



# Participation-effect pathways in transdisciplinary sustainability research: An empirical analysis of researchers' and practitioners' perceptions using a systems approach

Livia Fritz\*, Thorsten Schilling, Claudia R. Binder

École Polytechnique Fédérale de Lausanne, Laboratory for Human-Environment Relations in Urban Systems, Station 2, 1015 Lausanne, Switzerland

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## ABSTRACT

In sustainability research, transdisciplinary (TD) approaches that involve practitioners in the research process have emerged as promising tools for enhancing real-world knowledge and engendering societal change. However, empirical insights into how such participation can contribute to the societal effects of TD research are scant and largely rely on single case studies, neglecting practitioners' perceptions. In this article, we empirically investigate the perceptions of both researchers and practitioners on how practitioners' participation in TD research might instigate societal changes. We present the results of a qualitative meta-level study of participation processes in seven TD sustainability research projects from a large German research funding programme. Applying a systems approach, we (i) uncover direct, indirect and interlinked participation-effect pathways; and (ii) highlight feedback effects that shape a dynamically evolving participation process. By elucidating both researchers' and practitioners' perceptions of participation-effect pathways, this article contributes empirical insights to an emerging scholarship on theories of change in sustainability research and provides ideas on how to better include systems thinking into TD research and future studies of societal effects.

## 1. Introduction

Transdisciplinary (TD) approaches that involve diverse societal actors in sustainability research are gaining traction and political relevance in research policy and practice. In response to 'grand' societal challenges (European Commission, 2019), science policy and research funding programmes increasingly request researchers to co-create or co-produce knowledge with policy-makers, businesses, and civil society actors (Schneider et al., 2019a; Van der Hel, 2016), thus opening up knowledge production to actors beyond the scientific realm. Such proposals are generally rooted in the expectation that incorporating practitioners and their expertise into the research process produces 'robust' knowledge and engenders desired societal change (de Jong et al., 2016; Polk, 2014). With the increasing use and policy relevance of such approaches, the need to analyse and demonstrate the societal effects of research-practice interactions in TD sustainability research has intensified (Hansson and Polk, 2018; Van der Hel, 2016).

Existing approaches to identify and measure the societal effects of research commonly differentiate outputs, outcomes, and impacts (Morton, 2015; Shirk et al., 2012; Walter et al., 2007; Wiek et al.,

2014). Outputs are tangible or intangible products resulting from project activities and leading to first-order effects or outcomes, such as the enhancement of practitioners' capacities (Shirk et al., 2012; Wiek et al., 2014). Second-order effects or impacts refer to 'long-term and sustained changes' (Shirk et al., 2012) or 'structural changes and actions' (Wiek et al., 2014). In such conceptualisations, the participation of practitioners is commonly considered as an input factor whereas societal effects (outcomes and impacts) denote the desired endpoints ultimately reached through the creation of outputs (Shirk et al., 2012; Walter et al., 2007; Wiek et al., 2014).

Research in neighbouring fields to TD such as participatory action research has shown that participatory practices produce effects that are closely tied to the interactions and relations of the involved actors (Darby, 2017; Evans, 2016). Similarly, Spaapen and Van Drooge (2011) proposed to focus analytical efforts on processes by examining 'productive interactions' between researchers and stakeholders. Joining the call for process-oriented perspectives on the effects of collaborative research processes (Currie et al., 2005), formative evaluations conducted during the process have been identified as promising ways forward (Hellström, 2015; Wiek et al., 2014). Such varying facets of

\* Corresponding author.

E-mail address: [livia.fritz@epfl.ch](mailto:livia.fritz@epfl.ch) (L. Fritz).

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emerging scholarship on the societal effects of TD research indicate the need for further empirical insights into the interrelations between effects and the dynamics of participation processes (Hansson and Polk, 2018). Considering the perceptions of diverse actors—including researchers and practitioners<sup>1</sup>—is pivotal for understanding the role of participation on the pathway to societal effects (de Jong et al., 2016; Hansson and Polk, 2018; Spaapen and Van Drooge, 2011).

TD scholars generally agree that societal effects often emerge from complex and non-linear processes (Kaufmann-Hayoz et al., 2016; Meagher et al., 2008; Molas-Gallart et al., 2000; Van Kerkhoff, 2014); however, only limited methodologies and conceptualisations are currently available for the analysis of these interactions (Belcher and Palenberg, 2018; van Drooge and Spaapen, 2017). Relying predominantly on the conceptual chain of outputs-outcomes-impacts for understanding societal effects results in insufficient consideration of the procedural and dynamic nature of TD approaches that deliberately break with linear research logics (Carew and Wickson, 2010; Klenk and Meehan, 2017). There is a need for methodologies and conceptualisations that acknowledge participation as a dynamic, non-linear, and adaptive process (Fritz and Binder, 2018) and grasp the complexity of pathways linking participation to societal effects in a systemic, inter-related manner. Increasingly, theories of change (ToCs), which have originally been developed as tools for evaluating social and development programmes (Weiss, 1997), are proposed for thinking also about change related to research projects (Douthwaite et al., 2003; Oberlack et al., 2019; Paina et al., 2017; van Drooge and Spaapen, 2017; Vogel, 2012). Empirical applications of how ToCs can be used to elucidate the theoretical assumptions, perceptions and mental models of actors engaging in TD sustainability research have been scarce.

In this article, inspired by scholarship on theories of change, we aim at illuminating the perceptions of diverse actors on how practitioners' participation in TD research might instigate societal changes. We position participation processes at the centre of an empirical analysis of perceived pathways to societal effects of TD research and ask:

- How do researchers and practitioners in TD sustainability research projects perceive participation-effect pathways?
- Which role do participation dynamics play in researchers' and practitioners' perceptions of participation-effect pathways?
- To which extent do the perceptions of researchers and practitioners on participation-effect pathways diverge?

Addressing these questions, we take up the criticism of ToCs of often being caught in linear logics (Oberlack et al., 2019; van Tulder and Keen, 2018) and rely on a systems approach which takes into account non-linear relations and feedbacks in participation-effect pathways, thus embracing that 'change processes are often non-linear, with multiple interactions and feedback loops' (Belcher et al., 2019). A systems approach (Binder et al., 2020) enables an examination of the perceived effects of participation, relations between them, and their potential feedbacks into dynamically evolving participation processes. By means of an empirical meta-analysis of researchers' and practitioners' perceptions in seven ongoing TD projects from a large German funding programme in the field of sustainability research, we identify (i) diverse participation-effect pathways, i.e. sequential dependencies between the perceived effects of participation which allegedly affect the involved practitioners and trigger changes in the wider context and (ii) feedback effects which impact the participation process itself.

Although widely used, definitions of 'outcome' and 'impact' remain inconsistent (e.g. compare Walter et al., 2007 and Shirk et al., 2012) and challenging to empirically disentangle (Binder et al., 2015). In this

article, we rely on a simplified terminology that builds on the understanding of change being 'any event or variation in the state of affairs' (Belcher and Palenberg, 2018, p. 480). We consider the notion of 'societal effects' to refer both to changes affecting the involved practitioners and structural and processual shifts in the wider societal context of a project. Additionally, we consider 'effects' of participation in TD research to designate process-related changes in researcher-practitioner interactions and the overall research process that might or might not lead to societal effects.

By elucidating both researchers' and practitioners' perceptions of participation-effect pathways and related feedback effects, this article contributes empirical insights to an emerging scholarship on theories of change in TD sustainability research. An enhanced understanding of perceived participation-effect pathways also provides a basis for sharpening effect planning and monitoring as well as ex-post evaluation tools for participatory and TD research.

