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Using Materiality Analysis to Determine Actual and Potential Company Impacts on Sustainable Development

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Abstract
To contribute to sustainable development companies are called to identify and manage their impacts in a transparent and reliable manner. Materiality Analysis in sustainability reporting helps companies determine the threshold at which sustainability topics become sufficiently important to be included in the report, according to significant organisation's impacts and to stakeholder's interests and concerns. To deliver the highest level of transparency for organisational impacts on the economy, environment, and people, the latest version of Global Reporting Initiative (GRI) guidelines, the "Universal Standard 2021", propose to identify and assess both actual and potential material impacts. In light of this suggestion, the present paper proposes the Materiality Cube as a practical and structured approach for supporting the analysis of organisation's impacts. The proposed tool allows to evaluate the materiality of impacts considering the company's strategy, sustainability performance and stakeholder expectations. By comparing the positioning of sustainability topics under the three assessment dimensions, companies can improve the overall process of determining materiality and the accountability towards stakeholders: they can act to address and account for the most material impacts and identify those that could become material over time since they result much more significant from one perspective than the others. An illustrative application of the proposed Materiality Cube completes the paper.

Keywords: Materiality Analysis, Sustainability Reporting, Sustainability Impacts, Global Reporting Initiative (GRI) Guidelines, Stakeholder engagement.

1. Introduction

The United Nations 2030 Agenda for Sustainable Development calls for a shared responsibility to build a sustainable future (UN, 2015). Companies of various sizes and sectors have a crucial role to play given their capacity for financial, technological and resource mobilization towards sustainability (Rashed and Shah, 2020). To this aim, companies need to meet sustainability challenges with business opportunities while being inclusive of stakeholder expectations and needs (Ike et al., 2019).
Sustainability reporting, as the practise of "measuring, disclosing, and being accountable for organizational performance towards the goal of sustainable development (GRI, 2010), helps companies set strategic objectives to incorporate economic, social and environmental issues into their operating structures and decisions (Jørgensen et al., 2021; Calabrese et al, 2021; Whitehead, 2017). Given that not all the sustainability issues have

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the same relevance for every organization, companies adopt a materiality approach to sustainability reporting (AA, 2018; GRI, 2013a; 2013b). Materiality analysis is the process of identifying, selecting and prioritizing sustainability issues, with the aim to address those issues that pose significant risks and opportunities to the company business and to its stakeholders (Font et al., 2016).

Different standards and tools have been developed over the years to support sustainability reporting and drive companies to improve transparency and accountability for the impacts of organizational activities on people and planet (Siew, 2015). Among these, the Global Reporting Initiative (GRI) guidelines propose the use of a materiality matrix to assess the materiality of topics according to significant organisation's impacts and to stakeholder's interests and concerns (GRI, 2013a; 2016)

As emerges from the literature, the GRI materiality matrix is a flexible tool. Indeed, it allows companies to find the most suitable configuration for engaging with different groups of stakeholders taking their views into consideration in the assessment of economic, environmental, and social company's impacts (Forstater et al., 2006). However, the flexibility of materiality matrix results in a heterogeneity of approaches (Jørgensen et al., 2021) that can lead to the so-called greenwashing phenomenon (Moratis and Brandt, 2017) instead of an effective coverage of material aspects and significant economic, environmental, and social impacts. Prior studies reveal that engaging with stakeholders in reporting decisions helps inform sustainability management and improves transparency of reporting (Calabrese et al., 2016; 2019a; Bellantuono et al., 2016; Hsu et al., 2013). Nevertheless, disclosure of the process of determining material issues and impacts as well as information on engaging with stakeholders still results inadequate (Guix et al., 2018) and the need for new approaches to identify material impacts of an organisation on sustainable development, emerges (Adams et al., 2021). As suggested by the "GRI Universal Standard 2021", to ensure a comprehensive assessment of company's impacts both actual and potential impacts should be considered while performing materiality analysis, together with a strict stakeholder engagement that helps companies obtain useful information to identify and manage impacts that continuously evolve and arise (GRI, 2021).

The present paper intends to answer the call by integrating the well-known GRI materiality matrix (GRI, 2016) with a further dimension of analysis that ensures comparison of actual impacts of the company's sustainability activities with potential impacts of strategic decisions on the company's sustainability commitment. The proposed tool takes the configuration of a materiality cube with the aim to assess materiality of impacts according to the company's strategy, sustainability performance and stakeholder expectations. By comparing the positioning of sustainability topics under the three assessment dimensions, companies can improve the overall process of determining materiality and the accountability towards stakeholders: they can act to address and account for the most material impacts and identify those that could become material over time since they result much more significant from one perspective than the others.

The paper proceeds with a review of the relevant literature on materiality analysis and its usefulness to assess company's impacts. Then it describes the "Materiality Cube" framework and provides an illustrative example of the method application. Discussion and conclusions complete the paper.

2. Literature review

Materiality analysis in sustainability reporting is the process of identifying, selecting and prioritising information that matters most to reflect company's impacts and stakeholder concerns (Jørgensen et al., 2021). Since the analysis ensures determining sustainability issues that pose significant risks and opportunities to the company and to its stakeholders, it allows improving company accountability for the economic, environmental, and social impacts (Font et al., 2016). The Global Reporting Initiative (GRI) guidelines and AccountAbility (AA) standard prescribe principles and recommendations that promote material sustainability reporting as a practice that covers critical issues to achieve the company's goals and manage company's impacts on society (GRI, 2013a; AA 1000). In particular, the GRI guidelines suggest using materiality matrix for prioritising issues according to the "significance of economic, environmental, and social impacts" (x-axis) and to the "influence on stakeholder assessments and decisions" (y-axis) (GRI, 2016). Placing sustainability issues in the materiality GRI matrix allows companies to identify the most significant sustainability topics and impacts to be addressed and reported (Calabrese et al., 2019a).

