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Transdisciplinarity From Principles to Practice: Insights From EU Horizon Research Projects on Sustainability

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ABSTRACT

Transdisciplinary research (TD) is widely invoked to tackle complex sustainable-development challenges by integrating scientific and societal knowledge and fostering collaboration among researchers, decision-makers, practitioners and affected publics. Yet we still lack a refined understanding of the conditions that enable TD to succeed in EU research settings. We address this gap by analysing in-depth, semi-structured interviews with Horizon project coordinators working on sustainability topics. Our results reaffirm established enablers—broad and inclusive participation, robust knowledge integration, and balanced, adaptive governance—and surface additional, actionable levers: structured feedback and iterative learning, methodological flexibility, pathways for post-project continuity, and effective use of digital collaboration tools. We synthesise these insights into a practice-proximate framework that prioritises power-sharing, equitable dialogue and shared decision-making, thereby strengthening the credibility, salience and legitimacy of TD outputs. The article refines existing TD and joint-knowledge-production perspectives and offers concrete guidance for researchers, funders and policymakers seeking to design and steward more successful TD processes in future Horizon programmes.

1 | Introduction

Transdisciplinary research (TD) addresses complex sustainability problems by integrating scientific and societal knowledge, aiming for outputs seen as credible, salient, and legitimate by diverse involved and affected parties (Cash et al. 2003; Kirchhoff et al. 2013). However, operationalising these ideals in practice remains challenging (Sarkki et al. 2020; Andrews et al. 2024). Earlier frameworks have outlined principles for TD collaboration (Pohl and Hadorn 2007; Lang et al. 2012; Hegger and Dieperink 2014) and suggested that success hinges on broad stakeholder engagement, knowledge co-production, and iterative learning (Walter et al. 2007; Wiek et al. 2011). Hoffmann et al. (2019) further highlight the need for producing, assessing and disseminating new knowledge to facilitate knowledge blending across disciplines. This literature indicates what should matter in TD projects, yet empirical evidence on how project leaders interpret and implement these principles is limited (Osinski 2021).

A key impetus for TD research emanates from the intractable nature of socio-ecological challenges at the interface of society and the biophysical world (Rockström et al. 2009). Lang et al. (2012) framework, grounded in complexity theory, underscores the need to address the multifaceted nature of these systems and highlights policy relevance as a fundamental objective of TD research. Central to this vision is the active involvement of actors beyond academia—including decision-makers, practitioners, communities and affected publics from outside of the sphere of science, whose diverse perspectives can improve both

the quality of the research and its legitimacy in the eyes of various audiences, and thereby enhance the societal impact and uptake of the research results (Cilliers 2005; Audouin et al. 2013; Cash et al. 2003; Edelenbos et al. 2011; Rosendahl et al. 2015).

Ensuring that knowledge production is salient, credible, and legitimate to the actors and publics engaged in or affected by the research is a fundamental objective of TD projects (Cash et al. 2003). Different actors often define these qualities in divergent ways (Kirchhoff et al. 2013). Various initiatives have attempted this: for example, the UN Sustainable Development Goals (SDGs) call for multi-actor partnerships to tackle interdependent challenges, and the EU's Horizon 2020 program promotes systemic co-creation for sustainability (European Commission 2021c). Yet, we lack knowledge on how researchers on the ground interpret and enact TD principles (Thompson et al. 2017). Long-standing efforts to implement TD still face obstacles stemming for instance from entrenched institutional silos, power imbalances, and differing visions of "sustainability" among participants (Shackleton et al. 2023).

In line with the existing literature, we recognise that significant gaps remain in our knowledge on the practical application of TD principles and, more precisely, on the key factors that condition its success in the context of EU research projects on sustainability. We address this shortfall through an empirical study of the perceptions and experiences among selected coordinators of ongoing and recent EU projects in the area of sustainability, in order to identify critical success factors and potential pitfalls. Through our in-depth qualitative analysis, we contribute to the expanding literature on how to foster equitable and productive TD partnerships—an advancement that we hope will ultimately benefit also sustainability policy and TD research practice (Newig et al. 2019; Wardani et al. 2022).

Guided by coordinators' perceptions and experiences of TD processes in EU-funded Horizon 2020 sustainability projects, this article's primary aim is to identify the factors that condition the success of TD research and to derive actionable opportunities for researchers, policymakers, and funders. By empirically analysing the views of project and coordinators of existing projects, the study intends to test and refine the theoretical frameworks and typologies found in the literature on TD (e.g., Stock and Burton 2011; Lang et al. 2012), to help improve the applicability and usefulness of TD in future research.

2 | Joint Knowledge Production (JKP): From Inter- Through Multi- To Transdisciplinarity

In literature and practice, transdisciplinarity, multidisciplinarity, and interdisciplinarity are often used interchangeably. However, this interchangeable use can lead to misaligned perspectives and practices, ultimately hindering the effective implementation of TD in research projects (Walter et al. 2007; Stock and Burton 2011). A clear understanding of these concepts and their mutual relationships is essential both for practical application and for analytical and conceptual clarity.

In this article, we treat these three concepts as variants of integrative research, each exhibiting its own degree of collaboration among the involved disciplines and among both academic and non-academic stakeholders. Multidisciplinarity involves different disciplines working on a common theme but each with its own methodologies (Petts 2008). Interdisciplinarity entails a greater degree of collaboration, with researchers integrating methodologies to create new analytical frameworks and knowledge, thus crossing disciplinary boundaries (Buller 2009). Transdisciplinary research is the most ambitious form of integrative research, as it not only applies a joint interdisciplinary conceptual framework, but also involves actors outside of academia in an effort to solve real-world problems. This process includes forming a collaborative team, jointly defining the problem and clear research questions, designing a shared research framework, assigning specific roles to the involved participants, co-creating solution-oriented knowledge, engaging with stakeholders, integrating different types of knowledge, and continuously evaluating impact, to ensure that the results are useful for both science and society (Lang et al. 2012; Pohl and Hadorn 2007; Walter et al. 2007; Wiek et al. 2011; Hoffmann et al. 2022; Andrews et al. 2024). This way, TD seeks to produce insights and impacts that multi- or interdisciplinarity alone could not generate (Walter et al. 2007; Stock and Burton 2011).

Transdisciplinary scholars have advanced multiple ideas, paradigms, and principles to integrate abstract and case-specific knowledge, capturing the complexity of real-world problems and the diversity of scientific and lifeworld perceptions (Pohl and Hadorn 2007). Joint knowledge production (JKP) emerges as a core element of TD by emphasising co-production between science and society (Hegger et al. 2012), challenging the linear model of expertise and highlighting that equitable dialogue and shared decision-making between knowledge and power inevitably influence policy (Pielke 2007; Jasanoff 2004). Drawing on post-normal science paradigms (Funtowicz and Ravetz 1993), TD underscores broad stakeholder involvement, particularly under conditions of uncertainty, urgency, and value conflicts (Van den Hove 2007; Cash et al. 2003), operationalised through approaches such as those applying action-oriented methods (Pretty 1995), Mode 2 science (Gibbons et al. 1994; Nowotny 2003), or the collegial model (Biggs 1989), all of which seek to promote mutual participatory learning, and application-oriented collaboration (Reed 2008; Meadow et al. 2015; Van Kerkhoff and Lebel 2006; Vogel et al. 2007). By integrating different perspectives and knowledge systems (Lang et al. 2012; Pohl et al. 2010; Berkes 2009), TD research seeks to provide relevant, credible and legitimate results for tackling complex socio-ecological challenges (Schneider et al. 2019). Consistent with this theoretical foundation, Hegger et al. (2012) propose key conditions for JKP, including forming a broad coalition of actors with clearly defined roles and responsibilities, establishing a mutual understanding of goals and problem definitions, and fostering recognition and respect for each actor's perspective. These conditions align with the concept of boundary work processes, which involve strategic negotiation of expertise and exercise of power to define whose knowledge is prioritised and how decisions are made (Gieryn 1983, 2002; White et al. 2010; Clark et al. 2016; Augenstein et al. 2024). Reflecting on task division, clarifying the researchers' roles, innovating reward structures, and ensuring the availability of necessary resources (e.g., facilities, organisational forms, competences) can contribute to more robust and impactful knowledge production processes.