The remainder of this article is structured as follows: Section 2 provides a description of the methods and systems approach applied and the empirical materials used. Section 3 presents researchers' and practitioners' conceptions of participation-effect pathways and identifies feedbacks related to participation dynamics, before we critically discuss the conceptual and practical implications of these findings for practising and analysing TD research.

## 2. Material and methods

### 2.1. Funding programme and project sample

In this study, we conducted a meta-analysis of seven ongoing sustainability research projects that are part of a large German research funding programme. The funding programme is dedicated to fostering societally relevant research that contributes to sustainable development<sup>2</sup>. According to programme regulations, research projects are required to be interdisciplinary and involve societal actors in the research process. The selection of projects for an in-depth analysis was guided by the criterion of diversity regarding (i) scientific disciplines, institutions and funding volumes (project design); (ii) topics; (iii) intended societal effects; and (iv) types of participants. Consequently, the seven projects cover a broad range of sustainability-related topics and include researchers from various disciplines as well as practitioners with diverse professional backgrounds. The projects are part of two funding cohorts (Table 1).

### 2.2. Data collection

This study combines two bodies of materials. First, research proposals of the selected projects were collected and qualitatively analysed, considering the specific purpose (receiving funding) and audience (funding body and reviewers) for which they have been created (Wolff, 2004). Second, 21 interviews with researchers and 14 interviews with practitioners were conducted at different moments throughout the projects. Following a purposeful sampling approach (Lincoln and Guba, 1985), principle investigators (PI) were approached as gatekeepers and asked to establish contact with researchers who were closely involved in interactions with practice and with participating practitioners. At the time of data collection, all projects were ongoing and in different phases. The interviews were semi-structured and problem-centred (Witzel and Reiter, 2012), and aimed at gathering multiple perspectives on participation processes and their intended societal effects. An interview guide, which was used and adapted case-by-case, consisted of narrative questions about expectations regarding participation, perceptions of factors shaping research-practice

<sup>1</sup> We rely on the notion of 'practitioner' in a broad sense to designate any type of extra-scientific actor. Although these actors might have academic training, they do not conduct research as their main profession.

<sup>2</sup> The funding programme is scientifically accompanied by a research project of which this study is part.

**Table 1**  
Characteristics of projects according to project proposals.

CHARACTERISTIC/ PROJECT	A	B	C	D	E	F	G
Funding cohort	2015	2015	2015	2015	2014	2014	2014
Project duration	4 years	4 years	3 years	3 years	4 years	3 years	3 years and 3 months
Thematic cluster	health	regional development	food production	mobility	regional development	urban development	technology
Submitted budget (450 000 - 3 MM EUR)							
N° academic institutes	4	8	6	8	7	3	7
Type of practitioners involved	public service providers, associations	public sector actors	private sector actors, 'consumers'	public sector actors, private sector actors, service providers	NGOs, associations	NGOs, associations, public sector actors, 'citizens'	private sector actors, public sector actors, 'consumers'
Letter of intent of practitioners	yes	yes	yes	no	no	yes	no
Reference to notion of TD	Strong, mostly in the sense of interdisciplinary	strong	strong	strong	strong	strong	weak
Financing for practitioners budgeted	no	no	no	no	no	no	no

interactions, and factors influencing the realisation of intended societal effects. The interviews were conducted in January 2016, June–July 2017, Mai–June 2018 and lasted between 45 and 85 min. All interviews were recorded and transcribed verbatim. The transcripts and most documents are in German; we translated the excerpts included in this article into English (Table 2).

2.3. Data analysis

The empirical data were managed, coded, and analysed with the software 'MAXQDA'. The material was collectively analysed by the two first authors. Methods and data triangulation were ensured by including different data sources and the perspectives of multiple actors on the same processes (Patton, 1999). Furthermore, investigator triangulation relied on a 'negotiated agreement' approach to establish intercoder agreement (Campbell et al., 2013). Accordingly, disagreements between the authors regarding codes were discussed and resolved. In the few instances where coding differences could not be resolved, the disputed data were discarded.

The qualitative analysis of the empirical material relied on Clarke's 'situational analysis', which constitutes a methodological development of grounded theory. Therein, the researcher appears as knowledgeable about theory and a thorough literature review is an integral part of the analytical process (Clarke, 2005, p. 294). In our case, this meant that the data analysis was informed by our theoretical roots in system thinking, but provided room for both inductive coding of the data as well for considering deductive elements related to existing scholarship. We adopted a systems approach in order to explore effects and related interlinkages emerging from the interviews and defined a system as 'anything that is composed of system elements connected in a characteristic system structure' (Bossel, 1999, p. 20). We adapted the following key elements of a systems approach for our study purpose: (1) system elements, (2) system interrelations; (3) system boundaries; (4) system goals (Binder et al., 2020).

First, in line with our inductive approach, we coded perceived effects of participation as system elements. Thereby, we included expectations with regard to effects of participation as well as effects that were already observed by the interviewees during the ongoing project. The coding system was refined iteratively and emerging effect categories were grounded in literature - deducing them where available from established effect categories (Table 3).

Second, we condensed and aggregated interview statements across projects in the form of models representing participation-effect pathways. They illustrate different—albeit entangled—ways in which researchers and practitioners linked participation processes to societal effects. To inform the creation of pathway models, we specifically looked for dependencies in interview statements that indicated perceived relations between effects. The graphical display of our findings was inspired by Belcher et al.'s (2019) generic representation of ToCs, but adapted for the purpose of this study.

Third, we identified three types of system boundaries, which we conceptualised as arenas: (i) the arena of actor collaboration, where we analysed the effects of participation dynamics on the research and participation process itself; (ii) the arena of involved practitioners, where we examined effects on the practitioners involved in the project; and (iii) the arena of the wider practice context, which relates to changes in the wider context of the project.

Fourth, considering researchers' and practitioners' perspectives, we examined different actors' goals and expectations regarding participation-effect pathways and looked for commonalities and differences in their perceptions.

**Table 2**  
Overview of interviews conducted with researchers and practitioners.

	A	B	C	D	E	F	G
RESEARCH	2 Prof, 2 PhD, 1 collaborator	1 Prof, 1 Postdoc, 1 PhD	2 Prof	2 Prof	1 Prof, 1 Postdoc	3 Prof, 1 collaborator	2 Prof, 1 collaborator
PRACTICE	1 NGO, 1 employee of public service provider	1 political representative, 2 public administration	1 company employee	1 public administration	1 public administration	2 NGO, 1 public administration	2 entrepreneurs, 1 company employee

