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SHAPE-ID: Shaping Interdisciplinary Practices in Europe

Deliverable 4.2 Draft System of Preconditions for Successful Arts, Humanities and Social Sciences Integration

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Author(s)	Keisha Taylor-Wesselink (TCD), Doireann Wallace (TCD)
Contributors	Jane Ohlmeyer (TCD), Caitriona Curtis (TCD), Catherine Lyall (EDIN), Isabel Fletcher (UEDIN), Bianca Vienni Baptista (ETH Zurich), Christian Pohl (ETH Zurich), Sibylle Studer (ETH Zurich), Jack Spaapen
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2.0	11/01/21	Keisha Taylor-Wesselink, Doireann Wallace	Revised draft incorporating Expert Panel feedback, classifications literature review and new results from WP3
3.0	21/01/21	Keisha Taylor-Wesselink, Doireann Wallace	Revised draft following extensive partner feedback
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Partners

Partner	Short name	Principal Investigator
The Provost, Fellows, Foundation Scholars & the Other Members of Board of the College of The Holy & Undivided Trinity of Queen Elizabeth Near Dublin	TCD	Professor Jane Ohlmeyer
Istituto di Studi per l'Integrazione dei Sistemi (I.S.I.S) - Societa'cooperativa	ISINNOVA	Mr Carlo Sessa
Eidgenoessische Technische Hochschule Zuerich	ETH Zürich	Dr Christian Pohl
The University of Edinburgh	UEDIN	Professor Catherine Lyall
Instytut Badan Literackich Polskiej Akademii Nauk	IBL PAN	Dr Maciej Maryl
Dr Jack Spaapen		

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Abbreviations

AH – Arts & Humanities

AHSS – Arts, Humanities and Social Sciences

ALLEA – the European Federation of Academies of Sciences and Humanities

CHCI – Consortium of Humanities Centres and Institutes

CLARIN – European Research Infrastructure for Language Resources and Technology

COST – European Cooperation in Science and Technology

DARIAH – Digital Research Infrastructure for the Arts and Humanities

EC – European Commission

H2020 – Horizon 2020

IBL PAN – Institute of Literary Research, Polish Academy of Sciences (partner)

ID – interdisciplinary

IDR – interdisciplinary research

LERU – League of European Research Organisations

SSH – Social Sciences & Humanities

STEM – Science, Technology, Engineering and Mathematics

STEMM – Science, Technology, Engineering, Mathematics and Medicine

TD – transdisciplinary

TDR – transdisciplinary research

UBIAS – University-based Institutes of Advanced Studies

WP – Work package

YERUN – Young European Research Universities Network

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Executive Summary

SHAPE-ID is a Coordination and Support Action funded by the European Commission, which aims to improve the integration of Arts, Humanities and Social Sciences into interdisciplinary research (IDR) and transdisciplinary research (TDR). The project began with a number of activities intended to gather understandings and insights on best practices, barriers and enablers of IDR/TDR. We conducted an extensive review of academic and policy literature, surveyed interdisciplinary researchers across Europe, and organised a series of six learning case workshops (three in-person and three online) to learn from the experiences of researchers, funders, policymakers, decision-makers in higher education and representatives of other sectors that participate in and co-create research: industry, civil society and the cultural sector. Results from these activities will inform the final project output – a toolkit and recommendations to improve pathways to AHSS integration for each of these groups.

As an intermediate step, we undertook to establish a working system of preconditions for AHSS integration, using the outputs of the evidence-gathering phase: reports and a policy brief based on the literature review, survey and interviews (Work Package 2); and reports and a policy brief based on the learning case workshops (Work Package 3). The purpose of this task was, firstly, to synthesise results from the project and provide an organised point of access to what we have learned about the preconditions for good AHSS integration. Secondly, our goal was to derive recommendations based on this synthesis for initiating the processes of change needed to move towards improved interdisciplinary integration among the AHSS disciplines and between AHSS and Science, Technology, Engineering, Mathematics and Medicine (STEM) disciplines. A draft system of categories was presented to the SHAPE-ID Expert Panel in November 2020 and their feedback has informed this revised document. That feedback and the current document will inform the development of the SHAPE-ID toolkit.

In this document we begin with a discussion of the challenge of creating a system of categories adequate to such a complex domain, with reference to the project's findings and a review of previous classifications of various kinds for interdisciplinarity (ID) and transdisciplinarity (TD). These are complex concepts and practices with contested definitions and multiple histories across different geographical regions – as are disciplines themselves. Furthermore, as our findings have reinforced, the challenge is compounded by the need to account for multiple stakeholders, levels of activity ranging from the individual to the research and innovation system in its totality (including its intersection with societal challenges and policy priorities) and the fact that different challenges arise at different phases of planning, developing and evaluating funding programmes and individual research projects. We recognise that just as no single definition is adequate for such a complex set of

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practices, there can be no single system of categories that exhaustively maps the relevant actors, relationships and processes. Any system of categories is necessarily provisional. However, this system of preconditions contributes to existing IDR/TDR knowledge by increasing understanding of the challenge of integrating the Arts, Humanities and Social Sciences (particularly the underrepresented Arts and Humanities) for IDR/TDR and how they can be supported for better outcomes.

We propose a system of preconditions for AHSS integration based on a mapping of the SHAPE-ID findings and further informed by a thematic classification derived from a review of the existing literature on classifications of IDR/TDR.

These preconditions fall into three broad categories:

1. Structural factors supporting AHSS integration, including research policy and funding and institutional supports;
2. Competencies and attributes necessary for AHSS integration, such as individuals' attitudes and skills acquired through practical experience or training in IDR/TDR as well as disciplinary training;
3. Cross-cutting categories that underpin and connect the first two categories, for instance through improving shared understandings of IDR/TDR, clarifying partner roles and relationships in an IDR/TDR project and creating collaborative conditions.

Informed by this classification, the SHAPE-ID toolkit will offer practical recommendations and guidance for different users in achieving more successful AHSS integration.

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1 Introduction

1.1 Scope and objectives

The overall objectives of Work Package 4 (WP4) are to develop a working system of preconditions for successful inter- and transdisciplinary research with AHSS integration (hereafter, preconditions for integration), which will inform the development of a project toolkit in Work Package 5 (WP5). This system of preconditions was developed through mapping and synthesising the outputs of Work Package 2 (WP2) (reports and a policy brief based on the literature review, survey and interviews) and Work Package 3 (WP3) (reports and a policy brief based on the series of six learning case workshops conducted across Europe). A draft version was presented to a panel of experts who have advised on refining and improving its structure and contents.

We initially described this work as the creation of a "draft taxonomy of AHSS integration modalities providing a shared language of assessment" (SHAPE-ID, 2018). In the course of the project, we have concluded that this language risks oversimplifying a highly nuanced, multi-dimensional system that is not, ultimately, reducible to a single taxonomic structure. WP2 produced largely theoretical findings on understandings of IDR/TDR and factors for success or failure. WP3 sought to validate (or augment) these findings empirically through consultation with expert stakeholders, including researchers, policymakers, funders, representatives of higher education institutions and other sectors such as industry, the cultural sector and civil society. WP4 aimed to synthesise these findings to determine the preconditions for successful IDR/TDR, taking into account the complexity of the research and innovation system and the multitude of stakeholders involved in such processes.

To inform the development of this system of preconditions for integration, a preliminary review was undertaken of the academic literature presenting relevant classifications, taxonomies, typologies and frameworks for interdisciplinarity, transdisciplinarity and AHSS integration. This was intended to build on the more extensive literature review undertaken in WP2 and identify the focus and purpose of existing classifications to contribute to identifying gaps in our own efforts. Following this, the reports produced by SHAPE-ID were reviewed closely and their findings mapped carefully and iteratively to develop a comprehensive set of categories, which was refined and revised as new findings emerged. An initial draft was presented for feedback to the SHAPE-ID Expert Panel in November 2020 and the present version has been revised following feedback from this expert group. A first draft of the system of preconditions has also served as an input to an internal Facilitated Outcomes Workshop in December 2020, organised to review and agree project findings and plan the toolkit, and to the development of the SHAPE-ID toolkit.

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This document presents the system of preconditions with an overview of how they were developed.

- In the following two sections (Section 1.2 and Section 1.3) we discuss our understanding of "AHSS integration modalities", unpack some of the complexities inherent in the concept, then explain our approach to creating a system of preconditions for AHSS integration based on project findings.
- Section 2 presents a brief overview of the methodology used to conduct the literature review of existing classifications and the synthesis of project findings undertaken to arrive at the final system of preconditions.
- Section 3 summarises the findings of the literature review, outlining five main themes identified in the literature.
- Section 4 presents a detailed account of the system of preconditions for AHSS integration, with a longer list of terms under each broad category heading and a short explanatory text description for each.
- Section 5 draws conclusions and outlines how the system of preconditions informs the development of the toolkit in WP5.

1.2 AHSS integration modalities

SHAPE-ID aims to learn from experiences of IDR/TDR to inform the creation of better pathways for what the European Commission (EC) calls Social Sciences and Humanities (SSH) integration. We use the alternative term "AHSS integration" to include the Arts and foreground the Arts and Humanities, as both are currently significantly underrepresented in efforts to increase such integration. For the EC this has been a cross-cutting concern in its Horizon 2020 funding framework programmes, acknowledging the need for AHSS perspectives in topics across work programmes, such as health, energy, security, Information and Communications Technology (ICT) and food. For the purposes of Horizon 2020 the EC define SSH integration as "contributions from SSH disciplines" (European Commission, 2021, p. N/A) and define interdisciplinarity (following the US National Academy of Sciences) as "the integration of information, data, techniques, tools, perspectives, concepts or theories from two or more disciplines", noting that projects may also "need to integrate knowledge from stakeholders beyond academic disciplines, for example, from farmers, patient groups or consumer organisations." (European Commission, 2019) The latter is often termed transdisciplinary research (TDR) (although definitions, discourses and understandings of the terms vary). However, the EC do not define TDR for Horizon 2020.

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In its simplest sense, we understand "AHSS integration modalities" to mean ways of integrating AHSS disciplines in IDR/TDR. However, our research (Vienni Baptista et al., 2020a) has found that each of these terms opens up its own complexities:

- Internal differences in the AHSS: AHSS as a label covers diverse disciplines and disciplinary groupings which are unevenly oriented towards and involved in collaborative research and challenge-oriented research. For instance, the EC's own monitoring reports of projects funded under calls seeking an "SSH" contribution in Horizon 2020, find that Economics, Business, Marketing, Political Science, Public Administration and Law, between them constitute over 50% of participation from the overall "SSH" grouping, with "Humanities, the Arts" at 5-6% and individual Humanities disciplines even lower (Kania & Bucksch, 2020; Kania, Lemaire, & Swinnen, 2019)

- Plural definitions of IDR/TDR: Interdisciplinarity and transdisciplinarity are defined in a variety of ways, which vary historically and by geographical region. The differences between them are not always easy to untangle (Vienni Baptista, Fletcher, et al., 2020).

