D2.2

Participatory framework

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LEGAL NOTICE

ABOUT

Energy transition plans may challenge the social ecosystem of the regions where coal is still king: if energy transition plans don't consider local factors, they may cause higher unemployment rates, aggravated energy poverty, and economic migration. Energy poverty is already a big challenge today in the EU, with coal-dependent regions generally being more affected by the issue.

In the spirit of the EU principle to "leave no one behind" in the transition, JUSTEM addresses the energy transition planning through a double-sided approach: (1) it helps regional authorities to develop 'just' energy transition plans that are sensitive to regional impacts such as job losses and energy poverty; and (2) it helps citizens build their capacity and find their place in a greener economy.

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PROJECT PARTNERS

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ABBREVIATIONS

AHP	Analytic Hierarchy Process
APOLLO	A grouP decisiOn fuzzy TOoL in support of cLimate change pOlicy making
MCDA	Multi-criteria decision aid
MSP	Multi Stakeholder Partnership
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution

EXECUTIVE SUMMARY

Stakeholder engagement constitutes a vital process to involve citizens and regional stakeholders in the just transition. However, the notions of justice and action on climate change usually spark debates on how this transition should unfold in order to achieve decarbonisation objectives while mitigating any potential negative impacts on the local society at the same time. Given the existence of multiple methodologies to perform engagement exercises, in this research, we first perform a literature review to identify techniques from a wide range of scientific fields that could be useful to JUSTEM and other similar initiatives, both in terms of their easy-to-use approach, which is necessary when engaging with citizens, and their closeness to the thematic of the just transition. At the same time, as we have observed a lack of dedicated tools capable of bridging these different and occasionally conflicting viewpoints, apart from generic survey-type solutions, we present the APOLLO-Live, stakeholder engagement webtool, that can be used live in workshops to allow stakeholders express their opinions, find consensual solutions to problems that spark debates, and prioritise needs and evaluate solutions in a process of deliberative democracy to design the just transition with and for citizens and regional stakeholders.

This report, apart from the review section, constitutes a documentation of the APOLLO-Live open webtool, describing its functionalities, in order to assist potential users to use the tool in live workshops and similar exercises, even after the duration of the JUSTEM project. Within JUSTEM, the tool is envisaged to be used during the second round of workshops to be performed as part of the project's pilots. The report also describes the development process to reach this version of the tool, including three internal beta tests with more than 30 participants to gather feedback and improve its functionalities.

The links to access the tool and the open-source code can be found in the appendix to this report.

1. INTRODUCTION

Engaging with stakeholders as part of the scientific process has recently got significant attention (Lavery, 2018), in an effort to communicate scientific findings to broader audiences as well as enable implementation of said findings in real-life applications (Goodman et al., 2017). Stakeholder theory has its roots in the business world (Kujala, 2022), as a means for businesses and entities to engage with those that are affected by their decisions (Freeman, 1984), in the essence of corporate social responsibility (Andriof and Waddock, 2017; Greenwood, 2007). However, stakeholder engagement has found applications across many fields, including sustainability (Mathur et al., 2008), environmental conservation (Sterling et al., 2017; Phillipson et al., 2012) and the energy transition (Marcon Nora et al., 2023), and the relevant policy development aspects of these fields (Helbig et al., 2015; Wellstead and Biesbroek, 2023).

Within the transitions field, and in particular when raising aspects of justice and fairness, stakeholder engagement is of utmost importance but has so far been a largely underemployed option. This is because the transition, even though vital to ensure environmental conservation and addressing climate change, is expected to also have negative impacts in the regional development of communities that are so far dependent on fossil fuels, and notably coal. As such, citizens within these regions that are affected the most need to be part of the discussion to co-design their future, which will help towards society accepting, fine-tuning or even completely guiding pursued solutions and therefore being a part and legitimising the transition (Nikas et al., 2020).

However, despite good intentions, not all stakeholders share a common vision of what the future of their regions should be, or even the best path to reach any future. This sparks lively debates in the regions over the best course of action, including inter alia the timeline of the transition, investments to be implemented and the allocation of funds. When engaging with the local communities it is therefore important to flesh out and highlight these different priorities and preferences, as well as attempt to bridge conflicting viewpoints and converge, even though compromises, to widely acceptable paths forward.

With the JUSTEM project deeply rooted within the stakeholder engagement process to co-create the just transition with stakeholders and citizens of coal-dependent regions, in this deliverable we aim to present a wide range of easy to use and appropriate for the project's goal stakeholder engagement tools and frameworks which can be used in the workshops that will follow. Additionally, and noting the absence of specific and dedicated tools of (semi-)quantitative nature for stakeholder engagement, we developed and present APOLLO-Live, a stakeholder engagement webtool, that can be used live in workshops to allow stakeholders express their opinions, bridge the gap between different and occasionally conflicting viewpoints, and overall prioritise needs and evaluate solutions in a process of deliberative democracy to design the just transition with and for citizens and regional stakeholders.

2. METHODOLOGIES AND TOOLS FOR STAKEHOLDER ENGAGEMENT

In this section, we aim to identify several engagement approaches/tools that can be used as part of the project's workshops. In particular, we focus on providing a list including a variety of tools that originate from a wide range of scientific fields which we present in clusters, depending on how they can be used. We associate each one of these methods with a short description as a brief guideline on how it can be used and for which types of questions, and we further elaborate on this based on examples of its usage in actual case studies in the literature. The identification and description of the tools presented largely draws from "The MSP Tool Guide: Sixty tools to facilitate multi-stakeholder partnerships: companion to The MSP Guide" published by Brouwer et al. (2017) and ETH Zurich's "USYS TdLab Toolbox" (USYS TdLab, 2023) and additional sources in the literature. The two reports together notably include more than 60 stakeholder engagement methods that can be employed. Here, we focus on those that do not require a high expertise level from the stakeholders involved, considering that JUSTEM aims to engage with citizens as well, who may not have the required expertise, and that are relevant to the project's objectives.

'Get together' and 'define the subject' approaches

The approaches in this introductory category aim to make stakeholders open up and set the basis for a constructive dialogue, leading to all stakeholders having a clear understanding of the issues examined (Brouwer et al., 2019). Since these approaches are mainly used so that stakeholders introduce themselves and identify the examined problem, they are rarely used standalone.

The first approach "Introductions" aims to allow stakeholders to introduce themselves and get familiar with the group in a simple format. Although the method can be applied in various ways ranging in terms of complexity, the most common one is simply urging every stakeholder to stand up and present their background.

A similar way that can help stakeholders identify each other but can also be used for eliciting stakeholder perceptions based on preliminary questions is the "Human Spectrogram". A coloured tape is positioned on the floor and stakeholders are asked to position themselves behind it according to their opinion (or personal status) on a specific subject. Stakeholders that "Strongly Agree" and those that "Strongly Disagree" are positioned at the opposite ends of the tape, with the rest of them being positioned somewhere in the middle according to their opinion (or personal status).

The "Problem definition worksheet" aims to analyse the subject examined by posing five relevant questions. Common questions are related to the key question we aim to

solve, including identification of the people affected by the discussed issue or the social factors that form the problem examined.

Bringing a more personal touch in the process, the "Tell your story by means of an object", asks stakeholders to pick up an object with which they can describe their experience on the discussed subject. Then, stakeholders are asked to examine all the objects chosen by the rest of the participants and try to detect any similarities or tendencies. Although this needs some preparation beforehand so that stakeholders bring these objects with them, alternatives can be pursued using proxies (e.g., stickers or sticky notes) of them.

Questionnaires, surveys and polls

"Questionnaires and surveys" aim to investigate the preferences and opinions of the involved stakeholders, in quantifiable or at least semi-quantifiable terms. Their function and employment during workshops are very simple: the organisers of the engagement event prepare a questionnaire with questions regarding the subject analysed and the stakeholders are asked to fill it in, providing their preferences. Then, these preferences are analysed to provide insightful conclusions. Such approaches are widely used and are applied in several stakeholder engagement events due to their simplicity, employing voting polls either using printed sheets or by raising hands or alternatively using a number of online options such as Survey Monkey, Sli.do, Google/Microsoft Forms, Mentimeter or other similar platforms. Such polls can be combined with other methods as well "Prioritising and Ranking" approaches aiming to narrow down a big set of ideas proposed during the brainstorming phase of a workshop and then rank them using the aforementioned methods. Considering the vast use of such approaches and a wide range of tools available to enable such exercises, in the following paragraphs we provide examples of case studies taking advantage of such options.

For example, Katika et al. (2022) demonstrated an AR tool aimed at engaging citizens in circular economy concepts and then ran two surveys to draw insights from Greek citizens on the proposed solution. Another example of engaging citizens through surveys was demonstrated by Schalk (2014) who interviewed stakeholders on the needs of municipalities in Alberta, Canada. Next, Hentschel (2020) ran an online survey, combined with qualitative interviews, to examine citizens' opinions on municipal energy concepts in Germany. Yusuf et al. (2019), also focused on interviewing forty-three citizens in the Unites States about the social and ecological resilience to sea level rise. Lacroix et al. (2016) examined the formulation of the "Roadmap for Considering Water for Arizona's Natural Areas", interviewing stakeholders in 47 focus groups and then presented the results using word clouds, as well as a figure demonstrating the relation between various aspects. Tu et al. (2022), interviewed 40 stakeholders in China regarding the sustainable development of Rongcheng, China, involving stakeholders in both the identification of regional issues as well and the implementation phase, in a co-

design approach. In contrast, Pizarro-Irizar et al. (2020), performed a two-step online survey to assess the results procured within their analyses, while Heitkemper (2021) followed a similar validation-based approach using interviews with households.

Based on the previous examples, we can see that surveys/polls and similar approaches can be used in various ways, notably to assess and choose solutions as well as design paths forward, identify impacts, express opinions, figure relationships between examined aspects, and evaluate results. Within these categories, Olivier et al. (2021), also adds the spatial dimension through the notion of 'evidence-based stakeholder engagement', indicating the split between generalisable evidence/uncertainty and local evidence, as well as the possibility of a combination of these two. Bjørkan et al. (2023) hint that such local-based approaches can also help the analyst to better understand the stakeholders' connection to the location linked to a discussed subject.