JKP overlaps with co-design and participatory action research in prioritising stakeholder collaboration, but JKP specifically emphasises the iterative production of new knowledge through scientist–stakeholder partnerships (Hegger et al. 2012). While stakeholder participation is often expected to produce 'win-win' outcomes (Driessen and Vermeulen 1995), the degree to which different participants are willing to engage and their motivations to do so tend to vary widely (Lamers et al. 2010). Involving additional stakeholders can mitigate resistance stemming from self-interest or frustration (Driessen and Vermeulen 1995; Scharpf 1978), yet maintaining a manageable number of participants is essential (Driessen and Vermeulen 1995; Lamers et al. 2010).

Empirical evidence supports the assumption that these conditions are vital for fostering successful JKP. For instance, Jahn et al. (2012) and Harris et al. (2024) show that broad coalitions and clearly articulated, shared goals can improve the likelihood that the solutions are robust and adapted to the context. However, implementation is often power-laden: asymmetries in expertise, agenda-setting and control of resources shape who can participate, whose knowledge is judged credible, and which options remain on the table—thereby conditioning policy uptake (Van Kerkhoff and Lebel 2006; Hegger et al. 2012; Cash et al. 2003; Turnhout et al. 2020). Critics highlight difficulties in achieving consensus, managing conflict, and in employing hybrid methods that create spaces for reflection and dialogue among stakeholders with divergent interests (Shackleton et al. 2023; Thapa et al. 2022). Moreover, researchers' diverse interpretations and disciplinary backgrounds can make it difficult to define what 'success' means in any given TD context (Bieluch et al. 2016; Allen et al. 2013). As a result, project aims and participant expectations may change over the course of the project, ultimately undermining efforts at reaching the very collaborative ethos that TD research aims to promote (Thompson et al. 2017).

Hegger et al. (2012), Hegger and Dieperink (2014) framework provides a structured approach to understanding these dynamics by focusing on key elements essential for JKP: actors, discourses, rules and resources. As previously discussed, assembling a broad yet manageable coalition of diverse actors—including scientists, policymakers, and community representatives—can help to improve the social robustness of knowledge production (Nowotny 2003; Driessen and Vermeulen 1995). Discourses—the conceptual frameworks and narratives used to frame problems—directly influence how actors understand issues, recognise multiple perspectives, and work towards shared problem definitions (Hisschemöller and Hoppe 2001; Hajer and Versteeg 2005). Clarity regarding the rules that govern interactions, along with an explicit definition of roles and responsibilities of the participants, fosters transparency and trust (Gieryn 2002; Pielke 2007; Mollinga 2010). Finally, adequate resources, ranging from funding and facilities to negotiation and mediation skills, are necessary for sustained engagement (Hoffmann et al. 2022; Deutsch et al. 2021).

In an effort to institutionalise these principles, the EU has taken a pioneering role in promoting TD research. Within Horizon Europe and subsequently in Horizon 2020, the EU has funded numerous projects emphasising stakeholder engagement, co-creation of knowledge, and the integration of diverse perspectives (European Commission 2021c, 2024; Lieberknecht et al. 2022; Newig et al. 2019; Lieu et al. 2023). The EU framework for TD research is grounded in problem-oriented approaches designed to address real-world challenges, integrate knowledge across disciplines and actor groups, encourage reflexivity, and generate transformative outcomes (European Commission 2021c). By prescribing cross-national and cross-sectoral consortia and introducing explicit evaluation criteria to assess transdisciplinarity, the EU declares its commitment to principles that seem to align with the conditions that Hegger et al. (2012), Hegger and Dieperink (2014) consider crucial for TD. Indeed, transdisciplinarity has become a fundamental criterion in the evaluation of research proposals. Horizon 2020 already emphasised the need for research 'by, with and for society' and called for the integration of social sciences and humanities (SSH) and interdisciplinary collaboration. It also promoted transparent and interactive processes in which societal actors are actively involved in co-creation and co-design within the framework of responsible research and innovation (RRI). Horizon Europe goes a step further by encouraging people-centred approaches and the inclusion of SSH contributions in all areas of research and innovation. The evaluation of proposals now explicitly recognises the need for collaboration between SSH disciplines and between SSH and non-SSH fields, underlining the idea that no single discipline alone can tackle today's complex challenges. At least in its discourse and research evaluation criteria, the EU declares its commitment to advancing 'integrative research' through inter- and transdisciplinary approaches (European Commission 2021a, 2021b; European Research Council 2022; von Schomberg 2021).

Nevertheless, it is likely that the EU efforts face similar difficulties as those identified in the literature, such as how to align diverse stakeholder interests, balance academic rigour with practical stakeholder demands, and navigate institutional barriers to transdisciplinary engagement in contexts entailing entrenched asymmetries of power (Huutoniemi et al. 2010; Gibbons et al. 1994; Overland and Sovacool 2020). Although the EU's support structures and funding mechanisms represent a significant step towards mainstreaming TD research, their effectiveness hinges on how actors—especially researchers—interpret, implement, and sustain these principles in practice (Baum and Bartkowski 2020). Drawing on interviews with coordinators of sustainability-related EU research projects, this article explores the views of project and coordinators on the difficulties, challenges, and opportunities faced in the efforts towards transdisciplinarity, and the suggestions by these actors for improving TD research.

3 | Materials, Methods and Sample

To explore the implementation of TD research in the EU, the use of interviews as a central qualitative method is both appropriate and necessary. Such interviews allow for an in-depth exploration of individual experiences, perspectives and attitudes, which is essential for understanding the salience, credibility and legitimacy (CSL) of TD research processes by researchers, policymakers and community members (Cash et al. 2003). As DiCicco-Bloom and Crabtree (2006) point out, in-depth interviews provide flexibility and allow researchers to delve deeply into participants' subjective meanings while

maintaining the conversational flow necessary to capture rich, detailed narratives. The in-depth interviews conducted as part of this study were analysed using a thematic analysis (TA) approach (Braun and Clarke 2006, 2019) to examine the transcripts.

The research methodology involved a three-step approach: first, a review of the literature on key conditions for effective transdisciplinary research; second, conducting interviews to verify and expand the list of success factors identified in the literature; and third, synthesising and contrasting the interview findings with the literature review. We relied solely on interviews; no project documents or reports were analysed, which could introduce perceptual biases. Reflexive practices, such as team debriefings during coding, were used to mitigate this influence and enhance objectivity.