- Integration and Collaboration: Integration is not the only way disciplines can combine within a collaborative project. There are forms of collaboration between disciplines that do not require methods, concepts or knowledge from different disciplines to be integrated but where partners can work separately on different challenges, as in multidisciplinary research. Similarly, there are forms of interdisciplinarity that do not involve collaboration, as when methods, concepts or knowledge are "borrowed" or adopted to enrich one discipline without collaborating with experts from another discipline.

- Disciplinary Bias: Integration itself can have unwanted connotations of unilateral assimilation into a dominant (disciplinary) culture. The research and innovation policy landscape is marked by a tendency to prioritise (even a bias towards) STEMM disciplines (Spaapen, Vienni Baptista, Buchner, & Pohl, 2020) and a narrow conception of impact focused on economic impact (Koenig, 2019). Particularly when we speak of AHSS integration, we must be clear that negotiation, parity and avoiding tokenism are paramount if we are to avoid the too-common assumption that AHSS disciplines should perform "subordination-service" roles in projects (Barry, Born, & Weszkalnys, 2008) conceived of and led by STEMM disciplines.

- Lack of Shared Understanding: The bodies of literature on IDR/TDR and AHSS integration are largely separate. The academic literature on interdisciplinarity and transdisciplinarity often does not take AHSS into account specifically, while the policy literature that advocates for AHSS integration often does not define it or propose how it can be done. This has the added implication

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that far more research is still needed to understand how IDR/TDR teams with AHSS partners work in practice.

AHSS or SSH integration is still a useful term due to its familiarity in policymaking and embeddedness within EC research and innovation policy discourse. However, we must understand it not simply as a "contribution" from AHSS disciplines to STEMM-led projects, but as an active process. **Integration expertise** is needed alongside disciplinary expertise (Bammer, 2007). Further, widespread cultural change is needed within educational and research institutions, funding bodies and at policy level. This change is needed to overcome inherent disciplinary biases, resistances and asymmetric power relations (Barry & Born, 2013) and bring about the conditions for successful AHSS integration.

1.3 Preconditions for AHSS integration

IDR/TDR is undertaken by diverse individuals and teams, from many different disciplines and sectors, and takes place within the broader context of research and innovation policy priorities, funding supports and institutional cultures and structures that determine how researchers are educated, trained, hired, evaluated and promoted. In recognition of this complexity, SHAPE-ID has identified four key stakeholder groups to engage with through the project: policymakers and funders; researchers; research performing organisations; and research users and co-creators from other sectors.

The SHAPE-ID literature review (Vienni Baptista, Fletcher, et al., 2020) found 25 separate factors that can influence the success or failure of IDR/TDR projects. These ranged from individual attitudes, values and motivations, to interpersonal competencies, disciplinary cultures (including ontological, epistemological, axiological and political differences, as well as power imbalances, biases and academic tribalism) and the broader societal and institutional structures that underpin them (including educational institutions, funding agencies and policy contexts). No single factor was found to be "most important"; rather, there is a complex set of interrelated factors operating at different levels (individual, team, institutional, societal) and according to different time scales (for instance, career stage and research project phase). Based on a synthesis of the results of WP2 and WP3, we have organised the preconditions for successful AHSS integration into the following broad categories:

1. **Structural factors:** appropriate institutional and financial supports for IDR/TDR are essential enabling factors. Active commitment to change processes on the part of research performing organisations, funding agencies and policymakers is necessary to overcome disciplinary silos and biases and build capacity for robust IDR/TDR partnerships with meaningful AHSS integration.

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2. **Competencies and expertise:** In practice, individual attitudes and motivations, as well as specific integration expertise, AHSS disciplinary expertise and stakeholder expertise, are important enabling factors in undertaking successful IDR/TDR.

3. **Cross-cutting factors:** IDR/TDR practice and supports are influenced by different understandings of IDR/TDR, research life cycle phases, the multiple ways that IDR/TDR can be developed and the roles and relationships partners enter into. WP2 found a lack of shared understanding between different communities (academic and policy) and we know that arriving at shared goals and understandings is an important factor in successful collaborations. We therefore maintain that greater shared understanding is needed to support a sustainable culture of IDR/TDR. Furthermore, awareness of the different kinds of collaborative relationships partners enter into and the roles they play is important in addressing a tendency towards supplementary or tokenistic roles for AHSS disciplines in STEMM-led projects.

We combine this synthesis of SHAPE-ID empirical findings with insights from the WP4 literature review (see Section 3) and use this to further develop these three broad preconditions for integration into a series of more detailed schema (Section 4). These schema underpin the architecture for the SHAPE-ID toolkit (WP5) which will develop concrete guidance, with links to tools, resources, self-reflection checklists, etc. to help stakeholders develop pathways to better AHSS integration based on their practical needs.

2 Methodology

2.1 Overview

The work was undertaken in a number of stages, some synchronous and iterative:

1. Conducting a literature review to identify and analyse existing classifications relevant to creating a system of categories for AHSS integration modalities. From this we produced a synthesis of the main themes in this literature, which we refer to hereafter as the "thematic classification".

2. Open coding of available SHAPE-ID outputs (Glaser & Strauss, 1967) followed by focused coding (Gioia, Corley, & Hamilton, 2012) to identify key issues as well as analyse and synthesise findings across activities and Work Packages. This, in an iterative relationship with steps 3-5, has informed the production of what we term the "empirical classification" of preconditions for AHSS integration.

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3. Creation of a draft set of categories and definitions based on coding and analysis of SHAPE-ID findings, using a framework matrix method (Ritchie & Spencer, 1994; Ritchie, Spencer, & O' Connor, 2003).

4. Revision and refinement of these terms, categories and definitions with feedback from other partners to create a draft system of preconditions, which was shared with the SHAPE-ID Expert Panel for feedback.

5. Ongoing review and refinement of draft system of preconditions in light of Expert Panel feedback, partner feedback and the availability of new results from SHAPE-ID activities. This process led to the categories being reorganised to focus more clearly and explicitly on how each category constitutes a precondition for better AHSS integration.

2.2 Literature review

The development of the SHAPE-ID system of categories was informed by extensive preliminary research into the scientific literature classifying aspects of IDR/TDR. This aimed to provide insight into the kinds of classification systems, including frameworks, typologies and taxonomies, that have been developed, including their main concepts, purposes and focus areas.

2.2.1 Data Collection

A substantial database of literature on IDR/TDR was compiled for WP2 (see Vienni Baptista et al., 2019) and this formed the starting point for a separate review focusing specifically on efforts to create classifications for IDR/TDR that include AHSS disciplines. For the purposes of this research classification is understood as both "the system or process of organising objects of interest and the organisation of the objects according to a system" (Nickerson, Varshney, & Muntermann, 2013, p. 388); in other words, both the *process* of classifying and the classification produced as a result of this process. Thus, papers were reviewed that either engaged in classification as an activity or produced some kind of classification, or both.

The WP2 databases comprised 3,910 academic papers compiled from Scopus, Web of Science, JSTOR and other sources, as well as 95 grey literature papers. This was supplemented by a further search for literature that included the terms framework, typology, classification, taxonomy or ontology alongside terms related to interdisciplinary and transdisciplinary research and Arts, Humanities and Social Sciences was carried out using Scopus, Web of Science and Google Scholar, resulting in an additional 30 articles. Articles were reviewed and shortlisted if they met the following criteria:

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1. Aimed to classify aspects of IDR/TDR practice or process (for example, through the creation of frameworks, typologies or taxonomies);
2. Allowed for broad rather than very specific application (e.g. they were not narrowly focused on one discipline but were broadly applicable);
3. Sought to go beyond simple classifications (e.g. simply distinguishing between multi-, inter and transdisciplinarity).

Papers were also included that did not explicitly meet these criteria but that reviewed existing classification systems or engaged in classification activities without explicitly describing their intentions in these terms (for instance, organising IDR/TDR activities into categories or types).

On the basis of this review, 81 articles were selected for analysis.

2.2.2 Data analysis

Once identified, these 81 articles were reviewed and analysed through a process of conceptualisation. This refers to the process used to define what terms (such as concepts and words) mean in existing research in a certain field of research, which provides a foundation for common agreement on varied conceptualisations in that field (Allen, 2017). These articles were critically reviewed to identify the types of concepts prioritised within such classification systems, to allow for common understanding of how terms and issues are framed to provide new insight (Allen, 2017). This process led to the creation of a thematic classification based on an analysis of the classifications in the literature.

The following methodology allowed for a streamlined process of identifying, analysing and synthesising concepts in each article:

1. Guidelines were created to aid the identification of concepts within the classifications (Aurini, Heath, & Howells, 2016).
2. The main concepts identified in each article were identified, described and documented in tabular form.
3. Where there were similarities between classification systems these were explained, identified and described within the table.
4. Finally, five themes were identified as best capturing concerns most prevalent across the bulk of the literature. These are explained in detail in Section 3. This fivefold thematic classification based on the review of classification literature was used to provide a comparative theoretical backdrop

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for the development of the SHAPE-ID system of preconditions for integration, which were developed primarily from mapping and synthesising SHAPE-ID findings (as outlined in Section 2.3).

2.3 Developing the system of preconditions for integration

The development of the SHAPE-ID system of preconditions involved the following process:

1. Qualitative coding of SHAPE-ID project outputs was undertaken, using NVivo© computer-assisted qualitative data analysis software. Initially an open-coding approach was used to map challenges and recommendations that had been identified in the reports (Glaser & Strauss, 1967).

2. A detailed index of the reports was created as an internal reference document, linking each term to selected extracts from the reports.

3. Terms were clustered into a smaller set of categories, with accompanying descriptions, using a framework methodology.

4. The SHAPE-ID categories and descriptions were compared with the thematic classification derived from the classifications literature review, which were used as a theoretical backdrop and helped to refine categories and descriptions (see Section 3.6 below for more detail).

5. The terms, descriptions and categories were reviewed, refined, re-clustered and re-named, with a short explanation added for each, for clarity. This was shared with partners and the SHAPE-ID Expert Panel for feedback.

6. This was iteratively revised and refined on the basis of the feedback from the Expert Panel and SHAPE-ID partners. Existing categories were used where appropriate and new terms were added where necessary.

The criteria for developing this system of preconditions were that it should:

- be stakeholder-focused;
- make recommendations for preconditions where possible;
- be jargon-free;
- capture key insights from the project in a concise yet comprehensive manner;
- use as few terms as possible and as many as necessary to meet these criteria.