The GRI approach to materiality has been widely adopted in sustainability reporting (Torelli et al., 2020) however it is recognized that it contains a certain degree of flexibility. According to Forstater et al. (2006) the GRI matrix can be considered a flexible framework since it can assume different configurations useful to assess materiality of issues and the alignment among sustainability performance management and reporting. Nevertheless, the flexibility of the GRI materiality matrix results in a heterogeneity of approaches for materiality analysis (Jørgensen et al., 2021) and consequently, the need to ensure transparency and comparability of the information included in the reports, emerges (Guix et al., 2018). With this regard, prior studies highlight the importance of sustainability reporting to limit or exclude the credibility gap between company and stakeholders and avoid the occurrence of the so-called greenwashing phenomenon (Forstater et al. 2006; Calabrese et al., 2017a).

To ensure that reporting adequately covers material aspects and significant economic, environmental, and social impacts, GRI guidelines suggest engaging stakeholders in the process of assessing materiality (GRI, 2013a). Stakeholder engagement should not be used to merely meet stakeholders' expectations, but to promote a relationship of mutual responsibility and collaboration (Andriof et al., 2017; Menichini & Rosati, 2014). Thus, stakeholders should participate in company decision-making to select and manage those material issues that have significant positive or negative impacts on the organisational internal and external contexts (Manetti, 2011; Torelli et al., 2020). Different approaches have been developed to support companies engaging stakeholders and help inform sustainability management and reporting decisions (e.g., Bellantuono et al., 2016; Hsu et al., 2013; Calabrese et al., 2016; 2019a). However, prior studies reveal that disclosure of the process of determining material issues and impacts as well as information on engaging with stakeholders are inadequate (Guix et al., 2018; Font et al., 2016). As stated by Adams et al. (2021), to overcome these shortcomings, a "robust identification of material impacts of an organisation on sustainable development must be the starting point".

With the aim to comprehensively capture company impacts on the economy, environment, and people, including impacts on their human rights, across the organisation's activities and business relationships, the latest version of Global Reporting Initiative (GRI) guidelines, the "Universal Standard 2021" (GRI, 2021), suggests identifying and assessing either positive or negative potential and actual impacts though materiality analysis. The recent GRI approach to materiality (GRI, 2021) also reiterates that engaging stakeholders provide companies with useful information to identify and manage impacts that continuously evolve and arise. Considering this suggestion, the present paper proposes the materiality cube as a supporting tool to assess materiality of actual and the potential company's impacts according to the company's sustainability strategy, sustainability performance and stakeholder expectations and concerns.

3. Materiality Cube

In order to determine the material company's impacts on sustainable development, the present paper proposes to divide the impact analysis dimension (X-axis) by the well-known GRI materiality matrix (GRI, 2016) into two dimensions of analysis. Indeed, a relevant picture of risk and opportunities related to the company's impacts on sustainable development, requires that potential impacts of a topic be distinguished from the actual ones which need to be determined ex post (Schneider e Meins, 2012). The resulting tool takes the configuration of a Materiality Cube (Figure 1).

For each economic, environmental, and social issue derived from the GRI framework of sustainability topics (GRI, 2016), the proposed tool allows evaluation of both the impacts already raised (actual) and those that could arise (potential), in comparison with stakeholder concerns and expectations.

The relevance of impacts is evaluated overall materiality of sustainability topics according to the following dimensions: "Relevance for company's strategy - RCS" (X1-Axis), "Relevance for sustainability performance - RSP" (X2-Axis), "Relevance for stakeholders' expectations - RSE" (Y-Axis).

3.1 X1-Axis: relevance for company's strategy

According to the AccountAbility (AA) standard the materiality determination process requires to focus on organization's strategy (AA, 2018). The materiality approach to reporting helps companies account for strategic decisions that respond to both sustainability challenges and the company's plan to create, deliver, and capture value (Guix and Font, 2020). With this regard, companies are called to determine the significance of the economic, environmental, and social impacts, considering their chance of happening (GRI, 2021). Following this reasoning, for each GRI sustainability topic the X1 dimension of analysis ("Relevance for company's strategy - RCS") allows evaluating how much each sustainability topic is aligned with the company's sustainability strategic objectives according to the potential of company to reduce (increase) the negative (positive) impacts on the topic.

3.2 X2-Axis: relevance sustainability performance

Companies across different sectors use sustainability reporting to be accountable to stakeholders about sustainability performance. Indeed, reporting is a widely adopted practice to evaluate the social, economic and environmental effects of business activities (Osobajo et al., 2022).

In order to ensure adequate transparency of performance reporting, and enhance accountability towards stakeholders, the organizations should communicate how their operative actions are aligned with strategic objectives, and how and how much their activities impact on stakeholders (GRI, 2013a). With this regard, the significance of the economic, environmental, and social impacts relates to the severity of impacts in terms of obtained benefits or malus (GRI, 2021). Following this reasoning, for each GRI sustainability topic, the X2 dimension of analysis ("Relevance for sustainability performance - RSP") allows measuring how much the company's activities have contributed to reduce (increase) negative (positive) impacts on the topic.

3.3 Y-Axis: relevance for stakeholder expectations

Companies engage stakeholders in the process of assessing materiality with the aim to increase reporting transparency and accountability to a variety of stakeholders: employees and other workers, shareholders, suppliers, vulnerable groups, local communities, and NGOs or other civil society organizations, among others (GRI, 2013a; Torelli et al., 2020). What stakeholders expect from the company's commitment towards sustainability challenges is useful to inform reporting decisions about material impacts; indeed, stakeholders' opinions can affect the company's ability to implement its strategies or achieve its objectives (GRI, 2016). While the analysis enables companies to respond to stakeholders' concerns, it also allows managers and shareholders to understand the impacts of a company's activities on economy, environment, and society (Jørgensen et al., 2021). To effectively meet stakeholders' expectations by directly engaging stakeholders in the decision processes, different supporting approaches have been developed (e.g., Bellantuono et al., 2016; Calabrese et al., 2016; 2017b; 2019a). Following this reasoning, the Y dimension of analysis ("Relevance for stakeholder expectations - RSE") allows measuring how much is relevant for stakeholders, in consideration of their own needs, interests and expectations, that the company reduces (increases) the negative (positive) impacts related to GRI sustainability topics.

