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Sustainable business models and conflict indices for sustainable decision-making: An application to decommissioning versus reusing offshore gas platforms

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Abstract

This paper combines theoretical sustainable business models and conflict indices in making practical sustainable (i.e., participatory decisions involving economic, social, and environmental features within weak or strong sustainability paradigms) and rational (i.e., informed and consistent decisions within substantive or instrumental rationality) decisions with respect to *what*, *who*, *where*, *when*, and *how* to act. The case study, focused on an offshore gas platform, identified *when* (i.e., the end as opposed to the beginning of extraction activities) and *where* (i.e., the economic, social, and environmental contexts of the Adriatic Sea in Abruzzo region, Italy). A face-to-face questionnaire, submitted to stakeholders, produced the relative weights required by the tested sustainable business models (Lüdeke-Freund et al., 2018), and it reached a conclusion about *how* (i.e., in favor of the majority as opposed to average decisions). An application of a linear conflict index (Fasth et al., 2018) highlighted a lack of stakeholders' representativeness and knowledge and solved these issues with a 50% increase of stakeholders involved and an additional discussion with originally invited stakeholders on specific topics, respectively. In summary, the methodology suggested in this paper produced a (strong) sustainable and (substantive) rational decision about *what* and *who* based on relative weights expressed by representative and informed stakeholders being engaged at the smallest cost and with the largest support. Thus, the contribution of this paper is twofold: Theoretically, choices among alternative sustainable businesses depend on the adopted sustainability paradigm, and practically, choices among alternative sustainable businesses should be identified according to the adopted sustainability paradigm.

KEYWORDS

conflict index, offshore gas platform, stakeholder engagement, stakeholders' representativeness and knowledge, substantive and instrumental rationality, sustainable business model, sustainable decision-making, weak and strong sustainability

Abbreviations: CI, conflict index; SBM, sustainable business model.

1 | INTRODUCTION

Sustainable decision-making requires the consideration of at least three dimensions (i.e., economic, social, and environmental features) (e.g., Grimmel et al., 2019) with a participatory approach (i.e., involvement of stakeholders) (e.g., Ardebili & Padoano, 2020). Note that either substantive rationality (i.e., that focuses on the ethics of an action) or instrumental rationality (i.e., which focuses on whether the means can achieve the desired end, irrespective of the ethics of that means) can be pursued (e.g., Assuad, 2020; Bolis et al., 2017).

In traditional business models, firms create, deliver, and capture mere economic value; however, business models *then* suggest where value creation is outside the firm, with partners, suppliers, stakeholders, and customers (Teece, 2010). Sustainable business models (SBMs) have been *theoretically* defined as "business models that incorporate pro-active multi-stakeholder management, the creation of monetary and non-monetary value for a broad range of stakeholders, with a long-term perspective" (Geissdoerfer et al., 2018). Lüdeke-Freund et al. (2018) refer to the theory of patterns and *practically* define an SBM pattern as follows: "An SBM pattern describes an ecological, social, and/or economic problem that arises when an organisation aims to create value, and it describes the core of a solution to this problem that can be repeatedly applied in a multitude of ways, situations, contexts, and domains, by describing the design principles, value-creating activities, and their arrangements that are required to provide a useful problem–solution combination". Note that SBMs for weak sustainability (i.e., that aim at the maximization of stakeholders' welfare and are based on average decisions) focus on value creation from any economic and business activity (Nosratabadi et al., 2019), whereas SBMs for strong sustainability (i.e., which aim at the minimization of stakeholders' inequality and are based on majority decisions) focus on nature as the primary constraining factor for any economic and business activity (Brozovic, 2020).

The first *purpose* of this paper is to suggest a methodology to make SBMs a theoretical framework to practically recommend *what*, *who*, *when*, *where*, and *how* to act within sustainable decision-making, by relying on a practical application of theoretical conflict indices (CIs) to check for and cope with stakeholders' representativeness and knowledge, which is the second *purpose* of this paper. In particular, we will refer to the SBM by Lüdeke-Freund et al. (2018) as a very comprehensive framework for a synthesis of the SBM literature, where both weak and strong sustainability paradigms can be considered.

Moreover, we will discuss substantial and instrumental rational decisions about decommissioning versus alternative reuses of offshore gas platforms at the end of the extraction period, by using a case study in the Adriatic Sea, since this decision involves economic, social, and environmental aspects (Abhinav et al., 2020).

Finally, we will apply minimum-impact or maximum-outcome approaches, since decisions are characterized by negative interdependence (i.e., some stakeholders' interests can be achieved only at the expense of other stakeholders' interests) and options are given (Ferretti et al., 2019).

In other words, by stressing that sustainability is an ethical and practical problem (i.e., the solution depends on the adopted approaches and paradigms), this paper refers to the three fundamental characteristics of a business model for sustainability (Attanasio et al., 2021; Mendez-Leon et al., 2022; Preghenella & Battistella, 2021) (i.e., a long-term business vision; the integration of economic, social, and environmental values in the business value proposition, delivery, and capture; and stakeholder engagement, integration, and management) to address the following research question: do CIs enable decision-makers to engage informed and representative stakeholders at the smallest cost (i.e., a small sample to save time and money) and with the largest support (i.e., large interests and values according to the affected stakeholders) in order to account for the two main sustainability approaches and the two main sustainability paradigms?

Note that we will disregard the business model canvas for sustainability, since it is empirically similar to the SBM by Lüdeke-Freund et al. (2018), albeit in multi-dimensional frameworks (e.g., Cardeal et al., 2020; Joyce & Paquin, 2016); we will also not mention SBM innovation, since reuse is a new business (Mignon & Bankel, 2022; Shakeel et al., 2020; Velter et al., 2020); and we will disregard circular business models, because circular economy approaches are still not defined and measured to be applied in sustainable decision-making (Corona et al., 2019; Tapaninaho and Heikkenen, 2022) and because the decision on alternative reuses is taken after the extraction period (Geissdoerfer et al., 2020; Lewandowski, 2016).

Moreover, *why* to act is required by national and international laws and regulations (Fam et al., 2018) in many countries where a huge number of end-of-life gas and oil offshore platforms must either be decommissioned or reused.

Finally, alternative decisions could have been analyzed (e.g., decommissioning in Burdon et al., 2018, and Na et al., 2017; partial versus complete decommissioning in Bressler & Bernstein, 2015, and Sedlar et al., 2019), but the decision to focus on reuse versus partial or complete decommissioning (e.g., Bernstein, 2015, and Kolian et al., 2019) is an ethical decision as well as a business decision (Zagonari, 2021).

This paper is structured as follows. After this introduction, Section 2.1 provides a short literature review justifying the use of the SBM by Lüdeke-Freund et al. (2018), whereas Section 2.2 presents the theoretical specifications applied to this SBM (i.e., the relative weights attached to economic, and social and environmental features in the sustainability triangle as a three-dimensional simplex) and the practical uses of CIs by Fasth et al. (2018) (i.e., a presence of conflicts should be empirically observed and not observed for questions characterized by a deontological and consequentialist approach, respectively). Section 3 illustrates the case study, by detailing the elaboration of the face-to-face questionnaire and the choice of the original stakeholders. Section 4.1 presents the problems faced when engaging 22 stakeholders, whereas Section 4.2 presents the problems solved by engaging 33 stakeholders. This is followed by a discussion of the findings in Section 5, before the conclusions and final remarks in Section 6.

2 | THE THEORETICAL FRAMEWORK

This section introduces the underlying methods of this research: it justifies the reference to the SBM by Lüdeke-Freund et al. (2018) (Section 2.1), and it details the use of a conflict index by Fasth et al. (2018) (Section 2.2).

2.1 | The conceptual background

SBMs include (i) a long-term business vision; (ii) integration of economic, social, and environmental values in the business value proposition, delivery, and capture; and (iii) stakeholder engagement, integration, and management (Attanasio et al., 2021; Mendez-Leon et al., 2022; Preghenella & Battistella, 2021). By including also (i) and (ii), my focus here is on representativeness and knowledge in (iii) for sustainable decision-making.

In particular, in order to simplify the research context, we will refer to start-ups instead of innovation in existing firms (e.g., acquisition, diversification, and transformation in Geissdoerfer et al., 2022, and change leadership, experimentation, and boundary spanning in Mignon & Bankel, 2022) and we will refer to principles (e.g., 11 pattern groups in Lüdeke-Freund et al., 2018; eight archetypes in Bocken et al., 2014; eight services in Tukker, 2004; and six types in Henry et al., 2020) instead of strategies (e.g., cycling, extending, intensifying, and dematerializing in Goffetti et al., 2022, and outcomes, impacts, and values in Dembek et al., 2022). Note that Section 4 will apply this research context to the decommissioning versus reusing of off-shore gas platforms, since this decision includes all characteristics of SBMs (i.e., [i], [ii], and [iii]) and it enables future developments with respect to innovation (e.g., Ramadani et al., 2022) and strategies (e.g., Caputo et al., 2022).