Efforts have been made to keep redundancy between categories to a minimum but in some cases the same issues arise in different contexts for different stakeholder groups. The categories and a brief

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explanation of each are presented in Section 4 below. The system of preconditions constitutes a new classification based on the SHAPE-ID findings.

3 Findings from the review of classifications in the literature

Our review of selected literature engaged in classification activities found that many such efforts do not define what they mean by the various classification-related terms they use. Klein (2010) explains this lack of clarity, pointing out, for example, that "the terms 'typology' and 'taxonomy' are often used interchangeably, but typology is technically conceptual in nature and 'taxonomy' is an empirical ordering based on measurable characteristics" (Klein, 2017, p. 31). It should also be noted that many of the classifications reviewed did not usually explicitly reference AHSS disciplines, but instead took a generic approach or included specific AHSS disciplines, for example from the Social Sciences and to a much lesser extent the Arts and Humanities.

Our review of the literature identified some commonality in the ways various researchers conceptualise IDR/TDR in their classifications and we were able to identify five common themes:

1. Boundary Crossing and Levels of Integration;
2. Degree of Discipline/Actor Similarity, Variety and Balance;
3. Intrinsic/Extrinsic Motivations and Societal Impact;
4. Complex Relationships, Systems and Contexts;
5. Research Life Cycle.

Some researchers focus on one of these themes, while others include all five in their model. These themes are therefore not mutually exclusive. Each theme is discussed in more detail below.

3.1 Boundary Crossing and Levels of Integration

One common theme was levels of boundary crossing or integration between disciplines, with authors focusing on how these result in different kinds of IDR/TDR processes or practices. Levels of integration can range from very low, as in multidisciplinary research, to the kind of deep integration that can lead to new hybrid disciplines (Aboelela et al., 2007; Huutoniemi, Klein, Bruun, & Hukkinen, 2010; Karlqvist, 1999; Klein, 2017). Most influential here is Klein's seminal work on creating a taxonomy, or typology, of interdisciplinarity (ID). Klein (2010, 2017) extensively mapped prior efforts to classify IDR and TDR to create an overall conceptual system describing the characteristics of different kinds of ID, from multidisciplinary approaches that juxtapose or collate different disciplinary approaches or perspectives (low integration) through interdisciplinary approaches that involve more "proactive" interactions between the theories and methodologies of different disciplines, to the more systematic

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and transformative integration involved in some conceptions of transdisciplinarity. Other important distinctions include factors that go beyond the level of integration. For instance, the distinction between "instrumental" and "critical" ID relates to the question of motivations (Klein, 2017, p. 22).

The concepts of multi-, cross-, inter- and trans- disciplinarity have influenced a step or phased approach to IDR research. Some consider how researchers develop IDR/TDR by moving from a focus on just one disciplinary perspective to including more than one disciplinary approach (Klein, 2017); (Huutoniemi et al., 2010). This can occur unevenly within a given project with the integration of different features of participating disciplines. For example, epistemologies may be integrated, but a method may be borrowed from another discipline without any integration. This decision is often based on the needs of the project and the motivations of those involved.

Knowledge is not simply transferred but when exchanged becomes assimilated into researchers' or stakeholders' knowledge frameworks, resulting in new knowledge, perspectives and methods (Klein, 2017). Klein also refers to this process of integration as boundary crossing (Klein, 2017) and notes that it is not only a linear but a non-linear process. Other work also recognises that interpersonal, intrapersonal and interactional skills are required to effectively engage in boundary crossing or discipline integration skills needed to manage the team and project (Bammer, 2019; Bruhn et al., 2019; Carr, Loucks, & Blöschl, 2018; Hall et al., 2008; Huutoniemi et al., 2010; Mansilla, Lamont, & Sato, 2016; Stokols et al., 2003).

3.2 Degrees of Discipline/Actor Similarity/Difference, Balance and Variety

Another important theme emerging from the classification literature review is the degree to which participating disciplines are informed by different epistemologies, roles, methods, data and institutional structures. This disciplinary distance is captured in the concepts of "broad" and "narrow" ID (Newell, 1998, cited in Klein, 2010). As Klein summarises, *"Narrow ID"* occurs between disciplines with compatible methods, paradigms and epistemologies, such as history and literature", while "*Broad* or *Wide ID* […] occurs between disciplines with little or no compatibility, such as sciences and humanities" (Klein, 2010, p. 18).

Understanding of these degrees is especially important for research projects including both STEMM and AHSS disciplines because of the greater distance between partners (Barry & Born, 2013). Some researchers consider epistemology (Miller et al., 2008; Tobi & Kampen, 2018). Others examine the degree of similarity and differences of disciplines and stakeholders based on epistemology, methods, data and theory, for example (Klein, 2017; Wagner et al., 2011). Both the level of variety and balance of disciplines (Wagner et al., 2011) and stakeholders (Bunders et al., 2010, p. 134) are also considered

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in classifications. Wagner et al. (2011) offer a useful illustration of this category with a classification that explains the importance of having the right balance of disciplines involved in IDR/TDR. Their work accounts for the need to identify the degree of similarity, difference, balance and variety of disciplines in a project.

However, some classifications, depending on their objectives, may focus on identifying the types of skills and roles that may be needed, by researchers (König, Diehl, Tscherning, & Helming, 2013) as well as other stakeholders (de Oliveira, Amaral, & Pacheco, 2019; Lang et al., 2012). Skills may also be independent of the disciplines or actors involved. König et al.'s (2013) competing values framework is especially interesting because it maps general roles independent of disciplines, related to team development (mentor, facilitator, coordinator and monitor) as well as the creation of a more open system for IDR (innovator, broker, producer, director). In this framework the support that is need for a balance between order and spontaneity is considered in the context of IDR integration Barry et al. (2008) include artists, policy makers and businesses, among others, to map not just what stakeholders are involved but how they may influence the IDR process even when they are not involved in a specific project.

3.3 Intrinsic/Extrinsic Motivations and Societal Impact

Another important theme in the classification literature relates to the motivations of those involved in the project, which determines what is done (Stokols et al., 2003). This also relates to emotional and cognitive influences (Mansilla et al., 2016). Work addressing this theme consider intrinsic motivations related to the desire to break new ground in research and advance the state of the field (Klein, 2010) and extrinsic motivation related to macro influences such as funding and policy factors that often drive a demand for research with wider societal impact (Barry & Born, 2013). Some work provides problem solving guides, which aim to improve the potential for societal impact from the research (Bergmann & Jahn, 2017; Pohl, Truffer, & Hirsch-Hadorn, 2017).

It is important to recognise the importance of extrinsic influences on IDR/TDR, such as external funding and institutional structures. This is clearly seen with the way funding agencies have begun to prioritise societal impact (Efstathiou, 2016), for example, those specific to the Sustainable Development Goals (United Nations, 2020), or, the related EU Societal Challenges (European Commission, 2020) or emerging Mission-Oriented Research and Development paradigm (Mazzucato, 2018). It is worth noting that science disciplines received 70% of funding for research and development in 18 EU countries in the OECD. AHSS disciplines received 25% but Social Science disciplines received 1.5 times more funding than the humanities in most countries (Clarke, 2019).

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Other authors also consider the importance of IDR/TDR context for improving policy and addressing societal ills (Bammer et al., 2013; Pohl et al., 2017; Weyrauch & Echt, 2018).

3.4 Complex Relationships, Systems and Contexts

Many papers reviewed focus on the importance of understanding IDR/TDR as existing within and being influenced by complex relationships and dynamic systems and contexts. Political and economic context as well as institutional contexts are considered important (Barry & Born, 2013; Fazey et al., 2018; O'Rourke, Crowley, & Gonnerman, 2016). These connect with other factors such as individual cognition and emotions (Mansilla et al., 2016) as well as disciplinary contexts related to ontologies and epistemologies (Barry & Born, 2013; Huutoniemi et al., 2010). Here, the interaction within the whole complex system can support a better understanding of each component within it.

For example, Bammer (2005) identifies Theoretical and Methodological Pillars which consider context and relationships and applies theoretical principles such as Systems Thinking. Bruun, Hukkinen, Huutoniemi, and Klein (2005) argue that IDR/TDR consists of links between disciplines that continually multiply and grow. The framework of Constellation Analysis developed for IDR/TDR on technology, sustainability and innovation (Ohlhorst & Schön, 2015) provides a way of studying phenomenon through the adoption of different perspectives and approaches.

Physical location may inhibit collaboration between certain disciplines and support collaboration with others (Lyall, 2019), and may explain the type of academic culture and individual thinking (Apter, 2009) that is required to support IDR/TDR (Bruun et al., 2005; Mansilla et al., 2016). Building on existing methods of understanding relationships between components in the research cycle, with the individual and the wider environment, can prove useful.

3.5 Research Life Cycle

Addressing various stages of a research cycle is a common feature across much of the literature reviewed. Some work attempts to cover the entire research project life cycle in a broad way ((Bergmann et al., 2012; Carew & Wickson, 2010; Hall, Stipelman, Vogel, & Stokols, 2017; Lang et al., 2012; Muhar & Penker, 2018; O'Rourke, 2017), while others focus on specific elements, such as programme design (Tobi & Kampen, 2018) team development (Colarelli O'Connor, Rice, Peters, & Veryzer, 2003) or project evaluation (Carew & Wickson, 2010; Carr et al., 2018). Much of this work identifies the components and structures in the research cycle that could influence the process and development of IDR/TDR within each stage. This can include the institutional structures, management, administration, research procedures (for example, the identification of the research

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problem, methods used etc.), funding requirements, as well as the outputs like reporting and publications.

Several authors consider certain research cycle components; for example, the way a team may work together (Hall et al., 2017). Carew and Wickson (2010) present a framework for IDR/TDR by developing an adaptable *heuristic* or graphic called the *Transdisciplinary* or *TD Wheel (TDW)* that incorporates three stages and can be used throughout the research cycle process. It considers the importance of the research cycle process to the success of TD endeavours, particularly those that include non-academic stakeholders.

Lang et al. (2012) encapsulate various components of the research lifecycle which are outlined as three phases or design principles for transdisciplinary research: Phase A) the TDR team is formed, the problem is framed and the research process is co-designed; Phase B) the TDR team co-produces solutions and transferrable knowledge; Phase C) the produced knowledge is (re-)integrated into both scientific and societal practice.

Other researchers consider important research cycle components such as career and institutional structures (Oztop et al., 2017) Some important components, such as IDR/TDR training, are not usually explicitly considered, although the process of gaining skills and knowledge through engaging in the IDR/TDR process is included (Jahn, Bergmann, & Keil, 2012). Stokols et al. (2003) classification, which is referenced by researchers such as Hall et al. (2008); Klein (2008); Wagner et al. (2011), provides a simple way of understanding what is needed before, during and at the end of an IDR/TDR project.

