Awti Adviesraad voor wetenschap, technologie en innovatie

technopolis group

STIMULATING INTERDISCIPLINARY RESEARCH

INTERNATIONAL STUDY ON POLICIES FOCUSED ON INTERDISCIPLINARY COLLABORATION IN SCIENCE AND HIGHER EDUCATION

Awti Adviesraad voor wetenschap, technologie en innovatie

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Introduction and approach

On behalf of the AWTI, Technopolis Group has conducted an explorative study on public policy approaches to stimulating interdisciplinary research (IDR) in Germany, Finland and United Kingdom as well as at the European Union level. The objective was to explore how different public actors stimulate interdisciplinary research and which lessons could be identified for the Netherlands.

The research approach consisted of a systemic collection of comparable information across the different geographical contexts through literature review and case study analysis. This to further delve into the public policy approaches undertaken to stimulate interdisciplinary and/or transdisciplinary research. In this study the approaches within research systems have been analysed on national government, public organisation and research performing level (chapter 4), whilst distinguishing four different groups of actors (chapter 5) which can influence and undertake practices to stimulate IDR:

1. National governments and agencies
2. Research councils, advisory organisations, and funding bodies
3. Civil society, social partners and private foundations
4. Research performing organisations (universities, research centres and institutes)

Results

The following section provides a summary of national policy debates and priorities concerning research, innovation and interdisciplinary research in Germany, Finland, the UK and the EU.

Germany

In Germany scientific and research policy priorities in general are focused on topics of **societal relevance** such as **digitalisation** (including aspects such as AI and emerging technologies), **climate change** and sustainability, **societal divide** and the future of democracy**. Increasing the impact of research** has been defined as very important in the national context, as transfer of innovative research into economic potential is considered to be suboptimal in Germany.

According to the Science Council, interdisciplinarity has had a high status in the science policy discourse of recent decades. However, research suggests IDR has become more relevant in the last 5-10 years in response to increasing political and societal debates on resolving complex challenges. Resolving these challenges requires complex instruments and complexity is often equated with IDR.

Regarding recent policy debates and priorities in Germany, stimulating IDR is **discussed in the scientific community** but also by funding institutions, with different (incl. governmental) actors within the national research and innovation ecosystem issuing statements on the relevance and challenges of IDR. Some of our research suggests that **fundamental research** ("Grundlagenforschung") is **getting a little less attention in comparison to the past**. This is an observation that has been viewed critically in the past, highlighting that without fundamental research, applied or problem-oriented research cannot solve today's challenges. The German Science Council has recently published a detailed position paper highlighting how the focus on interdisciplinarity and thus the "neglect" of research within their own disciplines is creating considerable tensions within the research system and that high-performing, excellent disciplines are the prerequisite for IDR.

Trends at government and public organisations level: Even if mono- or interdisciplinarity are not usually explicit criteria in funding announcements, the funding programmes are generally based on the premise that answers to many social problems require the cooperation of several disciplines. As a result, interdisciplinary research projects, initiatives and networks have emerged increasingly in the last decades, supported by funding programmes of diverse actors such as the German Research Foundation (DFG) and the federal government or the state governments. Correspondingly, "strengthening interdisciplinary research" is one of five strategic cross-cutting goals of the DFG and around 60 percent of its funding went into interdisciplinary collaborative research in 2018.

Trends at research performing organisation level: Just like in the international context, interdisciplinarity has become a "science policy priority" and a "major trend in universities and research funding agencies" in Germany. The vast majority of university administrators consider it a priority to enable interdisciplinary research and to create framework conditions for it. IDR is thus often encouraged in university strategies through IDR projects, networking and even training of academics/researchers.

The private sector finances around two-thirds of annual R&D spending in Germany. It is mainly application-oriented and aims to develop commercially exploitable results, therefore a focus on high-tech sectors is prevalent (machinery, electronical, chemical, pharmacist industry). R&D departments of large corporations are described often as transdisciplinary and cross-sectoral because they combine practice and science. The research is mostly application- or product-oriented and thereby does not know the same organisational or structural boundaries existent in universities.

Finland

In 2020 the **National Roadmap for Research, Development and Innovation 2030** was set out, describing the national research strategy. One of the objectives of this roadmap is to increase the intensity of RDI activities increasing Finland's expenditure-to-GDP ratio for research and development. One of the three main pillars in this National Roadmap is "the new partnership model", which describes several policy goals which are **likely to result in increased interdisciplinary collaboration**.

There is increasing recognition in current debates of the importance of **addressing societal challenges** such as the *Sustainable Development Goals*, the *green transition* and *digitalisation*. However, here IDR is recognized as a **means to this end**, but not identified as a goal in its own right.

