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Limits and benefits of participatory agenda setting for research and innovation

Niklas Gudowsky

Abstract

Current governance of science, technology and innovation (STI) faces tough challenges to meet demands arising from complex issues such as societal challenges or targets, e.g. the United Nations' Sustainable Development Goals. For decades, scholars and civil society institutions have called for increased public participation in STI, and political institutions have been taking up the request to integrate engagement activities into their decision-making processes, at least in the form of consultations. Moving engagement in research and development further upstream makes early interventions and social shaping of technologies and innovation possible. Since research has also faced repeated requests towards taking on more responsibility for solving societal problems, engagement processes thus help in shaping research. Here, the earliest point for possible engagement can be found within the constituting phase of research agendas as topics, general lines of enquiry and targets are shaped in this phase. These are the boundaries in between which researchers later navigate. This article serves as introduction to this journal's topical collection on participatory agenda setting for research and innovation (PASE). It provides a review of the literature on theory and practice of PASE activities, summarises the topical collection's contributions regarding current international cases and analyses respective PASE limits and benefits, thereby promoting its conceptual and practical understanding.

Keywords: Participatory agenda setting, Research and innovation governance, transdisciplinarity, responsible research and innovation

Theory and practice of open agenda setting (a short history of PASE)

Current governance of science, technology and innovation (STI) faces tough challenges to meet demands arising from complex issues such as societal challenges [1–3] or the United Nations' Sustainable Development Goals[1]. When tackling complex problems, expertise in research integration and implementation is particularly important, yet currently exists in rather fragmented approaches such as inter- and transdisciplinary research, systems thinking or action research [4]. Here, transdisciplinary research generally refers to the integration of three types of knowledge: systems knowledge, target knowledge and transformation knowledge [5]. Providing these types of knowledge has long been reserved for a small and privileged group of actors.

As a result, and under the header of responsible research and innovation (RRI), there have been calls in the European Union and beyond for research and innovation (R&I) to orient itself more strongly towards societal needs, demands, and preferences. Building upon the ongoing development of democratic science and technology governance, for several decades, there has been a demand for reflexive and responsive institutions facilitating more constructive science-society interactions [6]. RRI emerged from preceding and ongoing developments in technology assessment, anticipatory governance or upstream engagement (Owen, [7]). Participatory technology assessment (pTA) specifically aimed at strengthening inclusive deliberation on emerging technologies

[1]This introduction builds upon the call for papers for this topical collection written by the author: https://eujournalfuturesresearch.springeropen.com/pase

Correspondence: niklas.gudowsky@oeaw.ac.at
Institute of Technology Assessment, Austrian Academy of Sciences, Apostelgasse 23, 1030 Vienna, Austria

and STI agendas [8, 9], whilst foresight, and here especially horizon scanning activities with participatory elements, focussed early on the potential of stakeholder engagement for on identifying new topics for STI governance [10–13]. Even though RRI is shifting its concept, its main dimensions inclusion, anticipation, responsiveness and reflexivity are established, with the addition of two emerging dimensions, i.e. sustainability and care [14]. Combining these dimensions can become "a transformative ingredient of 'responsibilisation' of actors and institutions in R&I systems" [15]. Whilst RRI's shift from academic discussion to institutional practice is well underway, a good part of these practices focusses on opening up research and innovation [16]. This shift has "inevitable institutional consequences for research funding, priority-setting and new collaborative models between science, policy, society and industry" [17]. Here, the question of whom to engage in such settings has evolved considerably over the years, whilst the triple helix has long been the main model for a reflexive innovation system, involving academia, industry and governments [18]. Within the last decade, however, the quadruple helix, adding the public as an additional factor, has gained importance [19, 20] and is being further refined by accepting the established socio-ecological necessities of the twenty-first century by adding natural environments as major driver for knowledge production and innovation [21].