3.6 Implications for the SHAPE-ID system of preconditions

While the SHAPE-ID system of preconditions is an empirical one based on project findings, it is informed by the themes arising from the review of existing research efforts on classification. The way this was carried out is described in Section 2.3 and elaborated further below.

3.6.1 Theoretical justification and augmentation of system of preconditions

The fivefold thematic classification developed from the literature review has provided theoretical verification of the SHAPE-ID system of preconditions and informed the development of the latter. Findings from the empirical classification based on analysing and synthesising SHAPE-ID findings have been cross-checked against the thematic classification derived from the literature review. Against this backdrop it is possible to confirm that the SHAPE-ID classification makes additional contributions by expanding on what is needed to support AHSS integration, moving beyond a more general (and often STEMM-centric) approach. Furthermore, the thematic classification fills some gaps in the empirical project findings, for instance in explaining the importance of research life cycle phases and

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augmenting the importance of understanding the different ways in which IDR/TDR take place for different purposes, at different levels, and with different configurations and relationships between participants. These have been used to better understand some of the empirical categories and inform their descriptions.

3.6.2 Unpacking complexity and context

The theme “Complex Relationships, Systems and Contexts” provided further insight into the contextual and relational nature of IDR/TDR practice and informed the SHAPE-ID preconditions related to structural factors, i.e. the “Research Funding and Policy” category and the “Institutions and Disciplines” category (see Sections 4.1 and 4.2 below). The SHAPE-ID “Competencies and Expertise" category (Section 4.3) helps to explain AHSS researchers’ unique advantage in dealing with such complexity because of the human-centric nature of many of their disciplines. The theme “Intrinsic/Extrinsic Motivations and Societal Impact” recognises, for example, that there are varying interests reflected at the individual level (cognitive and emotional) which overlap with wider social and political interests which actors must navigate and a growing association of IDR/TDR with the possibility of better social outcomes from research. These five broad and interrelated themes emphasise the diversity and complexity of actors involved, from the individual to team, institution and societal level, and informed the organisation of SHAPE-ID findings into categories accounting for this complexity.

3.6.3 Varying levels of integration

The SHAPE-ID literature review undertaken in WP2 already identified that there was a plurality of understandings of IDR/TDR and multiple discourses on these practices (Vienni Baptista, Fletcher, et al., 2020). By focusing on classifications, the present literature review enabled a more nuanced engagement with different kinds of IDR/TDR. The theme “Boundary Crossing and Levels of Integration” describes classifications that acknowledge that levels of integration can vary based on methods, epistemological commitments, motivations, and more, but also highlights that there may be varying levels of ID/TD within one project. This has informed the SHAPE-ID system of preconditions, which includes factors that cut across and influence IDR/TDR in practice (see Section 4.4 below).

3.6.4 Competencies and expertise

The theme “Degree of Discipline/Actor/Similarity/Difference” explains the importance of having the best possible group of people with the right knowledge and skills in an IDR/TDR project and is a helpful concept for informing the SHAPE-ID category “Competencies and Expertise” (see Section 4.3) which details the preconditions needed in terms of both those skills and attributes that are important

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to enabling successful IDR/TDR regardless of the disciplines involved and the skills and expertise that the AHSS and other stakeholders bring to IDR/TDR. This theme provides further context as to why a variety of disciplines and actors is important.

3.6.5 Stages of the research life cycle

The theme “Research Life Cycle” is also important, for it is considered in many classifications, and reinforces findings from the SHAPE-ID literature review (Vienni Baptista, Fletcher, et al., 2020) that the phase of a research project is an important contextual influence on how various factors interplay to potentially help or hinder IDR/TDR. The life cycle of a research project is an important cross-cutting category bearing on many of the categories and subcategories included in the SHAPE-ID system of preconditions, such as the design and evaluation of funding calls, education and training and the development of skills in team-building, IDR/TDR project management and evaluation (see Section 4). In refining these categories elements of the "Research Cycle” theme were used to organise empirical findings and finalise descriptions

4 Preconditions for AHSS Integration

As outlined in Section 1.3 above, a system of preconditions for AHSS integration was developed, based on a mapping of the SHAPE-ID findings and further informed by the fivefold thematic classification of the literature described in Section 3. The system of preconditions is divided into three broad categories: **structural factors** (primarily external factors such as research policy and funding and institutional supports), **competencies and attributes** necessary for AHSS integration (primarily those held or acquired by individuals as a result of experience or training in IDR/TDR or disciplines), and **cross-cutting categories** that underpin and connect the more external structural factors and the more internal set of skills and attributes (such as connecting understandings, understanding and clarifying roles and relationships, and creating collaborative conditions). The overall division is presented in Figure 1 and four high-level categories are further divided into sub-categories, as outlined in Sections 4.1, 4.2, 4.3 and 4.4 below. The figures and tables in these sections provide, respectively, a more detailed breakdown of each category and a description for each subcategory term.

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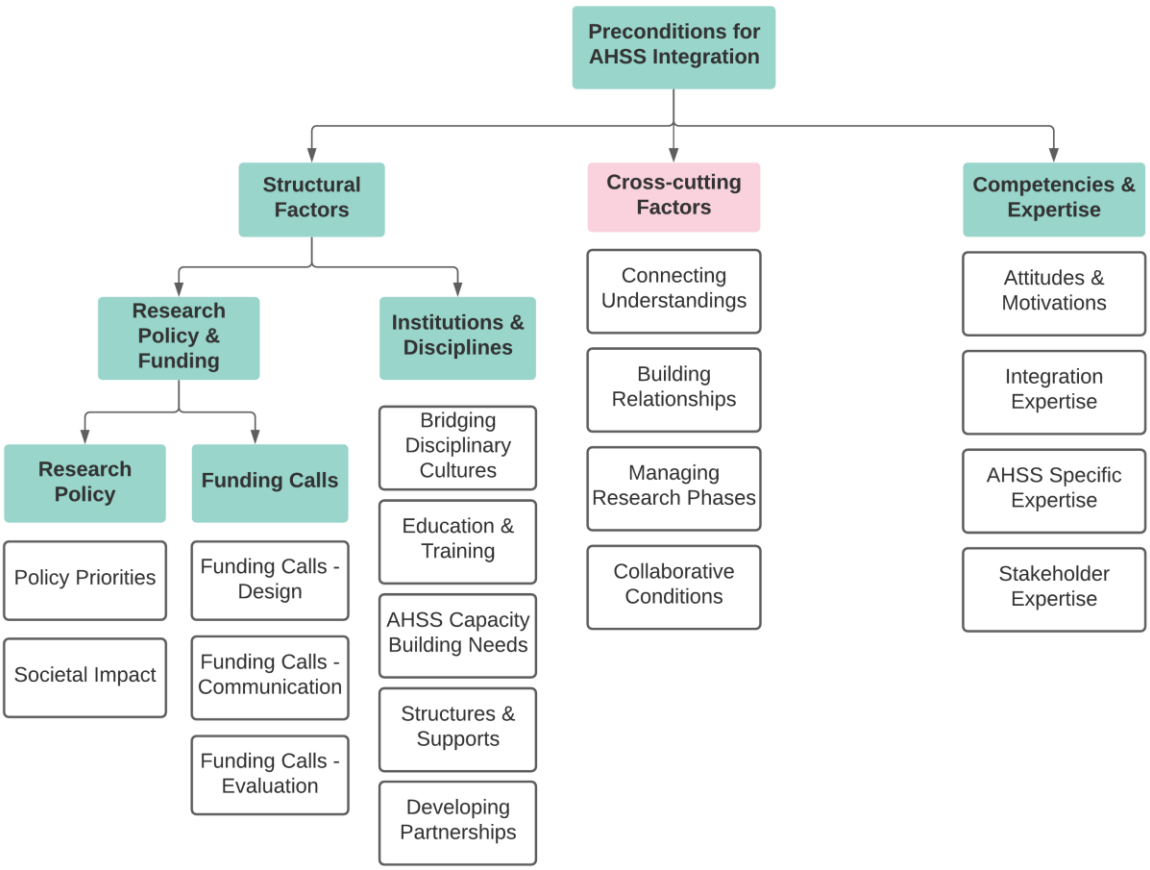

Figure 1 Preconditions – Overview

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4.1 Research Policy and Funding

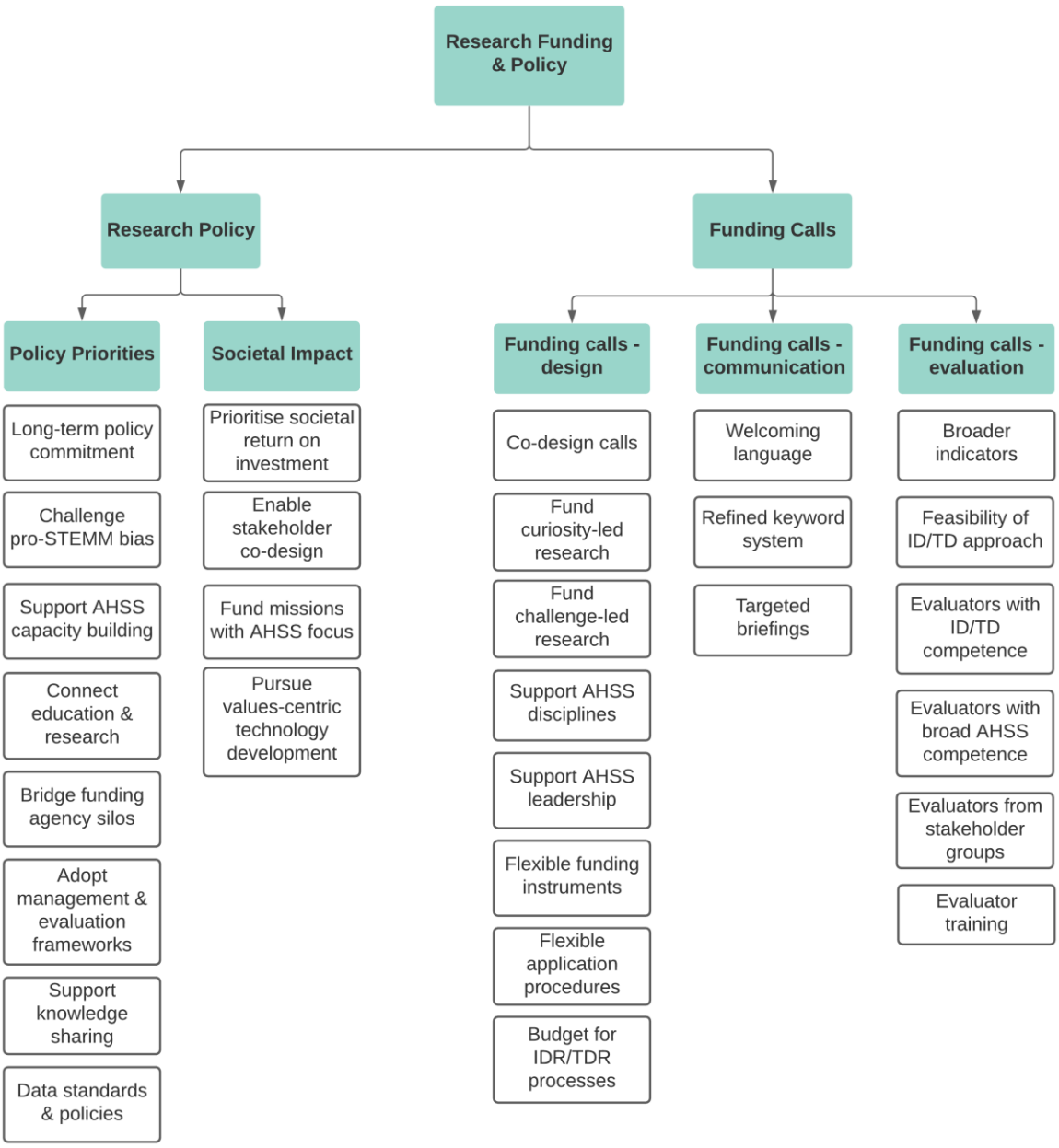

Figure 2 Preconditions – Research Policy and Funding

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Table 1 Preconditions – Research Policy & Funding