Moreover, in order to be consistent with a sustainability context, we will adopt a bottom-up approach based on the estimation of stakeholders' relative weights within a multi-criteria analysis rather than a top-down approach based on cost–benefit analysis (e.g., Leporini et al., 2019) or on life cycle assessment (e.g., Zagonari, 2021).

Finally, in order to suggest a decision-making procedure, we will adopt a quantitative approach instead of a qualitative one such as SBM canvas (e.g., Cosenz et al., 2019) or circular SBM (e.g., Tapaninaho and Heikkenen, 2022). Note that Section 4 will apply this quantitative approach to identifying coherent choices based on scores for weak sustainability and instrumental rationality or coherent choices based on majorities for strong sustainability and substantial rationality.

In particular, we will not provide a theoretical model for dynamic learning towards environmental capability in a multi-stakeholder setting, by favoring knowledge acquisition with a practical approach (Baranova, 2022). Moreover, we will not include references to other research studies using the same framework, since this is the first application of CIs to SBMs within sustainable decision-making. Finally, we will not directly refer to doughnut economics, as it combines weak and strong sustainability paradigms (Hausdorf & Timm, 2022).

Therefore, we will apply the SBM by Lüdeke-Freund et al. (2018) to a start-up for the possible reuse of an offshore gas platform with a quantitative approach within a multi-criteria analysis.

2.2 | The analytical context

Lüdeke-Freund et al. (2018) identify 45 SBM patterns, by arranging patterns into 11 groups: Pricing and Revenue, Financing, Eco-design, Closing-the-Loop, Supply Chain, Giving, Access Provision, Social Mission, Service and Performance, Cooperative, and Community Platform. These 11 patterns are then put into relation with 10 different forms of value creation (from a to j in Figure 1).

These 11 groups are related to a particular form of value creation, where the authors used a sustainability triangle to categorize sustainability problem–solution combinations (i.e., the sustainability triangle is divided into 10 areas that address 10 different forms of value creation to which the pattern groups can be associated with). Here, we will apply the SBM by Lüdeke-Freund et al. (2018) with the following specifications:

- Closing the loop (option 4) will be assumed to refer to a circular economy as opposed to a linear economy. However, the choice of option 4 will be shown to be biased in our case study;
- The sustainability triangle will be considered as a three-dimensional simplex to represent the relative weights attached to economic (w_{eco}), social (w_{soc}), and environmental (w_{env}) features (i.e., $w_{eco} + w_{soc} + w_{env} = 1$);
- Community platform (option 10) will be assumed to refer to the involvement of public institutions as opposed to cooperatives, where most actors are private. However, the choice of option 10 will be shown to be biased in our case study.

Note that some options (i.e., 1 and 2, 3 and 4, and 6 and 8) are very close in the three-dimensional simplex.

Moreover, the UN has stressed stakeholder participation in *all* sequential definitions of sustainable development (e.g., UN, 1992, Agenda 21, and UN, 2015, Agenda 2030). Thus, the involvement of stakeholders in science has been an expanding trend in an increasing number of research areas (Mielke et al., 2016). Many approaches have been adopted by sustainability science (i.e., environmental science applied in decision-making processes) to integrate stakeholder participation (Curseu & Schruiser, 2020):

- Stakeholders' engagement can be implemented at different stages. If stakeholders' perspectives are included early in the decision-making process, they contribute to framing the problem. If stakeholders are involved late in the decision-making process, they contribute to evaluating or ranking ready-made alternatives.

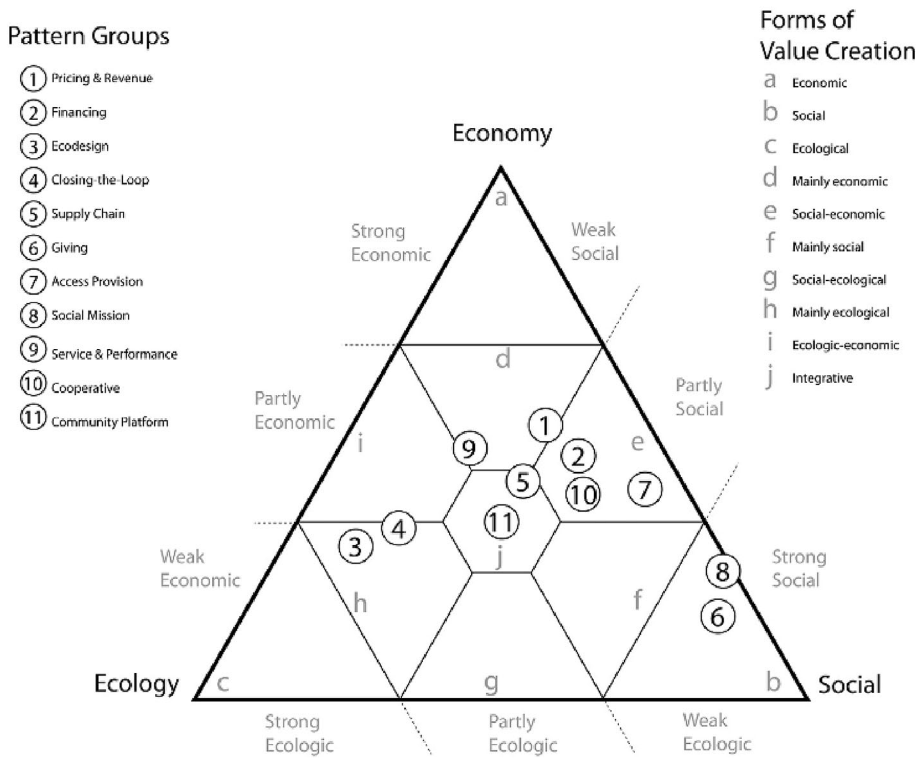

FIGURE 1 Pattern groups and forms of value creation in Lüdeke-Freund et al. (2018).

- Stakeholders' involvement can be substantive (i.e., participation is aimed at achieving better outcomes, and stakeholders bring in system knowledge through practical experience), normative (i.e., participation as an end in and of itself, and stakeholders add orientation knowledge via their opinions), or instrumental (i.e., participation is aimed at securing particular interests, and stakeholders bring in system values and motivations).
- Stakeholders' engagement can be classified into four main typologies: the technocratic type, if the role of stakeholders is to provide issue-specific and impartial information to be used by the experts' model or framework; the neo-liberal type, if stakeholders represent alternative or different interests; the functionalist type, if the role of stakeholders is to make experts more sensitive and concerned with social issues; and the democratic type, if stakeholders represent all affected citizens and organizations.
- Stakeholders' involvement can be aimed at identifying the option that maximizes positive economic, social, and environmental impacts (i.e., minimum impacts based on bounded rationality), at finding a compromise solution (i.e., it is based on stakeholders' perspectives/attitudes and goals/concerns), and at identifying the option that maximizes welfare or minimizes costs (i.e., maximum outcomes based on perfect rationality).

Here, we will apply a democratic engagement of stakeholders at the last stage of decision-making, with a substantive, normative, and instrumental involvement (i.e., decisions based on alternative opinions and conflicting interests) within both weak and strong sustainability paradigms (i.e., decisions based on scores and votes, respectively).

Finally, many CIs have been suggested in the literature (Fasth et al., 2018). Here, we will apply the following cardinal conflict index:

$$CCI = 1 - \left(\frac{\sum_{i=1}^{na} X_a}{X_t} - \frac{\sum_{i=1}^{nb} X_b}{X_t} \right)$$

with

$$X_t = \sum_{i=1}^{na} X_a + \sum_{i=1}^{nb} X_b,$$

where subscripts a and b refer to responses above and below the average. In particular, index values in [0.75–1.25] suggest the presence of conflicts, index values in [0–0.75] suggest the absence of conflicts with indexes above the average, and index values in [1.25–2] suggest the absence of conflicts with indexes below the average. Thus, these values will highlight potential issues of stakeholders' representative samples and information gaps. Indeed, questions in the questionnaire will cover all the main features involved in the decision-making process on reuses versus decommissioning of offshore platforms. Moreover, all relevant stakeholders involved directly or indirectly in decision-making will be invited to participate in a first meeting. Finally, questions in the questionnaire will represent all alternative perceptions and concerns about economic, social, and environmental issues. Consequently,

- if responses are equally distributed (i.e., presence of conflicts), the sample is representative of deontological issues (i.e., answers are personally arguable), although conflicts might arise due to information gaps on consequentialist issues (i.e., there is a correct answer): Additional meetings with the

initially invited stakeholders are recommended in order to share different perceptions and concerns and eventually lead to a common perspective on consequentialist issues;
- if responses are unequally distributed (i.e., absence of conflicts) for deontological issues, the sample might not be representative: The involvement of additional stakeholders with respect to the initial sample is suggested.