**Table 3**  
Inductive-deductive development of effect categories.

EFFECT CATEGORIES IN EMPIRICAL MATERIAL	DESCRIPTION	RELATED EFFECT CATEGORIES IN SELECTED LITERATURE*
CAPACITY BUILDING	Participation to create individual and collective learning effects that improve the knowledge base or capacities for decision-making	Bergmann et al., 2017; Binder et al., 2015; Currie et al., 2005; Hansson and Polk, 2018; Lang et al., 2012; Morton, 2015; Rau et al., 2018; Shirk et al., 2012; Walter et al., 2007
IMPLEMENTATION	Participation to facilitate using, implementing or applying the results and outputs of the projects, such as technologies, platforms, policy recommendations	Kaufmann-Hayoz et al., 2016; Mitchell et al., 2015
ADAPTING STRUCTURES AND PRACTICES	Participation to initiate changes in structures and practises that exist in the related practice context	Burkhardt-Holm and Zehnder, 2018; Morton, 2015; Shirk et al., 2012; Wiek et al., 2014; Walter et al., 2007
TRANSFER	Participation to disseminate the project results to a wider context, i.e. to other practitioners not involved in the project	Kaufmann-Hayoz et al., 2016; Mitchell et al., 2015
CONVINCING	Participation to persuade actors of behaving differently, e.g. to consider sustainability values in the decision-making process	/
EMPOWERMENT	Participation to improve the status, visibility and legitimacy of participating practitioners in their practice context and to enhance their ability to act	Blackstock et al., 2007; Darby, 2017; Evans, 2016
NETWORK EFFECTS	Participation to extend or strengthen networks among practitioners and between researchers and practitioners	Binder et al., 2015; Hansson and Polk, 2018; Molas-Gallart et al., 2000; Spaapen and Van Drooge, 2011; Talwar et al., 2011; Walter et al., 2007; Wiek et al., 2014; Wolf et al., 2013
AWARENESS BUILDING	Participation to create awareness for sustainability-related issues	Binder et al., 2015; Meagher et al., 2008; Morton, 2015
SELF-CONCEPTION	Participation to fulfil intrinsic motivations on individual and/or organisational levels, e.g. convictions, values, or philosophies	/
INPUT FOR RESEARCH PROCESS	Participation to improve the research process in particular regarding its practical relevance, e.g. through better access to the field or input of practical knowledge	/
FEEDBACK EFFECTS ON PARTICIPATION PROCESS	Participation builds the foundation for collaborating, e.g. through developing a common language or building trust	/

\* [not all focused on participation; not all based on empirical evidence].

### 3. Results

We present the results in two parts. First, we present the researchers' and practitioners' perceptions with regard to the diversity of pathways linking participation processes to societal effects. Thereby, we point to commonalities and differences in the researchers' and practitioners' perceptions. Second, we uncover feedback effects that stemmed from and influenced these processes. Throughout this section, we illustrate the results with interview excerpts. For reasons of comprehensibility, we refer only to extracts of the participation-effects pathway models in this section (Figs. 1–3) and include the complete models in the Appendices A–C of this article. The models contain effects associated with participation as system elements (boxes), their interrelations with each other and the participation process (arrows), and the system boundaries in the form of three arenas. Overall clusters of associated effects are displayed in italic writing.

#### 3.1. Diverse participation-effect pathways

##### 3.1.1. Direct and indirect pathways connecting participation and societal effects

Several interview statements reflect perceptions of a direct link between participatory processes and societal effects. Researchers and practitioners established direct participation-effect pathways mostly

related to effects on the practitioners involved in the project, i.e. effects in the 'arena of involved practitioners'. For example, implementing project outputs was a primary societal effect anticipated by both groups. Researchers in several projects named the implementation of project outputs as a critical success criterion and considered the involvement of practitioners as the potential implementers to be an important success factor (AR3; CR1a). Thereby, implementing outputs refers to practitioners taking up and using results of the project in the form of products, including for example digital and analogue platforms, technologies, software, recommendations or visions. Similarly, practitioners mentioned that the outputs shaped by the participation process would be directly implemented (AP1; CP1; EP1; GP1). Two practitioners with corporate backgrounds specified that the implementation depends on the profitability of the output – in these cases a new technology and an alternative business model, respectively (CP1; GP1).

We are of course open to new ideas and if there are any improvements [...] this would of course be an advantage for us. And if this implies even an economic benefit, then it is highly interesting for our company to take it up. (CP1)

The 'empowerment' of practitioners through collaboration with researchers was another perceived direct participation-effect pathway. Several practitioners perceived their collaboration with universities to increase their visibility, legitimise their position and activities in the

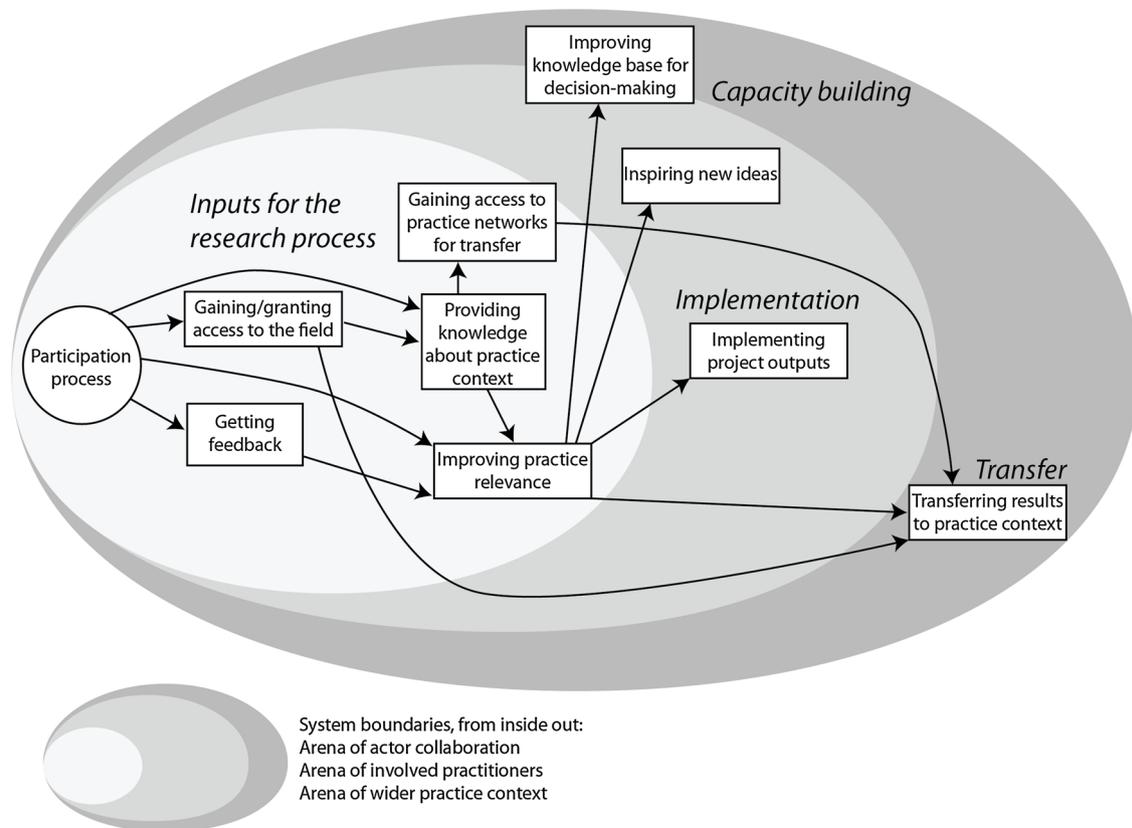


Fig. 1. Indirect participation-effect pathways: researchers' and practitioners' perceptions.

practice context (FP1; FP2; FP3), and improve fundraising opportunities for their organisation (FP2).

When we as a small association are affiliated with established research institutions conducting cutting edge research, then, of course, this helps our fundraising activities. [...] When we can say that we sit at the table with X and Y [researchers] and that we are connected with them, we get a whole different weight in the eyes of some institutions. (FP2)

Likewise, researchers narrated empowerment as a direct effect of practitioners' participation in their projects (FR1a). However, there are differences in considerations regarding empowerment across actor groups. First, the empowerment category is more central in practitioners' narrations than in researchers'; practitioners mentioned empowerment more often and with greater emphasis than researchers. Second, researchers described empowerment in relatively abstract terms, simply speaking of 'strengthening' and 'supporting' practitioners, whereas practitioners drew a more nuanced picture of how their involvement enhanced their ability to act.

Another type of societal effects directly linked to the participation process were network effects. Several interviewees mentioned that their interactions in participatory workshops resulted in new contacts among practitioners (GR1a; GR2; GP1; GP2; GP3). Researchers and practitioners tended to attach different weights to these network effects, as reflected in the statements below: a researcher described network effects as a side-effect of the collaboration process, while a practitioner – a self-employed consultant - referred to the same effects as the primary motivation to participate.