Our sample comprised 10 project leaders from EU-funded sustainability initiatives (Table 1). We used purposive sampling to cover a range of project types (climate adaptation, environmental management, sustainability education, etc.) and geographic contexts. Inclusion criteria were that the individual had a coordinating role (either overall Project Coordinator or leader of a major work package focused on stakeholder engagement or integration). The sample consisted of eight Horizon 2020 projects and two Horizon Europe Green Deal projects. The informants' roles included academic coordinators (six university-based scientists), applied research institute leaders (two), and NGO project managers (two). To preserve confidentiality in reporting we define them with project descriptors.

To identify participants, we employed a purposive sampling strategy through systematic outreach to project coordinators listed on the official EU Mission Projects portal. This technique is aligned with expert sampling—a non-probabilistic method used to recruit individuals with recognised experience in a specialised domain (Etikan et al. 2016). We emailed coordinators of ongoing Mission Projects to request interviews or referrals, yielding informants with decision-making authority and technical expertise in complex, multi-actor projects. The online interviews were conducted in February and March 2024. Each interview lasted 60 min on average.

A semi-structured guide was used to ensure comparability across interviews, focusing on transdisciplinary collaboration, governance mechanisms, project implementation challenges, and factors influencing success in climate adaptation.

4 | Results on Success Factors for Transdisciplinary Research: Lessons From Literature and Interviews

This section presents our findings concerning the conditions for success in transdisciplinary (TD) research, by drawing on both existing literature and insights from interviews. It first identifies factors found in the literature and evoked by the interviewees, then presents those success factors that were suggested by the interviewees but not mentioned in the literature, and finally reflects on how these findings contribute to refining existing TD frameworks. While many success factors identified in the interviews align with those found in the literature, several new factors emerged. Table A1 (Appendix A) summarises those success factors that were both found in the literature and mentioned by the interviewees. The results are presented under four sections corresponding to the four major theoretical dimensions identified by Hegger et al. (2012); Hegger and Dieperink (2014): actors, discourses, rules, and resources.

4.1 | Actors

4.1.1 | Participants Involved (Number and Backgrounds) (F1)

Interviewees consistently described the importance of engaging a broad coalition of actors across sectors and disciplines. Many projects assembled large consortia to ensure diverse expertise and stakeholder representation. This diversity was seen as vital to tackling complex problems, as it brings regional authorities, businesses, academics and community groups into a common platform. One coordinator exemplified this diversity of partners by noting, 'we have 57 partners involving diverse actors including regional authorities, municipalities, businesses, academics, and citizen groups' (Interview 7, RESIST) or 'in my team, we are about 35 people and we involve architects, engineers, climate scientists, social scientists, and communication specialists' (Interviewee 1, AGORA).

4.1.2 | Integrated Knowledge Systems (F2)

Across projects, there was a strong emphasis on integrating scientific knowledge with local and experiential knowledge. Some coordinators stressed that solutions are more robust and applicable when they emerge from blending academic research with practical insights from policymakers, businesses, and communities. Many interviewees described deliberate efforts to bridge technical and local perspectives, ensuring that climate models and analytical tools are informed by economic realities, cultural values, and community priorities, yielding outputs that are both scientifically sound and socially relevant. For example, one coordinator emphasised the need for broad collaboration: 'we actually see that academia, business, policymakers, and citizens need to work in a sustainable way towards the environment' (Interview 7, RESIST). Another interviewee asserted that working across disciplines is not optional, noting, 'you just have to work with other disciplines there's no way out' (Interview 7, SpongeScapes).

4.1.3 | Willingness to Participate/Expectations (F3)

Some of the interviewees acknowledged that sustaining stakeholder motivation and managing expectations are ongoing challenges. At a project's start, many stakeholders asn other participants join expecting beneficial outcomes (e.g., improved climate adaptation strategies or economic opportunities). However, keeping participants engaged requires that each party continue to perceive clear value for themselves. The interviewees noted that partners will disengage if the

TABLE 1 | Profiles of the interviewees.

Interviewee	Position	Project	Background/Discipline	Institution type	Country	Interview date
Interviewee 1	Senior Researcher	AGORA	Climate modelling, meteorology, geohydrology	Research Institute (CMCC)	Italy	15 Feb 2024
Interviewee 2	Consultant	CLIMAS	Interdisciplinary Disaster Mgmt., Climate Change Adaptation	University (Vilnius Tech)	Lithuania	7 Mar 2024
Interviewee 3	Program Manager	CLIMATEFIT	Climate finance, resilience policy	NGO (World Climate Foundation)	Denmark	20 Feb 2024
Interviewee 4	Associate Professor	FARCLIMATE	Industrial marketing, CSR, knowledge organisation	University (UVigo)	Spain	12 Feb 2024
Interviewee 5	Project Manager	IMPETUS	Science and project management, natural and social sciences	Technological Center (EURECAT)	Spain	15 Mar 2024
Interviewee 6	Associate Professor	MIRACA	Infrastructure risk, disaster economics	University (VU Amsterdam)	Netherlands	1 Mar 2024
Interviewee 7	Strategic Project Coordinator	RESIST	Digital technologies, EU funding, climate adaptation	Research Org (SINTEF)	Norway	27 Feb 2024
Interviewee 8	Senior Researcher	SpongeScapes	Nature-Based Solutions, ecohydraulics	Research Institute (Deltares)	Netherlands	12 Feb 2024
Interviewee 9	Senior Researcher	TransformAr	Economics, informatics, financial management	University (Antwerp)	Belgium	13 Feb 2024
Interviewee 10	Postdoctoral Researcher	VALORADA	Development studies, environmental sciences, urban resilience	Research Org (Hereon)	Germany	21 Feb 2024

project demands significant time without tangible returns, especially in cases where certain stakeholders (like municipalities or small businesses) do not receive direct funding. Thus, teams continuously communicate 'wins' for all involved and strive to balance what the project asks of stakeholders with what it offers in return. As one interviewee explained, 'we are very clear that those who participate represent a "win" for us, but they also must perceive a "win" for themselves' (Interview 4, FARCLIMATE) One interviewee illustrated the challenge by noting that for municipal representatives the key questions are: 'Why should I invest my time in this project? What will I get out of it?' (Interview 10, VALORADA).

4.1.4 | Facilitating Equitable Dialogue (F4)

Several coordinators highlighted that in multi-actor settings, scientific and political power must be negotiated to avoid marginalising community voices. Facilitating equitable dialogue—managing the interfaces between science, policy, and society—often involved creating special forums or roles to elevate perspectives that are typically underrepresented. For instance, one interviewee described establishing 'transdisciplinary dialogues… spaces for reflection to try to understand how interactions among different disciplines, both inside and outside academia, function' (Interview 5, IMPETUS). Such transdisciplinary dialogue helped decentralise influence so that no single group's expertise dominated problem-solving.

Another coordinator sought to give non-academic partners equal footing by 'generating spaces for reflection to see how collaborative, interdisciplinary research is actually working in practice, especially with representatives from outside academia' (Interview 4, FARCLIMATE).

4.1.5 | Feedback Mechanisms and Iterative Learning (F5, New)

Both the literature and the interviewees identified continuous learning loops as crucial for transdisciplinary success. Several coordinators described how their consortia documented lessons learned in real time and were not afraid to modify strategies in response to stakeholder input or new data. For example, one interviewee explained: 'We monitor and evaluate the engagement processes… and that's what we share in our deliverables in our reports' (Interview 5, IMPETUS). Another interviewee described holding regular 'legacy sessions' from the project's inception to define long-term goals: 'we have what we call legacy sessions, in which from the beginning of the project we have sought to define a concept of legacy… legacy indicators, KPIs in terms of legacy' (Interview 10, VALORADA).