In summary, the presence of conflicts should be empirically observed and not observed for questions theoretically characterized by a deontological and consequentialist approach, respectively. Note that stakeholders' sample representativeness and information gaps will affect sustainability decision-making (Scolobig & Lilliestam, 2016). Indeed, these issues are crucial in contexts where decisions are based on a deontological approach, that is, the choice of an action is based on its ethical principles, rather than on a consequentialist approach, where the choice of an action is based on its expected achievements (Linnerooth-Bayer et al., 2016).

3 | THE CASE STUDY

This section will describe the variables that define the benefits and costs for a specific context: a case study of an offshore gas platform in the Adriatic Sea at about 18.5 km from Pineto d'Abruzzo in Teramo Province, in the Abruzzo region of Italy. Thus, in meetings with stakeholders, we will refer to Abruzzo as the relevant region. Note that the large distance from the coast suggests that impacts on the coastline can be disregarded. However, the offshore platform is close to a protected marine area, Torre del Cerrano, which has been classified as a natural site of EU interest. Consequently, in meetings with stakeholders, we will refer to economic and social data from the Abruzzo region and ecological data from the Torre del Cerrano protected marine area to discuss positive and negative impacts as well as the benefits and costs of alternative reuses versus decommissioning.

The *questionnaire* submitted to stakeholders (see Supplementary Materials I) shows the decision on decommissioning versus reuse of offshore platforms at the end of the gas extraction process (i.e., we disregarded a life cycle assessment that systematically analyzes the full range of effects associated with all stages—from creation to disposal—of a product's life), by referring to positive and negative impacts (i.e., we also disregarded a cost–benefit analysis that applies a systematic set of rules for comparing economic benefits and costs—expressed in monetary terms—of alternative potential interventions to maximize social welfare) (see Supplementary Materials II).

Note that the original 22 stakeholders were chosen to include all interests possibly affected by the decision about decommissioning or reusing the offshore gas platform (e.g., ship owners, environmentalist organizations, energy producers, and diving groups).

Moreover, the *questionnaire* applied well-established procedures (Zagonari, 2016) to estimate the relative concerns for economic, social, and environmental features.

Finally, the main characteristics of the 22 stakeholders involved in the first (real) *meeting* in Pescara (Italy) on January 24, 2020, can be summarized as follows: 18 male and four female participants; one below 26 years of age, two between 26 and 35 years, five between 36 and 50 years, 12 between 51 and 60 years, and two above 61 years of age. Six had a higher education degree, nine had a bachelor's degree, four had a master's degree, and three had a doctoral degree. Eight were employed in public services, eight were employed in private firms, two were employed in environmental organizations, and four in other jobs. Note that the sample of stakeholders was deliberately chosen to be small so as to check for the effectiveness of the suggested methodology in saving time and money required to involve large numbers of stakeholders.

Note that the face-to-face questionnaire was elaborated to include all perspectives that could potentially be adopted in taking a decision about decommissioning or reusing an offshore gas platform (e.g., entrepreneurs, regional and municipal representatives, and universities).

The case study suggested disregarding options 5–8 of the SBM by Lüdeke-Freund et al. (2018) as irrelevant. In particular, the estimated relative weights (i.e., 0.33, 0.23, and 0.44 for economic, social, and environmental features, respectively) suggested that the *theoretical* choice should be 3 over 4 about *what* options, and 11 over 10 about *who* options. Indeed, Zagonari (2021) showed that reusing should be preferred to decommissioning within a linear economy rather than a circular one (i.e., 3 is better than 4) and that reusing versus decommissioning are inter-generational equity issues that require laws and regulations (i.e., 11 is better than 10).

4 | THE EMPIRICAL RESULTS

This section presents (Section 4.1) the knowledge and representativeness problems faced by using the questionnaire described in Section 3 for the 22 stakeholders identified in Section 3, and it presents (Section 4.2) the CIs after the second meeting with 11 additional stakeholders and after the third meeting with some stakeholders to show that both knowledge and representativeness problems have been solved.

4.1 | Problems faced in engaging 22 stakeholders

In order to identify the (weak or strong) sustainable and (substantive or instrumental) rational decision practically suggested by the 22 involved stakeholders, we linked each answer to each point in the questionnaire to options from 1 to 4 and option 9 about *what* options, and options 10 and 11 about *who* options (see Supplementary Materials I). In particular, we adopted two main perspectives about *how*: the average stakeholder perspective, where we calculated the scores of responses, under the assumption that the characterization of stakeholders is unimodal and symmetrical; the majority stakeholder perspective, where we calculated the votes that each option would obtain, under the assumption that each stakeholder votes his/her most preferred option. In other words, we refer to group decisions instead of management choices (e.g., Herghiligiu et al., 2019). Note that the comparison of the theoretical and empirical choices may highlight possible information gaps.

Table 1 presents the empirical choices. Thus, the ranking of options in terms of the representative stakeholder is 1–4 > 3 > 9 > 2 for *what* options and 10 > 11 for *who* options, whereas the ranking of options in terms of the stakeholders' votes is 4 > 1 > 3–9 > 2 for *what* options and 10 > 11 for *who* options.

Figures 2 and 3 represent the distribution of scores among the 22 stakeholders for the *what* and *who* options, respectively, whereas Figures 4 and 5 represent the distribution of votes among the 22 stakeholders for the *what* and *who* options, respectively.

TABLE 1 The empirical choices by the 22 stakeholders (percentages).

		What 1	What 2	What 3	What 4	What 9	Who 10	Who 11
Representative stakeholder	Mean	51	38	44	50	40	44	33
	Variance	0.07	0.02	0.09	0.11	0.05	0.09	0.02
Stakeholders' votes	Mean	25	0	20	36	18	59	41
	Variance	0.16	0.00	0.13	0.21	0.15	0.24	0.24

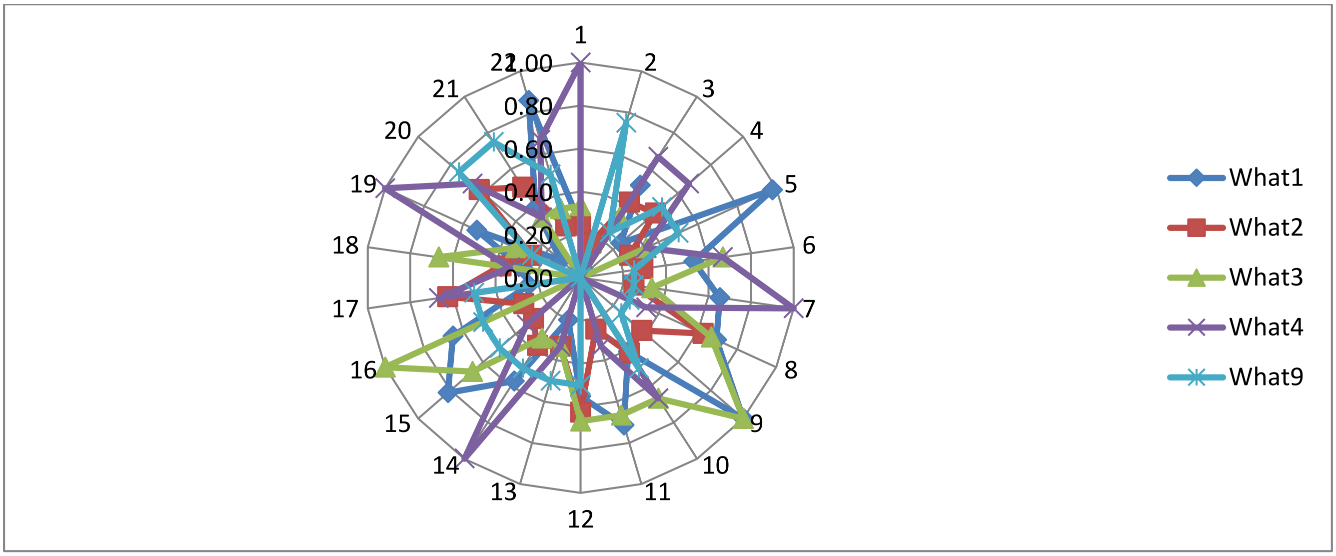

FIGURE 2 Distribution of scores among the 22 stakeholders on the *what* options.