Operational Research tools

Expanding on the previous category, operational research frameworks are conceptually similar to questionnaires and polls, adding however complexity in the background during the analysis of the received answers by the stakeholders. The "Delphi" tool is a widely used MCDA (Multi-Criteria Decision Analysis) method that aims to achieve convergence of opinions among stakeholders through detailed discussions and 2 rounds of questions, where the 2nd round of questions is heavily formulated after the examination of the 1st round's results that are publicly presented in an anonymized format. It is assumed that after some rounds, the solution space expressed by the stakeholders will start to converge. Other popular MCDA methods are TOPSIS and AHP, supported by relevant tools (Labella et al., 2020), to facilitate stakeholder engagement processes and provide ranking of specific alternatives. Another operational research technique is Fuzzy Cognitive Maps (Taylor et al., 2016), which is a framework used to enable stakeholders construct simple maps that offer a simplified representation of a system and its causal relationships.

Emancipatory boundary critique

The "Emancipatory boundary critique" aims to critically challenge experts on the solutions they suggest and help non-experts better understand experts' views. Usual questions asked by the non-experts to the experts are divided into four categories: sources of motivation, sources of power, sources of knowledge and sources of legitimisation. In the case of JUSTEM, where a key goal is to help inform citizens on the just transition and coal phase-out, such an approach could be of significant use.

Game-based methods

Games that imitate real-life decision-making processes have also started gaining ground in stakeholder engagement. Oosthuizen (2019) proposed a role-playing game, including various elements and action cards, in order to engage local stakeholders in the uThukela District Municipality in South Africa on Natural Resources Management. In this game, a map was designed in which stakeholders were asked to install various types of units (e.g., crops, buildings). Fuzzy cognitive maps and mental models can help in such endeavours. Similarly, Bernstein et al. (2020) engaged 39 stakeholders from 6 countries in a four-day workshop, aiming to examine issues on drug use regulation in Canada. The workshop focused on the "Regulation Game", a game (played in roundtables of 5 people) that aims to help stakeholders overcome barriers regarding policy choices on drug regulation. Genç et al (2015), trying to design and evaluate a Location Based Urban Information System, asked stakeholders to participate in the design process of the aforementioned system through a series of workshops which included interviews, a journal in which stakeholders filled in their experiences from the city, as well as a tabletop game based on events that have happened in the city.

Another gamification-type of stakeholder engagement includes the Six Hat Theory, in order to examine a problem from different aspects and roles. Within such a process, stakeholders are asked to express their opinions on a subject from six different viewpoints: the factual, the emotional, the cautious, the logical, the out-of-the-box and the management. In this role-playing manner, all participants have the chance to think in all six different ways.

Consultation and co-creation

A prolific method within the Consultation and co-creation cluster is the "Scenario Planning" or "Scenario Integration" which is a co-creation tool, in which stakeholders are asked to propose scenarios on how the discussed subject will evolve in the future, taking into account the driving forces of this subject. Such an approach is useful within the thematic region of JUSTEM, as it is particularly effective in transition-oriented questions. Within specific boundary systems, participants are asked to define specific relevant variables and then envisage their evolution in a vision/scenario-based approach. From boards and markers to online visualisation tools, numerous options exist to support such an approach.

Other such endeavours usually include combinations with other frameworks. Notably, Baer (2019) consulted stakeholders in 4 Norwegian towns regarding Zero-emission projects in Norwegian neighbourhoods. They examined four different projects and the consultation process was combined with methods such as a dialogue platform and a stakeholder brainstorming event. Vancea et al. (2019), focusing on maritime spatial planning in the Black Sea, also engaged in consultation meetings with local

stakeholders. Towards a more inclusive approach, Mačiuliene and Mačiulis (2017) introduced a stakeholder engagement framework that requires citizen input in all stages, proposing a co-creation framework for urban planning in Lithuania. Specifically, this framework was implemented in Vilnius and Biržai to propose multifunctional solutions for already-existent urban spaces. In a similar context, Betta et al. (2022) focusing on urban planning propose a stakeholder engagement framework (Cooking Recipe Challenge) that aims to identify important actors, evaluate their needs and examine how to assist a smoother transition to a circular economy. This framework has been used in the cities of Trento, Italy, Birmingham, UK and Göteborg, Sweden. Lastly, Pozniak et al. (2023) engaged stakeholders through communities of practice in 6 cities in the Mediterranean Sea, aiming to the establish a collaboration of different stakeholders (e.g., NGOs, municipalities, research centres etc.).

We see that the approaches in this category, whether aiming for high levels of inclusivity or a simple consultation workshop, usually still rely on questionnaires and interviews, as discussed above, to structurally elicit stakeholder knowledge.

Other notable studies of stakeholder engagement

Moodie et al. (2022) examined ways to engage citizens in the EU's cohesion policy formation. They proposed various methods such as focus groups, World Cafés and citizen juries that help citizens provide reflections on various issues. Participatory budgeting can also be an important tool to include citizens in decision-making, where citizens are asked to determine their priorities regarding budgeting issues (Sintomer et al., 2008).

Baker et al. (2023) present insights drawn from 10 different EU cities on the use of water, involving citizens in various engagement processes such as the use of AR applications, serious gaming, discussion with local groups. Similarly, Kay et al. (2006) examined which engagement tools have been used to engage fisheries-related stakeholders in 6 different communities (2 in Scotland, 2 in Thailand, 1 in Namibia and 1 in Mexico), demonstrating that some of the most used methods were surveys and interviews, whereas other more complicated methods, such as "Delphi" were used in fewer cases.

Other more complicated approaches or less useful in the project's context include:

- Rich picture (to understand the complexity of a subject)
- NetMapping (to understand how different stakeholder goals coexist); FCM tools can be used to assist in this process
- Problem Tree (to examine the causes and effects of a problem)
- Timeline (to illustrate the chronological sequence of several events) combined with Trendline (to illustrate possible future trends)
- Partnership Agreement (to form agreements on specific ways to collaborate)

- Visioning (to set a common goal regarding the examined issue)
- Comparing Proposals (to examine an issue from different perspectives by weighting specific proposals)
- Synthesis (to summarise the issues discussed and the things that have been achieved)
- Closing Circle (to conclude the workshop and increase the stakeholders' commitment)

Despite the existence of multiple and extremely useful methodologies for stakeholder engagement, these—originating primarily from the social sciences—mostly bring forward a qualitative perspective. Contrary, when shifting to methodologies opting for semi-quantitative or quantitative approaches, specific tools to facilitate such processes are scarce, and usually focus on polling and survey tools. But usually, these have a broader area of applications and are not tailored to stakeholder engagement and reaching consensus.

3. THE APOLLO-LIVE STAKEHOLDER ENGAGEMENT TOOL

Overview and key concepts of the tool

Drawing from the insights of the previous section, and to bridge the gap regarding the lack of dedicated and palpable tools tailored to facilitating stakeholder engagement exercises, in this section we present APOLLO-Live, a new stakeholder engagement webtool developed withing JUSTEM and which constitutes a significant expansion of the APOLLO tool (Labella et al., 2020; Koasidis et al., 2022), developed in the H2020 PARIS REINFORE project. This significantly updated version of the tool can be used live in workshops to allow stakeholders express their opinions, bridge the gap between different and occasionally conflicting viewpoints, and overall prioritise needs and evaluate solutions in a process of deliberative democracy to design the just transition in a participatory format. To understand the overall contribution of the tool, we first need to define the following concepts in simple terms:

- Alternatives: These are the options that we want the stakeholders to vote on.
- Criteria: These are the aspects against which each alternative is evaluated by the stakeholders.
- Vote: Each stakeholder provides their evaluations using Likert-type linguistic scales e.g., {Very Low, Low, Medium, High, Very High}. Symmetrical scales with both negative and positive values can be used but are not recommended within the methodological approach adopted here.
- Ranking: The end-result of the tool is a ranking of the alternatives.
- Consensus: A metric expressing the agreement between the group of stakeholders.

As such, within the tool, stakeholders are asked to vote on specifics options by answering questions, in a simple survey-type format which can be fully customisable. For example, Stakeholder 1 may believe that installing photovoltaics [Alternative X] will have a Very High impact [Stakeholder's vote] on job creation [Criterion A]. Then the tool combines all these votes from participants to offer a universal solution that represents the beliefs of the whole group. Essentially, this solution is a rank of the alternatives from the most to the least important which is defined from the votes of the alternatives across all criteria. Following the previous example, if most stakeholders believe that indeed photovoltaics have a very high impact not only on job creation but on other dimensions as well, this technology is expected to be placed in the top positions of the ranking with an evaluation of high importance. The tool also identifies the level of (dis)agreement between the participants and offer tailored tips to improve the consensus among the voters in multiple rounds of voting.

The methodological foundations of the tool are heavily rooted in the operations research field and in particular draw from the multi-criteria decision aid (MCDA), group decision making (GDM), and consensus making and reaching fields. In particular, it employs the 2-tuple group TOPSIS method, combining TOPSIS (Hwang and Yoon, 1981), a well-established MCDA methodology for ranking alternatives, with 2-tuples (Herrera et al., 2005) that essentially are an expansion of linguistic terms that are easy for stakeholders to comprehend, and a group decision-making setup (Krohling and Campanharo, 2011) meaning that it is based on multiple stakeholders voting simultaneously. Details on the development of the tool can be found in the Annex.

The tool from the perspective of the participants

Within this tool, participants can use one of the active poll sessions live during workshops to engage with different stakeholders and participate in shaping the future of the transition (see Figure 1). After joining a poll, the tool asks the user for some basic information that are fully anonymised (no names, e-mail addresses or other identifiable information are collected; a proper disclaimer is placed in the screen), and which can be used to provide aggregated results (Figure 2).