From science communication to participatory science governance

Modern science's relationship with the public during the past century up until the present can roughly be divided into three distinct paradigmatic phases: science literacy (1960s onwards), public understanding (after 1985) and science and society (1990s to present) [22]. The first two paradigms were characterised by attributing knowledge and attitude deficiencies to the public, rendering it incapable of understanding science, with the result of limited appreciation for and raising fears of science (and technology). Science literacy measures, attitude change and image marketing are the reported viable tools to meet such challenges. This "deficit model" has been much critiqued and resulted in the third paradigm of a rather equal science and society relation. Criticism towards the deficit model followed several lines of arguments, for instance that it fails to recognise the importance of local knowledge-in-context [23], or the flawed general assumption that because citizens show mistrust in science, they are deficient and therefore not to be trusted when asked about issues related to science and technology.

Lash et al. [24] describe how technology creates new forms of risk, whilst scientists are repeatedly drawn to mitigating problems created by science and technology, with Jasanoff [25] arguing that industrial society's capacity for prediction and control was outrun by its ability to create vast technological systems. As science is increasingly embedded in society, respective accountability and quality control, too, need to be shared with society [26]. Against this background, the "participatory turn" took place in science, and the governance of science and technology underwent reforms towards more and discursive engagement activities [25].

Sturgis and Allum [27] summarise that, on the one hand, perception of risk towards new technologies is strongly influenced by norms and values which do not primarily depend on peoples' scientific understanding. On the other hand, scientific knowledge does have an additional independent effect. Consequently, the first two paradigms of science literacy and public understanding of science are not superseded by the dialogical form of science and society relation, but continue to simultaneously inform research and policy [22]. This resulted in criticism, for instance regarding conflict between integrity/impartiality of science and its "involvement with the vested interests of the State and commerce on policy issues", threatening to destroy public trust in science [28], or regarding the alloted diminishing of democratically credible and sometimes effective "street-protest" in response to uneffective laboratory-like partcipation experiments [29, 30]. Stilgoe et al. [31], however, describe a 'gradual and incomplete shift from understanding to engagement', or, in short, from deficit to dialogue. Comparing the last four European science policy framework programmes with regard to the science-society relationship, Conceição et al. [32] also find a shift towards strengthening issues of governance of science and the transformation of scientific institutions when compared with to science education and public communication of science.

In general, there are three main arguments that are presented the most when examining why public participation is necessary for political decision-making [33]. (a) Democracy: counteracting a crisis of representative democracy by alleviating the general lack of transparency of political processes by involving the public more directly, ensuring a consideration of different opinions; (b) function: improving effectiveness of decisions on controversial issues when disagreement exists within scientific communities on a magnitude of problems and their solutions whilst public trust in experts simultaneously declines; (c) normativity: the moral obligation of involving a wider public in decisions on matters of public interest. Here, another addition may be the issue of capacity building, an often underrated effect of public engagement (PE) activities [34].

As institutions shifted towards public engagement and more activities were requested and commissioned, a

participation industry came to life [35], keeping public participation alive until today, in some countries more than in others. Chilvers and Kearnes [36] classify this reconfiguration of the science and democracy relationship as "what appear on face value to be novel and emergent participatory experiments are thus part of the cyclical and continual readjustments in the democratic order of things". Curato et al. [37] review the most discussed issues in deliberative democracy within the political and social sciences, and demonstrate, amongst others, that deliberation: (a) is a realistic endeavour (responding to criticism of being utopian), being implemented within and outside governmental institutions; (b) is essential to any democratic process; (c) is more than discussion and involves multiple sorts of communication; (d) can curtail elitist domination of policy; (e) does not primarily aim at consensus; however, (f) mitigates group polarisation and thus applies to deeply divided societies.

Methods and methodologies continue to evolve, not only driven by countless activities and actors on several levels, from local to global, but also topic-wise from single technologies to engaging with questions of macro-level governance. Attempting to grapple with this diversification, Rowe and Frewer [38] categorise public engagement activities by differentiating between public communication, public consultation, and public participation according to characteristics of information flow in the respective settings. To clarify the strength of engagement, Manafò et al. [39] define six levels arranged on a spectrum with increasingly required resources (time, knowledge, funds): learn/inform, participate, consult, involve, collaborate and lead/support. Gastil [40] highlights the need for analysing public deliberation methods, particularly in relation to the different points of entry within the policymaking system. Participatory science governance is a broadening field and it has been criticised mainly for failing to reach the intended impact, in both formal settings [41] and informal ones [42]. Abels and Bora [8] for instance conclude that regarding the "high potentials of conflict in ethical debates […] participatory TA is an unpredictable tool with limited possibilities". Whilst there are several reasons for failing to reach the intended impact, more and more scholars point towards public engagement activities to be inserted within the research and innovation system as early as possible (upstream engagement), as lateness of respective activities has been identified as an important reason for the failure [30, 43–46].