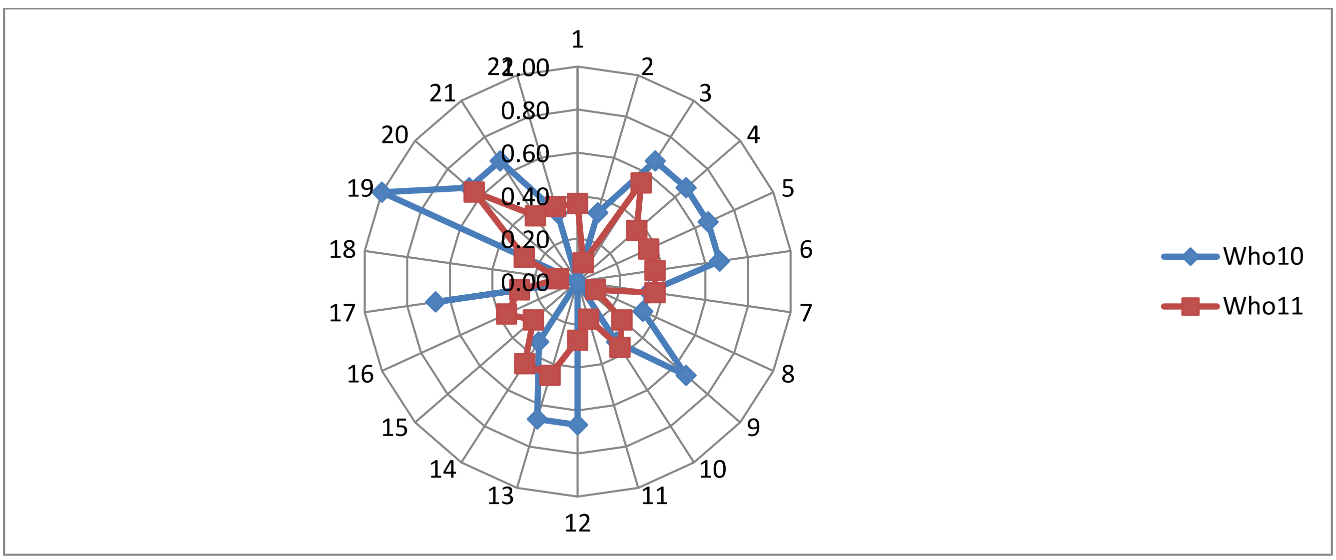

FIGURE 3 Distribution of scores among the 22 stakeholders on the *who* options.

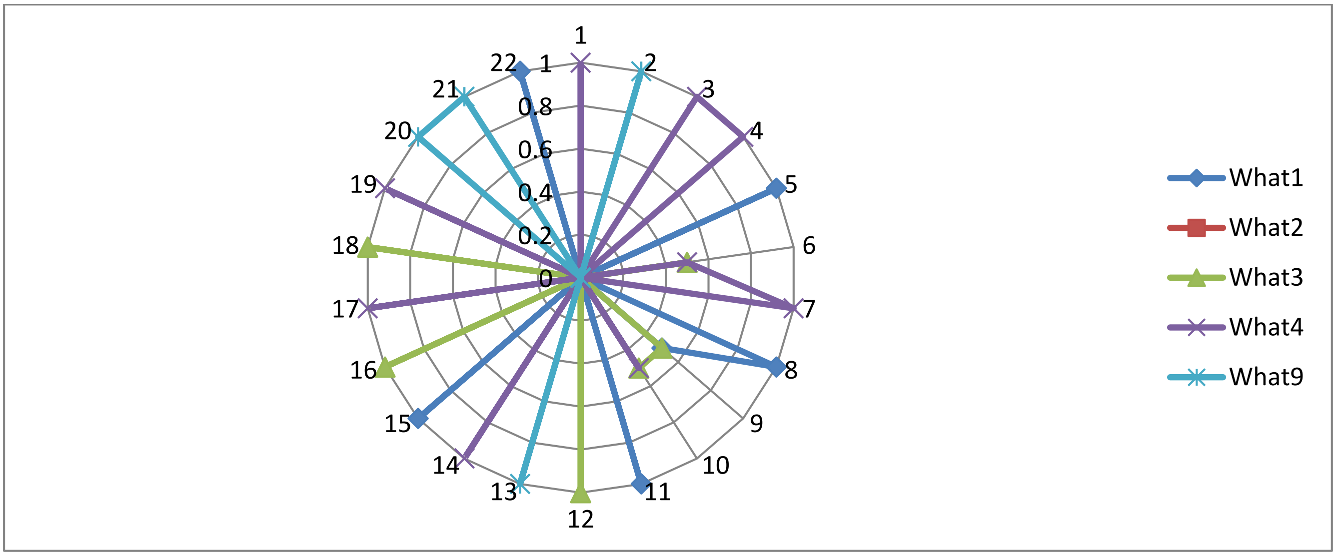

FIGURE 4 Distribution of votes among the 22 stakeholders on the *what* options.

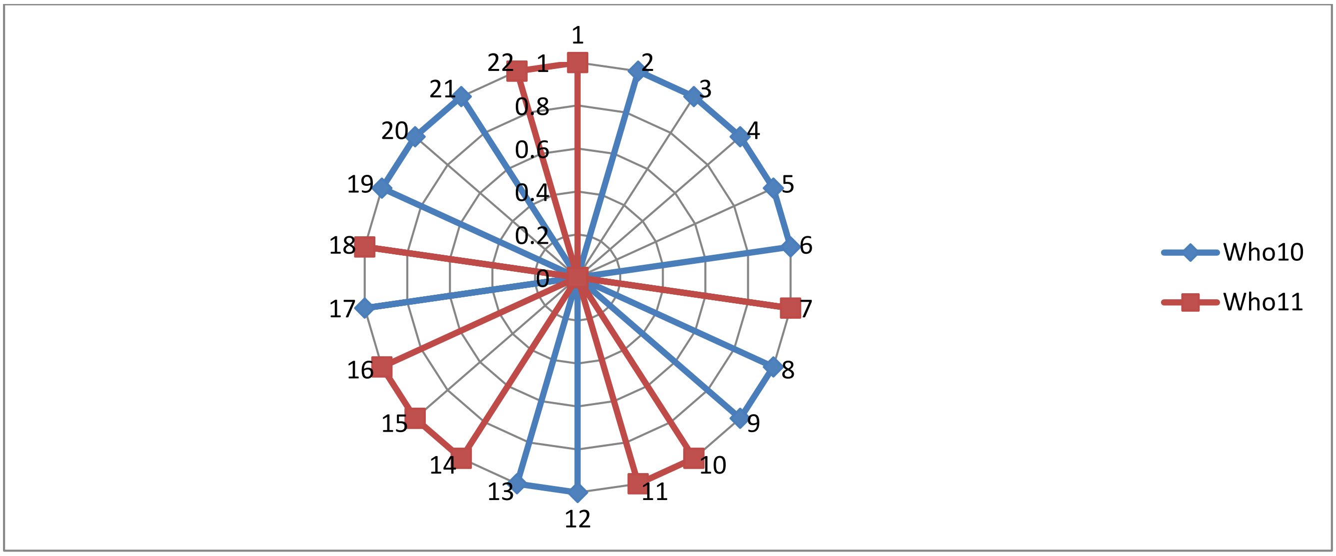

FIGURE 5 Distribution of votes among the 22 stakeholders on the *who* options.

TABLE 2 Correlations of scores by the 22 stakeholders.
Underlined = uncertainty between alternative *what* options; italics = inconsistency between *what* and *who* options; bold = consistency between *what* and *who* options.

	What 2	What 3	What 4	What 9	Who 10	Who 11
What 1	−0.23	0.60	−0.16	−0.24	−0.08	−0.10
What 2	1	−0.11	−0.09	0.26	*0.33*	0.14
What 3		1	−0.45	−0.42	−0.37	−0.29
What 4			1	−0.23	**0.13**	*0.42*
What 9				1	*0.34*	**0.33**
Who 10					1	0.35

Note that the variance of scores and votes for option *what* 3 is smaller than for option *what* 4 (i.e., 0.09 < 0.11 and 0.13 < 0.21). Moreover, in terms of scores, option *what* 4 is correlated with option *who* 11 to a greater extent than with option *who* 10 (i.e., 0.42 > 0.13) (Table 2), whereas in terms of votes, option *what* 3 is correlated with option *who* 11 to a greater extent than option *what* 4 (i.e., 0.17 > 0.05) (Table 3). Finally, there is no uncertainty (i.e., a stakeholder attaches the same score to two options) about the *who*

TABLE 3 Correlations of votes by the 22 stakeholders.
Italics = inconsistency between *what* and *who* options; bold = consistency between *what* and *who* options.