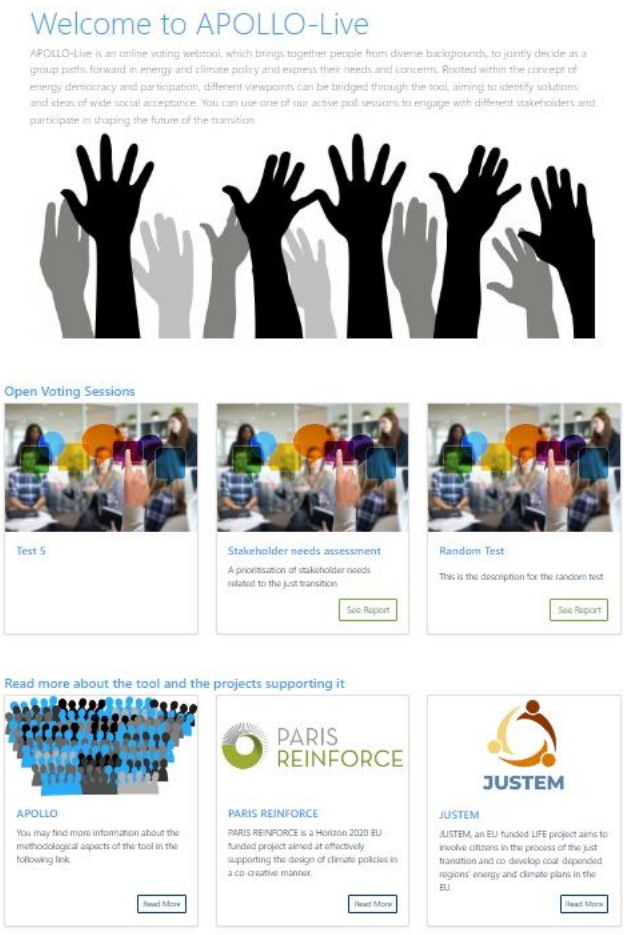


Figure 1 Landing page of the APOLLO-Live tool

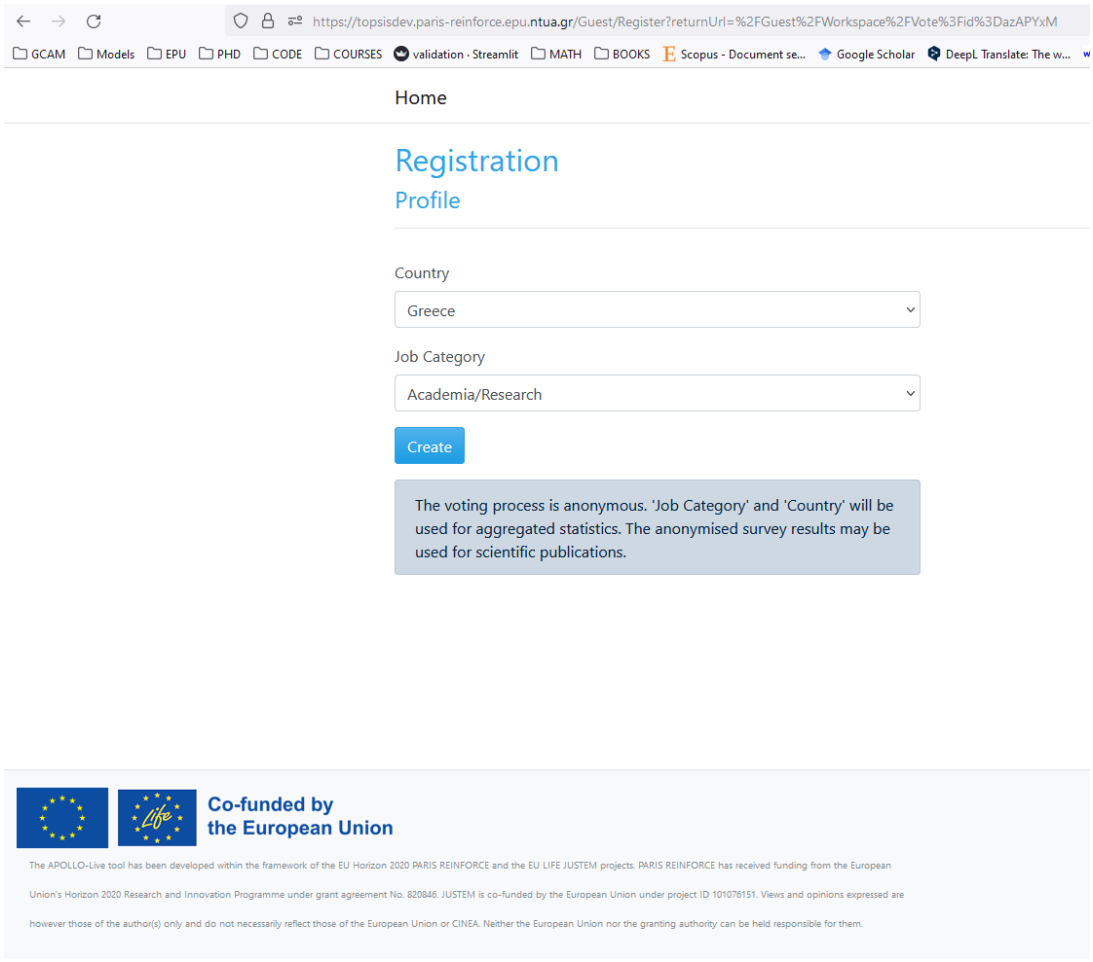
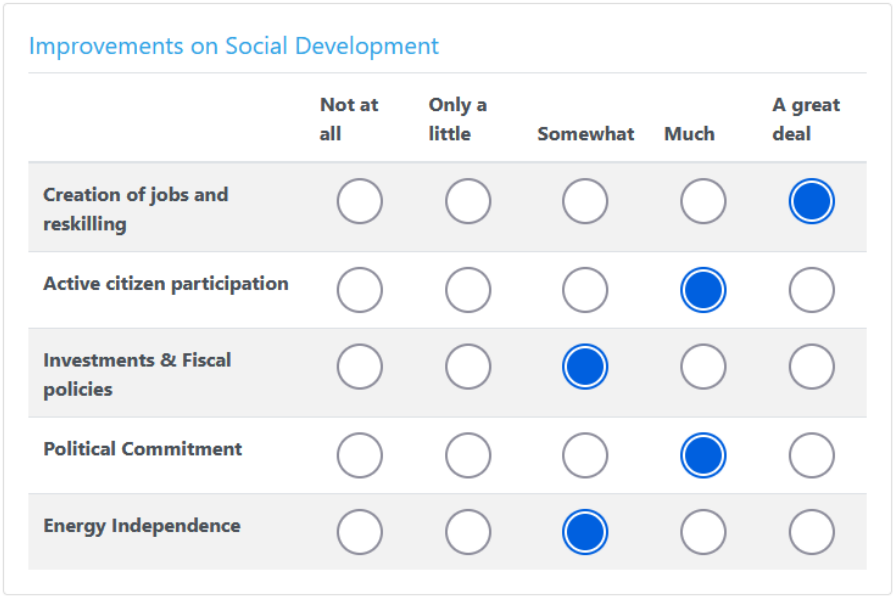
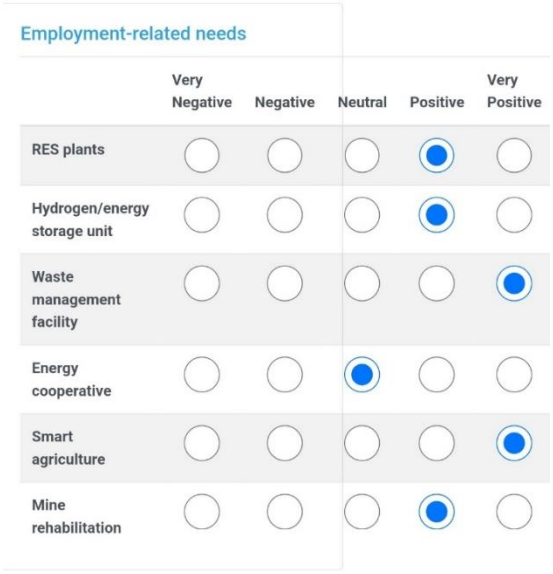


Figure 2: Registration Interface and anonymisation disclaimer

In Figure 3, we present two different cases of questionnaires that can be used within the tool. In case (a), we asked participants to share their perceptions over how addressing each of the following needs improves social development in their region (functionality to performs needs assessment and prioritisation). In case (b), we asked participants to evaluate specific actions that move forward the transition in terms of their impact on addressing the employment-related needs. In both cases, linguistic values easily understood by the participants were used.



(a) Browser view



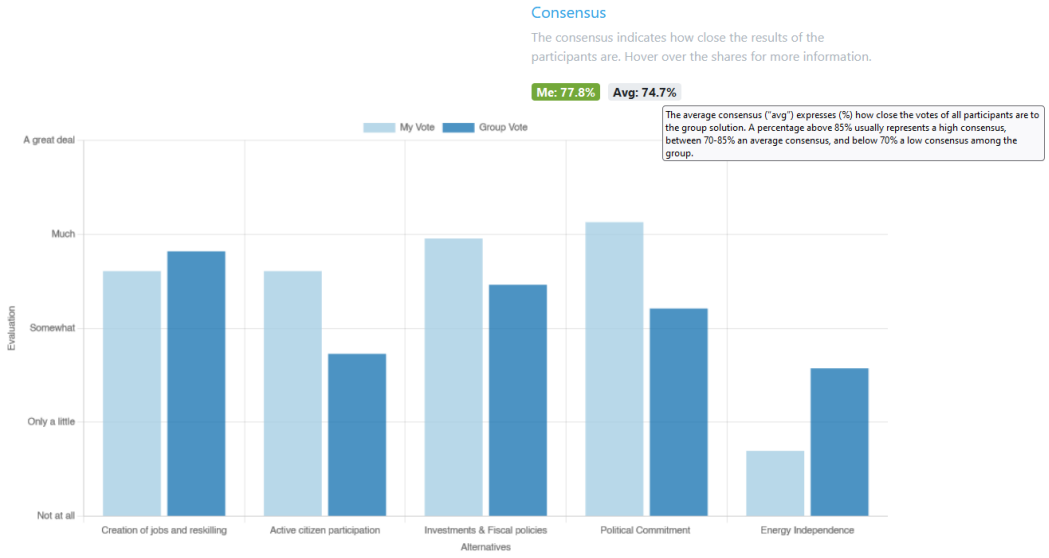
(b) Mobile view

Figure 3: Examples of questionnaires used within the tool through the voting interface.