Conveying the argument of favouring public engagement in agenda-setting, participation (a) helps to democratise the research arena dominated by an elite, making research funding decisions more transparent; (b) contributes to better understand societal impact of and a need towards science and technology, thus producing better decisions whilst increasing public trust in science; and (c) fulfils the moral obligation of involving the public into guiding decisions of distributing tax-money for research and innovation which may concern public and individual lives.

Research priority setting to research agenda setting

The terms "research priority setting" and "research agenda setting" are often used interchangeably [47]. Since health research has been, until today, the most prominent scientific field that applies participatory agenda setting, taking a closer look at the abovementioned arguments is essential. Referring to the three arguments described above, Schölvinck et al. [48] provide the following review: Involving patients at an early stage of research policy increases the chances of successful implementation of innovations, which increases quality and legitimacy of research policies (the democracy argument); patients require valuable experiential knowledge when dealing with their condition and its consequences that complements scientific and biomedical knowledge (the functional (substantial) argument); they have the moral right to engage in decision-making on research policy since they are affected by it (the normative argument).

After the value of experiential knowledge gained wider recognition around the turn of the millennium, for instance patient participation for health research, research priority setting became one focus within growing field of engagement activities for governing health systems, and included, amongst others, the setting and monitoring of ethical standards. Health research priority setting is arguably required by the judiciary when state interests are at stake, for example in the promotion of health equity [49].

Research funding organisations started to engage with the public to identify and prioritise research topics for investment and to decide between proposals [50]. Evaluations, for instance of the criteria used to take such decisions, show mixed results as well as possible bias regarding who presented the proposal [51]. Nevertheless, Smith [52] presents evidence indicating that "voting decisions were most influenced by potential benefits of the planned research to society".

Today, health research priority setting represents a maturing field, with patients mainly being involved "most often at the pre-preparation stage to identify 'high-level' priorities in health ecosystem priority setting, and at the preparation phase for health research" [39]. Here, specific focus is given to what knowledge and questions patients and the public value most when becoming experts for their own health care experiences [39][2]. This involvement can "redress power imbalances in health research agenda setting" [53].

[2]There are four global, highly structured patient and public engagement planning activities: the James Lind Alliance Priority Setting Partnerships (UK), Dialogue Method (Netherlands), Global Evidence Mapping (Australia), and the Deep Inclusion Method/CHoosing All Together (US) [39].

However, except for those four cases[1] where public engagement in priority setting takes place, it is rather informal and ad hoc, and not routinely used by research funding organisations because it threatens established research structures, procedures, and scientists' cultures and priorities [54, 55]. Such structures and an uneven distribution of power and resources lead to "undone science", a term referring to "areas of research that are left unfunded, incomplete, or generally ignored but that social movements or civil society organisations often identify as worthy of more research" [56].

Nonetheless, when such priority setting takes place, important framing decisions have already been taken. Participatory agenda setting inserts public opinion further upstream, at an earlier stage than priority setting. Here, a very early point of engagement can be found within the constituting phase of research agendas as topics, general lines of enquiry, and targets are shaped in this phase. These are the boundaries in between which researchers later navigate when proposing their intended research.

However, the inclusion of experts, stakeholders and even laypeople into agenda setting maybe acceptable to more applied fields of research, where benefits of such activities are more obvious. For instance, researchers may be more inclined to "listen" to outsiders in terms of agenda setting, when the issues at stake directly concern those outsiders, for instance when studying futures, medical treatments, or political issues. Actors within more basic research-oriented fields, e.g. in the natural sciences, may struggle more to see such benefits [57], especially when public engagement requires comprehensive information about the field prior to the involvement, e.g. in nanotechnologies [58]. Additionally, public interest in such basic research may be limited. Some fields actively foster PE activities, for instance space research [59]. PE in the natural sciences often comes in form of citizen science, which primarily focusses on science communication or the involvement in data collection [60, 61]. Whilst citizen science rather seldomly influences basic research agendas, it contributes to policy agenda setting, e.g. in environmental policy [62].