4.1.6 | Flexibility and Adaptability in Transdisciplinary Methods (F6, New)

The interviewees repeatedly stressed the need for methodological flexibility—the ability to adapt goals, methods, and even research questions as contexts change. Because sustainability challenges and stakeholder needs can evolve, a rigid work plan may become obsolete. Some of the interviewees noted that research teams benefited from context-tailored approaches that allowed adjustment on the fly (F5). They also acknowledged a tension: large EU projects have reporting requirements and predefined milestones that discourage deviation, yet effective TD work often demands iteration and openness to change. Some interviewees suggested that funders should reward flexibility and learning, not just adherence to initial plans. One interviewee argued: 'I think what should be rewarded is a flexible, context-tailored approach, because there is also a tension between the need for reporting and the need to allow flexibility' (Interview 5, IMPETUS) Likewise, a researcher reflecting on a decades-long project noted that initial problem definitions had to evolve: 'because it's a very long, long-lasting project – almost 30 years – our views on the world are quite different now' (Interview 7, SpongeScapes).

4.1.7 | Sustainability of Collaboration Beyond Project Timelines (F7, New)

A prominent theme was ensuring that partnerships continue after the EU funding period ends. Several interviewees expressed concern that without plans for post-project collaboration, the networks and trust built could dissipate quickly. Many interviewees discussed efforts to secure follow-up support or to institutionalise the partnerships so that the work could continue. For example, some projects empowered local demonstration sites or pilot communities to take ownership of ongoing activities that could persist independently. One interviewee explained, 'we kind of let the demo sites decide for themselves what are the best types of workshops or activities that they think would be relevant in their region to foster co-creation' (Interview 7, SpongeScapes). Others mentioned creating post-project working groups or seeking additional funds (from municipalities, NGOs, etc.) to sustain the momentum created by the project. The prevailing view was that TD projects should serve as launch pads for long-term collaboration, not one-off experiments.

4.1.8 | Role of Digital Tools and Technology in Facilitating Transdisciplinarity (F8, New)

The interviewees noted that digital platforms and tools have become indispensable for communication and data sharing in large, dispersed consortia. Online tools (shared data portals, collaboration software, webinars, etc.) enable real-time exchange and can broaden stakeholder engagement beyond those able to attend in person. However, the some of the interviewees also cautioned that digital tools are complements, not replacements, for on-the-ground interaction. Many projects deliberately combined virtual and physical engagement to include different demographics and social contexts. For example, one interviewee described having an interactive online tool for information sharing but also organising in-person meetings tailored to the needs of specific groups: 'we have a digital tool but we also are making a physical meeting with

the stakeholders and the specific target group' (Interview 1, AGORA).

4.1.9 | Trust Building and Relationship Development (F9, New)

All interviewees underscored that building trust among diverse participants is fundamental to transdisciplinary work. Fostering trust requires significant time—not only for repeated interactions, but to genuinely understand each stakeholder's background, values, and 'language'. A part of interviewees shared that early stages of projects often involved relationship-building activities (informal meetings, site visits, dialogues) aimed at alleviating initial scepticism. Trust was described as reciprocal: researchers, community members and local officials each had to demonstrate openness, reliability and respect before collaboration could deepen. One interviewee observed: 'You need a lot of time and resources to not only build relationships with people, but also to understand their backgrounds and the language they use' (Interview 5, IMPETUS). Over time, as trust grew, stakeholders became more forthcoming, creative, and willing to collaborate as another interviewee stated 'The key remains in building trust' (Interview 6, MIRACA).

4.2 | Discourses

4.2.1 | Inter-/Multi-/Transdisciplinary Narratives (F10)

The interviewees described how they constructed narratives that span the divide between scientific and societal perspectives. Many had long histories with interdisciplinary work and were thus comfortable straddling the boundaries between multiple domains. They noted that in sustainability projects, it is not just about combining academic disciplines (multi- or interdisciplinarity), but creating a truly transdisciplinary narrative that also includes community knowledge and practical know-how. Some of the interviewee also remarked on the sheer scale of integration in EU initiatives, calling them 'mega projects' that span a spectrum of fields: 'we really make these megaprojects and these megaprojects are especially marked with the multidisciplinary fields' (Iinterview 2, CLIMAS).

4.2.2 | Problem Framing and Definition (F11)

Som of the interviewees emphasised the importance of co-defining the problem at the outset with stakeholders. The interviewees noted that this bottom-up problem framing built buy-in and relevance, since stakeholders saw their own priorities reflected in the project agenda. One interviewee explained: 'We started with the needs assessment. We ask the regions, what do they want to achieve? First we ask what challenges they have, what is the most important for them at the moment' (Interview 7, RESIST). Another interviewee stressed that academic curiosity alone is not enough—a researcher must find 'a real problem' that genuinely matters on the ground: 'You need to consider in your problem statement... you need to find like a real problem, in a way' (Interview 9, TransformAr).

4.2.3 | Shared Problem (F12)

Closely related to framing is the notion of maintaining a shared problem definition throughout the project. The interviewees reported that when stakeholders from different regions or sectors came together, they often discovered overlapping interests that could be leveraged. By identifying common goals across diverse contexts, projects could focus on solutions with broad relevance. This convergence of priorities enabled collective action—partners learned from each other's approaches (for instance, nature-based solutions for flood control) and felt they were part of a bigger mutual effort. As one interviewee noted: 'The large demonstrators are twinned with other regions, e.g., Norway with Greece, or Finland and Normandy; they are very different but have common goals' (Interview 2, CLIMAS).

4.2.4 | Cultural and Disciplinary Barriers (F13, New)

Despite deliberate efforts at integration, the interviewees acknowledged persistent cultural and disciplinary divides within transdisciplinary teams. A common observation was the difficulty experts had in understanding each other's 'language'—not just literal language, but jargon, problem-solving approaches, and underlying mindsets. One interviewee noted: 'One thing that we find most often is the difficulty of understanding the different languages, the different ways of thinking, and the different ways of perceiving or looking at problems' (Interview 4, FARCLIMATE). Such differences sometimes led to miscommunication or friction. Additionally, disciplinary hierarchies and biases could emerge. For instance, in one project, natural scientists were initially cautious about the 'empirical value' of social science inputs. As the interviewees observed, 'there is a lot of caution among natural scientists regarding the empirical value of social science in these topics' (Interview 10, VALORADA). In a similar vein a an interview noted: 'A lot of people is comfortable in working with public authorities, but they also need to work with financial entities – and some of them are not so comfortable with this' (Interview 3, CLIMATEFIT).

4.2.5 | Evolving Problem Definitions (F14, New)

Several interviewees reflected on how their project's problem definition evolved over time in response to new insights and external changes. Transdisciplinary initiatives often span many years, during which initial assumptions can change. For example, one interviewee described that in a long-running climate adaptation effort, 'because it's a very long, long-lasting project—almost 30 years—our views on the world are quite different now' (Interview 7, SpongeScapes). In another case, a project that began focused strictly on flood risk later expanded its scope to include drought management, water quality, biodiversity, and even navigation issues as those concerns emerged. This meant reframing the problem to address interlinked issues—prompting

questions such as 'what are the co-benefits, what are the socio-economic benefits or trade-offs that you encounter, how do you finance implementing them and how do you get your stakeholders on board?' (Interview 7, SpongeScapes).