3.4 Positioning of sustainability topics in the materiality cube

The positioning of GRI sustainability topics is based on the assessment of relevance for company's strategy, sustainability performance and stakeholders' expectations. As proposed by prior studies, a useful scale of evaluation in materiality analysis considers five-point Likert scale responses (Niaki et al., 2018; Rasool et al., 2020): "Very Unimportant" (1), "Unimportant" (2) – "Fair" (3) – "Important" (4) – "Very Important" (5). By adopting the scale for evaluation of RCS (X1-axis), RSP (X2-axis), RSE (Y-axis), the materiality cube allows distinguishing between different volumes of materiality where sustainability topics can be positioned (Figure 1): high, low, medium, and emerging.

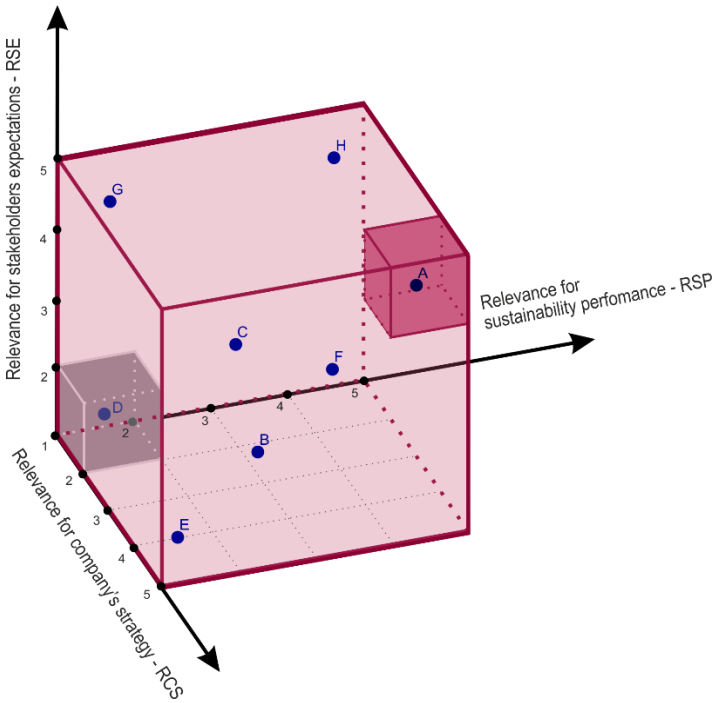

Figure 1. The materiality cube with high materiality volume (dark pink cube on the top right) and the low materiality volume (grey cube at the bottom left).

The topics positioned in the high materiality volume (point A, Figure 1) present a complete alignment of the high materiality of the company's impact related to the topic. Company's strategic objectives are judged relevant to reduce (increase) the negative (positive) potential impacts on the topic. Similarly, company's activities are perceived as relevant as they have contributed to reduce (increase) the negative (positive) actual impacts. Moreover, the materiality of impacts is judged relevant by stakeholders (Y-axis) making the company commitment to reduce (increase) the negative (positive) impacts on the topic, essential to achieve stakeholder expectations. Conversely, the topics positioned in the low materiality volume (point D, Figure 1) present a low materiality of the company's impact related to the topic, according to all the dimensions of analysis.

The materiality cube also allows distinguishing the sustainability topics whose related company's impacts result are more relevant for only one of the three perspectives (e.g., point E, F, G, Figure 1) or even for two perspectives at the same time (e.g., point H, Figure 1). The GRI guidelines consider the materiality of these topics as emerging materiality and suggest companies act to address and account for those aspects that could become material over time (GRI, 2013a). In case of emerging material topics according to one evaluation perspective, the materiality cube allows the following positioning:

- *Emerging materiality for company's strategy* (e.g., point E, Figure 1): while company's strategic objectives are judged relevant to reduce (increase) the negative (positive) company's potential impacts, the sustainability activities related to these aspects are

perceived as scarcely relevant to effectively contribute to sustainability performance. Significance for stakeholder's expectations is also low.

- *Emerging materiality for sustainability performance* (e.g., point F, Figure 1): the sustainability topics are exclusively relevant for the sustainability performance because company's activities have actually reduced (increased) the negative (positive) impacts related to the topics. However, the company's strategic objectives are perceived as not relevant to reduce (increase) the negative (positive) potential company's impacts on the topics. Significance for stakeholder's expectations is also low.
- *Emerging materiality for stakeholders' expectations* (e.g., point G, Figure 1): stakeholders consider highly relevant that company reduces (increases) the negative (positive) impacts on the topic. However, both the company's strategic objectives and sustainability performance are judged not relevant to reduce (increase) the negative (positive) company's impacts.

The cube also allows to position the materiality in the case of emerging impacts according to two evaluation perspectives, as shown in Table 1. In the remaining volume it is possible to allocate sustainability aspects with a medium materiality for all the three evaluation perspectives (points B and C, Figure 1).

4. Illustrative application

The present section provides the reader with guidelines to apply the proposed materiality cube clarifying how it works in practice through an illustrative application example which is structured according to five steps.

Step 1: as suggested by the recent GRI guidelines, materiality analysis requires identifying the most suitable stakeholders to be engaged in the assessment process of material impacts (GRI, 2021). Therefore, the company is firstly called to identify what stakeholders to involve in the analysis, according to their influence on the organization's strategic objectives, activities, and performance (Calabrese et al., 2019a). Among the company's stakeholders, senior managers with deep understanding of the processes and resources, and middle and line managers who are principal actors in strategy implementation (Dwyer et al., 2003), should be selected to assess the relevance of company's strategy (RCS on X1-axis) and to assess the relevance of sustainability performance (RSP on X2-axis). While external stakeholders such as clients, suppliers, the local community, and other external parties, as well as employees should be involved to assess the relevance of company impacts for stakeholder expectations (RSE on Y-axis). By engaging different types of stakeholders in the materiality assessment process, companies gain a multi-stakeholder contribution to the reporting decisions that enhance transparency (GRI, 2013a; Stocker et al., 2020). To this aim, companies need to establish the calculating procedure to synthesize evaluations expressed by stakeholders. A weighted average could be used as a suitable solution as it takes account of the different levels of stakeholders' knowledge and expertise through the allocation of different weights to each type of involved stakeholders (Calabrese et al., 2019b).