POLICY PRIORITIES	
Long-term policy commitment	Commit to a long-term strategy for developing IDR/TDR and AHSS integration, including piloting, evaluation and iterative improvements of IDR/TDR programmes.
Challenge pro-STEMM bias	Acknowledge that funding policy is often underpinned by prejudices against AHSS disciplines, their methods and contributions, and work with research communities to understand and counteract this implicit bias.
Support AHSS capacity building	Recognise that the AHSS start from a lower knowledge base in doing IDR/TDR and need appropriate long-term supports to build capacity. In particular, national funding agencies have an important role to play in this. An important aspect of this is general support for AHSS disciplines to ensure a solid disciplinary base from which robust and equal collaborations can be built.
Connect education and research	Support the creation of IDR/TDR cohort programmes at doctoral level, e.g. modelled on the US National Science Foundation IGERT programme.
Bridge funding agency silos	Identify mechanisms for cooperation across funding agencies where they are organised along disciplinary lines.
Adopt management & evaluation frameworks	Develop, test and implement robust frameworks for managing and evaluating IDR/TDR projects.
Support knowledge sharing	Support the creation of a community of practice for sharing best practice, e.g. toolkits, workshops, consultations with experts in IDR/TDR and AHSS integration.
Data standards & policies	Policies are needed for safeguarding and harmonising data, widening understanding and uptake of FAIR data principles, data re-use, copyright law, etc.
SOCIETAL IMPACT	
Prioritise societal return on investment	Consider longer-term impacts, capacity building and societal *return on investment* in evaluating impact. This takes a necessary step beyond the instrumental view of impact. Involving citizens in agenda setting and evaluation should be part of this.
Enable stakeholder co-design	Create new fora for enabling researchers to build partnerships with citizens, societal and industry stakeholders for future projects.
Commit to missions with AHSS focus	Support missions and challenges focused on building a better society and addressing issues around human values, cultures and behaviour in a contextual way. Such missions should be led or co-led by researchers with an AHSS background. The ALLEA paper Living Together: Missions for Shaping the Future provides compelling examples of several such missions (ALLEA et al., 2017).
Pursue values-centric technology development	Ensure technology development meets the needs of society and new technologies are transparent to those affected by their decisions. AHSS disciplines have a role to play in regulating technology development and ensuring individual and societal needs are paramount – including understanding and anticipating the negative implications of progress and technology development.
FUNDING CALLS – DESIGN	
Co-design calls	Involve experts in IDR/TDR, experts from across the spectrum of AHSS disciplines, citizens and societal actors in designing funding programmes and calls.
Fund curiosity-led research	Ensure adequate funding for curiosity-led, bottom-up collaborative research to stimulate new collaborations. Most IDR/TDR projects begin from the bottom up and curiosity-led research needs to be well supported to build capacity and disciplinary expertise.
Fund challenge-led research	Large-scale collaborative projects around 'grand challenges' are an ideal way to stimulate IDR/TDR collaboration. Meaningful AHSS participation should be expected wherever appropriate.
Support AHSS disciplines	Ensure funding for discipline-based research in the AHSS to facilitate a base of strong, sustainable disciplines confident to engage proactively and on an equal footing in IDR/TDR projects.

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Support AHSS leadership	Fund calls that require AHSS partners to lead research on societal challenges to build capacity in the AHSS community and encourage research that will approach challenges in a variety of ways.
Flexible funding instruments	Adopt a range of suitable funding instruments to build capacity in IDR/TDR, including: seed funding for pilot/preparatory projects, travel funding for researcher exchanges, large-scale research infrastructure funding to streamline standards in certain areas and large-scale challenge-oriented research centres to create institutional 'homes' for IDR/TDR.
Flexible application procedures	Introduce flexible application procedures to accommodate non-standard (academic) researchers such as creative/performing artists. Use 2-stage application processes to encourage more risk-taking and a wider variety of applications.
Budget for IDR/TDR processes	Permit, as eligible, costs required for building IDR/TDR collaborations, including personnel time, meetings, travel and facilitated workshops to develop strong collaborative methods and working relationships.
FUNDING CALLS – COMMUNICATION	
Welcoming language	Use language that is explicitly welcoming of a diversity of AHSS contributions and roles, with appropriate terminology.
Refined keyword system	Develop a more refined keyword system to enable better matching of proposals to evaluator expertise.
Targeted briefings	Provide targeted briefings to assist AHSS researchers and research support professionals to identify calls where AHSS involvement is encouraged, including the nature of such involvement.
FUNDING CALLS – EVALUATION	
Broader indicators	Use a broader range of indicators for evaluation, including reduced reliance on standard bibliometrics (e.g. h-index) and evaluating project processes as well as outputs.
Feasibility of ID/TD approach	Evaluate the feasibility of the ID/TD approaches proposed as part of evaluating the quality of the proposed implementation.
Evaluators with ID/TD competence	Recruit evaluators with experience and specific expertise in (understanding of) IDR/TDR.
Evaluators with broad AHSS competence	Recruit evaluators with expertise across a broad range of relevant AHSS disciplines, with knowledge of a range of AHSS methods and approaches. Given the breadth of AHSS disciplines, it cannot be assumed that a single disciplinary representative (e.g. a single economist or sociologist) can represent the diversity of AHSS approaches and contributions.
Evaluators from stakeholder groups	Recruit evaluators from societal or industry stakeholder groups and citizen evaluators as appropriate to the project.
Evaluator training	Provide evaluators with specific guidance and training on evaluating the interdisciplinary aspects of proposals and on different AHSS methods.

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4.2 Institutions and Disciplines

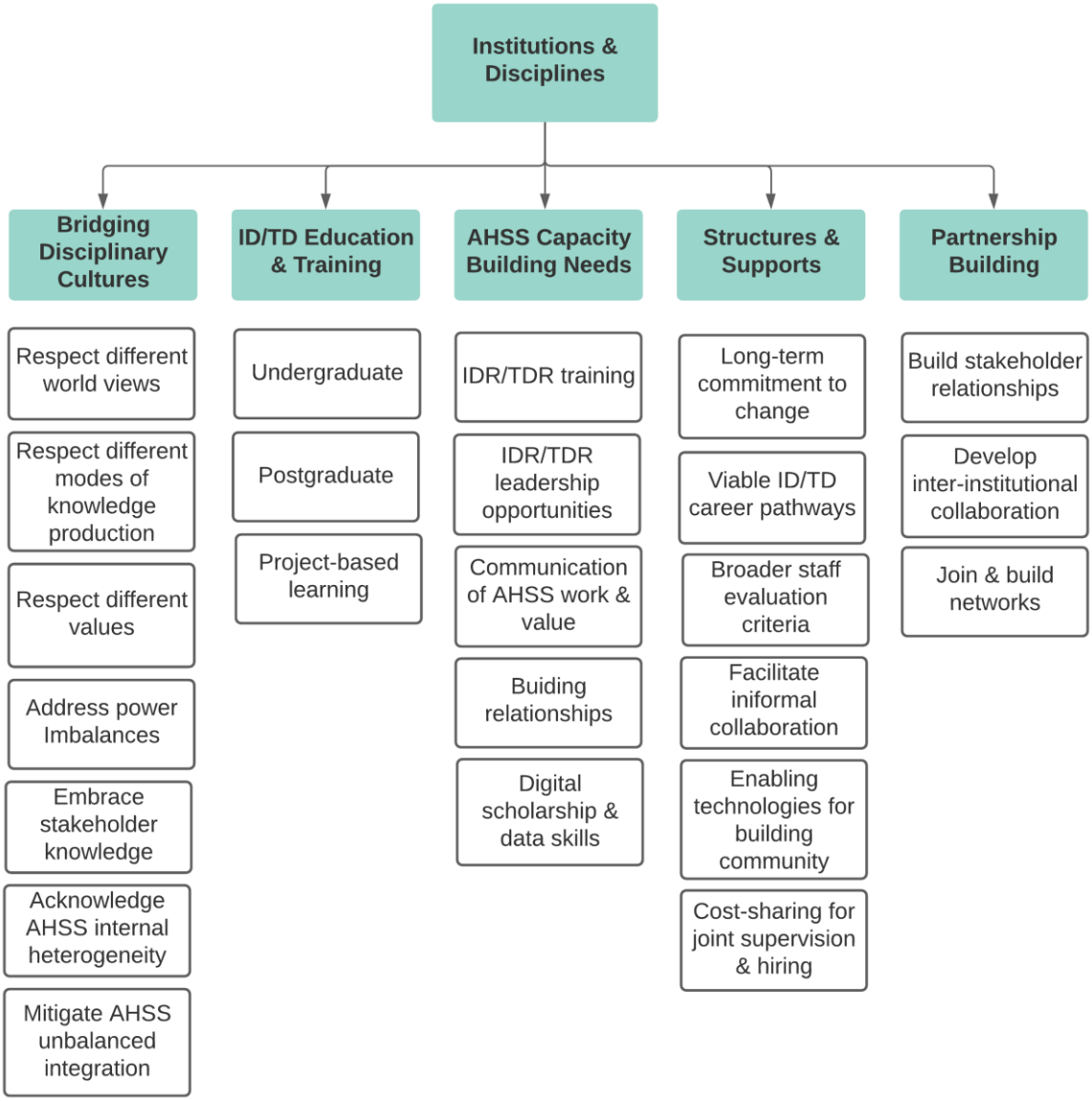

Figure 3 Preconditions – Institutions & Disciplines

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Table 2 Preconditions – Institutions & Disciplines