	What 2	What 3	What4	What 9	Who 10	Who 11
What 1	na	−0.26	−0.47	−0.28	−0.17	0.17
What 2	na	na	na	na	na	na
What 3		1	−0.32	−0.27	−0.17	**0.17**
What 4			1	−0.38	−0.05	0.05
What 9				1	*0.39*	−0.39
Who 10					1	−**1**

TABLE 4 Groups of questions.

		Overall	Economy	Society	Environment
Consequentialist	Perception	1, 2, 4, 6	8, 10	12, 15, 16, 27, 28, 17	17, 23, 24, 18
	Concern		15, 16	25, 15, 16	18, 20, 15, 16
Deontologist	Perception	3, 5		26, 27	21, 22
	Concern	14		19	7

options, while there is uncertainty about the *what* option (i.e., the same score for options *what* 3 and 4 by stakeholders 5, 6, 10, and 13; the same score for option *what* 1 and 3 for stakeholder 9).

Therefore, since experts highlighted that option *what* 3 > option *what* 4, option *who* 11 > option *who* 10, option *what* 3 must be correlated with option *who* 11, and option *what* 4 must be correlated with option *who* 10, the following two issues were identified:

1. option *what* 1 was preferred to *what* 4 which was preferred to *what* 3 for scores, whereas option *what* 4 was preferred to *what* 1 which was preferred to *what* 3 for votes
2. there was no correlation between *what* option 3 and *who* option 11 for scores, and there was no correlation between *what* option 4 and *who* option 10 for votes.

Note that option *who* 10 preferred to option *who* 11 is consistent with option *what* 4 preferred to option *what* 3.

These issues might be due to a lack of stakeholders' representativeness and knowledge.

Table 4 classifies the questions in the questionnaire in terms of approaches (i.e., consequentialist and deontologist), perceptions versus concerns (i.e., attitudes vs. goals), and features (i.e., economy, society, and environment).

Note that stakeholders' average values for the concerns (i.e., 0.33, 0.23, and 0.44 for economic, social, and environmental features, respectively) based on questions 28 and 30 suggested a greater concern for environmental issues and a smaller concern for social issues, while stakeholders' average values for perceptions (i.e., 0.96 and 1.19 for social and environmental issues, respectively) based on questions 31 and 32 suggested a slightly optimistic attitude for environmental issues and a slightly pessimistic attitude for social issues.

Tables 5 and 6 show the values of CIs in the *first* meeting calculated for all questions in the questionnaire as shown in Table 4. Note that we disregarded open questions such as 9 and 11, while we used answers to question 13 on self-stated access to adequate information (i.e., it asks stakeholders if they thought they had sufficient information to make a decision) to identify stakeholders to be involved in an additional meeting.

Thus, CIs for questions 3, 5, and 19 highlighted some problems in stakeholders' representativeness and recommended the involvement of additional stakeholders in a second (virtual) meeting (due to the COVID-19 pandemic).

4.2 | Problems solved by engaging 33 stakeholders

The main characteristics of the 33 stakeholders (i.e., the 22 initially invited plus the 11 additional stakeholders) involved in the second meeting (i.e., a 50% increase) can be summarized as follows: 23 male and 10 female participants; one below 26 years of age, three between 26 and 35 years, 10 between 36 and 50 years, 17 between 51 and 60 years, and two above 61 years of age. Six had a higher education degree, 13 had a bachelor's degree, seven had a master's degree, and seven had a doctoral degree. Sixteen were employed in public services, 10 were employed in private firms, one was employed in a research organization, two were employed in environmental organizations, and four in other jobs. Note that the second meeting cohort is better balanced compared to the first meeting in terms of age, education, and employment characteristics.

Tables 7 and 8 show the values of CIs after the *second* meeting (i.e., 33 stakeholders in total) calculated for all questions in the questionnaire as classified in Table 4.

Thus, the involvement of additional stakeholders solved the representativeness problem highlighted by question 19 but only reduced the representativeness problems behind questions 3 and 5, although to a large extent (CIs in the 33 stakeholders' sample were 1.25 = 0.55/0.44 and 7.19 = 0.63/0.09 times larger than the previous values in the 22 stakeholders' sample, for questions 3 and 4, respectively).

TABLE 5 Conflict indices for questions 1–12 in the *first* meeting. Underlined = missed conflict (i.e., the theoretical presence of conflict is not empirically observed); bold = inapt conflict (i.e., the theoretical lack of conflict is not empirically observed).

1	2	3	4	5	6	7	8	10	12
0.62	0.41	0.44	0.26	0.09	0.50	0.90	1.19	0.52	1.09

TABLE 6 Conflict indices for questions 14–28 in the *first* meeting. Underlined = missed conflict (i.e., the theoretical presence of conflict is not empirically observed); bold = inapt conflict (i.e., the theoretical lack of conflict is not empirically observed).

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1.01	0.49	0.67	0.79	0.57	0.64	1.20	0.77	0.92	0.39	0.66	0.43	0.70	0.87	0.81

TABLE 7 Conflict indices for questions 1–12 after the *second* meeting. Underlined = missed conflict (i.e., the theoretical presence of conflict is not empirically observed); bold = inapt conflict (i.e., the theoretical lack of conflict is not empirically observed).

1	2	3	4	5	6	7	8	10	12
0.60	0.58	0.55	0.55	0.63	0.33	1.02	1.22	0.55	1.11

TABLE 8 Conflict indices for questions 14–28 after the *second* meeting. Underlined = missed conflict (i.e., the theoretical presence of conflict is not empirically observed); bold = inapt conflict (i.e., the theoretical lack of conflict is not empirically observed).

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
0.84	0.50	0.48	0.27	0.46	0.75	0.55	0.93	1.03	0.48	0.42	0.38	0.66	0.78	0.69

TABLE 9 The empirical choices by the 33 stakeholders (percentages).

		What 1	What 2	What 3	What 4	What 9	Who 10	Who 11
Representative stakeholder	Mean	44	36	43	51	43	42	36
	Variance	0.07	0.02	0.07	0.10	0.05	0.08	0.02
Stakeholders' votes	Mean	20	3	24	38	15	55	45
	Variance	0.15	0.03	0.15	0.21	0.13	0.25	0.25

Note that we were not expecting to solve knowledge problems by increasing the sample size, but this happened in three out of five cases (for questions 17, 20, and 28).

The relative weights for 33 stakeholders were similar (i.e., 32, 24, and 44 for economic, social, and environmental features, respectively), and consequently, the theoretical choice was the same (i.e., 3 > 4 and 11 > 10, with 3 and 4 being correlated with 11 and 10, respectively).

Table 9 shows the empirical choices. Thus, the ranking of options in terms of the representative stakeholder is 4 > 1–3 = 9 > 2 for *what* options and 10 > 11 for *who* options, whereas the ranking of options in terms of the stakeholders' votes is 4 > 3 > 1 > 9 > 2 for *what* options and 10 > 11 for *who* options.

Figures 6 and 7 represent the distribution of scores among the 22 stakeholders for the *what* and *who* options, respectively, whereas Figures 8 and 9 represent the distribution of votes among the 22 stakeholders for the *what* and *who* options, respectively.

Note that the variance of scores and votes for option *what* 3 was still smaller than for option *what* 4 (i.e., 0.07 < 0.10 and 0.15 < 0.20). Moreover, in terms of scores, option *what* 4 was correlated with option *who* 11 to a greater extent than with option *who* 10 (i.e., 0.37 > 0.24) (Table 10), whereas in terms of votes option *what* 3 was correlated with option *who* 11 and option *what* 4 was correlated with option *who* 10 (Table 11). Finally, there was no uncertainty about the *who* options, while there was uncertainty about the *what* option (i.e., the same score for options *what* 3 and 4 by stakeholders 25).

Therefore, referring to a more representative sample solved the first issue highlighted above (i.e., option *what* 1 being preferred to option *what* 3) for both scores and votes and the second issue highlighted above (i.e., no correlation between *what* option 3 and *who* option 11 and between *what* option 4 and *who* option 10) for votes.