Step 2: in addition to the stakeholder identification and weighing, the proposed method requires to determine the set of significant sustainability aspects to analyse. GRI guidelines provide a standardized framework of sustainability topics useful for companies to address full accountability towards stakeholders, according to the Triple Bottom Line (TBL)

approach (Gray and Milne, 2013; Stenzel, 2010). As highlighted by the GRI guidelines, each company can integrate the standard framework with further aspects that are tailored to its sector (GRI, 2013b). Conversely, companies can exclude GRI aspects that are not applicable; in this case, the report should clearly express the reasons for the omission (GRI, 2013a).

Table A1 in the Appendix lists the GRI sustainability topics with their identification labels and the relative GRI standard (GRI, 2016) that identifies the specific GRI disclosure of each topic. The topics are grouped according to the TBL dimensions (economic, environmental, social) to comprehensively catch the company's impacts on people and planet (Gray and Milne, 2013; Stenzel, 2010).

Step 3: using the five-point Likert scale previously shown (Section 3.4), the involved stakeholders judge the relevance of company's impacts associated to the selected topics (Table A1), according to the three dimensions of materiality analysis: Relevance for the Company's Strategy (RCS on X1-axis), Relevance for Sustainability Performance (RSP on X2-axis), Relevance for Stakeholders' Expectations (RSE on Y-axis).

In this phase, support tools able to handle subjectivity of evaluations are recommended. With this regard, facilitators assume a key role to inform stakeholders about the evaluation perspectives and to mediate among potentially contrasting opinions (Krick et al., 2005).

Step 4: company can proceed with the positioning of GRI topics within the materiality cube (Step 4) with the aim to prioritize GRI aspects according to their relevance for the company's strategy (RCS), sustainability performance (RSP) and stakeholder expectations (RSE). Table 1 shows the range of RCS, RSP, RSE values that configure different materiality levels: high, medium, low, and emerging. Particularly, the emerging materiality is expressed according to the evaluation perspectives whose relevance is high.

Step 5: Based on the topic positioning (Step 4) the company can implement specific improving actions to align the materiality of the company's sustainability commitment and impacts to stakeholders' expectations and improve accountability through sustainability reporting. Table 1 specifies the improving actions for each materiality configuration.

Taking into consideration an industrial SME operating in the European context as a suitable example case of the Materiality Cube framework application, in the *Step 1* both internal and external stakeholders have been involved in the materiality assessment process to completely capture the company's operative and strategic approach to sustainability. A weighted average approach has been adopted to synthesize stakeholders' judgments and a same weight of importance has been assigned to all the involved stakeholders as to ensure balancing among the two different evaluation perspectives (internal and external to the organization). In the example all the GRI sustainability aspects in Table A1 have been judged as relevant and adequate for the company's materiality assessment; no further aspects have been added for evaluation (*Step 2*). A survey has been structured and submitted to stakeholders to collect their judgments for each one of the selected topics *(Step 3)*. Thanks to the weighted average of the stakeholders' judgments, the overall materiality score of GRI aspects has been calculated according to the three evaluation perspectives: Relevance for the Company's Strategy (RCS), Relevance for Sustainability Performance (RSP), Relevance for Stakeholders' Expectations (RSE). Knowing the overall materiality scores has allowed positioning of the GRI aspects in the Materiality Cube according to the materiality ranges defined in Table 1 *(Step 4)*. Results are summarized in

Table 2 where the appropriate improving actions are specified for each GRI aspect, according to Table 1 (*Step 5*).

Most of the Environmental GRI aspects have been placed in the high materiality volume (H in Table 1). The result is consistent with the example case since the company's production activities have significant environmental impacts concerning waste, pollution and water use (Lyu et al., 2023; Hole and Hole, 2019). Among the Environmental GRI aspects, GRI 303 "Water" is the most relevant according to RCS, RSP and RSE values. As illustrated in Table 1, GRI aspects in H volume needs of the improving action A1: the company should inform its stakeholders about how company activities impact on water resources, giving evidence of the activities that have contributed to reduce the withdrawal, discharge, and consumption of water. The reduction of the company's impacts needs to be explained and quantified with appropriate indicators. With this regard, GRI guidelines propose "the ratio of water consumption to availability" and "the ratio of total annual water withdrawal to total available annual renewable water supply". In addition, to make reporting on GRI 303 "Water" more informative, the report should show the future goals that the company intends to achieve as to maintain alignment among the actual and potential company's impacts on water usage and the stakeholder expectations about it. The company should take into consideration a similar improving approach for all the impacts directly linked to GRI aspects that are positioned in the high materiality volume (H).

Among the Social GRI aspects, some related to human rights, has been placed in the low materiality volume (L in Table 1). Among them, GRI 409 "Forced or Compulsory Labor", is the least relevant given the low values of RCS, RSP and RSE. Indeed, the result is consistent with the proposed example case since the company operates in the European context where forced or compulsory labor is prohibited by law, making it scarcely relevant for those company strategic and operative decisions that shape the voluntary company commitment to sustainability. Given the GRI 409 positioning, the appropriate action for improvement is A2: the company should clearly explain in the sustainability report the reason for the low materiality of impacts related to this sustainability topic.