4.3 | Rules

4.3.1 | Formal/Informal Norms (F15)

While recognising the need for formal structures for the management of a large consortium, the interviewees particularly emphasised the importance of informal norms and trust that develop through daily collaboration. Many projects set up formal governance arrangements (steering committees, defined work packages, partner agreements) to delineate responsibilities and accountability relationships. Yet, the interviewees observed that effective collaboration often relies on informal understandings that go beyond the organisation chart. As one interviewee summed up, 'formal project structures and clearly defined tasks coexist with informal norms emerging from practical collaboration and stakeholder interactions' (Interview 9, TransformAr).

4.3.2 | Task Definition (F16)

The interviewees stressed the importance of clearly defining tasks and responsibilities from the start. Breaking the project into specific work packages or thematic tasks helped participants know where to focus and how their expertise contributed as outlined in Horizon projects is defined (European Commission 2021c). Several interviewees described iterative discussions to develop a common understanding of each task or concept in the project—essentially ensuring everyone agreed on definitions and deliverables. Several interviewees explained that for every key concept, the team first had to determine its meaning and ownership: 'Each concept that is in the project must figure out, understand, and develop a common understanding of what this is, and who has to develop it' (Interview 5, IMPETUS). 'Another solution would be to simply give tasks and work packages names that automatically require inter-/transdisciplinarity' (Interview 3, CLIMATEFIT).

4.3.3 | Clear Definition of Roles (F17)

Clear definition of roles and responsibilities was highlighted as a key success factor. Many interviewees described that each partner organisation (or even each key individual) was assigned a specific role—whether as scientific lead, local coordinator, policy liaison, or other. This clarity of roles was seen to have helped prevent confusion and overlap. One interviewee explained: 'Each person has a very defined area of responsibility and tries to involve the other partners in decision-making' (Interview 9, TransformAr). Knowing who is accountable for what allowed experts to take ownership of their work packages while still remaining collaborative. Some interviewees noted that certain roles needed to be fluid and region-specific: 'Every region has a research partner: digital, social, nature-based, policy-making, environmental... Each region has a regional authority or municipality... For the 4 large demonstrators: private companies' (Interview 2, CLIMAS). In all cases, establishing clear accountability and communicating roles to the consortium was seen as essential.

4.3.4 | Innovation in Reward Structures (F18)

The interviewees noted that traditional academic reward systems do not adequately incentivise transdisciplinary collaboration. Innovative reward structures are needed to encourage all partners—especially non-academic ones—to invest time and effort. Some interviewees mentioned trying to acknowledge contributions through means other than scientific publications. For example, they might highlight community partners in project reports or ensure that policy partners receive public recognition. One interviewee argued that funding schemes themselves should 'reward the project with a good representation of social sciences... to ensure better and more effective stakeholder engagement' (Interview 7, SpongeScapes). Another interviewee pointed out that different sectors seek different forms of return: 'Everyone expects some return from these projects. For me, it's publishing; for others, it's getting patents; for others, it's showing the mayor that they're doing a good job – all completely legitimate' (Interview 10, VALORADA).

4.3.5 | Consensus-Building and Conflict Management (F19)

Building consensus among diverse stakeholders and managing conflicts was seen as an inherent part of transdisciplinary projects. The interviewees acknowledged that disagreements are a normal part of project work—whether over priorities, methods, or interpretations of data—and therefore stressed the importance of proactive conflict management strategies. Many projects convened regular dialogue forums (e.g., multi-stakeholder workshops, policy roundtables) specifically to surface and resolve tensions. One interviewee recounted: 'We held several workshops for science–policy dialogue because we had to reach a certain balance and agreement' (Interview 10, VALORADA). Such efforts were designed to help prevent either the scientific or policy perspective from overpowering the other. One researcher cautioned 'you cannot just take something away from someone if you don't give them something in return' (Interview 7, SpongeScapes).

4.3.6 | Recognition of Non-Academic Contributions (F20, New)

A number of interviewees highlighted the importance of formally recognising contributions from practitioners, community members, and other non-academic partners. One project lead described an initiative to valorize local data: 'We wanted to undertake an initiative related to giving value to the data generated by municipalities... these are non-climate data, but they have intrinsic climate value' (Interview 10, VALORADA). The consensus across majority of interviewees was that future TD projects should incorporate more structured ways to credit non-academic expertise—for instance, by citing community

knowledge sources, compensating local experts, or creating joint decision-making roles—to ensure all partners feel their input is respected and impactful.

4.3.7 | Long-Term Conflict Resolution Mechanisms (F21, New)

Beyond managing conflicts during the funded period, the interviewees highlighted the need for mechanisms to resolve disputes that persist or arise persist or emerge after the project ends. Sustainability challenges often involve trade-offs that do not disappear when the project ends—for example, conflicts over resource use or policy decisions may continue in the community. The interviewees spoke of fostering attitudes and processes for 'continuous negotiation' so that stakeholders can keep addressing disagreements constructively on their own. They cautioned against zero-sum approaches to stakeholder relations In line with this, one interviewee stressed, 'it's very important to realise the traditions and the cultural history in the area... farmers may be on a farm, generation upon generation, so you need to really take that into account' (Interview 7, SpongeScapes).

4.4 | Resources

4.4.1 | Material: Funding, Facilities, Time (F22)

Some of the interviewees agreed that adequate material resources—notably funding, physical infrastructure, and personnel time—are fundamental to transdisciplinary success. EU projects typically come with substantial budgets, but the interviewees noted that these resources must be equitably allocated, and even then they often remain insufficient relative to the projects' ambitions. One challenge mentioned was that some crucial stakeholders (such as municipalities or small NGOs) did not receive any direct funding under the project budget, making it hard for them to justify extensive involvement. 'Stakeholders have limited resources, engaging them is difficult' (Interview 2, CLIMAS). This was seen to have created imbalances: well-funded academic partners could dedicate full-time staff, whereas local partners had to participate largely on goodwill. They also pointed out that demonstrating practical benefits is necessary to attract and retain resources. As one interviewee put it, 'adequate resources, including funding and time allocation, are crucial but often challenging; clear demonstration of practical benefits is necessary to justify resource investments' (Interview 9, TransformAr).

4.4.2 | Individual: Time, Knowledge, Skills and Attitudes (F23)

The interviewees identified a suite of individual competences and conditions that influence transdisciplinary collaboration. Participants need sufficient time to engage meaningfully—which is not always the case for busy policymakers or volunteers. They also need the right skills: strong communication abilities, openness to other ways of knowing, mediation and negotiation skills, and a learning mindset. One interviewees emphasised that beyond technical expertise, team members must be willing to step out of their comfort zone: 'it requires openness, it requires going out of your box' (Interview 9, TransformAr). This openness and humility were seen as critical attitudes that enable mutual learning. The data suggest that when participants approached the project with a flexible, learning-oriented attitude (as opposed to a rigid 'expert' stance), the collaboration was perceived as more productive.

4.4.3 | Tools and Methods of Participation (F24)

The interviewees reported using a variety of participatory tools and methods to facilitate stakeholder engagement and co-creation. The choice of tools was often tailored to the audience. For instance, some teams developed very accessible, user-friendly instruments to involve non-experts in planning—one interviewee mentioned using 'Excel files, Gantt charts with activity timelines' (Interview 5, IMPETUS), to help partners visualise activities and progress. Other projects experimented with more interactive decision-support techniques: one interviewee described running 'choice experiments... asking citizens which solution they would choose' (Interview 9, TransformAr), as a way to directly incorporate public preferences into project outputs.