It happens, even though it is not necessarily intended. But because they [the practitioners] get to know each other, some kind of networking happens and people exchange among each other. (GR1a)

This is a really positive element of such projects and also the reason for which I engage in them: having the possibility to extend your own network. (GP3)

Several practitioners and researchers also drew indirect links between participation and societal effects. Such indirect pathways include effects on the research process as a first step that subsequently contributes to achieving societal effects. In these pathways, participation was assumed to improve the practical relevance of the research and its outputs (AR1a; AR2; BR3; BP2; GR1a; GR2) in order to maximise opportunities for subsequent societal effects, such as the implementation and/or transfer of research outputs (Fig. 1).

Interviewees referred to different pathways of how this practical relevance could be increased. One such differentiation related to knowledge inputs: practitioners' participation in the research process ought to ensure the availability and input of sufficient system knowledge. This knowledge was supposed to enable researchers to grasp the most striking problems and consider contextual factors, such as regulations or norms, that support or hinder the realisation of societal effects (BP2; BR3; GR2). As one researcher in a project on sustainable technologies expressed his/her expectation regarding practitioners' participation:

What do we expect? Well, definitely also to receive impulses: what are problems, what does not work, and why does it not work in practice. (GR2)

Pathways including the input of knowledge about the practice context were framed differently across the interviews. In some cases, the input of knowledge was framed as a direct outcome of the participation process – for example, via the contributions of practitioners in advisory board meetings (AR1a; AR2; AR3), workshops (BR2; BR3; GR2), or bilateral meetings (BR2; BR3). Others reflected an indirect logic whereby practitioners should primarily facilitate researchers' field

access, granting access to both data or people (AR2; AR3; BR2; BP1; CR1a; DP1; ER2). One researcher stressed access to a suitable audience to whom results could be regularly communicated as being critical for a successful transfer (CR1a). A policy-maker at the municipal level participating in a project on regional development described how they granted researchers access to the field and communicated remarks from local politicians to the researchers, thus acting as an intermediary between the project and the wider practice context:

And we have informed political actors as well, local politicians. They are invited, if they have specific questions, to communicate them to us so that we can pass them on to the researchers. (BP1)

‘Getting feedback’ was another frequently mentioned intermediary step in an indirect pathway to societal effects, such as ‘implementation’ or ‘transfer’. Researchers referred to receiving feedback from practitioners as a means of enhancing the practical relevance of the project results (AR1a; AR2; AR3; BR2; CR1a; CP1; DR1a). Such reasoning reflects an iterative research logic whereby practitioners are asked to test preliminary research outputs (e.g. the prototype of a platform) and provide feedback on how to adapt them on the basis of their experiences. As one researcher in the health sector expressed him-/herself with regard to the anticipated uptake of an interactive platform developed in the project:

Well, this project is about developing something that will later be of use in practice. And in order to ensure this, it is certainly important to have practitioners on board, because we aim at providing an interactive platform which is sustainable and which we can already test in our practice institutions. (AR2)

Both researchers and practitioners referred to inputs for the research process as a first step towards achieving societal effects; however,

practitioners put significantly less weight than researchers on indirect participation-effect pathways via the research process.

### 3.1.2. Pathways of interlinked societal effects

Beyond direct and indirect pathways connecting participation and societal effects, our results indicate that interdependencies and sequential links exist between societal effects in the arenas ‘of involved practitioners’ and ‘of the wider practice context’. The latter are perceived to be conditional on a series of intermediary steps. These pathways of interlinked societal effects typically contain a direct link between participation and a first societal effect, followed by subsequent societal effects. Which intermediary societal effects were supposed to contribute to other societal effects (e.g. transfer) differed across interviews. Accordingly, divergent strategies and approaches were planned to achieve the same societal effect. This is reflected in the interlinkages of ‘capacity-building’ with several other effects, including ‘awareness building’, ‘convincing’, ‘empowerment’ and ‘transfer’ (Fig. 2).

In one such pathway, ‘capacity-building’ serves as a precondition for ‘transfer’ (Fig. 2). Practitioners referred to learnings from the participation process to enrich their discussions with colleagues. They mentioned that the acquired competences and skills would strengthen their argumentation and enable them to transfer ideas about sustainability to the wider practice context (GP2; GP3). One practitioner from an association in the health sector expected to build capacities through first-hand access to research results. Emphasising their own role as an intermediary between research and the wider practice context, he/she perceived capacity-building as a precondition for transferring research results to other practitioners in the health sector (AP2). A researcher from the same project described how the practitioner would receive access to research results (‘capacity-building’), which would subsequently allow them to adapt their practices (AR1a). Hence, the

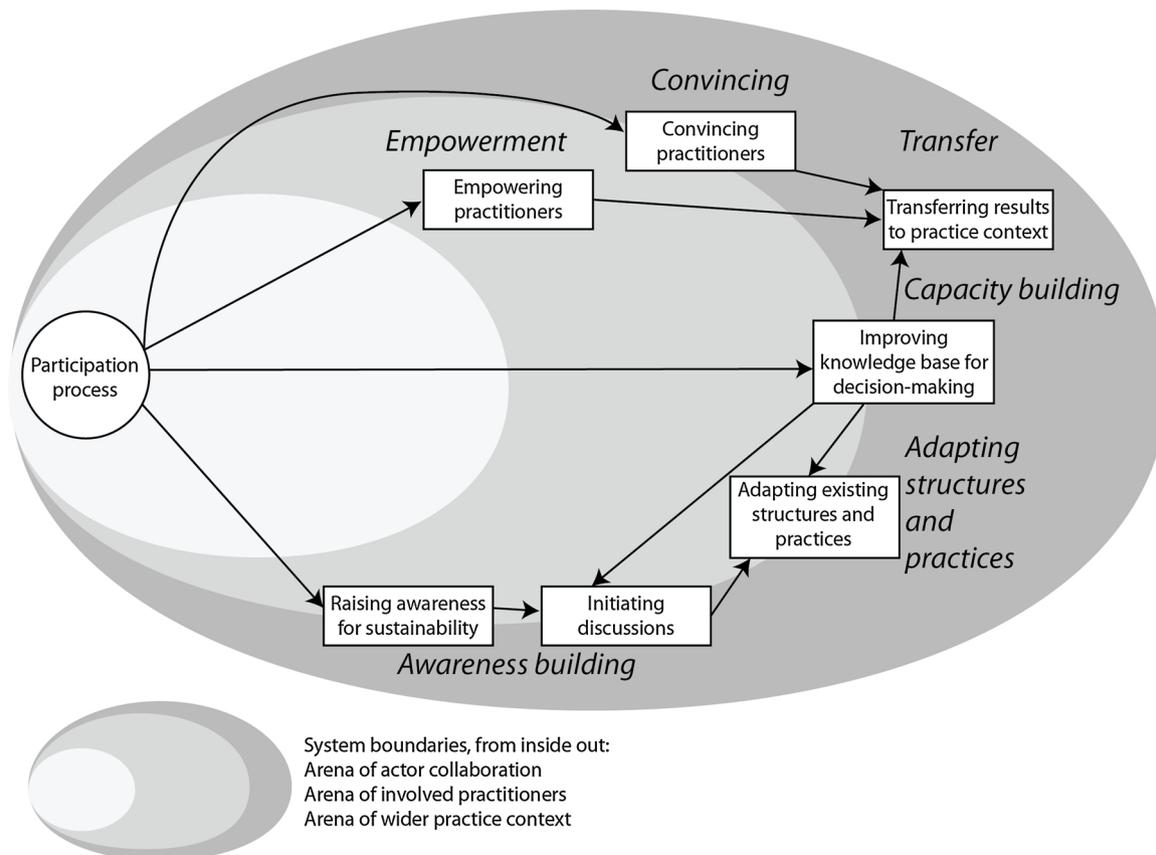


Fig. 2. Pathways of interlinked societal effects: researchers’ and practitioners’ perceptions.

researcher anticipated a societal effect that would affect the involved practitioner, whereas the practitioner saw himself/herself as an intermediary between research and a wider context.

