverage	2014	44	15.8648	13.0630	6.3757	14.9028	21.0313
Profitability	2014	53	9.7894	10.8104	3.6700	8.7700	16.1900
Performance MM	2013	53	0.3281	0.2763	0.1294	0.2151	0.5844
Performance EK	2013	53	0.2742	0.2189	0.1161	0.2174	0.4703
Favorable performance	2013	53	0.0539	0.1182	-0.0104	-0.0069	0.1153
Size	2013	53	15.8715	2.0430	14.3280	15.8394	16.6547
Leverage	2013	42	15.2510	14.2143	3.8493	11.6287	24.7322
Profitability	2013	52	12.0010	15.9196	4.1450	11.5050	17.4100

Table 8. Environmental scores using materiality matrices vs. environmental scores using expert knowledge

Sample	Hypotheses	D
Full sample[1]	Scores from experts are lower than from materiality matrices	0.1698
	Scores from experts are higher than from materiality matrices	-0.2453**
	Combined Kolmogorov-Smirnov test	0.2453*
Subsample 1: scores higher than industry median[2]	Scores from experts are lower than from materiality matrices	0.3462**
	Scores from experts are higher than from materiality matrices	-0.0385
	Combined Kolmogorov-Smirnov test	0.3462*
Subsample 2: scores lower than industry median[2]	Scores from experts are lower than from materiality matrices	0.0385
	Scores from experts are higher than from materiality matrices	-0.5000***
	Combined Kolmogorov-Smirnov test	0.5000***

Non-parametric test: Two-sample Kolmogorov-Smirnov test for equality of distribution functions.

[1]Number of observations: two samples of 53 companies

[2]Number of observations: two samples of 26 companies. The median value has not been considered.

Note that the p-value used for combined K-S test is corrected for small samples.

The significance levels are presented by P-values. *P<0.10, **P<0.05, ***P<0.01

The results are the same regardless the ranking used to define the subsamples: scores from materiality matrices or scores from expert knowledge.

Table 4 shows results from 2015 data. Note that the results do not change with data from years 2013 and 2014. The results are available upon request to the authors.

Table 9. Linear Regression Analysis

Dependent Variable: FAVORABLE PERFORMANCE	**Model A**	**Model B**
PERFROMANCE MM	0.4353 (0.0343)***	
PERFORMANCE EK		0.2195 (0.0708)***
SIZE	-0.0154 (0.0080)*	-0.0028 (0.0111)
LEVERAGE	0.0000 (0.0003)	0.0000 (0.0006)
ROA	-0.0001 (0.0003)	-0.0003 (0.0004)
NORTH AMERICA	0.0093 (0.0367)	0.0107 (0.0467)
LATIN AMERICA	0.0306 (0.0954)	-0.0597 (0.1213)
OCEANIA	0.0089 (0.0579)	0.0008 (0.0745)
ASIA	0.1511 (0.0393)***	0.1181 (0.0536)**
AFRICA	0.1524 (0.0952)	0.2463 (0.1208)**
CONSTANT	0.0941 (0.1257)	-0.0128 (0.1704)
Wald test (X^2)	177.03***	19.64**
N. obs.	131	131

Model A uses the environmental score applying company materiality matrices as proxy of the variable independent "PERFROMANCE".