Moreover, some GRI aspects are positioned in the emerging materiality volume as they result as more relevant for only one of the three perspectives (GRI 206, GRI 406, GRI 414) or even for two perspectives at the same time (GRI 412, GRI 305, GRI 308). Table 1 specifies the improving actions according to the different configurations of the emerging materiality (from A3 to A8). For instance, the GRI 414 "Supplier Social Assessment" is material only for the company's strategy (ECS in Table 1) as it has obtained a high value of RCS against low values of RSP and RSE. The high Relevance for the Company's Strategy (high value of RCS) is consistent with the industrial nature of the company for which is widely recognized the increasing attention to sustainable production and consumption issues within the context of sustainable supply chain management, especially with regard to the assessment of social impacts along the supply chain (Rajeev et al., 2017). As illustrated in Table 1, GRI aspects which result in ECS materiality volume needs of the improving action A3. Given the misalignment between the relevance for the company's strategy, judged as high, and the relevance for stakeholders' expectations and sustainability performance, judged as low, the company should improve the approaches used to determine the negative social impact of its suppliers. Sustainability reporting should be used to make stakeholders aware of the relevance of the GRI aspect "Supplier Social

Assessment" as well as to communicate the company commitment to improve the assessment approach. With this respect, GRI guidelines suggest specifying the social criteria used to screen new suppliers, as well as processes used to identify and assess significant actual and potential negative social impacts in the supply chain.
Finally, for the GRI aspects positioned in the medium materiality volume (M in Table 1), although the company's actual and potential impacts on the topics deserve inclusion in the sustainability report, it is not necessary that the company adopts any specific improving actions, as the materiality of these GRI aspect is "Fair" for all the three evaluation dimensions (RCS, RSP, RSE).

Table 1. Materiality levels, ranges and improving actions. Materiality ranges are defined according to the five-point Likert scale (from Very Unimportant 1, to Very Important 5).

Materiality levels			**Materiality range**			**Improving actions**	
			Relevance for company's strategy (RCS)	**Relevance for sustainability performance (RSP)**	**Relevance for stakeholders' expectations (RSE)**		
High Materiality		**H**	$4 \leq RCS \leq 5$	$4 \leq RSP \leq 5$	$4 \leq RSE \leq 5$	The topics deserve inclusion in the report. Describe in detail methods and indicators used to quantify sustainability performance; show how the sustainability aspects are managed and linked to business strategy; define strategic objectives and targets to be achieved in the future.	**A1**
Low Materiality		**L**	$1 \leq RCS \leq 2$	$1 \leq RSP \leq 2$	$1 \leq RSE \leq 2$	The topics may not be deepen explored in the report. Describe the reasons for which aspects are not relevant to company's strategy, sustainability performance and stakeholder expectations.	**A2**
Emerging Materiality for	Company's Strategy	**ECS**	$4 \leq RCS \leq 5$	$1 \leq RSP \leq 2$	$1 \leq RSE \leq 2$	Insight the reasons for the misalignment between the relevance for company's strategy judged as high, and the relevance for stakeholders' expectations and	**A3**
			$4 \leq RCS \leq 5$	$2 \leq RSP \leq 4$	$1 \leq RSE \leq 2$		
			$4 \leq RCS \leq 5$	$1 \leq RSP \leq 2$	$2 \leq RSE \leq 4$		
	Sustainability Performance	**ESP**	$1 \leq RCS \leq 2$	$4 \leq RSP \leq 5$	$1 \leq RSE \leq 2$	Insight the reasons for the misalignment between the relevance for sustainability performance judged as high and the relevance for stakeholders' expectations and	**A4**
			$2 \leq RCS \leq 4$	$4 \leq RSP \leq 5$	$1 \leq RSE \leq 2$		
			$1 \leq RCS \leq 2$	$4 \leq RSP \leq 5$	$2 \leq RSE \leq 4$		
	Stakeholders' Expectations	**ESE**	$1 \leq RCS \leq 2$	$1 \leq RSP \leq 2$	$4 \leq RSE \leq 5$	Insight the reasons for the misalignment between the relevance for stakeholders' expectations judged as high and the relevance for company's strategy and sustainability	**A5**
			$2 \leq RCS \leq 4$	$1 \leq RSP \leq 2$	$4 \leq RSE \leq 5$		
			$1 \leq RCS \leq 2$	$2 \leq RSP \leq 4$	$4 \leq RSE \leq 5$		

	Company's Strategy and Sustainability Performance	**ECSSP**	4 ≤ RCS ≤ 5	4 ≤ RSP ≤ 5	1 ≤ RSE ≤ 2	Insight the reasons for the misalignment between the relevance for company's strategy and sustainability performance judged as	**A6**
	Company's Strategy and Stakeholders' Expectations	**ECSSE**	4 ≤ RCS ≤ 5	1 ≤ RSP ≤ 2	4 ≤ RSE ≤ 5	Insight the reasons for the misalignment between the relevance for stakeholders' expectations and company's strategy judged as high and the relevance for sustainability performance judged as low. In view of analysis' result, management should define possible future actions to improve company's sustainability performance also through a reallocation of resources. Use sustainability reporting to underline the company's commitment to improving performance by communicating how much the company's activities have contributed to reduce (increase) negative (positive) actual impacts on the topics.	**A7**
	Sustainability Performance and Stakeholders' Expectations	**ESPSE**	1 ≤ RCS ≤ 2	4 ≤ RSP ≤ 5	4 ≤ RSE ≤ 5	Insight the reasons for the misalignment between the relevance for stakeholders' expectations and sustainability performance judged as high and the relevance for company's strategy judged as low. Understand what strategic actions that may indirectly have reduced (increased) the negative (positive) impacts and may have contributed to the high relevance assigned to sustainability performance. Specific stakeholder engagement initiatives should also be adopted to understand expectations on the topics and their feasibility for company. In view of analysis' result, management should focus future strategic objectives on these emerging topics and use sustainability reporting to give evidence of the established actions and obtained results.	**A8**
Medium Materiality		**M**	otherwise			The issues deserve inclusion in the report. The report coverage does not require improving actions since the alignment among all the evaluation perspectives.	**A9**

Table 2. Positioning of relevant sustainability topics in the materiality cube and related improving actions of the illustrative example case.