4.4.4 | Sustained Availability of Resources (F25, New)

This factor refers to ensuring that the resources and infrastructure for collaboration persist beyond the initial project funding period. The interviewees noted that short-term grants often build networks and tools that risk disbanding once the money runs out. While this concern was recognised (as also discussed under F7), explicit interview evidence on long-term resource continuity was limited—likely because at the time of the interviews, many projects were still ongoing rather than finished. Nonetheless, interviewees did express hopes and plans for continuity. They mentioned exploring follow-up grants, persuading host institutions to retain project staff, or setting up 'legacy' platforms that could be maintained by local partners.

4.4.5 | Digital Access and Literacy (F26, New)

Finally, the interviewees raised the issue of digital inclusion in transdisciplinary projects. As more engagement moves online (as noted in F8), not all stakeholders are equally able to participate. Some community members lack reliable internet access; others (especially older adults) may not be comfortable with digital tools. One interviewee explained that their project's climate information platform had to accommodate different user capacities: 'the aim is to design these kind of online platforms where people can access data and information about climate change and choose different pathways... to decide how we adapt to certain climate change issues across the different regions of Europe' (Interview 5, IMPETUS). Another described establishing two 'academies' to build capacity: 'two academia... one to spread climate data... at local level... and another digital academy for managing disinformation' (Interview 1, AGORA).

5 | Discussion

Our interviews with EU Horizon 2020 project coordinators confirm the importance of the well-established core principles of transdisciplinary sustainability research (TD)—broad stakeholder participation, knowledge co-production, adaptive governance, and equitable resources. At the same time, the interviewees highlighted how difficult it can be to operationalise these principles on the ground. Simply acknowledging TD principles is obviously not enough. This study contributes new empirical evidence on that translation process, identifying several underexplored dimensions (F5, F7, F9, F13, F20–F21, F25–F26) that complicate or extend the standard TD framework (Table 2). In particular, our findings highlight the importance of equitable dialogue and shared decision-making, iterative integration, tailored communication, flexible governance, and long-term continuity—factors, whose importance has been acknowledged (e.g., the need for credibility, salience and legitimacy) but whose implementation in concrete project settings remains difficult.

Key findings from our analysis can be summarised under six propositions. Our first insight is that TD must move beyond nominal inclusion to genuine equitable dialogue and shared decision-making (F1, F4, F9, F20). Despite diverse representation, a gap persists between 'a seat at the table' and real agency: community partners are commonly relegated to advisory roles and remain subordinate to scientific or institutional authority. Closing this gap requires structures that grant non-academic actors substantive influence—for example, co-designing research agendas and governance rules so that priorities and accountability are jointly defined (F4, F19)—and recognising and rewarding non-academic contributions (F20). This aligns with calls for more inclusive knowledge co-production and suggests that capacity-building should extend to all actors—researchers and policymakers included—to support genuinely collaborative, decision-making authority, responsibilities and recognition are jointly defined and periodically reviewed (Hoffmann et al. 2022; Deutsch et al. 2021).

Second, knowledge integration must be treated as adaptive and iterative rather than a one-off task (F2, F5, F14). While combining scientific, local, and contextual knowledge is fundamental (F2), our interviewees stressed that integration should be periodically revisited as projects evolve. Problem framings and data needs change over time; objectives judged 'settled' may need redefining when new actors join or unexpected evidence emerges—illustrated by a flood-management project that broadened mid-course to address drought (F14). Integration is thus an ongoing negotiation, requiring flexible methods, revisable goals (F5, F6), and funding designs that permit such mid-term recalibration (Powell and Joosse 2024).

Third, effective TD communication demands tailored, audience-specific strategies (F8, F13, F24). Interviewees emphasised that messages must be framed differently for policymakers, communities, businesses, and scientists, and that linguistic, disciplinary, and cultural barriers can hinder mutual understanding (F13). Knowledge brokers and co-creation workshops can help bridge these gaps, while digital tools expand reach yet risk excluding those with poor access or literacy (F8). TD teams should act as facilitators of two-way dialogue, adapting formats—from informal meetings to visual aids and local champions—to ensure that the projects remain salient and legitimate to the various involved and affected parties (F24; Andrews et al. 2024; Mauser et al. 2013).

Fourth, TD governance should be dynamic and reflexive (F15, F19, F21). Clear roles and ground rules at the outset are valuable (F16–F17), yet no single arrangement suffices over long collaborations. As contexts evolve, governance must be recalibrated—for example, reconstituting advisory boards when policy windows open (F6) or establishing ad hoc mediation when tensions arise (F21). Such adaptability maintains legitimacy, trust, and fairness over time, consistent with governance frameworks that advocate periodic review and adjustment (Dedeurwaerdere 2013; Pohl and Hadorn 2007).

Fifth, 'resources' for TD success extend beyond start-up funding and physical and digital infrastructure plus support services, to include continuity, equity, and digital inclusion (F22, F25, F26). The interviewees underscored that continuous access to resources matter as much as total amounts: planning for post-project maintenance of personnel and data (F25), ensuring equitable distribution so that community and NGO partners can participate fully (F22), and addressing digital divides that undermine engagement (F26). This broadens resource considerations beyond tangible inputs (European Commission 2021c; Van Kerkhoff and Lebel 2006), calling on funders for longer-term commitments (Baum and Bartkowski 2020; Overland and Sovacool 2020) and on leaders to integrate capacity-building (skills training, technical support) as core design features rather than optional add-ons.

Finally, our sixth key insight is that transdisciplinary initiatives should be conceived as open-ended, long-term collaborations rather than time-bound projects (F7, F24). Research projects have defined start and end dates. In order to make progress on complex sustainability issues, it is necessary to ensure that partnerships, learning processes and momentum are sustained well beyond a single funding cycle (F7). In practice, this means reframing success not just as meeting short-term project goals, but as fostering enduring networks and capacities that continue to deliver benefits. Embracing a long-term perspective also entails iterative learning, that is, treating each project as part of a continuum of inquiry and action. This mindset resonates strongly with ideas of collective adaptive management and social learning in the sustainability literature. It also dovetails with the 'post-project' sustainability discourse that urges extending the life and impact of project-generated networks and knowledge. By moving away from episodic engagement toward sustained partnerships, TD teams can better navigate emerging challenges and ensure that the solutions and relationships they develop remain relevant and robust over time (Baum and Bartkowski 2020; Overland and Sovacool 2020).

6 | Conclusion

This study examined, from the vantage point of Horizon coordinators, the factors that condition success in transdisciplinary (TD) processes—rather than documenting how TD is operationalised. Drawing on their perceptions and experiences, we

TABLE 2 | Success factors of transdisciplinary success: Summary and new dimensions.