Agenda setting is a specific way of shaping futures by guiding the allocation of significant funds towards the chosen targets or fields of priority. Orienting research and innovation is a complex task in itself, and respective agenda setting processes have traditionally been expert-driven because scientific knowledge has long been considered the only appropriate form of knowledge for, e.g. framing research agendas. Expert- and stakeholder-based anticipation of future developments, identification of possible challenges and solutions to frame respective strategic decisions has been embedded into research programming [11, 63, 64]; nevertheless, it presents a limited approach to shaping futures as this may neglect societal needs and values and therefore valid alternative futures.

Such a goal is shared by the open science initiative which has been unfolding for the past decade, aiming at increasing science's responsiveness to public needs amongst other things [65]. The integration of organised stakeholders' interests has, of course, a long tradition (e.g. in form of lobbyism) as agenda setting is in most cases partly, or mainly, a political process. This elitist form of visioning renders large parts of the population "not having futures" [66]. As a result, advice-giving processes opened up to public participation, becoming a norm in, for instance, foresight [67]. Technology assessment over the last decades [8, 9, 68]. As TA is inherently democratic, it has actively promoted public engagement in science and technology, relying not only on functional arguments of inclusion in modern democracy, but also on a normative one such as the empowerment of citizens and stakeholders, and its value in itself [69]. Participatory agenda setting is therefore, as deliberative democracy is in general, a normative project.

In summary, research agendas are increasingly becoming the target of multi-actor engagement processes aiming at integrating a broader base of information by considering other forms of knowledge [70]. Research programme development acts as an early entry point for public needs and values into the innovation process [71, 72]. Experience with participatory agenda setting processes suggests that "laypeople's experiential and value-based knowledge is highly relevant for complementing expertise to inform socially robust decision-making in science and technology" [43]. Recent empirical evidence from comparing citizen-driven STI agenda setting with expert-based foresight studies strengthens this claim [73, 74]. Aiming at producing sustainable strategies for responsible socio-technical change, research funding can benefit from combining forward-looking and public participation to elicit socially robust knowledge by consulting with multi-actors, including citizens [75]. However, the inclusion of laypeople into futures studies and foresight in general, and into forward-looking STI governance in particular, is underexplored.

Topical collection: participatory agenda setting for research and innovation

This current topical collection collects theoretical contributions as well as empirical papers regarding cases and methods of participatory agenda setting activities to map international progress in this upcoming field of research and practice. It includes contributions from several disciplines and interdisciplines as well as adjacent fields, including futures studies, foresight, technology assessment (TA), science and technology studies (STS), design and innovation management. The topical collection maps

selected international cases in the field, analyses barriers and drivers for participatory agenda setting, thereby develops its conceptual understanding further.

This article serves as introduction to the topical collection and presents an analysis of the contributions' content asking: What are beneficial and limiting factors for conducting participatory agenda setting activities?

First, the diverse contributions are summarised to provide readers with an overview. The following section presents an analysis of their content with regard to limits and benefits of participatory agenda setting processes and discusses the results in relation to the literature.

A qualitative content analysis was performed by 'assigning categories to text passages as a qualitative-interpretative act, following content-analytical rule' [76] to analyse content and contextual meaning of text passages [77]. The applied exploratory study with inductive category development [76] allowed categories to emerge from the data. This is also referred to as 'open coding' in grounded theory [78], aimed at 'at a true description without bias owing to the preconceptions of the researcher, an understanding of the material in terms of the material' [76].

Quotes that at least partially related to the research question and large enough to provide sufficient context were extracted and comprised in a database, where preliminary categories were assigned. These preliminary categories were revisited several times during the course of analysis and revised if necessary to allow clustering with other quotes. In this way, overarching clusters emerged from the data which resulted in the final categories. Whilst these categories may be somewhat arbitrary and other researcher may have assigned different labels, they fulfil their function in allowing for a structured discussion of limits and benefits of the reported PASE activities as well as for drawing generalised conclusions for the field.

Summary of contributions: international cases

This section shortly summarises the diverse contributions to the topical collection. Each case included in this paper points towards the dynamics of change and continuity.