In their narrations, researchers often tailored pathways to the type of practitioner. For practitioners to whom the above-mentioned researcher ascribed the roles of implementers and users of project outputs, he/she built a different pathway leading from ‘raising awareness’ to ‘initiating discussions’ and ‘adapting existing structures and practices’. This reflects an interlinked logic whereby the direct effect was limited to practitioners’ increased understanding of sustainability. The project leader framed the potential follow-up effects (‘initiating discussions’ and ‘adapting existing structures and practices’, referred to as ‘cultural change’ in the quote) as ideal outcomes of the practitioners’ raised awareness of sustainability problems:

We need to be cautious: to which extent we can really achieve a cultural change within the frame of the project? So, if we put it in a bit more humble way, we could say that we can achieve [...], or trigger a discussion, which at some point might lead to a cultural change. (AR1a)

The above examples illustrate how one researcher considered different pathways of interlinked societal effects to ultimately contribute to a change in structures and practices. These represent different strategies to achieve societal effects for different groups of participants.

Transferring results to a wider practice context, described above as a follow-up effect to ‘capacity-building’, was linked to further preceding societal effects (Fig. 2). One practitioner from a NGO highlighted the empowering effect of collaborating with researchers in a project on regional development, anticipating his/her influence in the practice context to be positively affected by the scientific authority of the researchers with whom he/she collaborated (EP1). Ultimately, this was assumed to enable him/her to transfer development measures, which were recommended by the project, to other villages and to contribute more effectively to the sustainable development of the region:

Here in our region it is very difficult to find an association. And that’s also why this partnership with the project [name of the project] is very important for us; that they [the researchers] help us better understand how we can have an impact on the people in our association; that we better understand which measures we can apply in different villages. And it makes the people in our association proud that university comes and asks them, what they need and what they want. This is why it is important for us to have these measures being analysed scientifically; then we are backed up to recommend it in other villages. (EP1)

Similarly, in a project on sustainable technologies a researcher referred to a pathway of interlinked societal effects leading to the transfer of research outputs via ‘convincing practitioners’ (CR1a). He/she stressed the importance of promoting the research output through adequate communication channels, which subsequently would enable them to convince practitioners who were not directly involved to also implement research outputs. Thereby, he/she highlighted the importance of convincing so-called ‘multipliers’—actors who have outreach to and a high influence on other practitioners. In this interlinked participation-effect pathway, convinced practitioners are a precondition for the transfer of results to a wider context. A practitioner from the same project, conversely, emphasised his/her role as a ‘technical pioneer’, referring to a competitive advantage gained through the collaboration and the corresponding early access to the output developed. These two perspectives represent opposing views on the relation between the involved practitioners and the wider practice context. The researcher ascribes the role of ‘multipliers’ to the involved practitioners, while the practitioner sees the collaboration as an opportunity to set him-/herself apart from the competition in the wider practice context.

### 3.2. Feedback effects influencing the participation process

Examining the role of participation dynamics in narrations on participation-effect pathways uncovered another type of effects, namely feedback effects impacting the participation process. Feedback effects stem from and influence interactions between researchers and practitioners and unfold within the inner system boundary defining the ‘arena of actor collaboration’ (Fig. 3). These effects appeared as crucial success factors for the collaboration in interviewees’ reflections about participation-effect pathways.

Several interviewees referred to changes in interpersonal relations over time that built a foundation for their collaboration with researchers and practitioners, respectively. Such reflections include trust-building and becoming acquainted with the other actors (FR1a; CR1a; ER2). In an urban development project involving mostly NGOs and associations, the PI concluded towards the end of the project:

And then there are persons with whom we built a trustful relationship so that we can now [towards the end of the project] say: ‘now we could start to really collaborate with them’. That’s the way it is. These short-term projects are in fact way too short. (FR1a)

Other interviewees described learning effects from participation as having shaped interactions between researchers and practitioners (BR3; EP1; GR1a; GR2; GP1; GP3). For example, one practitioner from a NGO explained that he/she understood how to translate scientific knowledge into practice only after several years of participation and specified the need for a common language to enable effective collaboration. Confronted with communication problems, the project team in this regional development project engaged an intermediary actor with the task of facilitating exchanges between research and practice. A researcher from the same project shared her/his perception of this process and described how several years of field collaboration were necessary to build trust with practitioners (ER2). The practitioner explained:

Because in the first project I sometimes had the impression, well, that we did not really understand the academic language [laughs]. And now, with X [person] as a link between us [the practitioners and researchers], I think it works really well. And I think because we are having a person at the interface, both sides benefit more from the project because we understand each other better and we better know how to go about it. (EP1)

Another feedback effect relates to changes in attitudes towards participation and their influence on practitioners’ and researchers’ commitment toward engaging in the process. In explaining how positive experiences early on in the collaboration process increased motivation to further engage in projects, several interviewees described how their attitudes or those of others shifted from scepticism towards participation to being optimistic and enthused (BP1; ER2; GR2; GP2). A policy-maker involved in a research project on regional development shared her/his assessment of such a change in attitudes:

Meanwhile, there is a positive attitude towards this [collaborating with researchers], [...] through this collaboration, a process took place that has truly been accompanied by a change in awareness here. (BP1)

In some cases, these feedback effects related to past collaborations in other project contexts. Several interviewees recalled previous collaborations as critical success factors for a fruitful participation process (AR1a; CP1; ER2, BP1, EP1), thus indicating that limiting examination only to the present project entity might obscure other participation-related effects. Researchers and practitioners tended to focus on similar aspects when reflecting on participation-related effects, such as developing trust, a common language and aligning expectations. The importance of feedback effects from previous collaborations furthermore points to the need for considering effects related to the participation process as a central category when evaluating effects of TD research.