Component		Category	Details
Actors	F1	Participants involved (number and backgrounds)	Broadest possible coalition within boundaries, including scientists, policymakers, businesses, marginalised communities, and local communities.
	F2	Integrated knowledge systems	Diverse perspectives and expertise from stakeholders aiming for a holistic understanding, with scientific, local, and regional contextual knowledge integrated.
	F3	Willingness to participate/ expectations	Driven by win-win outcomes, participation varies depending on the perceived relevance, with ongoing efforts to engage policymakers and build trust with marginalised groups.
	F4	Facilitating equitable dialogue	Strategic selection influenced by power relations and the relevance of expertise, with efforts to decentralise power and include marginalised voices.
	F5	NEW: Feedback mechanisms and iterative learning	Establishing processes for continuous feedback, reflection, and learning throughout the project to adapt strategies and outcomes.
	F6	NEW: Flexibility and adaptability in transdisciplinary methods	Allowing the project to adapt its goals and methods to emerging challenges and the changing needs of stakeholders.
	F7	NEW: Sustainability of collaboration beyond project timelines	Ensuring that collaborative networks and partnerships continue after the formal project period ends.
	F8	NEW: Role of digital tools and technology in facilitating transdisciplinarity	Using digital platforms and technological innovations to enhance communication, collaboration, and engagement with stakeholders.
	F9	NEW: Trust building and relationship development	Fostering trust and relationship building between stakeholders from different disciplines, sectors, and communities to strengthen collaboration.
Discourses	F10	Inter-/multi-/transdisciplinary narratives	Emphasises socially distributed, application-oriented, and transdisciplinary research, balancing scientific, local, and regional contextual perspectives.
	F11	Problem framing and definition	Requires shared problem definitions and inclusion of diverse perspectives, with attention to framing problems for multiple audiences and managing scientific uncertainty.
	F12	Shared problem	Enhances credibility, salience, and legitimacy of produced knowledge by ensuring co-defined, shared problems that evolve over time.
	F13	NEW: Cultural and disciplinary barriers	Navigating communication challenges between different disciplines and sectors to align approaches and methodologies for a unified problem-solving strategy.
	F14	NEW: Evolving problem definitions	Handling shifting priorities and emerging challenges to redefine goals and strategies over the project timeline.
Rules	F15	Formal/informal norms	Clear division of responsibility; transparency concerning the roles of participants, with formal governance structures and informal norms like trust-building emphasised.
	F16	Task definition	Organised reflection on task division, with well-defined roles based on expertise, and some projects allowing flexibility to adapt roles as the project evolves.
	F17	Roles clarity	Essential for effective joint knowledge production, with specialised roles clearly outlined, but more flexibility may be required in political contexts.

(Continues)

TABLE 2 | (Continued)

Component		Category	Details
	F18	Innovation in reward structures	Economic incentives and social recognition used to reward participation; recognition of non-academic contributions is still underdeveloped, especially for communities.
	F19	Consensus-building and conflict management	Mechanisms for ongoing dialogue and workshops help integrate diverse perspectives; there is a need for long-term conflict resolution strategies.
	F20	NEW: Recognition of non-academic contributions	Developing reward systems that recognise local, practical, and social contributions beyond traditional academic metrics.
	F21	NEW: Long-term conflict resolution mechanisms	Establishing conflict management systems that persist beyond the immediate needs of the project, especially in long-term, evolving collaborations.
Resources	F22	Material: funding, facilities, time	Adequate funding and facilities for large-scale projects, but resource equity needs improvement, particularly for marginalised communities.
	F23	Individual: time, knowledge, skills and attitudes	Requires negotiation and mediation skills, along with technical expertise. Time availability varies for policymakers and marginalised groups, who may need more support.
	F24	Tools and methods of participation	Digital platforms and in-person methods are used to ensure stakeholder involvement, but digital literacy and access are barriers for some communities.
	F25	NEW: Resource sustainability and continuity	Ensuring long-term resource availability and maintaining collaboration after project timelines end, with sustained funding and facilities.
	F26	NEW: Digital access and literacy	Addressing the digital divide by ensuring that all participants, especially local communities, have access to and understanding of digital platforms.

Note: Own elaboration.

identified enabling and constraining conditions and translated them into actionable levers for researchers, funders and policymakers. Our analysis confirms the centrality of well-established TD foundations—broad and inclusive participation, robust knowledge integration, and balanced/adaptive governance underpinned by equitable resourcing—and shows that, in practice, these foundations operate as dynamic processes that repeatedly recalibrate five elements across the project life cycle: (1) problem framings; (2) division of roles and responsibilities; (3) equitable dialogue and shared decision-making arrangements (clear rules, spaces and procedures); (4) allocations of time, funds and infrastructure; and (5) success indicators. We further highlight levers that help sustain these dynamics: structured feedback and iterative learning, methodological flexibility, credible pathways for post-project continuity, and the effective use of digital collaboration tools. Taken together, the findings refine TD/JKP frameworks and connect them to the CSL triad by specifying how credibility, salience and legitimacy can be maintained through staged, reflexive design. By answering our question—about leaders' perceptions of success conditions—the study offers concrete guidance for future Horizon programmes and TD teams seeking more durable science–policy–society impact.

Building on our data, three propositions follow. First, collaborations benefit when CSL is pursued concurrently and revisited at milestones, recalibrating what counts as rigorous, relevant and fair as contexts shift (Cash et al. 2003; Lemos et al. 2012). Second, governance is a moving target: leadership, task allocation and conflict handling require periodic adjustment as capacities evolve and policy windows open or close, echoing evaluation work that connects societal effects to process design and adaptation (Hegger et al. 2012; Belcher et al. 2016). Third, resources extend beyond budgets and laboratories to include continuity pathways after the grant, digital access and literacy, and formal recognition of non-academic contributions—extensions consistent with co-creation frames in sustainability science (Mauser et al. 2013).

There is now substantial empirical TD scholarship showing that co-framing, joint knowledge production and structured iteration enhance social robustness, policy relevance and policy uptake (Lang et al. 2012; Hegger et al. 2012; Belcher et al. 2016; Norström et al. 2020; Turnhout et al. 2020; Hoffmann et al. 2022; Lieu et al. 2023; Harris et al. 2024). Our findings extend these strands with success-proximate guidance—embedding feedback loops, methodological flexibility, digital inclusion, post-project sustainability, and fair reward structures for non-academic partners—shifting TD from episodic engagements to ongoing partnerships that can absorb emergent challenges, evolving priorities, and new knowledge across the project lifecycle.

Translating these insights into practice entails institutionalising feedback cycles at decision points to normalise iterative learning and timely course correction; designing boundary work around CSL-oriented facilitation and translation so that credibility (for scientific peers), salience (for intended users/decision settings) and legitimacy (for affected publics) are jointly optimised rather than traded off, using co-defined criteria and regular check-ins at decision points (Cash et al. 2003; Lemos et al. 2012; Norström et al. 2020); and adopting dynamic governance—for example, planned role rotation, decision logs and standing conflict-resolution arrangements—to keep rules and responsibilities fit for purpose (Hegger et al. 2012; Hegger and Dieperink 2014; Belcher et al. 2016). Sustained impact needs post-grant continuity—micro-funds, host-institution commitments, open repositories and hand-off agreements—and recognition of non-academic expertise through authorship, compensation and community-valuing evaluation (Mauser et al. 2013).

Although drawn from Horizon 2020 sustainability projects, these lessons are relevant beyond the EU Evidence reflects leadership perspectives from mainly European H2020 projects based on one-off interviews, so transferability may be constrained. The core levers—equitable dialogue and shared decision-making, role fluidity (rotating key tasks across partners), legacy planning (early decisions on post-project ownership, governance and funding), and equitable resourcing—apply wherever teams co-produce knowledge for action. Implementation will vary with local institutions, but the underlying logic is to treat TD as a living, adaptive process.

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Conflicts of Interest

The authors declare no conflicts of interest.

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Appendix A

TABLE A1 | Success factors identified in the literature and confirmed by the interviews.