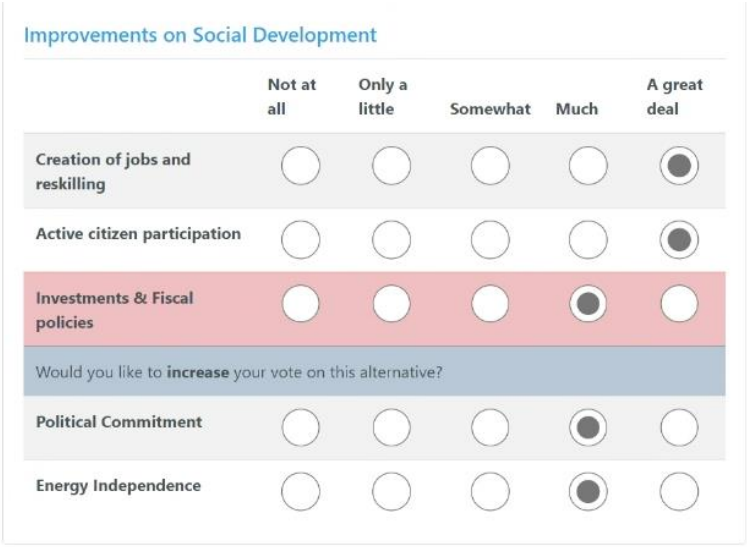
As discussed in the previous section, the questionnaires rely on two notions: 1) the alternatives which are the options that we want the stakeholders to vote on (needs in Figure 3a and actions in Figure 3b); and 2) multiple criteria which are the aspects against which each alternative is evaluated by the stakeholder (note that in Figure 3 only one criterion is presented, while a typical questionnaire entails multiple such questions, e.g., social, environmental and financial development).

The votes of all participants are combined to create a unique solution that represents the solution of the group. In Figure 4 you may see how these results are presented and notably how the individual results of a participant compare to this “group solution” for

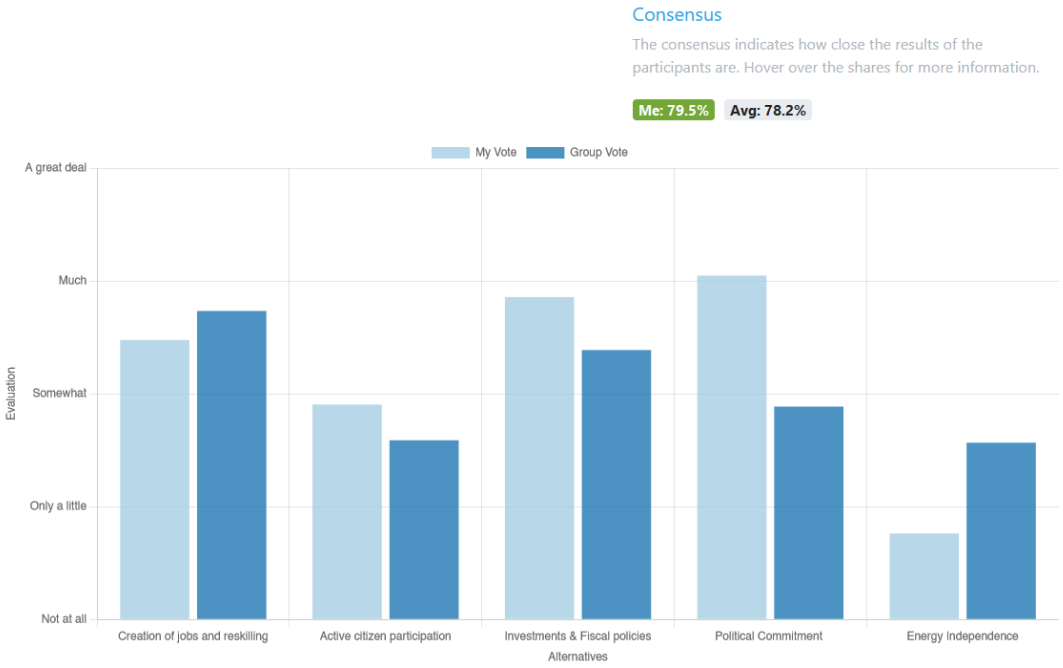
each of the options. A higher rating for an option indicates a higher priority/importance. A large difference in the two bars indicates a large disagreement between the individual votes of a participant and those of the rest of the participants. In some cases, a large difference may trigger a suggestion to adapt the participants vote in the next voting round, depending on the other participants as well. This tip is based on the consensus level which indicates how close the results of the participants are. In particular, in Figure 4a we can see that in this specific exercise employment-related needs are the most important based on the whole set of participants, but our specific stakeholder indicated that they believe it is actually political commitment that is the most important. The consensus in the first round was 74.7%. To improve this, some participants received tips, suggesting that they could—but they are not obligated to—change their vote (Figure 4b), while between rounds, extensive discussions take place to enable all voices to be heard. After participants voted again, we can see that the consensus improved to 78.2% (Figure 4c). Iterative processes could further improve this in order to reach a widely acceptable result.



(a) First round results



(b) Tip to improve solution



(c) Second round results

Figure 4: Results from a preliminary dry run on the assessment of needs with two rounds of voting

The webtool also generates a diagram (Figure 5) depicting how the results of the "group solution" have changed between rounds following the deliberations in between. Although large differences are not always evident (especially in case like this one we are talking about only two rounds), we can see that notably the value in the 'political commitment' option presents some differences, as the participant highly prioritising this need agreed to tone down their vote.

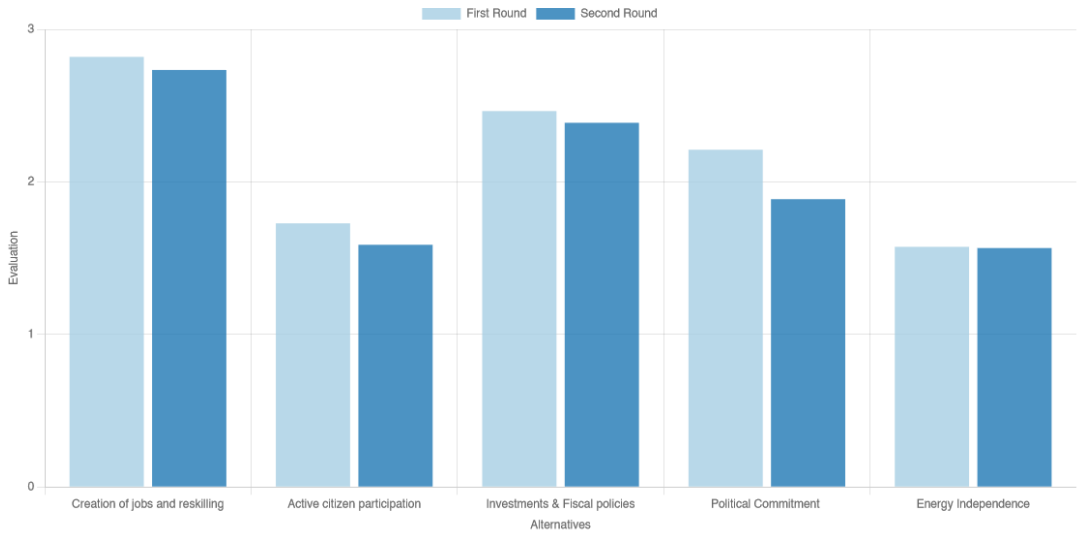


Figure 5: Comparison of the solution generated in each round

Stakeholders are also grouped together based on their working capacity background (e.g., academia) to create a unique solution for their group and understand the dynamics and the different viewpoints of each group of participants (Figure 6).

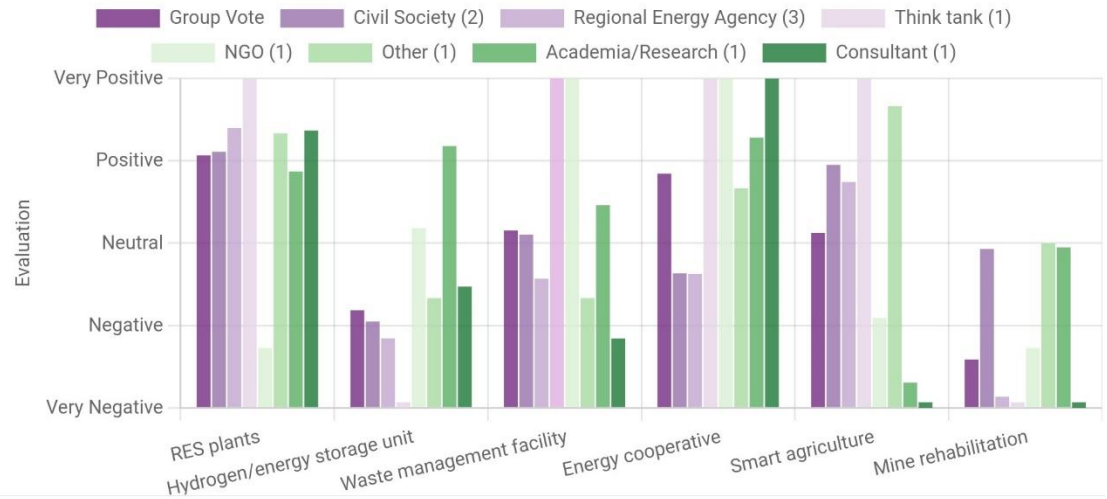


Figure 6: Preview of evaluation per stakeholder group diagram

We have also created a number of intermediate pages to help users navigate the tool.

The tool from the perspective of the participants

When using APOLLO-Live as an organiser of a workshop, the tool presents a slightly different interface, to assist the user set up the structure of the workshop as well as moderate the process. To perform such tasks, one must register for an 'admin' account. Being deeply rooted in open science, such options are open and free of charge, but are subject to confirmation from the development team. After logging in as an admin, the

tool offers the chance to create a new workspace, namely the setup of a workshop (Figure 7). To properly set up the structure, the tool requests the user to add basic information on the questionnaire, namely a name as well as the number of alternatives and criteria. These can be changes from within the workspace afterwards.