BRIDGING DISCIPLINARY CULTURES	
Respect different world views	Researchers in different disciplines can view the world in different ways bound up with their disciplinary training. Dialogue within institutions about these different world views and exposure to such differences from an early stage of education is needed to develop mutual understanding and respect.
Respect different modes of knowledge production	Disciplines value different methods and differ in how they produce knowledge and legitimise these procedures. Dialogue about these different modes of knowledge production and world views within institutions as well as exposure to these from an early stage of education is needed to develop mutual understanding and respect.
Respect different values	It must be recognised that disciplinary training entails both cognitive and affective apprenticeships and researchers may often identify personally with their disciplinary cultures and values. This may produce dismissive or defensive attitudes towards others and sustained work is needed to build greater mutual understanding.
Address power imbalances	Disciplines may adopt defensive stances in the face of perceived threats such as a requirement that they become interdisciplinary. This reflects existing power imbalances, such as the greater prestige in which many STEMM disciplines are held in society and the greater investment in STEMM research on the part of many governments. Measures to acknowledge such power imbalances are needed within institutions and funding agencies, to enable, recognise and reward achievements in AHSS disciplines and IDR/TDR.
Embrace stakeholder knowledge	There are many modes of knowledge production and often a lack of respect for or lack of understanding of the value of different kinds of knowledge produced by different sectors. The arts are often not understood as creating knowledge in their own right, and knowledge produced by societal actors (e.g. patients, citizens, refugees), industry and other sectors are not always appropriately valued within academia. Academic researchers need to acknowledge other kinds of knowledge and work with those impacted by societal challenges to co-create solutions rather than propose top-down solutions. The AHSS can help mediate these modes of knowledge due to greater reflexivity and cultural and contextual sensitivity.
Acknowledge AHSS internal heterogeneity	The 'AHSS' (or 'SSH') grouping, like the STEMM grouping, is internally extremely heterogeneous. Although all deal with human society, behaviour, culture and values, there are significant differences in approach. There are major sub-groupings that vary greatly – the Arts, the Humanities, the Social Sciences – and there are major differences within these. Furthermore, disciplinary knowledges are themselves heterogeneous and disciplines are often divided internally along theoretical, methodological or political lines. More research is needed on how different disciplines within this broad grouping engage in IDR/TDR and form different unique configurations with each other and with STEMM disciplines.
Mitigate AHSS unbalanced integration	Disciplines in the broad AHSS grouping vary substantially in the extent of their integration in IDR/TDR. In a European context, reports monitoring efforts to encourage SSH integration have shown that the Social Sciences - in particular Economics, Business, Marketing, Public Administration and Political Science - make up the vast majority of SSH participation in projects funded under SSH-flagged topics, with the Humanities and even more so the Arts very underrepresented (Kania & Bucksch, 2020; Kania et al., 2019). The AH also appear linked to different (and fewer) non-AHSS disciplines than do Social Sciences disciplines in an analysis of publications where discussions of interdisciplinarity take place (Vienni Baptista et al., 2019). Again, this points to the need for more research on the specific ID/TD configurations individual disciplines enter into.

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ID/TD Education & Training	
Undergraduate	Integrate interdisciplinary training and projects into undergraduate curricula and ensure exposure to a variety of disciplinary perspectives at this early stage.
Postgraduate	Ensure exposure to IDR/TDR in doctoral training and develop IDR/TDR graduate schools.
Project-based learning	Use project-based learning to develop students' ability to work with non-academic stakeholder (industry or societal) and build their experience in solving wicked problems for real-world contexts. Unstructured learning is valuable in developing these competencies but requires significant work in scaffolding the learning experience to begin with.
AHSS Capacity-Building Needs	
IDR/TDR training	AHSS disciplines often start from a lower knowledge base concerning the practice of IDR/TDR and team-based research in general. Training in IDR/TDR methods, project management and leadership is needed to address these gaps. This should be developed for AHSS researchers and professional staff.
IDR/TDR leadership opportunities	AHSS researchers often have fewer opportunities to lead collaborative projects due to the predominance of single-scholar research and publication. Opportunities are needed to gain the appropriate leadership skills, e.g. through university incentives or small-scale funding from national funders.
Communication of AHSS work & value	The AHSS community needs to improve its ability to communicate to STEMM researchers, policymakers, industry and societal stakeholders and the public what the different AHSS disciplines do and why they are important. This is needed to counter a prevailing bias towards STEMM research, reflected in prominent and high-quality science communication in recent decades that is not matched by the AHSS.
Building relationships	The AHSS community needs to build relationships with STEM researchers, policymakers and societal or industry stakeholders – a long-term process.
Digital scholarship & data skills	The AHSS do not always think of their work as involving data collection or processing, yet working with data and understanding data management practices is often an important enabler in working with other disciplines and sectors (such as cultural heritage institutions). More training for and recognition of data skills are needed.
Structures & Supports	
Long-term commitment to change	Develop a long-term strategy to develop new structures and supports necessary to mainstream IDR/TDR. This should be embedded as part of the institution's Strategic Plan and allocated adequate resources. Recognise that cultural change takes time, will encounter resistance and requires long-term commitment.
Viable ID/TD career pathways	Develop viable career paths for IDR/TDR scholars, including joint appointments, better research-teaching links and revised hiring and promotion criteria.
Broader staff evaluation criteria	Adopt broader evaluation criteria for evaluating staff's research activities. The hidden work involved in IDR/TDR needs to be recognised, such as building networks and managing collaborations. It must be understood that integration is a process. Other enabling activities such as data creation and curation also need to be recognised in staff evaluation. Because of existing publication structures, it is more difficult for interdisciplinary researchers to publish in traditional high impact journals and a broader range of criteria need to be applied.
Facilitate informal collaboration	Facilitate informal collaboration where possible, for example through physical spaces and events where researchers can meet casually and have serendipitous encounters. This is often how good collaborations begin.
Enabling technologies for community-building	Technology can be an important enabler of collaboration and community building and adequate infrastructure, support and training should be put in place for this. Best practices should be shared around organising remote workshops, webinars and meetings to engage different stakeholders.

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Cost-sharing for joint supervision & hiring	Develop and implement mechanisms for cost-sharing to facilitate supervision and appointments across disciplines and faculties to strengthen inter-faculty cooperation and reduce competition for resources.
PARTNERSHIPS	
Build stakeholder relationships	Build relationships with non-academic partners in civil society and industry and with policymakers. This takes time and requires institutional commitments to support and sustain. Initiatives to exchange students or faculty, host visiting fellows from other sectors and create joint appointments between higher education and other sectors, e.g. cultural heritage institutions, can help develop longer-lasting links.
Develop inter-institutional collaborations	Formal partnerships between educational institutions are valuable in establishing opportunities for relationship-building and collaboration. Multi-institution ID/TD research centres and alliances at European level, such as the new European University Alliances, are valuable in building capacity for IDR/TDR over the longer term.
Join and build networks	Active participation in existing networks and contribution to building new networks is important for finding partners for IDR/TDR. This can include networks of universities such as the League of European Research Universities (LERU), Young European Research Universities Network (YERUN), The Guild and The Coimbra Group; networks of advanced studies institutes such the University-Based Institutes of Advanced Studies (UBIAS) and the Consortium of Humanities Centres and Institutes (CHCI); and European research infrastructures such as DARIAH and CLARIN. COST networks also provide valuable opportunities for relationship-building that can make it easier to find partners for future ventures.

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4.3 Competencies and Expertise

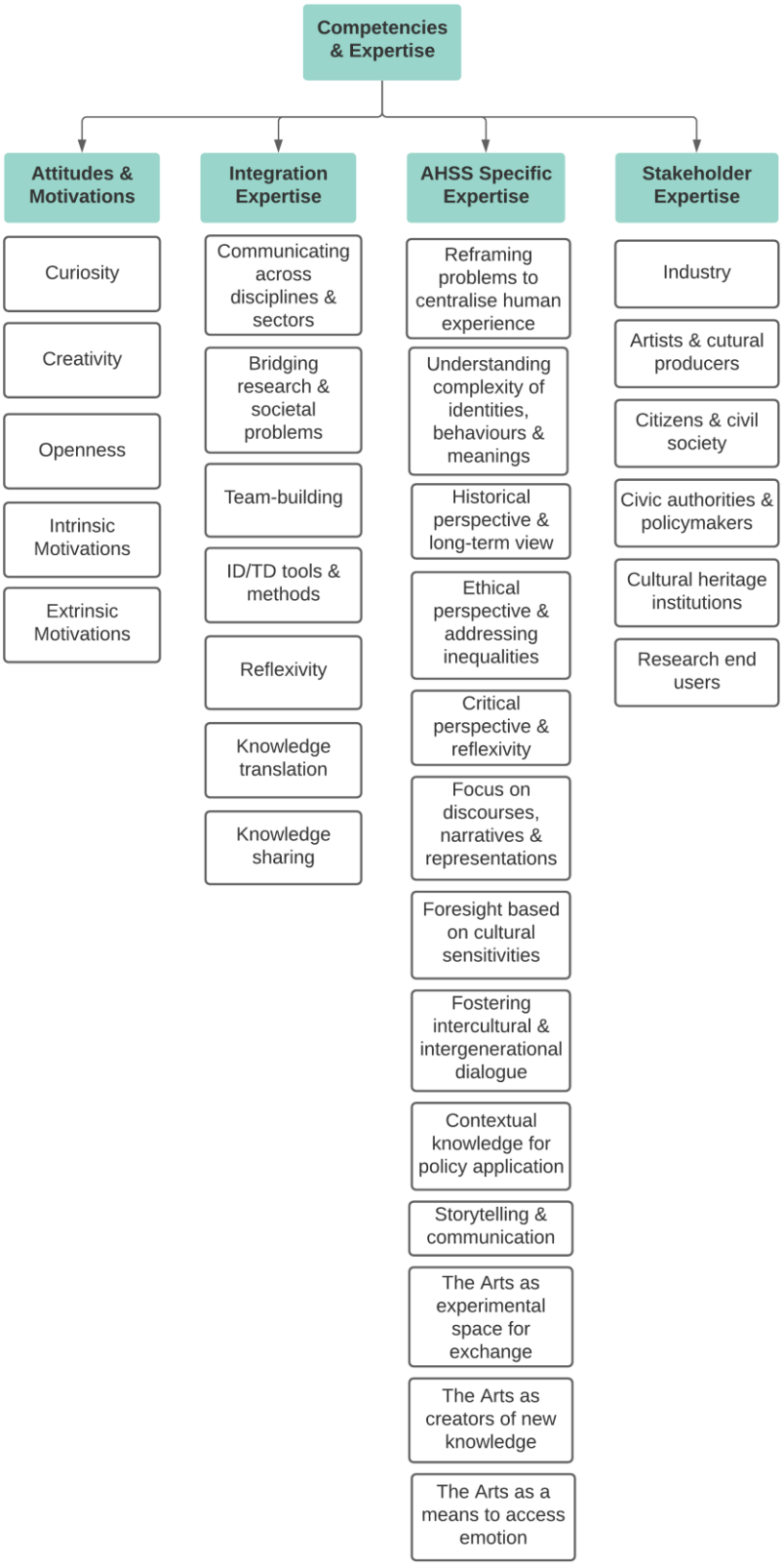

Figure 4 Preconditions – Competencies & Expertise

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Table 3 Preconditions – Competencies & Expertise