	GRI aspects		**Overall rating**			**Positioning**	**Improving actions**
			RCS	*RSP*	*RSE*		
Economic	GRI 201	Economic Performance	4,5	4	4,5	H	**A1**
	GRI 202	Market Presence	4,5	5	4,5	H	**A1**
	GRI 203	Indirect Economic Impacts	2,5	3	2,5	M	**A9**
	GRI 204	Procurement Practices	4,5	4	4	H	**A1**
	GRI 205	Anti-Corruption	4,5	4	4,5	H	**A1**
	GRI 206	Anti-Competitive Behavior	1,5	4,5	2	ESP	**A4**
	GRI 207	Tax	1,5	1	1,5	L	**A2**
Environmental	GRI 301	Materials	4	4	5	H	**A1**
	GRI 302	Energy	4	4,5	4,5	H	**A1**
	GRI 303	Water	5	4,5	5	H	**A1**
	GRI 304	Biodiversity	2	2,5	2,5	M	**A9**
	GRI 305	Emissions	2,5	4,5	5	ESPSE	**A8**
	GRI 306	Waste	4,5	5	4,5	H	**A1**
	GRI 307	Environmental Compliance	1,5	2,5	2	M	**A9**
	GRI 308	Supplier Environmental Assessment	5	1	4,5	ECSSE	**A7**
Social	GRI 401	Employment	4,5	4	4	H	**A1**
	GRI 402	Labor Management Relations	4,5	4	4,5	H	**A1**
	GRI 403	Occupational Health and Safety	4,5	4	4,5	H	**A1**
	GRI 404	Training and Education	4,5	5	4,5	H	**A1**
	GRI 405	Diversity and Equal Opportunity	2,5	3	2,5	M	**A9**
	GRI 406	Non-Discrimination	3	1,5	4	ESE	**A5**
	GRI 407	Freedom of Association and Collective Bargaining	4,5	5	4,5	H	**A1**
	GRI 408	Child Labor	4	4	4,5	H	**A1**
	GRI 409	Forced or Compulsory Labor	1	1,5	1,5	L	**A2**
	GRI 410	Security Practices	2	1,5	1	L	**A2**
	GRI 411	Rights of Indigenous Peoples	2	2,5	2,5	M	**A9**
	GRI 412	Human Rights Assessment	5	4	2	ECSSP	**A6**
	GRI 413	Local Communities	4,5	4,5	5	H	**A1**
	GRI 414	Supplier Social Assessment	4,5	3	1	ECS	**A3**
	GRI 415	Public Policy	1,5	1,5	2	L	**A2**
	GRI 416	Customer Health and Safety	4,5	4	4,5	H	**A1**
	GRI 417	Marketing and Labeling	4,5	5	4,5	H	**A1**
	GRI 418	Customer Privacy	1,5	1,5	1,5	L	**A2**
	GRI 419	Socioeconomic Compliance	4,5	5	4,5	H	**A1**

5. Discussion and conclusions

To effectively contribute to sustainable development goals, companies are called to be accountable and transparent about actions and impacts (AA, 2018; Costa et al, 2022). Sustainability reporting is an even more adopted practice for public disclosure of relevant economic, environmental, and social impacts (Adams et al., 2021). However, not all

sustainability issues have the same relevance for every organization making materiality analysis a crucial approach to achieve accountability to stakeholders (Lindman et al., 2020; Bellantuono et al., 2018; Calabrese et al., 2016). The analysis allows taking into consideration the more relevant sustainability topics, meets interests of a widening group of stakeholders, and fosters a suitable and participative contribution to reporting decisions (Harrison and Wicks, 2013; Font et al., 2016). In order to strengthen the transparency of materiality in sustainability reporting, the latest version of GRI guidelines, the "Universal Standard 2021", proposes to identify and assess both actual and potential material impacts whether they be negative or positive. Indeed, a comprehensive capturing of company's impacts requires to determine the relevance of the economic, environmental, and social impacts, considering their chance of happening, according to the company's strategic decisions and its ability to create and maintain value for itself and stakeholders (GRI, 2021; Guix and Font, 2020; Jørgensen et al., 2021; Karagiannis et al., 2022; Menichini and Rosati, 2014). Also, the intensity of obtained benefits or malus should be taken into consideration to analyse the relevance of a company's impact (GRI, 2021). Through materiality analysis, companies can better meet expectations of its stakeholders, especially by involving stakeholders in the reporting decisions (Calabrese, 2019a; GRI, 2013a).

The proposed materiality cube poses stakeholders at the centre of materiality analysis. The method is conceived to directly consider stakeholder views in the materiality assessment procedure. Both external and internal stakeholders can be involved in the method application to ensure a multi-stakeholder evaluation of materiality. The company's impacts are analysed according to the GRI framework of sustainability topics, thus ensuring a comprehensive capturing of the company's impacts on people and planet. The materiality cube allows considering how stakeholders evaluate the relevance of company's strategic objectives to contribute to the potential of company to reduce (increase) the negative (positive) impacts. The cube also allows considering how stakeholders evaluate the relevance of company's sustainability activities to reduce (increase) the negative (positive) impacts. In addition, the method permits taking into consideration the relevance that stakeholders assign to the reduction (increasing) of the negative (positive) company's impacts related to the GRI sustainability topics, according to their own interests, expectations, and concerns.

The proposed materiality cube is designed to assess materiality of company's impacts according to three evaluation perspectives ("Relevance for company's strategy - RCS", "Relevance for sustainability performance - RSP", "Relevance for stakeholders' expectations - RSE"), thus distinguishing GRI sustainability aspects with high, medium, and low levels of materiality. In addition, the materiality cube permits to determine emerging sustainability issues as those GRI topics that could become material over time, hence requiring companies to act to address and account for the related impacts (GRI, 2013a).