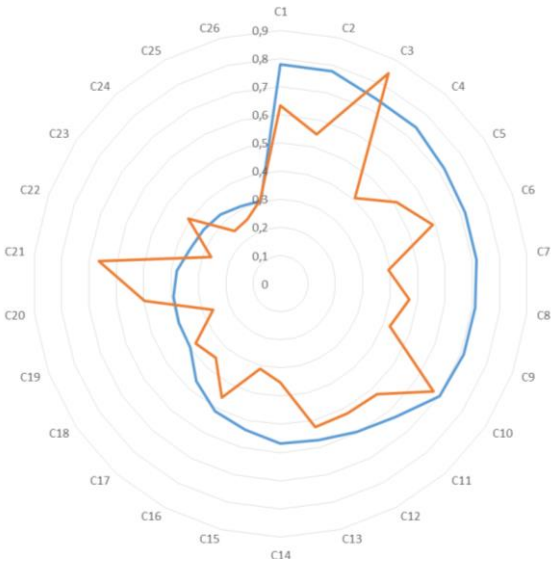
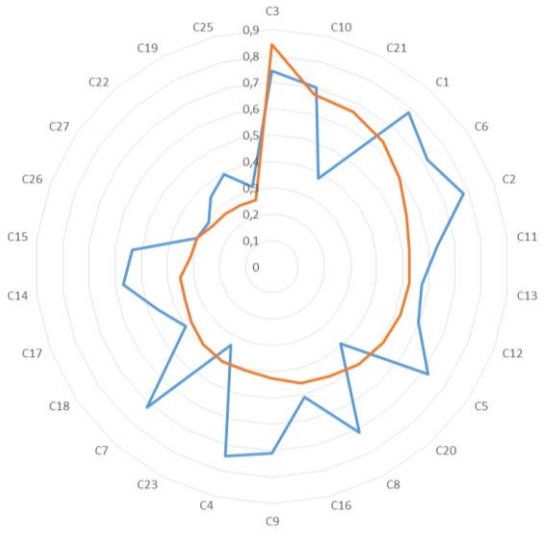
Model B uses the environmental score applying expert knowledge as proxy of the variable independent "PERFROMANCE".

Standard errors are in brackets.
The significance levels are presented by P-values. *P<0.10, **P<0.05, ***P<0.01

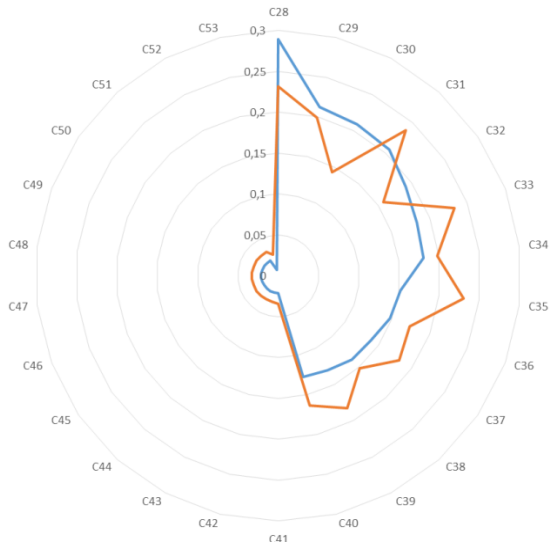
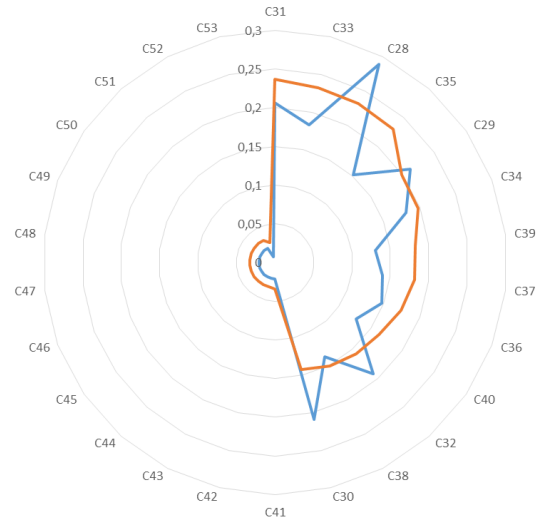
FIGURES

Figure 1. Environmental performance: materiality matrices vs. expert knowledge

Subsample 1: Performance higher than the industry median[1]

Ranking according to materiality matrices	Ranking according to expert knowledge
	

Subsample 2: Performance lower than the industry median[1]

Ranking according to materiality matrices	Ranking according to expert knowledge
	

[1]Number of observations: two samples of 26 companies. The median value has not been considered.

Blue means environmental scores using materiality matrices

Red means environmental scores using expert knowledge

Figure 1 shows results from 2015 data. Note that the graphs do not substantially change with data from years 2013 and 2014. The graphs are available upon request to the authors.