ATTITUDES & MOTIVATIONS	
Curiosity	Willingness to engage with other perspectives. Curiosity and enthusiasm for learning about new perspectives and adapting to accommodate or negotiate with them.
Creativity	Inclination to seek novel solutions to solving problems and producing new knowledge.
Openness	Willingness to leave one's ego at the door and accept that one doesn't have all the answers. Recognition of one's own limits and biases and disposition to learn together with others.
Intrinsic motivations	Researchers may be motivated by curiosity, a desire to push the boundaries of a discipline and create new knowledge or a desire to learn from others and extend knowledge base.
Extrinsic motivations	Researchers may be motivated by external incentives such as receiving funding or career rewards (being hired or promoted), or by addressing particular societal problems.
INTEGRATION EXPERTISE	
Communicating across disciplines & sectors	Partners must work to communicate their own expertise to others from different backgrounds. This requires more than disciplinary expertise. Integration expertise is a specific set of competencies entailing the ability to bridge boundaries between disciplines and sectors.
Bridging research & societal problems	The ability to understand and reflect on the relationship of the research to problems in society such that the research (where it addresses a societal challenge) involves the right partners and adopts the appropriate strategies.
Team-building	Teams must be assembled to address different aspects of the challenge, including relevant disciplinary expertise from different domains and stakeholders from other sectors whose knowledge or experience is important to understanding the challenge and seeking solutions.
ID/TD tools and methods	Knowledge of existing tools and methods for facilitating ID/TD processes and groups to enable collaboration, including joint problem-framing, aligning goals and expectations and team building.
Reflexivity	The ability to learn from the experience of doing ID/TD and improve methods and approaches iteratively.
Knowledge translation	The ability to translate disciplinary and interdisciplinary knowledge for different audiences, both within ID/TD teams and for policymakers and societal stakeholders, as appropriate. Mediation, translation and interpretive work is essential to navigating knowledge boundaries.
Knowledge sharing	Participation in communities of practice to share best practice, learn from more experienced fields or disciplines and conduct research and share knowledge about how IDR/TDR work in practice.
AHSS SPECIFIC EXPERTISE	
Reframing problems to centralise human experience	Many of the specific competencies of AHSS researchers can be most valuable if engaged in projects or funding call design at an early stage so they are involved in reframing problems to centralise human experience and values, rather than playing subordinate roles in projects driven by technological, scientific or economic imperatives. This also applies to so-called problems that may not have ready solutions, such as the challenges of ageing or chronic conditions, where learning to live with rather than overcome these involves a reconfiguration of values. The AHSS are accustomed to dealing with uncertainty.

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Understanding complexity of identities, behaviours & meaning	Human values, emotions, identities and identifications drive their meaning-making activities and behaviours and these need to be understood through the complex intersection of history, languages and culture that they have emerged from. The AHSS understand that communication is about interpretation and translation between different views and experiences.
Historical perspective & long-term view	Historical memory is directly relevant to many societal problems. Disciplines like History and Archaeology permit a long-term perspective on past failures, such as the causes of past crises. Learning from the past can counter short-term solutionism and encourage the consideration of consequences.
Ethical perspective & addressing inequalities	Prioritising an ethical perspective informed by societal and individual needs can contribute to technological and scientific development that serves these needs instead of exacerbating existing inequalities.
Critical perspective & reflexivity	Many AHSS disciplines are sensitive to how knowledge and truth are historically produced and often determined by access to power. This critical perspective helps identify underlying concepts, values and narratives that are taken for granted and opens up the potential for alternatives based on an acknowledgment of the contingency of current narratives or values.
Focus on discourses, narratives & representations	A core competency of some AHSS disciplines is the analysis of discourses, narratives and representations. This can help interrogate the language used to describe phenomena and the assumptions embedded in such language and narratives, leading to greater reflexivity and reframing how a problem is understood.
Foresight based on cultural sensitivities	A better understanding of human societies, behaviours and values can enable greater predictive power in anticipating likely or unforeseen consequences of an intervention.
Fostering intercultural & intergenerational dialogue	Contextual knowledge sensitive to differences at the level of identity and values can serve as a strong foundation for fostering dialogue between groups with conflicting interests or values and facilitating participatory work with these groups.
Contextual knowledge for policy application	AHSS knowledge can facilitate the scaling of policy to local levels based on a nuanced understanding of regional and local issues and stakeholder participation.
Storytelling and communication	Facts alone do not constitute effective communication and stories can appeal to the emotional aspect of people's relationships to their world. Storytelling competencies can contribute to building trust, connecting with people and showing them their place in things. This can be used to re-present a problem, challenge or solution.
The Arts as experimental space for exchange	The creative and performing arts can create experimental spaces for exchange and dialogue to foster new relationships between partners in collaborations and between societal actors. Creative play can loosen hierarchical structures and build trust.
The Arts as creators of new knowledge	The creative and performing arts have their own modes of knowledge creation that can bring unexpected perspectives and see challenges in ways others might miss.
The Arts as a means to access emotions	The arts recognise that we often act for emotional reasons and can play an important role in integration by helping to creatively connect different groups enabling understanding different cultures, allowing us to explore conflict and difference, engaging emotion and providing opportunities for reflection. The arts can also contribute to integrating emotional factors.
STAKEHOLDER EXPERTISE	
Industry & enterprise	Engagement with industry is hugely important for developing impactful collaborations, given the sector's influence on society and economy. Industry is increasingly pursuing stakeholder capitalism and adopting the SDGs and frequently recognises the value of innovative and imaginative thinking.

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	However, the sector tends to focus strongly on the impact of research and policies. There are opportunities for the AHSS to engage industry in thinking about the purpose and impact of research projects.
Artists & cultural producers	Academic researchers need to connect with other ways of knowing. Knowledge production outside of academia, such as in museums, can be ignored or side-lined when the focus is on academic disciplines in interdisciplinary collaboration. Artists should not only be considered as partners to be brought in at the end of a process to aid in communication or presentation of research results. Arts practices have an important role in drawing in emotional and creative factors and can participate in integrative experiences. Artists' training enables them to approach problems very differently and think outside the box in ways that can be productively disruptive.
Citizens & civil society	There are enduring issues of inequality of knowledge and framing. More inclusion and involvement of citizens and other groups across communities, ages, social classes, cultures, etc. is needed to ensure the R&I system better addresses the concerns of citizens and other actors in civil society. Citizen participation and more co-design with citizens are important in areas such as medical application developments (for patients and their families) and urban sustainability initiatives. In IDR/TDR processes, attention should be paid to the representativeness of social groups engaged, the transparency of the process and its social legitimacy.
Civic authorities and policymakers	Universities need to build strong links with municipal authorities and local policymakers to develop research and educational programmes that will equip graduates with the means to tackle real-world problems. Bridging links between policy and academic knowledge is essential to addressing the right problems in the right way with research projects.
Cultural heritage institutions	Cultural heritage institutions (CHIs), such as museums, libraries and archives, play a central role in managing, safeguarding and promoting cultural heritage artefacts and data and the value of our collective cultural heritage. Fostering strong links with these institutions can benefit (digital) humanities researchers and the heritage sector. CHIs have unique knowledge of their collections and may also place greater value on public engagement. Creating hybrid positions that encompass academic research and heritage management activities is one way of building stronger links. Longer-term engagement on the part of universities, from undergraduate education right through to postdoctoral research, is needed to build sustainable relationships.
Research end users	The professional and personal cultures and experiences of the end users of new technologies, products, processes or solutions will have an impact on their potential uptake. The knowledge and experiences of such users should be taken into account through active engagement with these communities from an early point in a project. For example, healthcare professionals and patients should be part of the design of technology solutions for medical treatment; citizens and local authorities should be part of the decision-making process involved in technology solutions for urban planning and mobility.

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4.4 Cross-cutting Factors

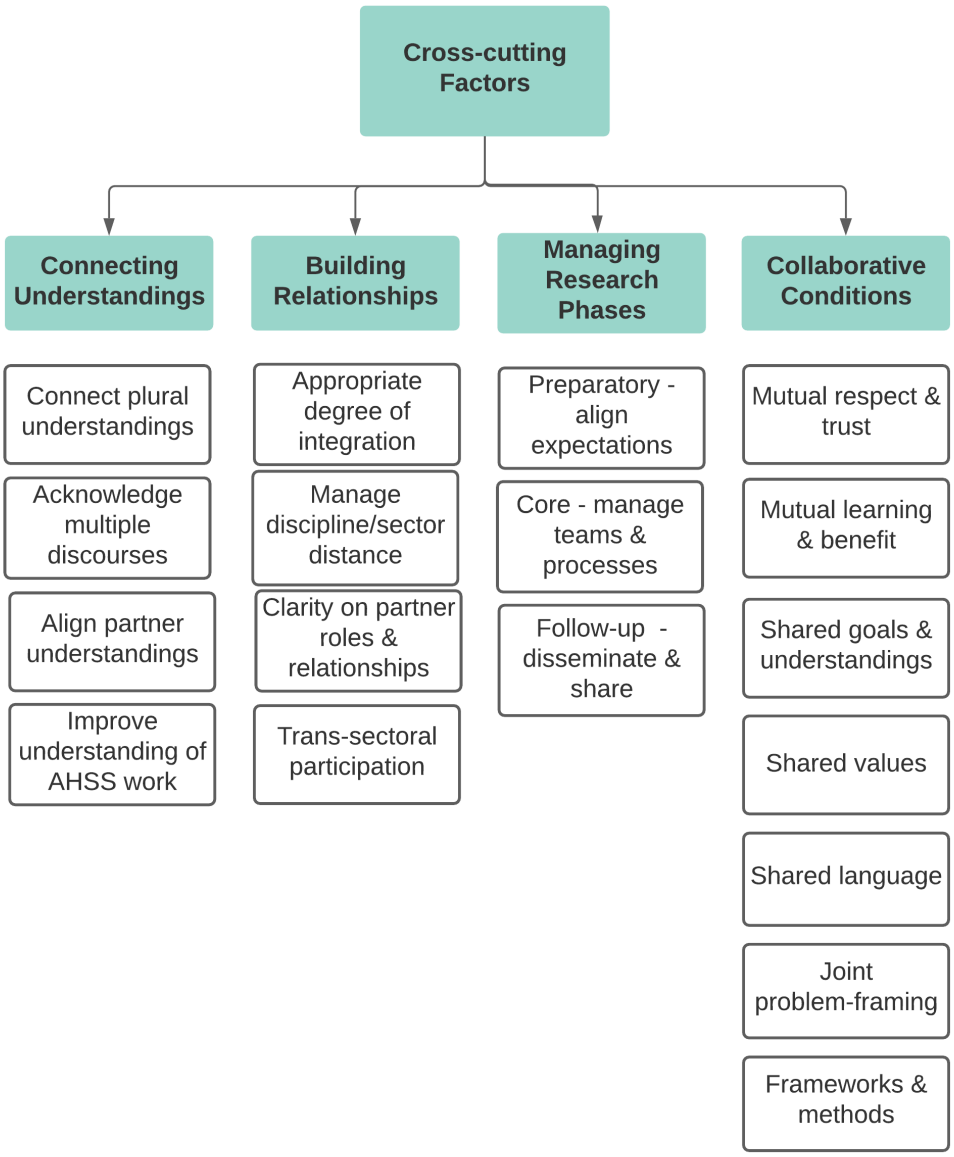

Figure 5 Preconditions – Cross-cutting Factors

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Table 4 Preconditions – Cross-cutting Factors