Matschoss et al. [79] describe how transdisciplinary co-creation of a research agenda for global change research at national level in Finland led to the inclusion of important societal topics that may otherwise have been neglected by researchers. In their pilot study, the authors describe how a large variety of participants, including actors outside of academia or research funding, engaged in a series of events. The authors conclude that a particular strength of the analysed approach to research agenda setting could be found in its capacity to combine the multiplicity of views emerging from the diversity of participants.

Rosa et al. [80] scrutinise two recent participatory foresight activities within the framework of reflexive innovation as forums for contextualising alternative futures. They discuss the activities' capability to advise on mission-oriented innovation policy-making and their potential in strengthening citizens' role in providing strategic input for the European Commission's framework programme for research and innovation that has recently been issued. The authors stress the importance of furthering multilateral dialogues methodologically, in implementation and reception, to ensure mutual learning and balanced actor-power relations in reflexive innovation.

Hinrichs and Johnston [81] assess two PASE exercises for future-oriented education and health governance taking place within a specifically designed workshop space (the decision theatre), aimed at fostering informed decision-making. Mediators facilitated discussions between scientists, policymakers, and the public, supported by the co-creation of boundary objects such as data-driven models, to stimulate complex systems thinking in order to imagine alternative futures.

Schroth et al. [82] describe a participatory agenda setting process aimed at integrating the needs of rural areas into research and innovation processes. Visions as outcomes of a participatory social foresight were translated into scenarios which were illustrated by speculative design artefacts, followed by a participatory needs assessment regarding technological innovations in three rural areas across Germany. The authors identify fields of action with opportunities to strengthen innovation, and describe how networks of local and national actors facilitated their integration into regional planning processes. They investigate both the effects and epistemic community and translation processes within PASE, and conclude that their effectiveness depends primarily on the translation and transference of results to relevant arenas as well as relevant networks and actors. Here, they describe the organisers of PASE as non-neutral actors who exercise agency when they translate and transfer issues into respective networks and agendas.

Gudowsky et al. [74] assess methods applied in a standardised trans-European citizen visioning process that elicited laypeople's experiential and value-based knowledge, forming the base for EU research and innovation agenda setting. Setting out for methodological improvement, the authors discuss empirical results of participant evaluation questionnaire to explore potential loss and gain of diversity of opinions and creativity.

[3]Whilst this article was in writing, few contributions to the topical collection were still in review and are thus not yet considered here.

Fritz and Binder [83] discuss the dimensions of politics and power inherent to transdisciplinary sustainability research. Differentiating between instrumental, structural, and discursive power, the authors uncover how funding bodies, researchers, and practitioners exert power over participatory processes, and how this limits participation in STI governance.

Pagliarino et al. [84] critique the linear top-down model which has characterised agricultural innovation since the green revolution in which farmers are mainly recipients and users of technology, with this dependency resulting in a loss of much of the knowledge, experience and skills necessary for sustainable production. The authors describe the rise of agroecology as innovative paradigm in agriculture, which relies on participatory research and sustainability principles. The authors use ethnographic methods to analyse the learning and empowerment processes of a participatory research network consisting of farmers, scientists, public officials and managers of private companies who are concerned with organic rice production in Italy.

Balázs et al. [85] analyse data from a participatory research agenda setting process for green care services which employ nature in a therapeutic context to offer well-being and health-promoting activities. Examining outputs of a multi-step method of expert interviews and a science café setting, the authors conclude that a mutually responsive engagement of laypeople and experts can serve for successfully mapping societal concerns and knowledge needs in emerging research fields. Referring to the concept of "undone science" [56], the authors show that several research questions emerged during the PASE, which are largely ignored by health research.

Limits and benefits of PASE activities

This section presents results of the qualitative content analysis that examined and clustered factors influencing limits and benefits of the PASE activities that authors report in this topical collection. These are discussed in relation to the body of literature presented in the introduction.

Factors limiting successful PASE implementation

This topical collection's contributions elaborate factors instrumental in limiting both the uptake of PASE results into the political arena as well as their impact, i.e. the organisers' agency or normativity, unreflected power relations within or insufficient inclusiveness of the process, a lack of skills and resources as well as inadequate quality of the results. Furthermore, political appreciation of results and a will to implement democratic STI governance is a key limiting factor.