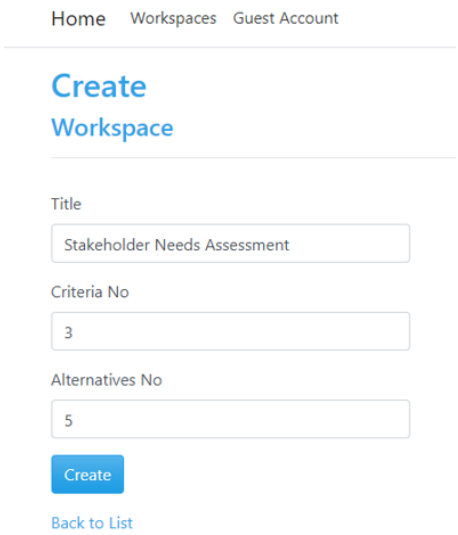
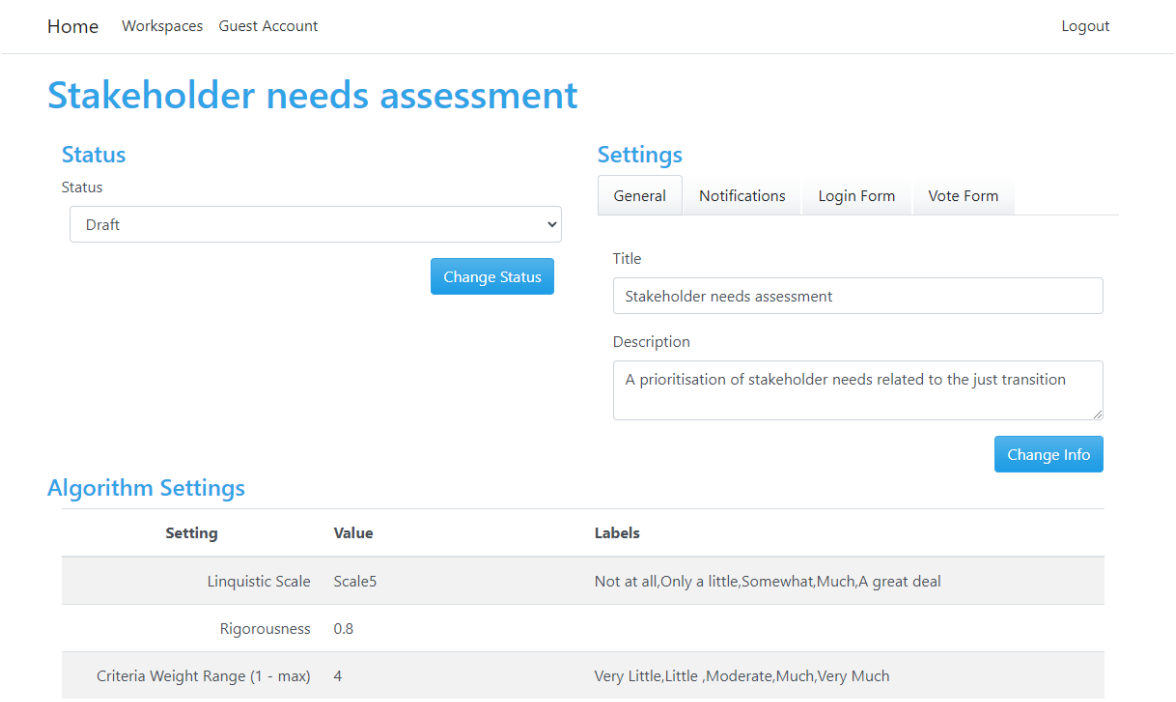
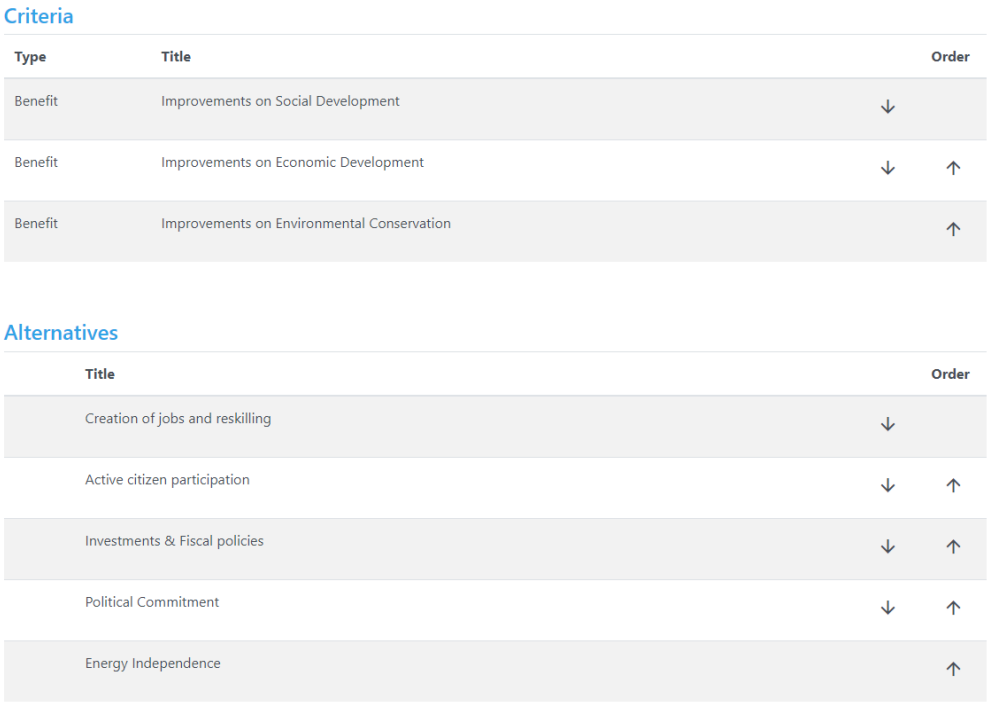


Figure 7: Interface to create a new workshop

In the main interface for setting up the questionnaire (Figure 8), the user must fill all the necessary information required to ensure that the participant will have a proper understanding of what they need to do, and for what purpose. In particular, the user can add details about the name and description of the model both in the landing and the voting page. From a technical perspective (Figure 8a), the user needs to define a set of parameters necessary to run the framework of the tool, including the linguistic terms that the voters should use for evaluating the alternatives and the one for evaluating the importance of the criteria (these two can be similar). Finally, the rigorousness parameter should be set between 0.8 (stricter value; should be used for multiple rounds) and 1 (less strict) and depends on how much the organiser wants to penalise disagreements in consensus measuring.



(a) Setup of questionnaire status, general settings and linguistic scale



(b) Setup of alternatives and criteria for the questionnaire

Figure 8: Main interface for setting up a questionnaire in APOLLO-Live

When editing the workspace, the status should be set to 'draft', enabling the user to perform any change to the questionnaire (e.g, edit the alternatives and criteria; Figure 8b). In this case the poll is hidden from non-admin users. Once the admin is happy with

the choices made and the format, the status can change to “Accepting Votes” (Figure 9). This will create a public poll in the land page and the users can start voting (like the survey in Figure 3). The ‘pre-calculate’ button enables the moderator to check the number of participants that have already voted and have a better overview of the flow of the workshop. Messages can also be sent through the tool (e.g., that voting will close in a couple of minutes). Finally, when all votes are collected, the moderator should change the status of the workspace to ‘Finalised with Feedback’. Essentially, this closes the voting form and automatically redirects participants to the page of the results and the tips presented in the previous section.