However, an information gap was still relevant, since 4 was preferred to 3 (i.e., the social features were over-weighted): an additional meeting between stakeholders and experts seemed to be needed to

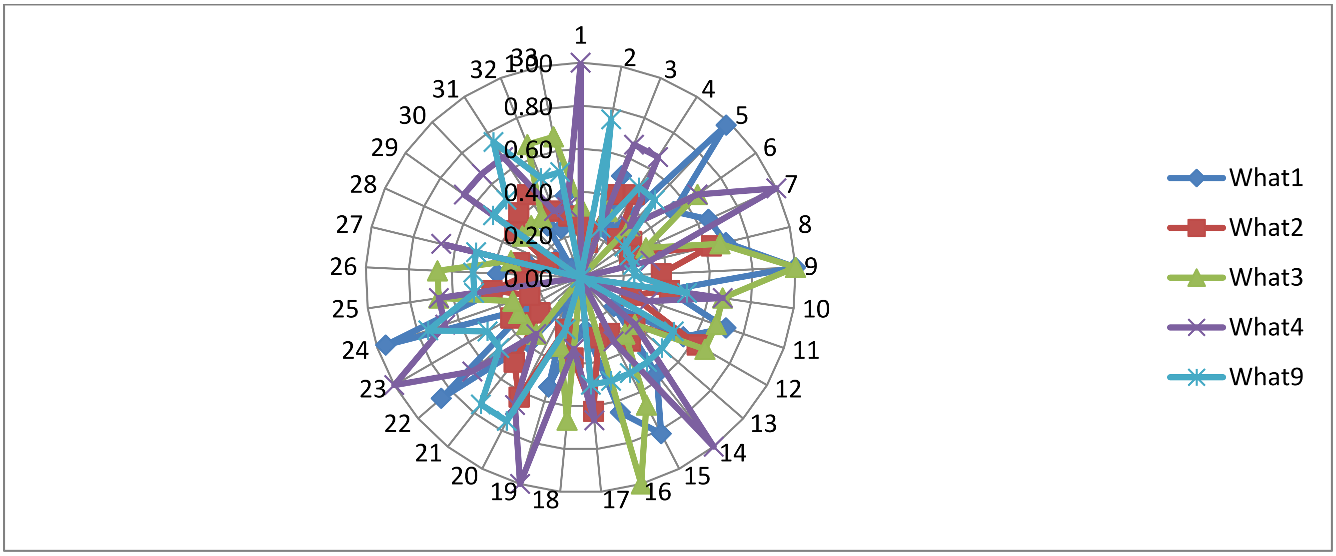

FIGURE 6 Distribution of scores among the 33 stakeholders on the *what* options.

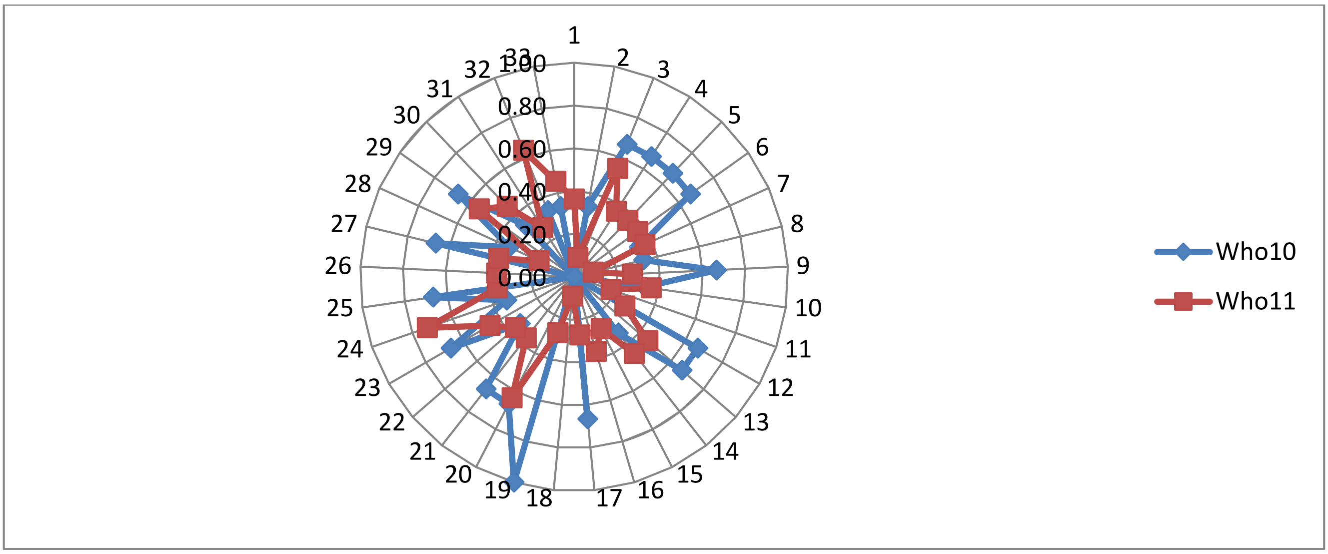

FIGURE 7 Distribution of scores among the 33 stakeholders on the *who* options.

discuss some specific issues. In particular, CIs for questions 8, 12, 17, 20, and 28 in Tables 8 and 9 highlighted some problems in stakeholders' information gaps and necessitated attendance in a third (virtual) meeting (due to the COVID-19 pandemic) of the initially invited stakeholders who declared a lack of information in question 13 (i.e., levels below 4 where 1 means "not at all informed" and 7 means "strongly informed") or who did not answer questions 8, 12, 17, 20, or 28. Note the goal was to increase the information shared between stakeholders and experts (Rehr et al., 2014), by reducing the information biases of some stakeholders (Fritz & Blinder, 2018).

Table 12 shows the CIs for the initial sample of stakeholders after the *third* meeting with some stakeholders calculated for questions 8, 12, 17, 20, or 28.

Thus, additional discussions with initially invited stakeholders on some specific topics solved knowledge problems highlighted by questions 12, 17, and 28 but only reduced these issues behind questions 8 and 20, albeit to a larger extent (CIs after the focused meeting are $0.69 = 0.83/1.19$ and $0.73 = 0.88/1.20$ times smaller than the previous values for questions 8 and 20, respectively).

Note that questions 20 and 8 refer to environmental and economic features, respectively (i.e., those perceived as the first and second most important issues). In summary, three meetings with stakeholders produced suitable (for 24 out of 28 questions) and acceptable (for 4 out of 28 questions) CIs, where a lack of conflict is never represented by values larger than 1.25 (i.e., stakeholders agreed on positive responses with large scores).

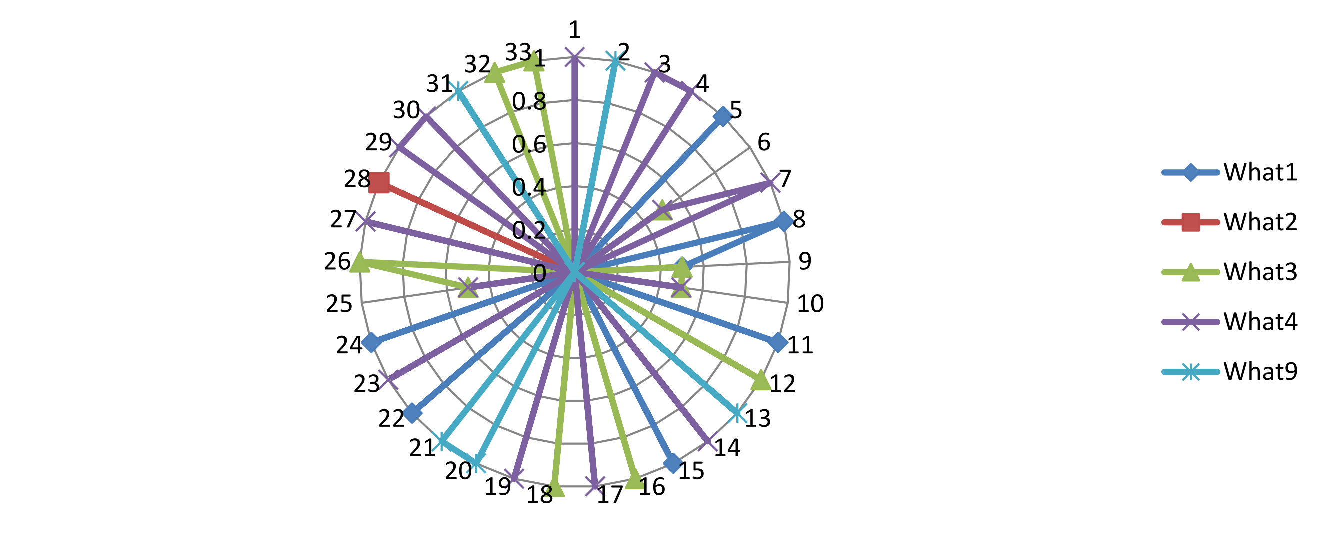

FIGURE 8 Distribution of votes among the 33 stakeholders on the *what* options.