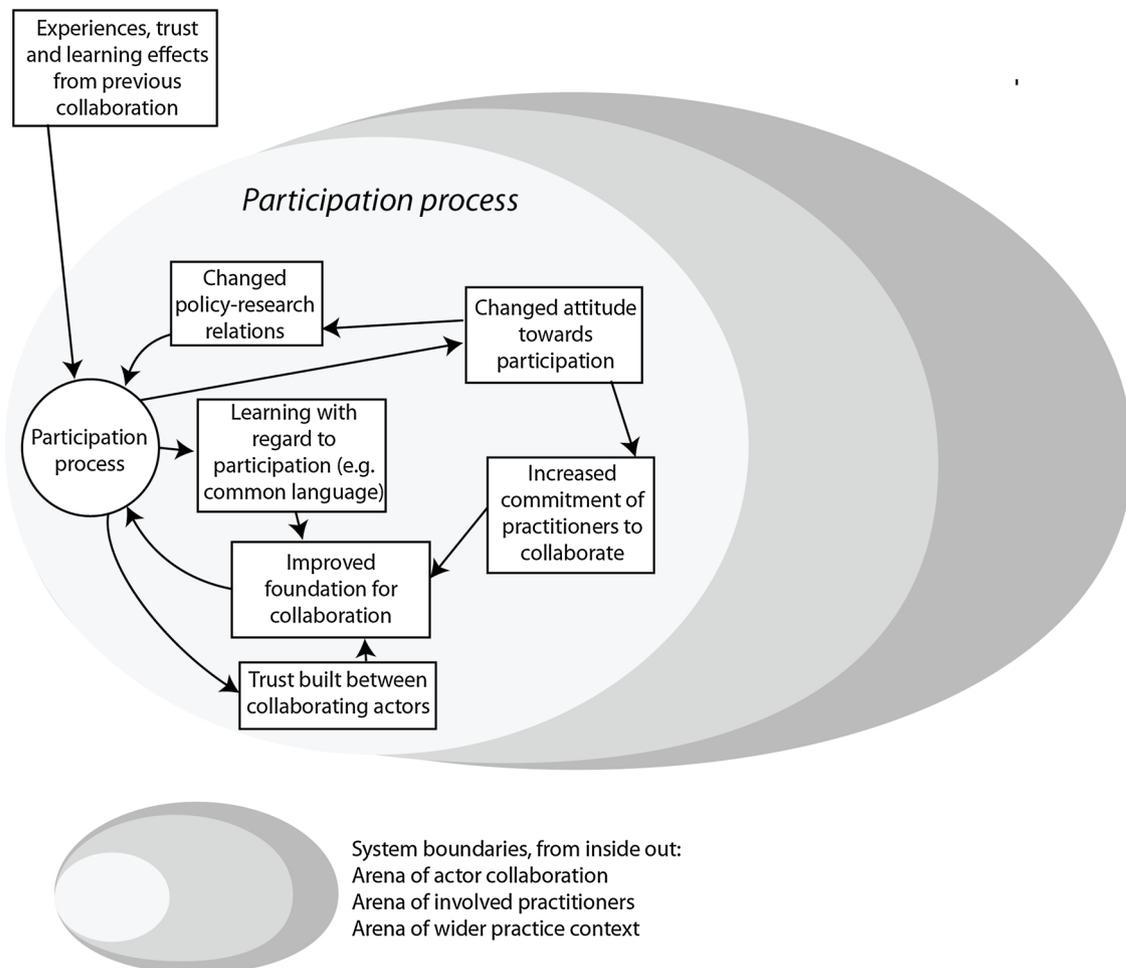


Fig. 3. Feedback effects influencing the participation process: researchers' and practitioners' perceptions.

#### 4. Discussion

In this section, we discuss the contribution of our findings to the conceptual understanding of participation-effect pathways as well as their practical implications for impact-oriented TD research. We also critically reflect on the study's limitations and identify future research avenues.

##### 4.1. Participation dynamics and interrelations of effects: a contribution to the conceptual understanding of participation-effect pathways

Firstly, our findings fleshed out effect categories for impact studies more narrowly focused on participation in TD research and contribute to process-oriented perspectives on the effects of participation (Currie et al., 2005; Darby, 2017; Hellström, 2015). In particular, we showed that feedback effects in the 'arena of actor collaboration' constitute a crucial type of effects that requires due consideration when studying or evaluating participation. Feedback effects, such as developing a common language or building trust, dynamically shape researcher-practitioner interactions across projects and appear as critical for achieving a fruitful and presumably effective collaboration process. These effects emerge directly from actors' interactions and influence the evolution of the process. They are both process-driven (Darby, 2017) and drive the process. Such emerging effects in the 'arena of actor collaboration' corroborate some of the factors shaping participation processes that have been discussed in the wider participation literature (Ernst, 2019; Fritz and Binder, 2018). Conceiving of these factors as feedback effects sharpens our perspective on how they impact the

collaboration process as it evolves and the potential for societal effects in the arenas 'of involved practitioners' and 'of the wider practice context'. The dynamics of the collaboration process also point to the importance of the temporal context (Klenk and Meehan, 2017). Prior collaborations and personal participation histories affect subsequent collaborations and their potential for unfolding effects; our analysis identified trust built, mutual understanding developed, and lessons learned about working with actors from diverse backgrounds as elements that overarched project entities.

Secondly, our findings contribute empirical insights to the scholarship on theories of change of researchers and practitioners in TD sustainability research (Belcher et al., 2019; Oberlack et al., 2019) and participatory research more generally (Douthwaite et al., 2003). We could confirm existing conceptualisations of a direct link between participation and the emergence of societal effects (e.g. Walter et al., 2007; Wiek et al., 2014; Shirk et al., 2012). Unlike in either-or conceptualisations of impacts and outcomes (e.g. Morton, 2015; Shirk et al., 2012; Walter et al., 2007), we found, however, that the same type of effect can occur at different positions in pathways of interlinked societal effects (e.g. raising awareness for a sustainability problem of the involved practitioners vs. practitioners as intermediaries to raise awareness in the wider context). This indicates that either-or categorisations of societal effects as impacts or outcomes might insufficiently represent the complexity of effect pathways. This complexity manifested in the perceived interlinkedness of societal effects. Societal effects of participation are oftentimes perceived to be embedded in sequential dependencies with other societal effects. Hence, conceptualising societal effects as parts of larger participation-effect

pathways instead of an isolated view on single effects, facilitates a comprehensive and holistic approach to analysing, evaluating, or planning societal effects of TD research. In addition to interlinked societal effects, our findings illuminate indirect links between participation and societal effects. In these pathways, participation creates effects on the research and participation process as a first step towards subsequent societal effects. Our findings thus reinforce previous calls for considering complex and non-linear relations in studying impacts and setting up ToCs (Oberlack et al., 2019; Van Kerkhoff, 2014; van Tulder and Keen, 2018).

Thirdly, our results contribute more detail to TD and participation scholarship stressing the need for paying attention to diverse actors' goals, values and roles (de Jong et al., 2016; Di Giulio et al., 2016; Enengel et al., 2012; Pohl et al., 2010; Zscheischler et al., 2018). Our results demonstrate the diverging perspectives of researchers and practitioners regarding participation-effect pathways and the weights given to specific effects. Some elements that researchers perceived as side-effects (e.g. network effects), constituted a core expectation and indeed motivation for practitioners to participate and vice versa. For example, researchers tended to conceive of participation as an input into the research process that increases the practical relevance of outputs and eventually leads to effects, whereas providing inputs for the research process was less important for practitioners, who focussed on societal effects. The assumptions about participation-effect pathways were accompanied by roles ascribed to oneself and to others. Thus, whereas some researchers conceived of practitioners as the key actors in the realisation of societal effects ('the implementers'), practitioners perceived their own roles as 'intermediaries' between research and a wider context. These findings lead us to concur with Schneider et al. (2019b) and Mitchell et al. (2015) that researchers and practitioners need to reflect on their epistemic values and their assumption about the appropriate division of roles between research and practice. The participating practitioners in the projects studied included actors with multifaceted professional backgrounds and reference systems as well as holding diverse convictions (de Jong et al., 2016). Our empirical insights substantiate previous assertions that participants do not act as isolated individuals, but rather are entangled in socio-material collectives (Chilvers and Kearnes, 2015) and different structural and organisational contexts (Fritz and Binder, 2018). They illustrate how practitioners' perceptions of societal effects relate to the overall goals of their home organisation, their function in that organisation, and/or their political or societal commitments. Hence, intended societal effects must be negotiated in relation to existing norms and belief systems. This confirms previous research highlighting the inherent normativity of sustainability-related TD research (Schneider et al., 2019b). Judging whether or not an effect is 'desired' and represents a contribution to sustainability is a fundamentally normative decision and largely depends on the sustainability values of the involved actors (Meinherz et al., 2020; Weiss et al., 2011).

#### 4.2. Practical implications for TD research

The diversity of pathways and interrelated effects has important implications for the design of impact-oriented TD research. Different collaboration processes and strategies are likely to be effective depending on which types of participation-effect pathways actors seek to pursue. Hence, a common understanding of targeted pathways is pivotal to bundling their efforts for achieving them.