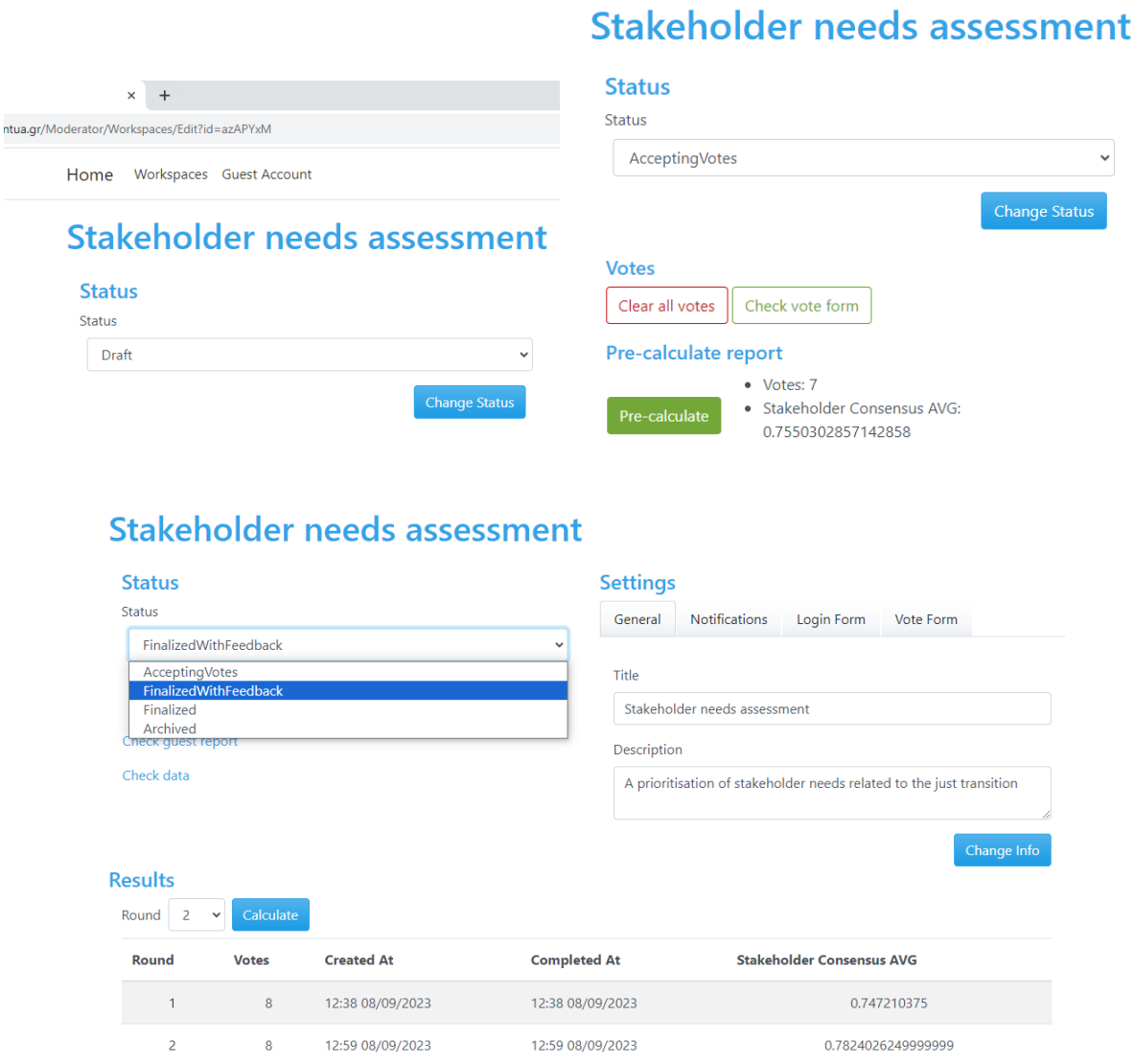
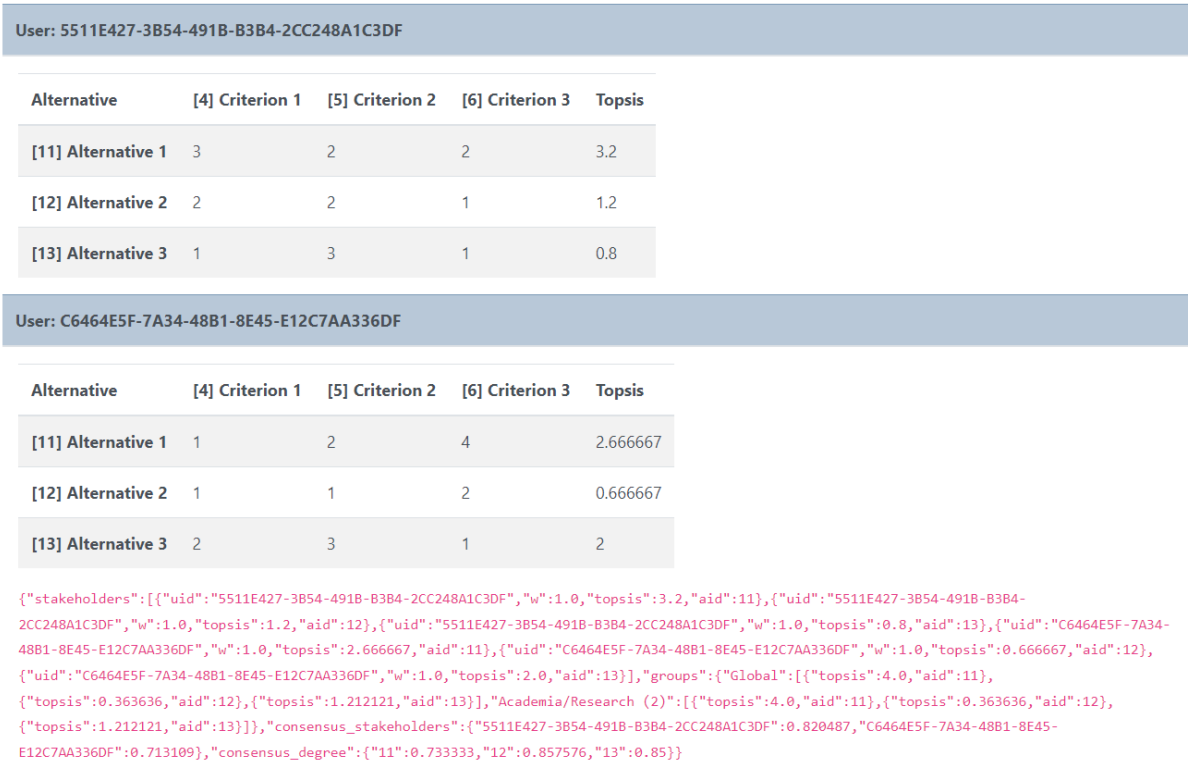


Figure 9: Stages of the voting process

During the ‘Finalised with Feedback’, deliberation between the group can take place. The moderator has an option to share their screen and present the group’s results (without personalised results. Although the participants can view the results in their own screen, this option enables the moderator to help all participants follow the same discussions.

When deliberations are over, the moderator can return to an 'Accepting votes' status, enabling participants to change their votes.

Finally, an admin has an opportunity to view and download the results for further processing offline through a concise JSON format (Figure 10), which is easy to handle by most common data processing software, including MS Excel. Again, with each user receiving an encrypted user-ID, anonymity is ensured.



User: 5511E427-3B54-491B-B3B4-2CC248A1C3DF

Alternative	[4] Criterion 1	[5] Criterion 2	[6] Criterion 3	Topsis
[11] Alternative 1	3	2	2	3.2
[12] Alternative 2	2	2	1	1.2
[13] Alternative 3	1	3	1	0.8

User: C6464E5F-7A34-48B1-8E45-E12C7AA336DF

Alternative	[4] Criterion 1	[5] Criterion 2	[6] Criterion 3	Topsis
[11] Alternative 1	1	2	4	2.666667
[12] Alternative 2	1	1	2	0.666667
[13] Alternative 3	2	3	1	2

{"stakeholders":[{"uid":"5511E427-3B54-491B-B3B4-2CC248A1C3DF","w":1.0,"topsis":3.2,"aid":11},{"uid":"5511E427-3B54-491B-B3B4-2CC248A1C3DF","w":1.0,"topsis":1.2,"aid":12},{"uid":"5511E427-3B54-491B-B3B4-2CC248A1C3DF","w":1.0,"topsis":0.8,"aid":13},{"uid":"C6464E5F-7A34-48B1-8E45-E12C7AA336DF","w":1.0,"topsis":2.666667,"aid":11},{"uid":"C6464E5F-7A34-48B1-8E45-E12C7AA336DF","w":1.0,"topsis":0.666667,"aid":12},{"uid":"C6464E5F-7A34-48B1-8E45-E12C7AA336DF","w":1.0,"topsis":2.0,"aid":13}],"groups":{"Global":[{"topsis":4.0,"aid":11},{"topsis":0.363636,"aid":12},{"topsis":1.212121,"aid":13}],"Academia/Research (2)":[{"topsis":4.0,"aid":11},{"topsis":0.363636,"aid":12},{"topsis":1.212121,"aid":13}]},"consensus_stakeholders":{"5511E427-3B54-491B-B3B4-2CC248A1C3DF":0.820487,"C6464E5F-7A34-48B1-8E45-E12C7AA336DF":0.713109},"consensus_degree":{"11":0.733333,"12":0.857576,"13":0.85}}

Figure 10: Data saving format of each workspace

Impact of APOLLO-Live

To ensure that APOLLO-Live is useful, the process followed understandable and has an overall high impact and contribution, we performed 3 beta tests which had two purposes: the first was to gather feedback on the tool and suggestions for improvement (Table 1); and second, to use the tool for a variety of questions, i.e., different choices on alternatives/criteria, to present a wide range of the possibility space of uses of the tool (Table 2). The final test also had the added purpose of familiarising the partners of JUSTEM with the tool, so that they have a proper understanding of how to use it in the workshops to come.

Table 1: Input received during the testing phase of the tool

Test #	Date	Participants	Notable Feedback from participants and solutions

Test 1	07/04/2023	11 members of the EPU unit at NTUA outside the development team	- Improvements on the design of the tool: The tool as presented in the previous section follows a modern, innovative, and user-friendly approach with the support of the participants, while the proper guiding pages are developed to ensure a smooth flow of the process. - Colour of the plots: Participants requested that the colour palettes are accessible to viewers who are colourblind, which is now ensured - Additional plots: The plot directly comparing the results of the different rounds (Figure 5) emerged as a request in this test
Test 2	08/09/2023	8 members of the EPU unit at NTUA outside the development team	- Corrections: Participants in this tool performed a stress-testing to identify outstanding errors and bugs in the software. - Information presented in hover text: Participants requested further colour enhancements in the hover text appearing in the consensus field, and that this hover functionality is fully responsive (no time delay)
Test 3	2/10/2023	16 members from the JUSTEM consortium	- Flexibility: JUSTEM partners requested that the setup of the questions is fully customisable to fit the context of the regions. - Saving of results: Since workshops are expected to run on parallel or during similar periods, we established a dedicated functionality (JSON files) to ensure that results and sessions are not mixed. - Voting: Participants identified that the use of negative scales (which were used only in this test may lead to misleading overall evaluation and are therefore not suggested (left as future research in the development of the tool). The same

			applies to the option of allowing the responder not to respond to a question.

Table 2: Purpose and alternative and criteria selection on the three tests performed

Test #	Alternatives	Criteria	Purpose
Test 1	9 investments/actions outlined in the Greek JTP: - PV plant - Green Hydrogen Unit - Energy Storage Unit - Energy Research and Technology Valey - E-mobility park - Waste management facility - Biomass processing unit - Smart agriculture unit - Wine tourism	Based on the on the overarching dimensions of the review in D3.1: - Impact on social dimensions: - Impact on economic dimensions - Impact on environmental Dimensions	Understand what the impact of these alternatives is on the selected criteria and find a ranking that reflects on which actions the participants want to be prioritised.
Test 2	Indicative stakeholder needs based on the review in D2.1: - Creation of jobs and reskilling - Active citizen participation - Investment & Fiscal policies - Political Commitment - Energy Independence	Based on the on the overarching dimensions of the review in D3.1: - Improvements on social Development: - Improvements on Development dimensions - Improvements on environmental Development	Shed light on how do addressing some of the most common stakeholder needs expressed as part of the just transition improve regional development. The outcome should be a rank of needs which reflects the urgency of each one (e.g., the need being in first place should be the top priority)

Test 3	A subset of common investments/actions outlined in the JTPs: - Instalment of a RES plant (e.g., PV plant, wind farm) - Build a hydrogen and energy storage unit - Build a waste management facility - Establish an energy cooperative - Enhance smart agriculture - - Rehabilitation of mines	Based on the on the overarching categories of stakeholder needs of the review in D2.1: - Employment-related needs (jobs in general, training, re-skilling) - Financial needs (investments, funding, R&D) - Social-oriented needs (participation, political commitment) - Environmental needs (rehabilitation of mines, impact on agriculture) - Energy-related needs (energy independence, energy poverty)	Understand what the impact is of each one of the actions that can be pursued by a region as part of a just transition plan towards addressing each of the most commonly identified needs of local stakeholders. The ranking will indicate which actions have the most positive impact across most dimensions.