Whilst *agency and normativity* are tolerated, appreciated or even aimed for in stakeholder or other public engagement settings, the organisers' potential normativity and agency within a certain topic are less transparently reflected on or even discussed. Organisers of PASE processes, who are often researchers, bear great responsibility when selecting the appropriate tools and methods applied in the respective exercise [85], and agency may influence these decisions. Here, Fritz and Binder [83] describe how the preselection of issues and rules governing the processes has an effect on the inclusion of values and knowledge, and call for increased reflexivity and transparency concerning mechanisms which may have been omitted. Additionally, Schroth et al. [82] reflect on PASE organisers' non-neutrality in exercising agency when they are translating and transferring issues into respective networks and agendas. For this reason, amongst others, reflecting the field's normativity, actors' roles and trailing implications have recently experienced a revival in technology assessment [86, 87] and sustainability science [88], and remain an ongoing activity. Other fields that frequently act as organisers of agenda setting activities, e.g. foresight, or public actors such as non-governmental organisations (NGOs), may benefit from increased attention towards reflexivity and transparency of inherent normativity.

Focusing on *power relations* within PASE, Fritz and Binder [83] find that the ascription of roles within processes was shaped by the exercise of discursive power, which, in their cases, led to preserving traditional roles of users and producers of knowledge, then to knowledge co-creation. In relation, Abma [53] examines how the involvement of patients can "redress power imbalances in health research agenda setting". Furthermore, the transference of a dominant actor's power onto the process may lead to reproduction of an already dominant societal discourse or one that is politically desirable. To some extent, such settings emerge from conditions prescribed by the funding body of the PASE activity, resulting in limited accountability of the dominant groups [83]. This argument is in line with Bora and Hausendorf [41] who critiqued participatory science governance, and Stilgoe et al. [31] who observed that outcomes may "not sufficiently challenge, and so serve to reinforce, incumbent power structures". Here, Gudowsky et al. [74] conclude that "the impact of a participatory agenda setting activity on research and innovation governance needs to become transparently traceable", as otherwise trust the commissioning institution suffers. This underlines the importance of several factors in procedural designs, which can limit coercive power through, e.g. participant recruitment, facilitator training or transparency of deliberations [37].

A selection bias towards elitist representations of futures leads to the aforementioned mechanism of rendering entire groups in the population to "not having

futures" [66], with a direct link to the importance of recruitment in participatory settings and therefore also concerns about *insufficient inclusiveness* as a limiting factor for successful PASE activities. Balázs et al. [85] emphasise that it was mainly participants with a specific professional interest who took part in their study, which lead to biassed knowledge production, whilst Fritz and Binder [83] conclude that the agenda of the participatory setting affected the actor composition. Matschoss et al. [79] add that simultaneous reproduction of a PASE setting in various localities, supported by digital conflation, would have ensured better inclusiveness.

Whilst *insufficient skills* can also be a limiting factor, it has become apparent that successful implementation of PASE activities requires organisers and participants to have separate sets of skills. Inter- and transdisciplinary skills of participants are crucial, with scientists in need of acquiring profound expertise in very specific fields often lacking interdisciplinary perspective, whilst transdisciplinarity requires both researchers and other stakeholders to have a new set of practical and interpersonal skills [79]. Clearly, organisers' participatory skills play a major role, especially with regard to the co-creation of knowledge. Here, Schroth et al. [82] find that facilitating the adaptation and translation of issues and concepts for specific target audiences is a key step that should receive greater attention in multi-stage processes. Rosa et al. [80] support this and go further by stating that this adaptation of issues through "translation, comparison, categorisation, and combination" should be subject to close scrutiny, especially where different actor groups such as laypeople and experts are concerned. This shows that expert takeovers in citizen involvement processes can contribute to a loss of authenticity [89].