CONNECTING UNDERSTANDINGS	
Connect multiple understandings	There are a range of understandings of interdisciplinarity and transdisciplinarity, with national differences and differences in use across academic and policy communities (Vienni Baptista, Fletcher, et al., 2020). These differing definitions reflect differences in practice. Rather than seek a single definition, efforts should be made to build connections between different definitions.
Acknowledge multiple discourses	The literature reveals multiple discourses on interdisciplinarity and transdisciplinarity. Three discourses in particular are observed (following Thompson Klein (2004); Osborne (2015)): an **instrumental or problem-solving discourse**, where IDR/TDR is presumed to be undertaken to solve societal problems or fuel innovation; a **philosophical or transcendence** discourse which valorises IDR/TDR as a means of overcoming the narrowness of disciplinary perspectives; and a **critical or transgressive** discourse, which seeks to challenge the foundations of current systems of knowledge and education. In a funding policy context, the problem-solving discourse prevails.
Align partner understandings	The literature reveals a gap in understandings between academic and policy communities and a lack of uptake of knowledge from the study of IDR/TDR in policy contexts. In particular, IDR/TDR are frequently not defined in policy literature, yet presumed to refer to a problem-solving mode of discourse. Furthermore, the terms can be used superficially in research proposals to indicate innovation without consideration for IDR/TDR knowledges and practices. This points to a need for spaces for knowledge exchange and community building.
Improve understandings of AHSS work	What AHSS disciplines do and why this is important is often poorly understood (Vienni Baptista et al., 2020). More efforts are needed on the part of the AHSS community to communicate the nature and value of their work. Furthermore, more meta-research on the AHSS, particularly the Arts and Humanities, is needed to understand the place of these disciplines and the work they do.
BUILDING RELATIONSHIPS	
Appropriate degree of integration	The extent to which expertise from different disciplines is integrated varies. Lack of integration, where partners work in parallel or in sequence on a common problem using their own disciplinary expertise, is often referred to as **multidisciplinarity**. Unilateral incorporation of insights from other disciplines without engagement with researchers from those disciplines is sometimes not considered true interdisciplinarity. **Interdisciplinarity** usually assumes a degree of integration, with some degree of mutual engagement, shared purpose and teamwork. It may lead to modest or substantial changes in the participating disciplines.
Manage discipline/sector distance	Partnerships may involve disciplines that are closer to each other and share more concepts, methods, theories, assumptions, etc. (e.g. within the humanities, literature and history) or disciplines that are more distant from one another and have to bridge greater distances to understand one another's methods, theories, concepts, language, etc. (e.g. between the humanities and sciences, literature and neuroscience). Adequate resources should be available within institutions and projects to facilitate negotiating these differences, and project leaders must be willing to dedicate the time to doing so.
Clarity on partner roles and relationships	Relationships between partners can take a variety of forms with different levels of influence in decision-making and problem-solving. For example, the relationship may be more asymmetrical, with some disciplines in a subordinate relation to others; relatively symmetrical, where problem-framing and approaches are arrived at more collaboratively; or more intentionally challenging, with partners committed to a more thoroughgoing critique and

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	transformation of disciplinary knowledges (Barry et al., 2008). It is common for AHSS partners to play more subordinate roles in STEMM-led projects.
Trans-sectoral participation	Participation of partners with a stake in the challenge, e.g. actors from industry, the policy sector, civil society, citizens. The inclusion of these stakeholders often leads to a project being defined as **transdisciplinary** (although that term has also been used to refer to more far-reaching integration that transcends traditional disciplinary boundaries). The spectrum of differences in degrees of integration, distance and parity also apply here, e.g. in the extent to which diverse knowledges are integrated, participate in problem-framing and are seen as co-creators or end-users of knowledge.
MANAGING RESEARCH PHASES	
Preparatory – align expectations	**Ensuring the project and team goals and expectations are aligned from the outset is important.** This phase involves defining the problem, developing a research design and identifying the type of IDR/TDR approach. The scope of the project is defined and the resources needed are outlined (for example, infrastructure, time, project team, finances and technologies). A team is created, roles are assigned and decisions are made about team processes.
Core – manage teams & processes	**Team and project leadership and management are important to ensure outcomes align with goals.** This phase involves project execution and important team processes, related to executing tasks, interdisciplinary methods, knowledge translation, learning and conflict management. Some aspects of the project may change based on project and team learning and reflection and this iterative process is important.
Follow-up– disseminate & share	This phase involves documenting and reporting on the outcome of the project, assessing its short, medium- and long-term impact and project evaluation that is accountable to relevant organisations, communities and funders. This can be more difficult for IDR/TDR as venues and funding opportunities are often scarcer.
COLLABORATIVE CONDITIONS	
Mutual respect & trust	IDR/TDR must be built on a foundation of mutual respect and trust. It must be acknowledged that this can take time and effort to build and often emerges over time from informal collaboration. Time should be dedicated to building trust early in a project. In particular, the validity of different knowledges, including stakeholder knowledge, must be acknowledged.
Mutual learning & benefit	The collaboration must benefit all partners and enrich all participating disciplines. E.g. the humanities and sciences can learn a great deal from each other to better understand the human brain or senses. Both can challenge their own assumptions and be enriched by the exchange. Creating time and space for collective reflexivity is important.
Shared goals & understandings	Work is needed at the outset of a collaboration to test and align partners' goals and understandings for the project. Different disciplines will have different ways of evaluating success and these differences need to be made explicit and worked through.
Shared values	Partners bring their own personal and disciplinary values to a collaboration and these may be at odds with one another. It may not be possible to align values but it is important to understand the differences and how they may productively or negatively affect collaboration.
Shared language	Work may be needed to explain concepts, theories, methods, etc. from different disciplines and 'translate' them for partners.
Joint problem-framing	Truly collaborative work entails joint problem-framing, where each partner contributes to how the problem is understood and addressed.
Frameworks & methods	Appropriate use of validated frameworks and methods for collaborative work is important for facilitating collaboration, testing assumptions and expectations and reflexivity.

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5 Conclusion and Next Steps

In this document we have proposed a system of preconditions for AHSS integration in interdisciplinary and transdisciplinary research informed by the results of the extensive literature review and survey undertaken in WP2, the results of a series of learning case workshops with 166 expert participants, undertaken across Europe between December 2019 and October 2020, in WP3, and a review of existing classifications in the academic literature in WP4.

Our work synthesising the outputs of these completed project activities has confirmed that the factors that help or hinder IDR/TDR with AHSS integration are diverse and interconnected. Moreover, they cut across a range of institutional contexts (policy, funding, higher education) and involve diverse attributes and competencies developed by individuals, teams, academic disciplinary cultures and many other sectors that are essential stakeholders in knowledge production and co-creation. The need for adequate supports and capacity building is underpinned by a need for improved and shared understanding on the part of all actors concerning what IDR/TDR can be or do, the diversity of ways it can play out in practice and the conditions for mutually beneficial and impactful collaboration.

In this sense, it is worth concluding with a recap of recommendations made in our two policy briefs (Vienni Baptista, Lyall, et al. (2020), Wallace, de Moura Rocha Lima, Sessa, and Ohlmeyer (2021)):

- Policymakers need to make a long-term commitment to AHSS integration as a means to addressing complex societal problems more effectively, with due consideration for the need to build capacity in the AHSS community, which is currently underrepresented and often undervalued. Selecting grand challenges or missions driven by the human dimensions of such challenges is important in reflecting and reinforcing this commitment.

- Funders need to design programmes that are more explicitly welcoming of AHSS participants and leaders, engage AHSS experts substantively in programme design and evaluation, and use flexible instruments, such as seed funding, funding for network-building and capacity building, large-scale challenge-oriented programmes to create occasions for IDR/TDR and research infrastructure funding to support sustainability and sharing of best practices longer term.

- Higher education institutions need to take measures to de-risk IDR/TDR careers, including developing ID/TD education programmes and modules from an early stage, making training and funding available for AHSS capacity building, enabling and rewarding the often-hidden work involved in developing IDR/TDR, and respecting and engaging seriously with stakeholders from other sectors. Building relationships through partnerships at institutional

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level with citizens, industry, civil society and the cultural heritage sector are also important enablers of IDR/TDR practice.

- Researchers in the AHSS need to acquire skills in managing IDR/TDR projects and engaging in co-creation with policymakers, STEMM researchers and other knowledge producers, but also work to better understand and communicate the nature and value of AHSS research to other stakeholders, including the impact it can make on society and how it can play a role in rethinking challenges to centralise the human, cultural and societal issues at their heart.
- The European Commission would be well served to fund sustainable digital research infrastructures that are needed for IDR/TDR communities and practitioners to share and continuously develop tools, methods and experiences. The SHAPE-ID toolkit will serve as a working prototype of such a resource, but individual projects are hampered by their finite time frames and further investment is badly needed to create a resource and space that can continue to innovate and develop longer term.

The SHAPE-ID toolkit under development will be informed by the system of preconditions outlined above and will offer practical guidelines to stakeholder groups on improving pathways to AHSS integration. This resource will be developed and tested with users during early 2021 and will be launched in early summer 2021.

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Appendix A: SHAPE-ID Reports Informing the System of Preconditions

SHAPE-ID Public Project Outputs

Galvini, G., Sessa, C., Wallace, D., Ohlmeyer, J., Taylor Wesselink, K., Lyall, C., & Fletcher, I. (2020). SHAPE-ID Learning Case Workshops Intermediate Working Paper. doi: http://doi.org/10.5281/zenodo.4012384

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