The purpose of these tests was not to provide solutions on these topics since all three of them were performed internally within JUSTEM, but rather to provide an understanding of the possibilities of the tool. The selection of these dimensions lies entirely on the purposes and context of each region.

Offering guidelines for these selections, it is important for the analysts to be as exhaustive as possible, but at the same time avoid creating a massive questionnaire that would discourage participants from engaging. Essentially, the user of the tools aiming to employ it in a workshop needs to think, what is the most important topic in their area with lively debates were a prioritisation needs to be performed (selection of investments is always a best practice scenario for these exercises). After deciding on the alternatives, then the selection of the criteria needs to take place, by identifying the axes that an alternative may have a high or how impact.

Finally, we envisage the tool to be used by the wider stakeholder engagement community, even after the end of JUSTEM. For this reason, the project partners and the development team of APOLLO is on discussion with the colleagues from the H2020 PARIS REINFORCE project to host versions of the tool in the I2AM PARIS PLATFORM (and with derivative projects maintaining the platform, e.g., HE IAM-COMPACT and HE DIAMOND), as well as the H2020 ENCLUDE project to host versions of the tool in the ENCLUDE platform that is currently under development.

4. CONCLUSIONS

Stakeholder engagement will play a vital role in an effective just transition process, as those affected by the efforts to achieve a cleaner and more sustainable future need to be part of the discussion,. At the same time, their needs should be taken into consideration. However, not all stakeholders agree on the best way forward, even though most share a common vision of maintaining and strengthening the development of their regions while protecting the environment in which they live.

To assist projects like JUSTEM that aim to engage with stakeholders, and in particular citizens, a wide range of stakeholder engagement frameworks exist. Most of these however originate from the social sciences field, which—despite their overall contribution—offer primarily qualitative insights. On the other hand, common quantitative techniques rely almost exclusively on existing voting platforms, leaving a gap on the existence of tools that are tailored to stakeholder engagement, and on bridging the gap between different viewpoints.

The purpose of this deliverable was first to present a wide range of stakeholder engagement frameworks that the project would benefit from employing during the workshops and engagement activities performed. From the wide range of options existing, we focused on tools/approaches that are easy to use/employ to make the process for citizens that are not always accustomed to such activities easy to participate, and that are relevant to the goals of the project. Where applicable, we presented examples from the literature of how these approaches have been used in practice.

Second, we also presented the participatory framework developed in the project in the form of a web tool that can facilitate stakeholder engagement to prioritise needs and priority topics as well as evaluate potential courses of action to better guide the planning process of territorial just transition plans by (further) integrating the opinion of local stakeholders in the deliberation processes. This tool is envisaged to be used in workshops in coal regions for citizens to express their views on just transition and cooperate with their peers and neighbours to better coordinate their actions, and co-design the just transition through deliberative democracy processes.

References

Andriof, J., & Waddock, S. (2017). Unfolding stakeholder engagement. In Unfolding stakeholder thinking (pp. 19-42). Routledge.

Baer, D. (2019). Tools for Stakeholder engagement in Zero Emission Neighbourhood Developments Mapping of tools in use in Trondheim, Steinkjer, Elverum and Bodø. In ZEN IOP Conf. Series: Earth and Environmental Science (Vol. 352, p. 012019).

Baker, K., Khoury, M., & Katika, T. (2023). D3. 4 Public engagement through Living Labs.

Bernstein, S. E., Amirkhani, E., Werb, D., & MacPherson, D. (2020). The regulation project: Tools for engaging the public in the legal regulation of drugs. International Journal of Drug Policy, 86, 102949.

Betta, A., Nikologianni, A., Berg, M., Ciolli, M., Ternell, A., & Gretter, A. (2022). Decision Making in City Planning: Processes of Visioning and Stakeholders Engagement and their Relation to Sustainable Land-Use in the SATURN Project. Athens Journal of Architecture, 8(3), 261-276.

Bjørkan, M., Steiro, V., Nogueira, L. A., Lindeløv, B., Nys, C., Palenzuela, N. M., ... & Manago, C. (2023). Engaging Citizens with Mission Ocean and Waters: A toolbox of approaches.

Brouwer, H., Woodhill, J., Hemmati, M., Verhoosel, K., & van Vugt, S. (2019). The MSP guide: How to design and facilitate multi-stakeholder partnerships. Practical Action Publishing.

Brouwer, J. H., Brouwers, J. H. A. M., Hemmati, M., Gordijn, F., Mostert, R. H., & Mulkerrins, J. L. (2017). The MSP Tool Guide: Sixty tools to facilitate multi-stakeholder partnerships: companion to The MSP Guide.

Freeman, R. E. (1984). Strategic management: A stakeholder approach. Pitman, Boston.

Genç, Ö., Çay, D., & Yantaç, A. E. (2015). Participatory explorations on a location based urban information system. In Design, User Experience, and Usability: Interactive Experience Design: 4th International Conference, DUXU 2015, Held as Part of HCI International 2015, Los Angeles, CA, USA, August 2-7, 2015, Proceedings, Part III 4 (pp. 357-367). Springer International Publishing.

Goodman, M. S., & Sanders Thompson, V. L. (2017). The science of stakeholder engagement in research: classification, implementation, and evaluation. Translational behavioral medicine, 7(3), 486-491.

Greenwood, M. (2007). Stakeholder engagement: Beyond the myth of corporate responsibility. Journal of Business ethics, 74, 315-327.

Heitkemper, J. (2021). How can digital tools be used to engage citizens in the energy transition? A case study of the simulation tool ESSIM within the H2020 Making City Project (Doctoral dissertation).

Helbig, N., Dawes, S., Dzhusupova, Z., Klievink, B., & Mkude, C. G. (2015). Stakeholder engagement in policy development: observations and lessons from international experience. In Policy Practice and Digital Science: Integrating Complex Systems, Social Simulation and Public Administration in Policy Research (pp. 177-204). Cham: Springer International Publishing.

Hentschel, V. (2020). Empowering Civic Engagement in Energy Concepts: Design Implications for Citizen Participation.

Herrera, F., Martínez, L., & Sánchez, P. J. (2005). Managing non-homogeneous information in group decision making. European Journal of Operational Research, 166(1), 115-132.

Hwang, C. L., & Yoon, K. P. (1981). Multiple attribute decision making: Methods and applications. Springer-Verlag, Berlin/Heidelberg/New York.

Katika, T., Karaseitanidis, I., Tsiakou, D., Makropoulos, C., & Amditis, A. (2022). Augmented reality (AR) supporting citizen engagement in circular economy. Circular Economy and Sustainability, 2(3), 1077-1104.

Kay, R. C., Gardner, S., Bello Pineda, J., Juntarashote, K., Pierce, G. J., Pita, C., ... & Chuenpagdee, R. (2006). Concepts and tools for ICZM with a special focus on stakeholder engagement and visualization tools in fisheries management. INCOFISH Report Work Package, 6.

Koasidis, K., Karamaneas, A., Kanellou, E., Neofytou, H., Nikas, A., & Doukas, H. (2021). Towards Sustainable Development and Climate Co-governance: A Multicriteria Stakeholders' Perspective. Multiple Criteria Decision Making for Sustainable Development: Pursuing Economic Growth, Environmental Protection and Social Cohesion, 39-74.

Krohling, R. A., & Campanharo, V. C. (2011). Fuzzy TOPSIS for group decision making: A case study for accidents with oil spill in the sea. Expert Systems with applications, 38(4), 4190-4197.

Kujala, J., Sachs, S., Leinonen, H., Heikkinen, A., & Laude, D. (2022). Stakeholder engagement: Past, present, and future. Business & Society, 61(5), 1136-1196.

Labella, Á., Koasidis, K., Nikas, A., Arsenopoulos, A., & Doukas, H. (2020). APOLLO: A fuzzy multi-criteria group decision-making tool in support of climate policy. *International Journal of Computational Intelligence Systems*, *13*(1), 1539-1553.

Labella, Á., Koasidis, K., Nikas, A., Arsenopoulos, A., & Doukas, H. (2020). APOLLO: A fuzzy multi-criteria group decision-making tool in support of climate policy. International Journal of Computational Intelligence Systems, 13(1), 1539-1553.

Lavery, J. V. (2018). Building an evidence base for stakeholder engagement. Science, 361(6402), 554-556.

Mačiuliene, M., & Mačiulis, A. (2017). Public spaces as evolving frameworks: applying principles of co-creation in urban planning.

Marcon Nora, G. A., Alberton, A., & Ayala, D. H. F. (2023). Stakeholder theory and actor-network theory: The stakeholder engagement in energy transitions. Business Strategy and the Environment, 32(1), 673-685.

Mathur, V. N., Price, A. D., & Austin, S. (2008). Conceptualizing stakeholder engagement in the context of sustainability and its assessment. Construction management and economics, 26(6), 601-609.

Moodie, J. R., Salenius, V., & Kull, M. (2022). From impact assessments towards proactive citizen engagement in EU cohesion policy. Regional Science Policy & Practice, 14(5), 1113-1132.

Mott Lacroix, K. E., Xiu, B. C., & Megdal, S. B. (2016). Building common ground for environmental flows using traditional techniques and novel engagement approaches. Environmental management, 57, 912-928.

Nikas, A., Lieu, J., Sorman, A., Gambhir, A., Turhan, E., Baptista, B. V., & Doukas, H. (2020). The desirability of transitions in demand: Incorporating behavioural and societal transformations into energy modelling. Energy Research & Social Science, 70, 101780.

Oliver, S., Langer, L., Nduku, P., Umayam, H., Conroy, K., Maugham, C., ... & Roche, C. (2021). Engaging Stakeholders with Evidence and Uncertainty: developing a toolkit.

Oosthuizen, S. (2015). Assessing the effectiveness of a role playing game as a stakeholder engagement tool for integrated natural resource management (Doctoral dissertation).

Phillipson, J., Lowe, P., Proctor, A., & Ruto, E. (2012). Stakeholder engagement and knowledge exchange in environmental research. Journal of environmental management, 95(1), 56-65.