Resources in terms of *availability of funding* have been a much-discussed limiting factor in public engagement literature (e.g. [57, 90]. Public engagement activities, especially multi-stage PASE ones, need sufficient resources, and a lack thereof decreases process function, quality and ownership, and thus any impact. A comprehensive range of skills and resources is needed for the management of co-creation processes [82] which are often open-ended and therefore greatly dependent on the availability of financial resources [79]. Dedicating time and space to the development of interaction is also contingent upon the availability of resources, and influences the development of relationships between groups, especially where competing agendas are supported and receive targeted attention and funding [81]. Societal power relations, including inequalities, are reproduced within funding structures; consequently Fritz and Binder [83] note that demands for greater participation are irresponsible without respective adaptation of funding mechanisms. And it is not only the lack of financial resources alone that hampers successful co-creation in the STI context but also missing incentives and reward systems which allow researchers to engage in such activities "without the fear of losing in academic merits or career opportunities" [79].

Whilst all the abovementioned factors contribute to ineffectiveness, *translation of PASE results into the policy realm* remains a central challenge [80], for instance when aiming at inspiring a change in national funding schemes [85]. Here, the initial positioning and rationality of participatory agenda setting activities within STI governance often only allows for a limited—if not marginal—influence on policy-making [74]. This is however not a design fault made by organisers, but already inscribed into the funding schemes of such initiatives. And this leads to pondering over, again, the most important limiting factor: political appreciation of results and a will to implement democratic STI governance, emphasising the importance of both gatekeepers' roles at the margins as well as central political actors.

Benefits of PASE

The analysis of all contributions of this topical collection suggests that PASE can contribute to enhanced reflexivity of research and innovation systems as well as participants; network building in diverse actor groups; mutual learning; co-creation; contextualisation of research with regard to local social and cultural specifics; science communication; increased responsiveness of science to society by translating societal needs and values into research agendas; and finally transformation when such research is carried out, providing new knowledge, resulting in actual change of practices.

Establishing and deepening networks between various actor groups can be a primary task of PASE activities, for instance when common concerns are addressed and mutual trust is built [84]. However, network building can be a side-effect as well. Politically neutral boundary organisations can also foster the growth of networks between diverse social groups and therefore foster collaboration [81]. This corresponds to Selin et al. [34] who discuss intra-personal relations in public engagement and conclude that building such networks contributes to the notion of capacity building, and should be seen as a major effect.

Alongside anticipation, inclusion and responsiveness, reflexivity is one of the main dimensions of the concept of RRI (Stilgoe, [91]), and defined as ability to reflect on values and beliefs during research and development [14]. *Enhancing reflexivity* is an often-mentioned benefit of PASE activities. Balázs et al. [85] conclude that the examined PASE exercise created "reflection on and momentum for pressing research needs". Diversifying stakeholder dialogues and enabling citizens to

demonstrate greater agency enhances reflexive capacities [80]. Stakeholders previously unknown to each other get the opportunity to interact on topics which affect them directly, discussing contradicting or competing viewpoints to explicitly highlight differences, and even partially overcome those [81]. Whilst PE's ability to enhance reflexivity is often discussed with a focus on science and scientists [92], these finding also show the important effect of enhancing reflexivity within participants, i.e. stakeholder communities. Pagliarino et al. [84] found that the room created for reflection had an emancipatory effect as it committed participants to "changing unsatisfactory and oppressive realities".

The ability to build trust and enhance reflexivity in participants is a basis for *mutual learning* to take place within participatory processes. Here, mutual learning is built on a common understanding of an issue and a prerequisite for "meaningful deliberations" in participatory agenda setting [53]. Creating a depoliticised space for deliberation lowered cultural barriers between stakeholder groups and facilitated mutual learning [81]. Pagliarino et al. [84] describe how an "effective process of scientific and local knowledge sharing" took place within the agenda setting activities. Balázs et al. [85], too, observed mutual learning between "experts, practitioners and lay audiences on substantive research topics". Several authors report that the use of boundary objects—data-driven or design-based—in terms of models, scenarios or artefacts as tools for facilitating dialogue was successful in establishing a common understanding of issues and partially shared meaning [80–82].