Component	Category	Details	References	Justifications
Actors	Participants involved (number and backgrounds)	Broadest possible coalition within boundaries, including scientists, policymakers, businesses, marginalised communities, and local communities.	Lang et al. 2012; Augenstein et al. 2024	Lang et al. (2012) emphasise the importance of involving stakeholders from multiple sectors to ensure the research outcomes are socially robust. Augenstein et al. (2024) highlight that a broad coalition, including marginalised communities, is key to tackling societal challenges.
	Integrated knowledge systems	Diverse perspectives and expertise from stakeholders aiming for a holistic understanding, with scientific, local, and regional contextual knowledge integrated.	Cash et al. 2003; Pohl and Hadorn 2007; Hegger et al. 2012; Mauser et al. 2013	Cash et al. (2003), Pohl and Hadorn (2007) and Mauser et al. 2013 stress the importance of integrating multiple knowledge systems, including scientific and contextual or local knowledge, to ensure holistic understanding. Hegger et al. (2012) add that this is essential for joint knowledge production.
	Willingness to participate/ expectations	Driven by win-win outcomes, participation varies depending on the perceived relevance, with ongoing efforts to engage policymakers and build trust with marginalised groups.	Dedeurwaerdere 2013; Lang et al. 2012; Mauser et al. 2013	Dedeurwaerdere (2013) and Lang et al. (2012) emphasise that stakeholders often engage when they see potential for mutual benefits. Trust-building efforts are particularly important when engaging marginalised groups.
	Boundary work processes	Strategic selection influenced by power relations and the relevance of expertise, with efforts to decentralise power and include marginalised voices.	Gieryn 2002; Hegger et al. 2012; Augenstein et al. 2024	Gieryn (2002) and Hegger et al. (2012) highlight that boundary work often reflects power relations and expertise hierarchies. Augenstein et al. (2024) stress the need to decentralise power and elevate marginalised voices in these processes.
Discourses	Inter-/multi-/transdisciplinary narratives	Emphasises socially distributed and application-oriented balancing scientific, local, and regional contextual perspectives.	Lang et al. 2012; Mauser et al. 2013; Klein 2004	Lang et al. (2012) and Mauser et al. (2013) emphasise that transdisciplinary research should be application-oriented and focus on practical solutions through collaborative knowledge production. Klein (2004) supports this by highlighting how transdisciplinarity requires engaging both scientific and societal actors.
	Problem framing and definition	Requires shared problem definitions and inclusion of diverse perspectives, with attention to framing problems for multiple audiences and managing scientific uncertainty.	Hisschemöller and Hoppe 2001; Pohl and Hadorn 2007; Jahn et al. 2012	Hisschemöller and Hoppe (2001) and Pohl and Hadorn (2007) discuss the importance of developing shared problem definitions that incorporate a wide range of stakeholder perspectives. Jahn et al. (2012) stress the challenge of managing uncertainty in problem definitions.
	Shared problem	Enhances credibility, salience, and legitimacy of produced knowledge by ensuring co-defined, shared problems and stakeholders perspectives that evolve over time.	Cash et al. 2003; Lang et al. 2012; Hegger et al. 2012	Cash et al. (2003) and Lang et al. (2012) argue that shared problems enhance the credibility, salience, and legitimacy of knowledge. Hegger et al. (2012) stress the importance of continuous engagement with stakeholders to maintain relevance throughout the project.

(Continues)

TABLE A1 | (Continued)

Component	Category	Details	References	Justifications
Rules	Formal/informal norms	Clear division of responsibility; transparency concerning the roles of participants, with formal governance structures and informal norms like trust-building emphasised.	Pohl and Hadorn 2007; Driessen and Vermeulen 1995	Pohl and Hadorn (2007) highlight that both formal structures and informal norms, such as trust-building, are necessary for successful transdisciplinary collaborations. Driessen and Vermeulen (1995) emphasise the need for clear responsibilities and transparency among participants.
	Task definition	Organised reflection on task division, with well-defined roles based on expertise, and some projects allowing flexibility to adapt roles as the project evolves.	Pohl and Hadorn 2007; Dedeurwaerdere 2013	Pohl and Hadorn (2007) stress that well-defined roles are crucial for effective collaboration, but flexibility is also needed as projects evolve. Dedeurwaerdere (2013) notes that adaptive task management is necessary for complex transdisciplinary projects.
	Roles clarity	Essential for effective joint knowledge production, with specialised roles clearly outlined, but more flexibility may be required in political contexts.	Hegger et al. 2012; Cash et al. 2003	Hegger et al. (2012) argue that well-defined roles are key to joint knowledge production, while Cash et al. (2003) highlight the need for role flexibility, especially in politically sensitive contexts.
	Innovation in reward structures	Economic incentives and social recognition used to reward participation; recognition of non-academic contributions is still underdeveloped, especially for communities.	Mauser et al. 2013; Augenstein et al. 2024	Mauser et al. (2013) discuss how economic incentives and social recognition are crucial for motivating stakeholders. Augenstein et al. (2024) emphasise the need for more inclusive reward structures that recognise non-academic contributions, particularly from communities.
	Consensus-building and conflict management	Mechanisms for ongoing dialogue and workshops help integrate diverse perspectives; there is a need for long-term conflict resolution strategies.	Driessen and Vermeulen 1995; Pohl and Hadorn 2007	Driessen and Vermeulen (1995) and Pohl and Hadorn (2007) highlight the importance of workshops and continuous dialogue for building consensus and managing conflicts in transdisciplinary projects. Long-term strategies are needed to address ongoing challenges.
Resources	Material: funding, facilities, time	Adequate funding and facilities for large-scale projects, but resource equity needs improvement, particularly for marginalised communities.	European Commission 2021c; Van Kerkhoff and Lebel 2006	The European Commission (2021c) sets guidelines for providing sufficient resources in large-scale projects like Horizon Europe, but Van Kerkhoff and Lebel (2006) point out that resource equity remains a challenge, especially for marginalised communities.
	Individual: time, knowledge, skills and attitudes	Requires negotiation and mediation skills, along with technical expertise. Time availability varies for policymakers and marginalised groups, who may need more support.	Hegger et al. 2012; Pohl and Hadorn 2007	Hegger et al. (2012) highlight the need for strong negotiation skills in transdisciplinary research, while Pohl and Hadorn (2007) emphasise that time availability varies, particularly for policymakers and marginalised groups.
	Tools and methods of participation	Digital platforms and in-person methods are used to ensure stakeholder involvement, but digital literacy and access are barriers for some communities.	Cash et al. 2003; Schneider et al. 2019	Cash et al. (2003) discuss how digital platforms can facilitate stakeholder engagement, but Schneider et al. (2019) caution that digital literacy and access remain significant barriers for some communities.

Appendix B

Interview Protocol

Transdisciplinary Dialogues

- What is your background?
- Is the natural/social sciences gap among your research interests?
- Do you have previous experience from transdisciplinary projects or is this your first one?
- What kind of different backgrounds do the people in your project represent (different disciplines, academics/non-academics, professional or national cultures and practices)?
- What do you do in practice in your project to foster transdisciplinarity (any specific measures)?
- What helps/prevents transdisciplinary work in your project (drivers and barriers)?
  - What kind of difficulties have you experienced (e.g., to understand others or to be understood by others)?
- Individually, have you learnt something new (new understandings, ways of doing things)?
- How, if in any way, does this transdisciplinary work manifest itself in outcomes from your project, for example in publications, in the ways in which stakeholders and academics interact, in novel organizational practices and structures?
- How to further enhance transdisciplinarity in your project?