Pizarro-Irizar, C., Gonzalez-Eguino, M., van der Gaast, W., Arto, I., Sampedro, J., & van de Ven, D. J. (2020). Assessing stakeholder preferences on low-carbon energy transitions. Energy Sources, Part B: Economics, Planning, and Policy, 15(10-12), 455-491.

Pozniak, I., Orthodoxou, D., & Kallitsi, D. (2023). SeaClear2. 0. Work, 6, 1.

Schalk, P. (2014). Citizen engagement in Alberta: current practices and improving resources available to municipalities.

Sintomer, Y., Herzberg, C., & Röcke, A. (2008). Participatory budgeting in Europe: Potentials and challenges. International journal of urban and regional research, 32(1), 164-178.

Sterling, E. J., Betley, E., Sigouin, A., Gomez, A., Toomey, A., Cullman, G., ... & Porzecanski, A. L. (2017). Assessing the evidence for stakeholder engagement in biodiversity conservation. Biological conservation, 209, 159-171.

Taylor, J. L., Nikas, A., & Suljada, T. (2016). Transitions Pathways And Risk Analysis For Climate Change Mitigation And Adaptation Strategies.

Tu, C., Ma, H., Li, Y., Fu, C., You, Z. J., Newton, A., & Luo, Y. (2022). Transdisciplinary, Co-designed and adaptive management for the sustainable development of rongcheng, a coastal city in China in the context of human activities and climate change. Frontiers in Environmental Science, 10, 670397.

USYS TDLab (2023) *USYS TdLab Toolbox*. Available at: https://tdlab.usys.ethz.ch/toolbox.html

Vancea, D., Văidianu, N., Bobe, A., & Gîrțu, M. (2018). Stakeholder involvement in the development of the maritime spatial plans for the Black Sea. In MSP Conference, Bucharest.

Wellstead, A. M., & Biesbroek, R. (2022). Finding the sweet spot in climate policy: balancing stakeholder engagement with bureaucratic autonomy. Current Opinion in Environmental Sustainability, 54, 101155.

Yusuf, J. E., St. John, B., Rawat, P., Covi, M., Nicula, J. G., & Considine, C. (2019). The Action-oriented Stakeholder Engagement for a Resilient Tomorrow (ASERT) framework: An effective, field-tested approach for engaging stakeholders. Journal of Environmental Studies and Sciences, 9, 409-418.

Annexes

ANNEX I: ARCHITECTURE OF APOLLO-LIVE

The APOLLO-Live webtool is a sophisticated platform designed to facilitate anonymous online voting workshops while ensuring data security and integrity. This application leverages the Hexagonal Architecture to provide a robust, maintainable, and scalable system with the addition of TOPSIS, a multi-criteria decision-making algorithm, to enhance decision support. At the same time, in support of the open science (open code and open access), we developed the tool using, to the extent possible, open-source programming languages and the tool is open to use and replicated in a dedicated repository (Table 3).

Table 3: APOLLO-Live code metadata

Current code version	v1.1.0
Tool access link	https://apollo-live.epu.ntua.gr
Permanent link to code/repository used for this code version	https://github.com/i2amparis/Apollo
Permanent link to reproducible capsule	N/A
Legal code licence	Apache-2.0 license
Code versioning system used	Git
Software code languages, tools and services used	C#, Javascript
Current code version	AutoMapper.Extensions.Microsoft.DependencyInjection BuilBundlerMinifier 3.2.449 ExcelDataReader 3.6.0 FluentValidation 11.7.1

Hexagonal Architecture promotes the Dependency Inversion Principle (DIP) by allowing the application core to define abstract interfaces (ports), leaving the implementation details (adapters) to be provided by external components. This inversion of dependencies enhances flexibility and testability, as the core remains decoupled from specific technologies or frameworks.

The clear separation of concerns and the use of interfaces make it easier to write unit tests for the application core. Test doubles can be easily created for ports, allowing for isolated testing without the need for external resources.

The modular structure of Hexagonal Architecture makes it more straightforward to maintain and extend software systems. Changes to the external interfaces do not affect the core logic, reducing the risk of introducing bugs during maintenance.

Hexagonal Architecture enables easier transitions between technologies and frameworks. Replacing or updating external dependencies is simplified, as long as the new adapters conform to the existing ports.

The first step to take when designing with the Hexagonal Architecture is to define the primary and the secondary actors. In our case, we have three primary actors, the administrator of the system, the moderator of the workshops and the voter. Our secondary actors are the algorithm we use to support our decisions, the way we cache some of the requests, the database, the emailing, the encryption and the import (Figure 11).

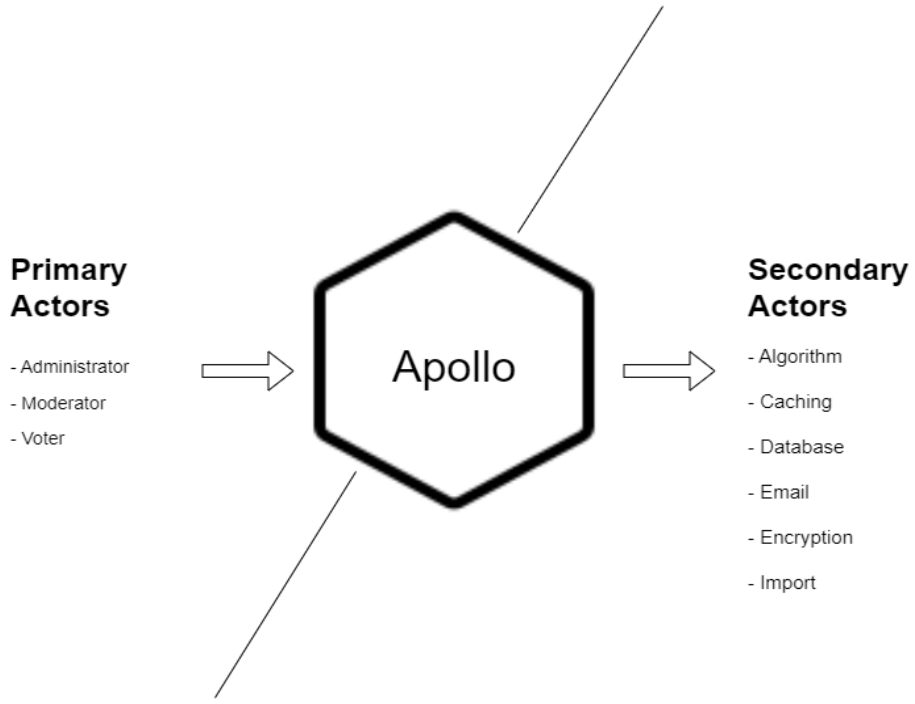


Figure 11: Primary and secondary actors in the Hexagonal Architecture of APOLLO-Live

The second step is to identify our ports through the use cases. The actors interact with the hexagon through ports. The ports are implemented through a programming interface, that is agnostic of technologies. Ports group is actually a group of use cases. In our case, the primary ports are (Figure 12):

- User Management
- Workshop Management
- Anonymous Voting
- Workshop Reports

To support these, we need these secondary ports:

- Algorithm Service
- Caching Service
- Email Service
- Import Service
- Encryption Service
- Users Repository
- Workshops Repository

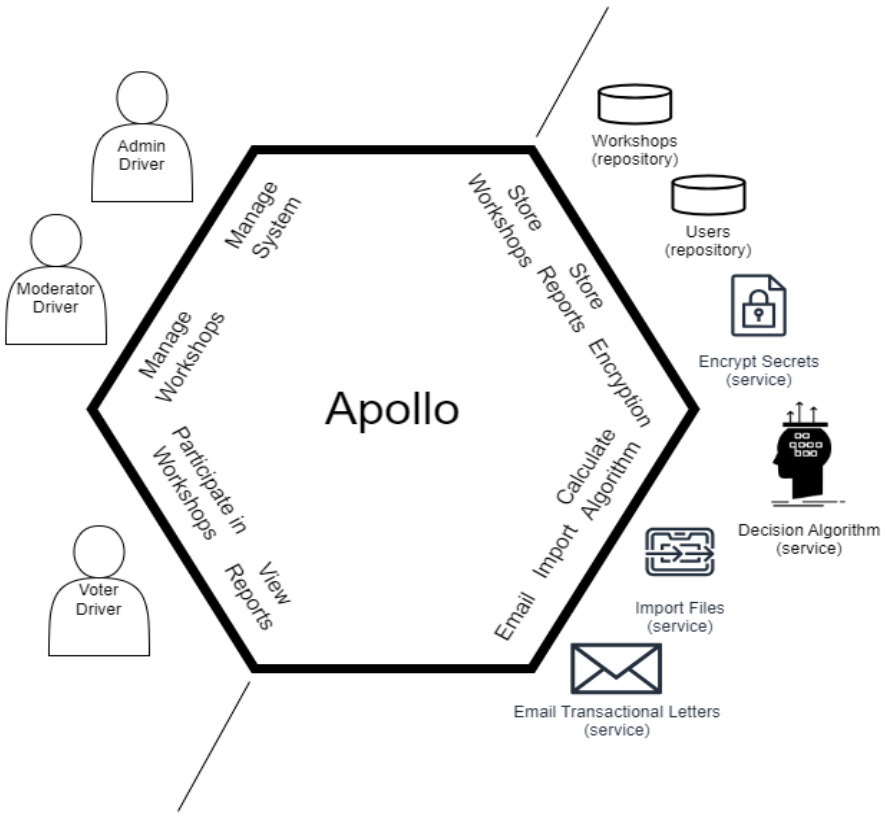


Figure 12: Use cases in the Hexagonal Architecture of APOLLO-Live

Adapters are the "real" technology we are using. For every adapter usually we have two implementations, the real one doing the work and the tester that tests the port's functionality. In our case we have the below adapters:

- Algorithm Adapter, that implements TOPSIS calculations
- Database Adapter
    - We are using Entity Framework, that supports all known databases like: SQL Server, MySql, MariaDb, Postgresql, Sqlite. The current implementation works with a Postgresql database.
- Cache Adapter, using .net core process in-memory caching
- Email Adapter, that sends e-mail letters using smtp protocol
- Encryption Adapter, using Entity Framework Core and Microsoft Data Protection stack to store secret keys

- Import Adapter, using excel files to import manually ran workshops
- UI Adapter
    - .net core web app
    - .net xunit acceptance tester