Enabling mutual learning and reflexivity lays the foundation for *(knowledge) co-creation* [93–96]. PASE activities show the possibility of harnessing diversity by combining a multiplicity of views emerging from a diverse group of participants [79] whilst negotiating knowledge between science, policy, and the public. Continuity of the process and face-to-face participation were procedural aspects identified to support co-creation: whilst a series of workshops provided a sense of stability for participants, who were thus able to build sequential lines of arguments [81], ongoing network activities over several years provided the necessary trust for sharing sensible data and practices which were then copied, adapted, and combined [84]. Moreover, face-to-face encounters fostered prosocial behaviour, collaboration, and increased participation and innovative thinking [81]. Whilst knowledge integration is uncontested, the authors nevertheless state that much less is known about "the how", which is in line with previous findings regarding the often prevalent implicitness of knowledge on knowledge integration [4].

Contextualisation of research by fostering systems thinking is described as another benefit of PASE activities. For instance, Rosa et al. [80] highlight how citizens' input into holistic, systemic and transdisciplinary research displays high embeddedness into local, cultural, and social context. Gudowsky et al. [74] describe that participatory agenda setting uncovers "alternative rationalities, values and realities that may serve as important counter-weights to state-of-the-art policy and its priorities and hence the business as usual". Others such as Matschoss et al. [79] find that the respective PASE was successful in contextualising global sustainability issues by highlighting regional research needs. Hinrichs and Johnston [81] conclude that quadruple helix actors are increasingly engaged in systems thinking through mapping interrelated social systems influencing the respective research question or issue.

Whilst all PASE exercises explored in this topical collection had other primary aims, successful *science communication* was noted in some of the cases. Complex scientific issues were made accessible through the help of speculative objects and narrative futures framed towards the challenges faced by people in rural areas [82]. Quantitative data, modelling and qualitative storytelling helped to make complex phenomena visible and understandable for public actors [81]. Balázs et al. [85] describe how especially the creation of an open and informal platform supported the bridging of the science-society gap.

Increasing science's responsiveness to society is a main pillar of RRI (Stilgoe, [91]) and a primary aim of most PASE activities since responsiveness can be reached, in terms of upstream engagement, by translating societal needs and values into research agendas [43, 71]. Providing spaces for co-creation and bringing together various actor groups allowed for the co-design of a future research agenda which focused on how to "solve real-life societal questions", for instance by exploring emergency usages, behaviours and market opportunities based on societal and user needs [79]. Others conclude that stakeholders' active participation in a networked PASE activity was mainly the result of the fact that the activities' content originated "from real needs and concrete research questions", and that their personal attitudes and values were crucial to the process [84]. Schroth et al. [82] state that "challenges of the investigated rural areas were translated into political and scientific problems", delivering a product that can be integrated into national research and local development agendas. Referring to the concept of "undone science" [56], Balázs et al. [85] show that several research questions emerged during the PASE, which were previously largely ignored by health research, whilst Matschoss et al. [79] state that the PASE lead to the "inclusion of important societal topics that may otherwise have been neglected by researchers".

Finally, it has been described that PASE activities have *transformative capacities,* e.g. when new knowledge is gained by solving the co-created research topics, which is then put into practice, or by changing ideas and believes or paradigms. PASE activities, for instance in form of horizon scanning with participatory elements as established in foresight, can focus attention on emerging technologies and breakthroughs as well as emerging challenges and questions outside the present scope of the major scientific establishment on research agendas.

"In combination with anticipation and reflection, responsiveness can become a transformative ingredient of 'responsibilisation' of actors and institutions in R&I systems" [15]. Here, Pagliarino et al. [84] describe how agronomic techniques in organic farming have been improved, yields stabilised and increased, and actual discoveries made, for example the allelopathic function of certain species used as cover crop. Furthermore, a change of science governance itself is carried out by successfully implementing PASE activities or even by carrying out experiments towards that goal. Hinrichs and Johnston [81] conclude that refined PASE "can support the development of governance infrastructures that maintain inclusion and accountability of the public in the decision-making process", whilst Balázs et al. [85] state that a better alignment "with societal values and demands is essential to gaining more democratic legitimacy, beyond expert- or technology-driven processes".

Abbreviations

EU: European Union; EC: European Commission; FLA: Forward-looking activities; PASE: Participatory agenda setting; R&I: Research and innovation; RRI: Responsible research and innovation; STI: Science, technology and innovation

Availability data and materials

Supporting data can be found in the annex of the manuscript.

Author's contributions

NG is the sole author of this article. The author read and approved the final manuscript.

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