A systems approach can make such tacit assumptions about interrelations between participation effects transparent, assessable, and negotiable. The development of pathway models can be a useful tool to elicit researchers' and practitioners' perceptions of the pathways to effects and communicate their ToCs (van Drooge and Spaapen, 2017). Particularly, the divergences of perspectives and perceived roles and responsibilities found in this study reveal the necessity of illuminating researchers' and practitioners' perceptions in both planning and

assessing societal effects. Researchers and practitioners involved in TD research should communicate their expectations, goals, and normative positions to ensure an effective collaboration.

Since differentiating outputs-outcomes-impacts can be overwhelming particularly when working with diverse actors not familiar with impact assessment (Binder et al., 2015), the reduced 'effect' terminology suggested in this article can be useful for eliciting researchers' and practitioners' ToCs. It allows to simply ask for changes which are supposed to emerge in different actor and system contexts. In so doing, a tripartite categorisation according to system contexts can serve as a way of disentangling the effects that primarily impact the involved practitioners from those that represent changes in the wider context and of grasping smaller-scale effects on the collaboration process. Mapping effects within different system boundaries can inform researchers and practitioners about their own capacity to contribute to the realisation of effects, and thus constitutes a first step towards assessing their influence over it, as suggested in ToC scholarship (Belcher et al., 2019; Earl et al., 2001; Vogel, 2012). Effects closer to the participation process (inner system boundary) tend to be susceptible to the influence of the involved actors, whereas those in the wider practice context (outer system boundary) are hardly steerable.

For funding bodies and academic institutions, the results suggest to reflect on the right degree of flexibility and adaptability of their assessment and evaluation schemes and to account for small-scale effects of participatory and TD research. Findings for the 'arena of actor collaboration' illustrated that effects also emerge in unintentional and serendipitous ways (Darby, 2017; Evans, 2016), which necessitates funding structures that provide flexibility for spaces of experimentation to develop (Rau et al., 2018) as well as for adaptive learning and reflexivity of those involved (Oberlack et al., 2019).

#### 4.3. Limitations and future research

One limitation of this study relates to the ongoing nature of the projects during the data collection and analysis periods. Hence, the study relied on expectations and perceived effects and could not provide an ex-post assessment of how pathways to societal effects actually unfold over the long term. Second, the meta perspective and level of aggregation chosen to display findings across projects limited the extent to which the situatedness and structural and organisational context specificities of each project were considered. Accordingly, our analysis did not include factors inside (e.g. formats and degrees of actor interactions) and outside of the participation process (e.g. socio-political factors, power relations) that impede or drive the realisation of effects.

Further research is needed on how the system context shapes the potential of societal effects to unfold. Our results illustrate the importance of critically examining system boundaries when analysing societal effects. Focusing primarily on research projects risks neglecting processes and structures in their respective practice contexts. Influence factors that exist independently of the project (e.g. resistances against change) can significantly affect how participation-effect pathways unfold. Hence, there is a need to take into consideration project-related as well as contextual factors to understand when and under which conditions societal effects of participation emerge. Future research should focus on further developing the systems approach used in this study in order to also include such factors. Furthermore, building on the diversity of perceptions revealed in this article, future research should inquire into how varying perceptions of participation-effect pathways relate to the epistemic and ethical values of actors in TD sustainability research.

## 5. Conclusion

In this article, we provided empirical insights into the perceptions of both researchers and practitioners regarding the effects of their collaboration in TD sustainability research. Using a systems approach,

perceived effects of participation were found to be interwoven in complex and sequential pathways that either directly linked the participation process to societal effects or included effects on the research and participation process as intermediary steps. Differentiating the perceived effects of participation according to the system contexts in which they unfolded, we proposed a tripartite categorisation of effects in the context of TD research, namely in the ‘arena of actor collaboration’ (e.g. trust built); the ‘arena of involved practitioners’ (e.g. networks formed), and the ‘arena of the wider practice context’ (e.g. raised awareness of sustainability). Furthermore, different links among effects and feedbacks across the three arenas are conceivable. This shows how recognising feedbacks and multidirectional links allows to grasp the bigger picture of participation-effect pathways that typically go beyond linear relations between participation and single societal effects. The process-related effects that we identified as feeding back into participation processes furthermore suggest the need for grounding studies of the societal effects of TD research in a procedural and dynamic understanding of participation, including personal and collective participation histories.

The systems approach followed in this article enabled the mapping of effects as well as their interrelations and provides a first step for grasping the complex entanglements between participation and diverse effects. The pathway models developed showed that although similar effects appeared across interviews, perceptions of pathways to societal effects varied depending on the actor’s standpoint and the project context. A systems approach can support those engaged in TD research

in better designing their research process by eliciting and negotiating tacit assumptions on how participation contributes to societal effects and in communicating the distribution of roles and responsibilities among actors. This enables a consideration of multiple perceptions in both planning and studying societal effects. Notwithstanding the need for further refinement, adopting a systems approach is essential for a better understanding of the complex ways in which the inclusion of heterogeneous actors and knowledges leverages the transformative potential of sustainability research.

**Declaration of Competing Interest**

None.

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**Appendix A**

Fig. A1

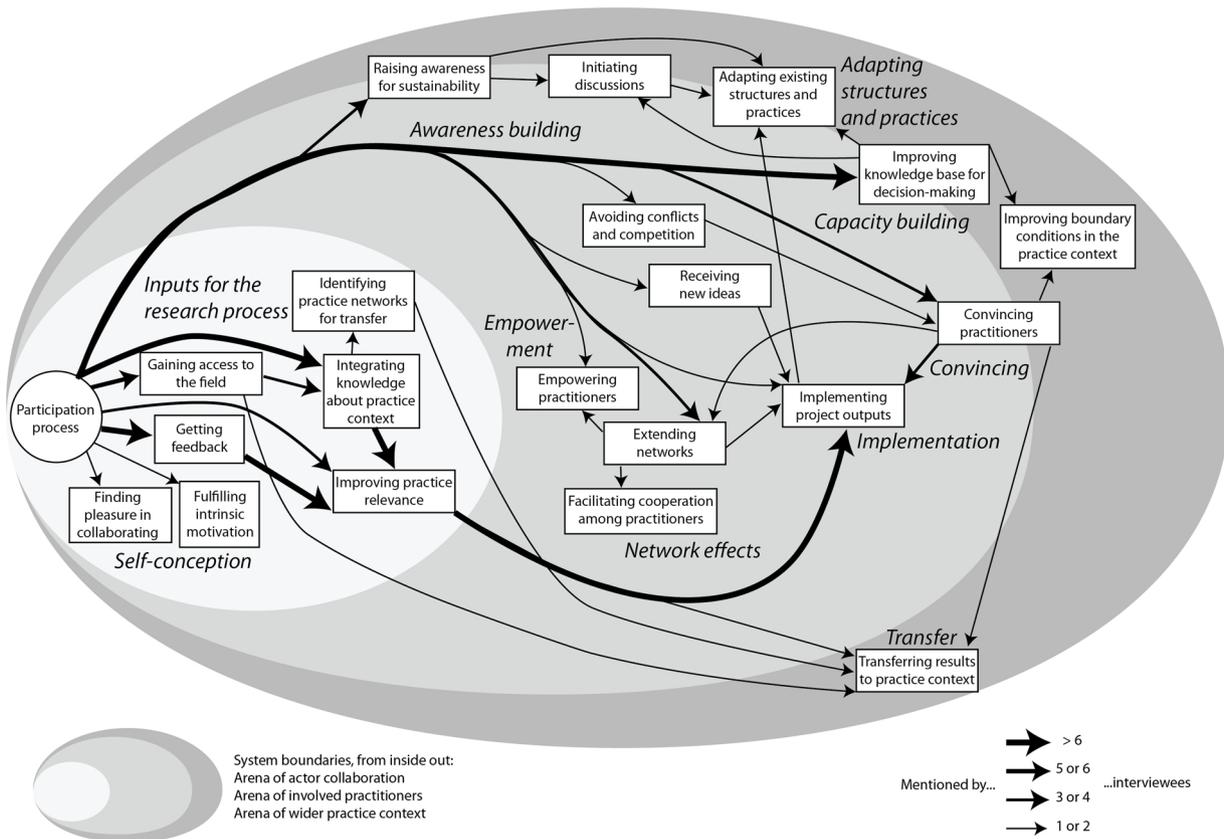


Fig. A1. Full model of researchers’ expectations regarding the effects of participation in TD research.