With the aim to show how the materiality cube works in practice, as well as to discuss its usefulness, an illustrative application to an example case is presented. The consistency of obtained results that emerges from the comparison with prior studies (Lyu et al., 2023; Hole and Hole, 2019; Rajeev et al., 2017) confirms the usefulness of the materiality cube to make materiality analysis more informative. By comparing the positioning of relevant GRI sustainability issues, companies can act to address and account for the most material

impacts and identify impacts with emerging materiality as those that result much more significant from some perspectives than the others. The proposed method is designed to provide companies with guidelines to align company's commitment towards sustainability to stakeholder expectations. In consideration of the materiality level of the company's impacts (high, medium, low, emerging) different improving actions are suggested to improve transparency of sustainability reporting and hence, accountability to stakeholders. The proposed materiality cube can be applied by companies regardless of size and sectors. However, it could be especially useful for companies with limited resources to devote to reporting activities, as for SMEs (Verboven and Vanherck, 2016), since it assists step by step materiality analysis and links improving actions to materiality levels making the reporting practice more effective. With this regard, future studies should be developed to analyse the advantages that companies can achieve by systematic repeated materiality analysis, through the application of the proposed materiality cube. Furthermore, considering that the suitability of the proposed framework to perform materiality analysis is complete when it is used in conjunction with the well-known GRI Guidelines and Standards, future studies should aim to validate the materiality cube in case of other Environmental Social Governance (ESG) standards such as ISO 26000, SASB or CDP.

References

AccountAbility. (2018). *AA1000 Accountability Principles*. Retrieved from https://www.accountability.org/

Adams, C. A., Alhamood, A., He, X., Tian, J., Wang, L., & Wang, Y. (2021). The double-materiality concept: application and issues.

Andriof, J., Waddock, S., Husted, B., & Rahman, S. S. (2017). *Unfolding stakeholder thinking: Theory, responsibility and engagement*. Routledge.

Bellantuono, N., Pontrandolfo, P., & Scozzi, B. (2018). Guiding materiality analysis for sustainability reporting: the case of agri-food sector. *International Journal of Technology, Policy and Management*, *18*(4), 336-359.

Bellantuono, N., Pontrandolfo, P., & Scozzi, B. (2016). Capturing the stakeholders' view in sustainability reporting: a novel approach. *Sustainability*, *8*(4), 379.

Calabrese, A., Costa, R., Ghiron, N. L., Menichini, T., Miscoli, V., & Tiburzi, L. (2021). Operating modes and cost burdens for the European deposit-refund systems: A systematic approach for their analysis and design. *Journal of Cleaner Production*, *288*, 125600.

Calabrese, A., Costa, R., Levialdi Ghiron, N., & Menichini, T. (2019a). Materiality analysis in sustainability reporting: a tool for directing corporate sustainability towards emerging economic, environmental and social opportunities. *Technological and Economic Development of Economy, 25(5)*, 1016–1038.

Calabrese, A., Costa, R., Levialdi, N., & Menichini, T. (2019b). Integrating sustainability into strategic decision-making: A fuzzy AHP method for the selection of relevant sustainability issues. *Technological Forecasting and Social Change*, *139*, 155-168.

Calabrese, A., Costa, R., Ghiron, N. L., & Menichini, T. (2017a). To be, or not to be, that is the Question. Is Sustainability Report Reliable?. *European Journal of Sustainable Development, 6*(3), 519-519.

Calabrese, A., Costa, R., Ghiron, N. L., & Menichini, T. (2017b). Materiality analysis in sustainability reporting: a method for making it work in practice. *European Journal of Sustainable Development*, *6*(3), 439-439.

Calabrese, A., Costa, R., Levialdi, N., & Menichini, T. (2016). A fuzzy analytic hierarchy process method to support materiality assessment in sustainability reporting. *Journal of Cleaner Production*, *121*, 248-264.

Costa, R., Menichini, T., & Salierno, G. (2022). Do SDGs really matter for business? Using GRI sustainability reporting to answer the question. *European Journal of Sustainable Development*, *11*(1), 113-113.

Dwyer, S., Richard, O. C., & Chadwick, K. (2003). Gender diversity in management and firm performance: The influence of growth orientation and organizational culture. *Journal of Business Research*, *56*(12), 1009-1019.

Font, X., Guix, M., & Bonilla-Priego, M. J. (2016). Corporate social responsibility in cruising: Using materiality analysis to create shared value. *Tourism Management*, *53*, 175-186.

Forstater, M., Zadek, S., Evans, D., Knight, A., Sillanpää, M., Tuppen, C., & Warris, A. M. (2006). The materiality report: aligning strategy, performance and reporting. *Retrieved October*, *13*, 2015.

Global Reporting Initiative. (2021). Material Topic 2021 – GRI 3. Retrieved from https://globalreporting.org

Global Reporting Initiative. (2016). 101: Foundation. *Amsterdam: Global Reporting Initiative*. Retrieved from https://globalreporting.org

Global Reporting Initiative. (2013a). G4, Part 2, implementation manual.

Global Reporting Initiative. (2013b). G4, sector disclosures.

Global Reporting Initiative. (2010). G3.1, *Sustainability Reporting Guidelines.*

Gray, R., & Milne, M. (2013). Towards reporting on the triple bottom line: mirages, methods and myths. In *The triple bottom line: Does it all add up?* (pp. 70-80). Routledge.

Guix, M., & Font, X. (2020). The materiality balanced scorecard: A framework for stakeholder-led integration of sustainable hospitality management and reporting. *International Journal of Hospitality Management*, *91*, 102634.

Guix, M., Bonilla-Priego, M. J., & Font, X. (2018). The process of sustainability reporting in international hotel groups: an analysis of stakeholder inclusiveness, materiality and responsiveness. *Journal of Sustainable Tourism*, *26*(7), 1063-1084.

Harrison, J. S., & Wicks, A. C. (2013). Stakeholder theory, value, and firm performance. *Business ethics quarterly*, *23*(1), 97-124.

Hole, G., & Hole, A. S. (2019). Recycling as the way to greener production: A mini review. *Journal of Cleaner Production*, *212*, 910-915.

Hsu, C. W., Lee, W. H., & Chao, W. C. (2013). Materiality analysis model in sustainability reporting: a case study at Lite-On Technology Corporation. *Journal of cleaner production*, *57*, 142-151.

Ike, M., Donovan, J. D., Topple, C., & Masli, E. K. (2019). The process of selecting and prioritising corporate sustainability issues: Insights for achieving the Sustainable Development Goals. *Journal of Cleaner Production*, *236*, 117661.