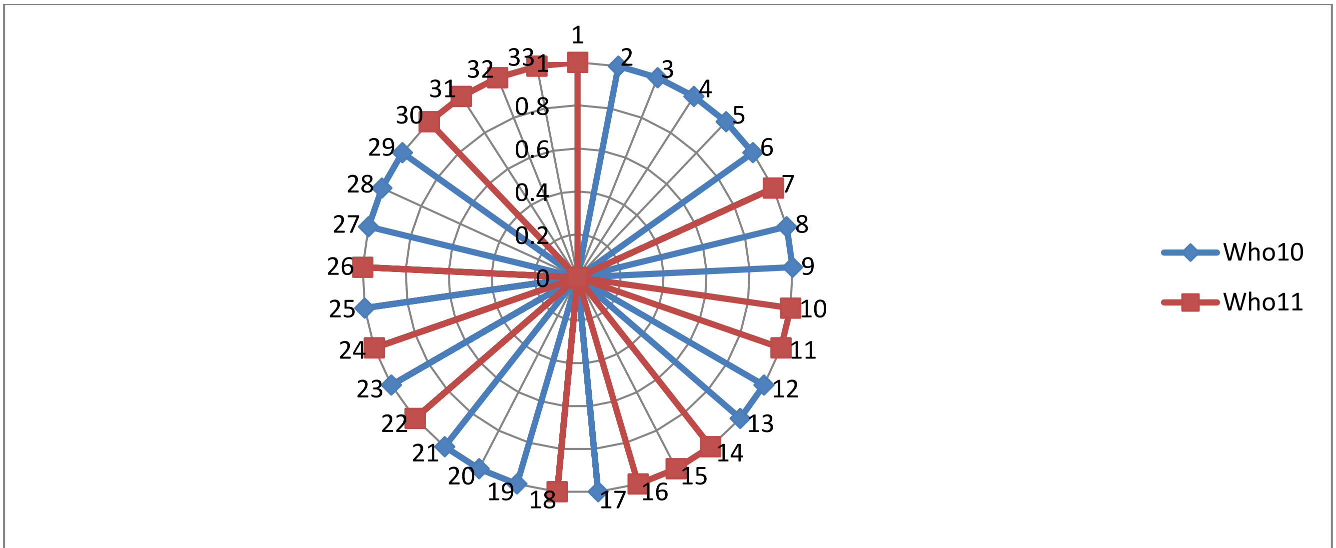

FIGURE 9 Distribution of votes among the 33 stakeholders on the *who* options.

TABLE 10 Correlations of scores by the 33 stakeholders.
Underlined = uncertainty between alternative *what* options;
italics = inconsistency between *what* and *who* options; bold = consistency between *what* and *who* options.

	What 2	What 3	What 4	What 9	Who 10	Who 11
What 1	−0.15	0.49	−0.08	−0.09	−0.06	−0.02
What 2	1	−0.05	0.07	0.27	*0.30*	0.04
What 3		1	−0.36	−0.23	−0.31	−0.12
What 4			1	−0.01	**0.24**	*0.37*
What 9				1	*0.19*	**0.43**
Who 10					1	0.25

TABLE 11 Correlations of votes by the 33 stakeholders.
Underlined = uncertainty between alternative *what* options;
italics = inconsistency between *what* and *who* options; bold = consistency between *what* and *who* options.

	What 2	What 3	What 4	What 9	Who 10	Who 11
What 1	−0.09	−0.26	−0.42	−0.21	−0.16	0.16
What 2	1	−0.11	−0.15	−0.07	*0.16*	−0.16
What 3		1	−0.38	−0.26	−0.29	**0.29**
What 4			1	−0.35	**0.16**	−0.16
What 9				1	*0.22*	−0.22
Who 10					1	−**1**

Table 13 shows the empirical choices. Thus, the ranking of *what* options in terms of the representative stakeholder is 3 > 4–1–9 > 2, whereas the ranking of *what* options in terms of the stakeholders' votes is 3 > 4 > 1 > 9 > 2 for *what* options.

Note that the variance of scores and votes for option *what* 3 were similar to the variance for option *what* 4 (i.e., 0.11–0.13 and 0.23–0.22). Moreover, in terms of scores, option *what* 4 was correlated with option *who* 10 (i.e., 0.09) (Table 14), whereas in terms of votes option *what* 3 was correlated with option *who* 11 (i.e., 0.07) and option *what* 4 was correlated with option *who* 10 (i.e., 0.13) (Table 15). Finally, there was no uncertainty about the *who* options and the *what* option.

Therefore, referring to a more informed sample solved the first issue highlighted above (i.e., option *what* 4 being preferred to option *what* 3) for both scores and votes and the second issue highlighted above (i.e., no correlation between *what* option 3 and *who* option 11 and between *what* option 4 and *who* option 10) for votes.

In summary, the comprehensive SBM proposed by Lüdeke-Freund et al. (2018), to suggest what to do by who, *combined with* a linear CI proposed by Fasth et al. (2018) to achieve a representative and informed sample of stakeholders, leads to an empirical sustainable decision for a complicated case (i.e., the absence of previous stakeholders' experiences at a local and national level), which is consistent with relative weights expressed by stakeholders for votes (i.e., strong sustainability and substantive rationality).

5 | DISCUSSION

In this paper, we used an established procedure to estimate relative weights attached to economic, social, and environmental features (Zagonari, 2016), and we applied these relative weights to a comprehensive SBM (Lüdeke-Freund et al., 2018), by identifying the theoretical choices based on stakeholders' concerns. We submitted a questionnaire to stakeholders and we identified biased or inconsistent decisions, by comparing decisions by experts and stakeholders within alternative perspectives in taking a collective decision. We checked for a potential lack of stakeholders' representativeness and knowledge, by referring to a linear CI (Fasth et al., 2018). We solved these issues, by increasing the original sample size by 50% and by meeting again some stakeholders on certain topics. We identified an unbiased decision based on stakeholders' concerns and consistent with strong sustainability and substantive rationality, as expected since we focused on an ethical decision (Zagonari, 2021).

TABLE 12 Conflict indices for questions 8, 12, 17, 20, and 28 after the *third* meeting. Underlined = missed conflict (i.e., the theoretical presence of conflict is not empirically observed); bold = inapt conflict (i.e., the theoretical lack of conflict is not empirically observed).

8	12	17	20	28
0.83	0.36	0.56	0.88	0.62

Note that the replicability of the methodology suggested in this paper to different contexts is straightforward. Indeed, if reuse options are chosen by stakeholders instead of being fixed by experts (i.e., strategies rather than principles), weights within a multi-criteria analysis should be replaced by certain crucial variables within a threshold analysis (e.g., financial returns and environmental damage from alternative reuses), since the bottom-up approach required by sustainability is ensured by reuse options being chosen by stakeholders. Similarly, if innovation of an existing business was under consideration instead of a new business (i.e., corporate social responsibility firms rather than start-ups), weights within a multi-criteria analysis should be applied to new people for the same roles as stakeholders, since new skills and feelings are likely to be required for old roles as stakeholders.

The main *general* insights can be summarized as follows. A small sample of representative and informed stakeholders and a neutral assessment of options by experts enable to practically obtain sustainable (i.e., strong or weak sustainability based on votes and scores, respectively) and rational (i.e., substantive or instrumental rationality based on votes and scores, respectively) decisions within a theoretical framework provided by SBMs, where the application of cardinal CIs to the stakeholders' sample identifies problems of representativeness and knowledge.

In other words, by referring to the SBM by Lüdeke-Freund et al. (2018), which includes all essential features of sustainable decision-making, we provided a *general* methodology (i.e., majority vs. average decisions, relative weights, three-dimensional simplex, and experts' vs. stakeholders' decisions) to highlight all the main problems related to sustainable and rational decisions (i.e., participation; economic, social, and environmental features; decisions consistent with concerns; and information and representativeness issues), by referring to the CI by Fasth et al. (2018) to solve these problems.

TABLE 13 The empirical choices by the 33 *informed* stakeholders (percentages).

		What 1	What 2	What 3	What 4	What 9	Who 10	Who 11
Representative stakeholder	Mean	41	36	**51**	**42**	43	42	36
	Variance	0.07	0.02	0.11	0.13	0.05	0.08	0.02
Stakeholders' votes	Mean	15	3	**36**	**33**	12	55	45
	Variance	0.13	0.03	0.23	0.22	0.11	0.25	0.25

TABLE 14 Correlations of scores by the 33 *informed* stakeholders. Underlined = uncertainty between alternative *what* options; italics = inconsistency between *what* and *who* options; bold = consistency between *what* and *who* options.