Appendix B

Fig. B1

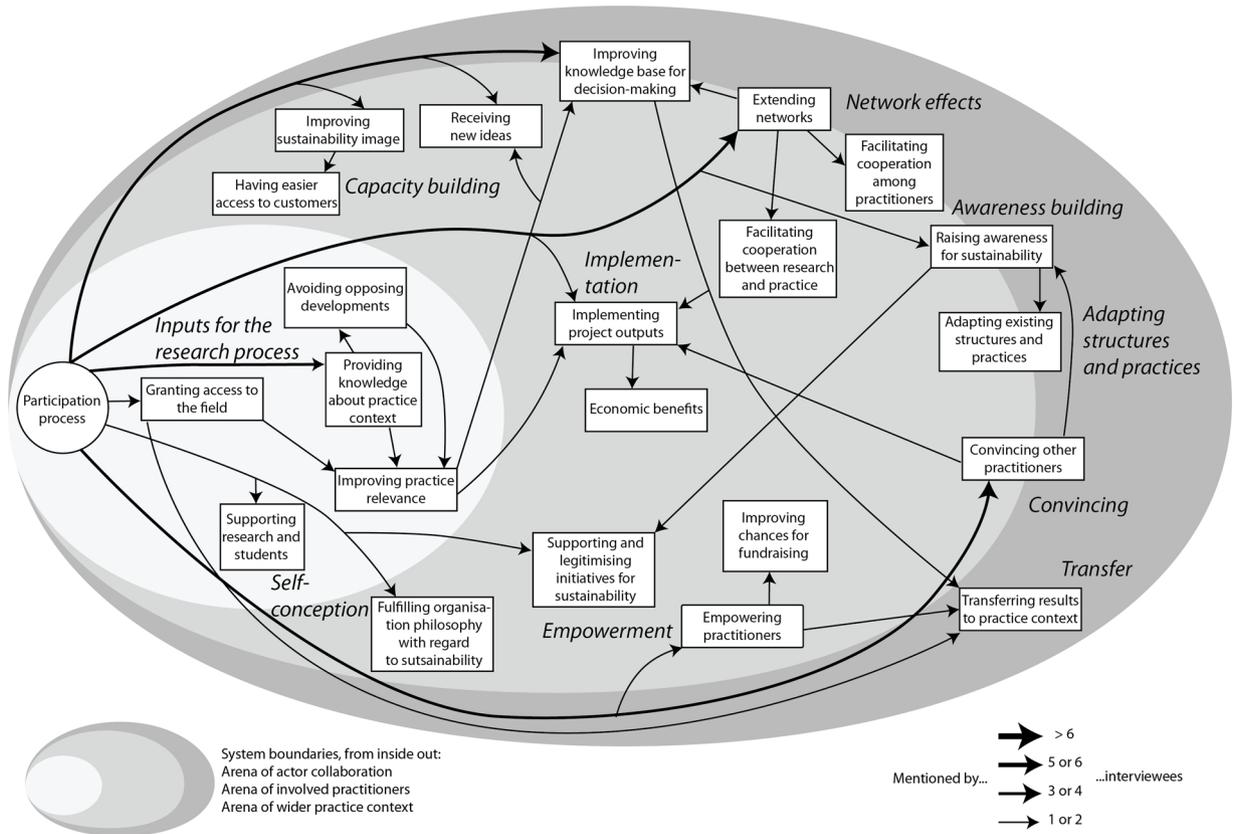


Fig. B1. Full model of practitioners' expectations regarding the effects of participation in TD research.

Appendix C

Fig. C1

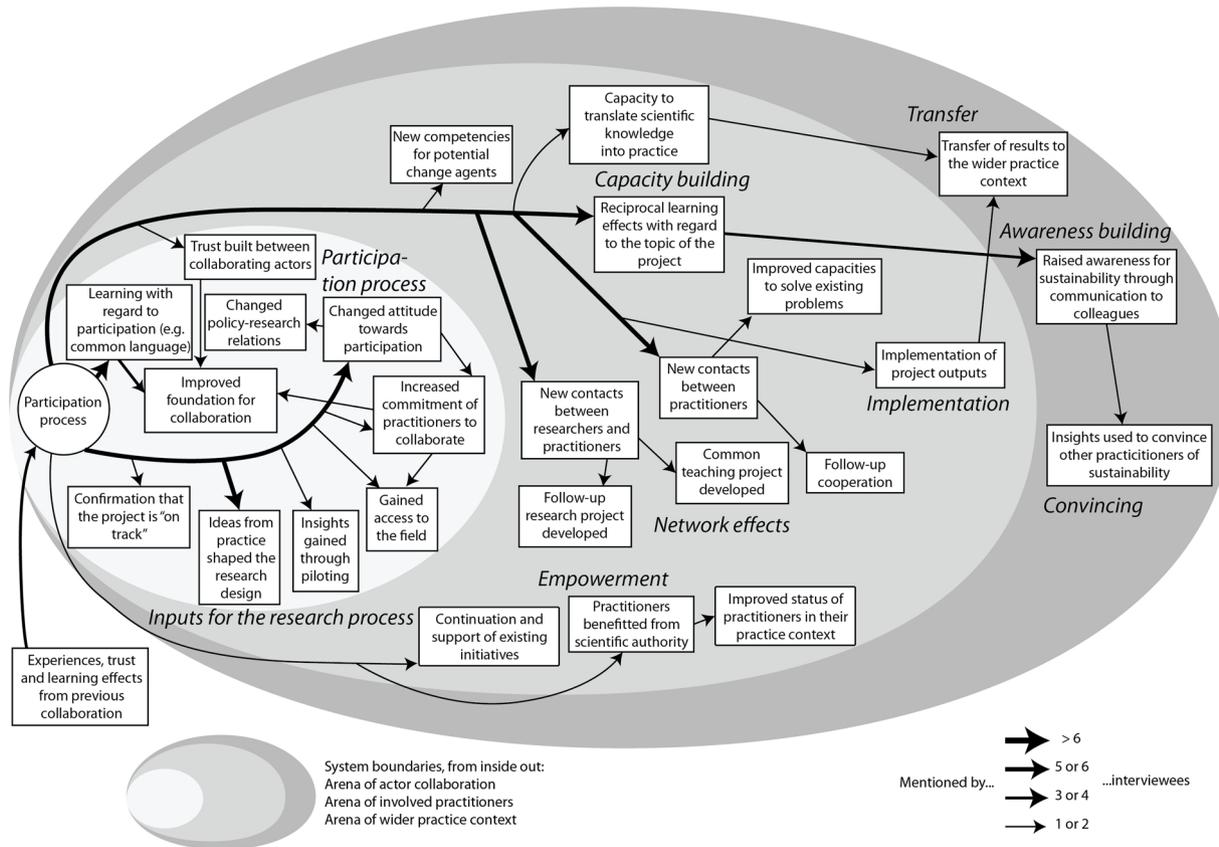


Fig. C1. Full model of observed effects during the participation process: researchers' and practitioners' perspectives.

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