Jørgensen, S., Mjøs, A., & Pedersen, L. J. T. (2021). Sustainability reporting and approaches to materiality: tensions and potential resolutions. *Sustainability Accounting, Management and Policy Journal*.

Karagiannis, I., Vouros, P., Sioutas, N., & Evangelinos, K. (2022). Mapping the maritime CSR agenda: A cross-sectoral materiality analysis of sustainability reporting. *Journal of Cleaner Production*, *338*, 130139.

Krick, T., Forstater, M., Monaghan, P., & Sillanpää, M. (2005). The stakeholder engagement manual volume 2: The practitioners handbook on stakeholder engagement. *AccountAbility, the United Nations Environment Programme, and Stakeholder Research Associates*.

Lindman, Å., Ranängen, H., & Kauppila, O. (2020). Guiding corporate social responsibility practice for social license to operate: A Nordic mining perspective. The Extractive Industries and Society, 7(3), 892-907.

Lyu, F., Zhang, H., Dang, C., & Gong, X. (2023). A novel framework for water accounting and auditing for efficient management of industrial water use. *Journal of Cleaner Production*, 136458.

Manetti, G. (2011). The quality of stakeholder engagement in sustainability reporting: empirical evidence and critical points. *Corporate social responsibility and environmental management*, *18*(2), 110-122.

Menichini, T., & Rosati, F. (2014). The strategic impact of CSR consumer-company alignment. *Procedia-Social and Behavioral Sciences*, *109*, 360-364.

Menichini, T., & Rosati, F. (2013). A managerial tool for environmental sustainability. *APCBEE procedia*, *5*, 551-556.

Moratis, L., & Brandt, S. (2017). Corporate stakeholder responsiveness? Exploring the state and quality of GRI-based stakeholder engagement disclosures of European firms. *Corporate Social Responsibility and Environmental Management*, *24*(4), 312-325.

Niaki, M. K., Nonino, F., Palombi, G., & Torabi, S. A. (2018). Economic sustainability of additive manufacturing: Contextual factors driving its performance in rapid prototyping. *Journal of Manufacturing Technology Management*, *30*(2), 353-365.

Osobajo, O. A., Oke, A., Lawani, A., Omotayo, T. S., Ndubuka-McCallum, N., & Obi, L. (2022). Providing a Roadmap for Future Research Agenda: A Bibliometric Literature Review of Sustainability Performance Reporting (SPR). *Sustainability*, *14*(14), 8523.

Rajeev, A., Pati, R. K., Padhi, S. S., & Govindan, K. (2017). Evolution of sustainability in supply chain management: A literature review. *Journal of Cleaner Production*, *162*, 299-314.

Rashed, A. H., & Shah, A. (2020). The role of private sector in the implementation of sustainable development goals. *Environment, Development and Sustainability*, 1-18.

Rasool, S. F., Wang, M., Zhang, Y., & Samma, M. (2020). Sustainable work performance: the roles of workplace violence and occupational stress. *International journal of environmental research and public health*, *17*(3), 912.

Schneider, A., & Meins, E. (2012). Two dimensions of corporate sustainability assessment: Towards a comprehensive framework. *Business Strategy and the Environment*, *21*(4), 211-222.

Siew, R. Y. (2015). A review of corporate sustainability reporting tools (SRTs). *Journal of environmental management*, *164*, 180-195.

Stenzel, P. L. (2010). Sustainability, the triple bottom line, and the global reporting initiative. *Global EDGE business review*, *4*(6), 1-2.

Stocker, F., de Arruda, M. P., de Mascena, K. M., & Boaventura, J. M. (2020). Stakeholder engagement in sustainability reporting: a classification model. *Corporate Social Responsibility and Environmental Management*, *27*(5), 2071-2080.

Torelli, R., Balluchi, F., & Furlotti, K. (2020). The materiality assessment and stakeholder engagement: A content analysis of sustainability reports. *Corporate Social Responsibility and Environmental Management*, *27*(2), 470-484.

United Nations (2015). Transforming our world: the 2030 Agenda for Sustainable Development A/RES/70/1. Resolution adopted by the General Assembly on 25 September 2015, (p. 35). Paris.

Verboven, H., & Vanherck, L. (2016). Sustainability management of SMEs and the UN sustainable development goals. *uwf UmweltWirtschaftsForum*, *24*(2), 165-178.

Whitehead, J. (2017). Prioritizing sustainability indicators: Using materiality analysis to guide sustainability assessment and strategy. *Business Strategy and the Environment*, *26*(3), 399-412.

Appendix

Table A1. GRI sustainability topics with their identification labels and the relative GRI standard disclosure

Category	**GRI aspects**	
Economic	GRI 201	Economic Performance
	GRI 202	Market Presence
	GRI 203	Indirect Economic Impacts
	GRI 204	Procurement Practices
	GRI 205	Anti-Corruption
	GRI 206	Anti-Competitive Behavior
	GRI 207	Tax
Environmental	GRI 301	Materials
	GRI 302	Energy
	GRI 303	Water
	GRI 304	Biodiversity
	GRI 305	Emissions
	GRI 306	Waste
	GRI 307	Environmental Compliance
	GRI 308	Supplier Environmental Assessment
Social	GRI 401	Employment
	GRI 402	Labor Management Relations
	GRI 403	Occupational Health and Safety
	GRI 404	Training and Education
	GRI 405	Diversity and Equal Opportunity
	GRI 406	Non-Discrimination
	GRI 407	Freedom of Association and Collective Bargaining
	GRI 408	Child Labor
	GRI 409	Forced or Compulsory Labor

	GRI 410	Security Practices
	GRI 411	Rights of Indigenous Peoples
	GRI 412	Human Rights Assessment
	GRI 413	Local Communities
	GRI 414	Supplier Social Assessment
	GRI 415	Public Policy
	GRI 416	Customer Health and Safety
	GRI 417	Marketing and Labeling
	GRI 418	Customer Privacy
	GRI 419	Socioeconomic Compliance