	What 2	What 3	What 4	What 9	Who 10	Who 11
What 1	−0.17	0.31	0.03	0.00	−0.17	0.05
What 2	1	−0.09	0.07	0.27	0.30	0.04
What 3		1	−0.61	−0.16	−0.10	−0.06
What 4			1	−0.02	**0.09**	0.31
What 9				1	0.19	0.43
Who 10					1	0.25

TABLE 15 Correlations of votes by the 33 *informed* stakeholders. Underlined = uncertainty between alternative *what* options; italics = inconsistency between *what* and *who* options; bold = consistency between *what* and *who* options.

	What 2	What 3	What 4	What 9	Who 10	Who 11
What 1	−0.07	−0.32	−0.30	−0.16	−0.29	0.29
What 2	1	−0.13	−0.13	−0.07	0.16	−0.16
What 3		1	−0.53	−0.28	−0.07	**0.07**
What 4			1	−0.26	**0.13**	−0.13
What 9				1	0.15	−0.15
Who 10					1	−1

The following main *specific* insights (i.e., related to the case study in the Adriatic Sea) were obtained:

- A representative sample can avoid biased and inconsistent choices (i.e., it makes option *what* 4 preferred to option *what* 1 and correlated with option *who* 10)
- The involvement of additional stakeholders (i.e., a 50% increase in the sample size), to cope with stakeholders' representativeness, always increases the conflict index values for deontological questions, although in two out of three cases, it did not meet the adopted threshold (i.e., from 0.75 to 1.25).
- Majority decisions (as opposed to average decisions) can increase consistency of choices (i.e., option *what* 3 correlated with option *who* 11).
- An informed sample can avoid biased choices (i.e., it makes option *what* 3 preferred to option *what* 1).
- An additional discussion with some initially invited stakeholders on specific topics (i.e., stakeholders who declared a lack of information and who did not answer specific questions on investment costs, employment, species conservation, or revenues), to help cope with stakeholders' knowledge, always decreases the conflict index values for consequentialist questions, although in two out of five cases, it did not meet the adopted threshold (i.e., below 0.75 and above 1.25).

Note that a belief propagation framework within a Bayesian belief network methodology, as opposed to a conflict index methodology, elicits ambiguity (i.e., stakeholders perceive and represent the context differently) by comparing probability distributions of the same variable among different stakeholders (Laurila-Pant et al., 2019; Salliou et al., 2017).

In summary, we combined and applied two methodologies (i.e., SBM and CI) to an ethical and a practical problem, where an ethical problem means that the solution depends on approaches, although it must be consistent, whereas a practical problem means that once an approach is adopted, there is an explicit solution. In fact, this context represents all sustainable decisions, since environmental sustainability is an ethical and practical problem (Zagonari, 2020). We showed that SBMs suggest what stakeholders would like to do within weak sustainability (based on scores) or strong sustainability (based on votes), provided that the sample of involved stakeholders is representative and informed, where CIs check for a possible lack of representativeness and information, by suggesting how to modify the stakeholders' sample to cope with these issues with minimum effort. Therefore, SBMs and CIs complement each other in sustainable decision-making.

The main (methodological) weaknesses of the suggested methodology are as follows:

1. We adopted a multi-criteria approach (Süß et al., 2021) within both weak and strong sustainability paradigms by using scores and votes, respectively. However, alternative assessment

approaches (e.g., cost–benefit and life cycle) would require additional assessment efforts to estimate economic, social, and environmental features in monetary terms (in cost–benefit analysis) at different times (in life cycle assessment).
2. We did not consider governance issues to a great extent (Bull & Love, 2019), although questions 2 and 14 refer to who and how businesses should be expected to manage mariculture and tourism activities, respectively. However, this would require an additional questionnaire.
3. We did not pay much attention to legal issues (Fam et al., 2018), although questions 4 and 15 refer to overall norms and marine rights to be accounted for in taking a decision on decommissioning versus reuse, respectively. However, this would require a different questionnaire.

The main (operational) strengths of the suggested methodology are as follows:

1. Our methodology can be applied to small samples. Indeed, we obtained the expected values of CIs for both deontologist and consequentialist questions once responses were taken into account from the 11 additional stakeholders and the six initially invited stakeholders were offered an additional discussion on four topics. In other words, our methodology enables decision-makers to save time and money.
2. Our methodology enables decision-makers to consider both substantive rationality (i.e., combining different worldviews into a representative stakeholder's goal) and instrumental rationality (i.e., choosing the option that best meets the representative stakeholder's goal) (Silvestre et al., 2022).
3. Our methodology can be applied to any sustainable decision-making process. Indeed, we differentiated between alternative perceptions and concerns about economic, social, and environmental issues, by measuring the relative importance attached to them by the involved stakeholders. In other words, our methodology enables decision-makers to reduce the impacts on decisions of stakeholders' representativeness and knowledge issues for irrelevant features.

Note that responses are assumed to be symmetrical for deontological issues and non-symmetrical for consequentialist issues, whereas no assumptions were made about unimodal or multimodal distributions of responses. By contrast, averaging alternative perceptions and representations by different stakeholders in a single model (e.g., the VIKOR method on the distance from the utopia point or TOPSIS method on distances from utopia and nadir points) makes sense if responses can be assumed to be unimodal, whereas decisions based on majority rules (e.g., maximize consensus on mean or median options) about available options from representative and informed stakeholders should be preferred otherwise (Dowling et al., 2016).

In summary, the key theoretical implication of the present study is that choices among alternative sustainable businesses depend on the adopted sustainability paradigm. For example, choices arising from welfare maximization are different from choices arising from impact minimization. In addition, the key managerial implication of the present study is that choices among alternative sustainable businesses should be identified according to the adopted sustainability paradigm. For example, choices within weak sustainability should be based on average scores, whereas choices within strong sustainability should be supported by majority votes.

6 | CONCLUSION

The *first purpose* of this paper was to suggest an empirical methodology to make SBMs a theoretical framework that practically recommends *what*, *who*, *when*, *where*, and *how* to act within sustainable decision-making about reusing versus total or partial decommissioning of an offshore gas platform in the Adriatic Sea. The main result obtained in the present study is that an SBM might *not* be accurate in identifying an unbiased and consistent collective choice. In particular, while *when* and *where* depended on the case study and *how* was depicted by an average decision based on scores rather than on a majority decision based on votes, we found that options *what* 3 and *what* 4 were not the most preferred, option *what* 4 was correlated with option *who* 10 for scores only, and option *what* 3 was correlated with option *who* 9 for votes only. Note that an overemphasis on a cooperation approach over an institutional approach was observed together with a preference for eco-design (although properly correlated with an institutional approach) over a circular economy (although properly correlated with a cooperative approach), without and with uncertainty about *who* options and *what* options, respectively.

However, stakeholders' sample representativeness and knowledge could affect sustainable decision-making. The straightforward solution to these problems could have been (1) to set up a large sample of stakeholders, although these additional stakeholders might cope with sample representativeness, but might not deal with information gaps about some topics; (2) to organize subsequent focus groups on specific topics, although these additional meetings might help cope with stakeholders' knowledge but might not deal with stakeholders' representativeness. Nevertheless, the enlargement of the number of stakeholders or the organization of focus groups is expensive in terms of money and time.

The *second purpose* of this study was to refer to an original CI to achieve more representative and informed decisions at a minimum cost. In particular, we suggested an increase of the sample by 50% (i.e., 11 additional stakeholders involved in the second meeting on all questions) to deal with a lack of representativeness and an additional discussion with a few initially invited stakeholders on certain topics (i.e., six additional stakeholders involved in the third meeting concerning four questions) to deal with a lack of knowledge. Note that the suggested methodology also measured the relative concerns and perceptions attached to features and issues, and, consequently, the importance that must be given to information gaps observed on these features and issues. Indeed, a persistent information gap (e.g., employment from reuse) on an issue considered to be irrelevant by stakeholders (e.g., social issues) would not affect the stakeholders' representative decisions.

Combining SBM with CI demonstrated that stakeholders could agree on partial decommissioning (i.e., carbonate coating a submerged structure for tourism activities), where the relative concerns (i.e., greater for environmental than for economic and for social features) and perceptions (i.e., optimism for environmental versus pessimism for social issues) were coupled with the factual net revenues (larger net revenues for tourism than for mariculture activities due to the significantly larger costs and the non-significantly larger revenues characterising mariculture versus tourism activities, respectively) and impacts (larger increase in biodiversity related to tourism activities versus smaller increase in employment due to mariculture activities).

Future research should examine sustainable decisions on decommissioning versus reuse with a long-term perspective (e.g., life cycle assessment), by emphasizing governance issues (where stakeholders' knowledge is likely to be relevant) and legal issues (where stakeholders' representativeness is likely to be crucial).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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