Finland has long had an agenda promoting the development of IDR. **In 2004**, the International Evaluation Panel of the Academy of Finland, (the public agency implementing research and university funding form the Ministry of Education and Culture), indicated that the Academy should develop its research policies, evaluation systems and organization to **encourage more interdisciplinary research**. Over the last decade, the importance of IDR has gained further recognition. There are two main reasons for this, namely the **growing prominence** of **challenge-driven research** and the importance of **impact of research**. These trends are reflected in the establishment of the Strategic Research Council and the Flagship Programmes within the Academy of Finland, but also in the increasing mergers and collaborations between traditional universities and universities of applied science.

Trends at government and public organisations level: The *Academy of Finland (AoF)* funds high quality fundamental scientific research in all disciplines and fields. It **fosters interdisciplinary collaboration** through its **criteria for scientific quality**, which includes 'quality of research environment and collaborative networks'. The researcher-oriented funding options make up

about 56% of the funding within the academy, the majority (ca. 85%) of these projects being multidisciplinary.

Trends at research performing organisation level: More than half of the 13 Finnish universities make a **statement about interdisciplinarity** in their mission or on their homepage. This however does not apply to the 22 Universities of Applied Science in Finland, as none of these make explicit statements about interdisciplinarity.

Within the **private context** *Business Finland* provides funding for research, development, and innovation projects in leading companies' ecosystem themes. It has **no explicit requirement** for interdisciplinarity for research projects, however proposed research projects do need to include international cooperation and at least three companies must participate in the project steering group.

Beyond national funding, there is also an important source for interdisciplinary research funding for researchers living in Finland, Sweden, Denmark or Norway, called the **NordForsk's initiative.** This is a collaboration of research councils from the participating countries, which provides funding for and facilitates Nordic cooperation on research and research infrastructure. NordForsk is currently running an ongoing programme (2018-2025) which **aims explicitly at interdisciplinary projects** that combine disciplines.

United Kingdom

UK R&I policy has been increasingly prioritised in recent years, with commitments to increase government investment and strategic initiatives, to leverage the strong UK research base to boost productivity and economic growth. The UK's 2017 'Industrial strategy' was a central document in UK R&I policymaking but was replaced in March 2021 by a new strategy, '**Build Back Better: Our Plan for Growth**.' Developed in the backdrop of the COVID-19 crisis, the new strategy articulates the ambition to support productivity growth through high-quality skills and training by transforming further education and supporting apprenticeships. Combined with the **UK Research and Development Roadmap** (2020) key priorities include raising research ambitions, investing in leadership within global collaborations, inspiring and enabling talented people and teams, driving up innovation and productivity, as well as committing to long-term flexible investment into world-leading infrastructure and institutions.

In order to **respond to crises** concerning climate change and COVID, **supporting interdisciplinary research** has become **more evident**, as these challenges can only be tackled effectively through a combination of scientific, economic, and behavioural insights. Policymakers and stakeholders in the UK are increasingly interested in understanding the potential for research and innovation to address complex (societal) challenges and missions. Mainly by focussing on cutting across traditional disciplines and sectors, and the role of multi- and inter-disciplinary research and innovation (MIDRI).

Trends at government and public organisations level: Based on the recommendations from a 2017 review of the R&I system, the **UK Research and Innovation** (UKRI) was created in 2018 among other things to increase **coordination** and **support** for **cross-cutting initiatives** across **different discipline-oriented research councils**. The 2017 review and the creation of UKRI have signified a step-change and led to significant investments in new cross-cutting initiatives that demand an IDR approach. In the past decade barriers have been identified in the funding system. In response, IDR funding programmes now commonly involve interdisciplinary peer review with individual reviewers or review panel members, covering different disciplinary and/or sectoral expertise and often having interdisciplinary experience. UKRI sees IDR as crucial to addressing complex societal challenges and addressing government priorities.

Trends at research performing organisation level: Civic society organisations and foundations also largely follow the same principle as the main public research funder, UKRI, i.e., IDR is

supported as a means to an end and not at the expense of good quality monodisciplinary research. **All universities support IDR** to some degree. Some mechanisms at their disposal include (interdisciplinary) research centres focussing on societal challenges or interdisciplinary themes, and support for faculties who are conducting IDR exclusively or as part of their research. Most universities have some **research partnerships with the private sector** though these usually comprise applied research in the same discipline rather than interdisciplinary research.

European Union

One of the recent policy developments in the areas of research and innovation is the new **Strategic Plan for 2020 – 2024** developed by DG Research and Innovation (RTD). The plan outlines six main priority areas to pursue: 1) building a stronger Europe in the world; 2) promoting our European way of life; 3) an economy that works for people; 4) a new push for European democracy; 5) a European Green Deal; and 6) a Europe fit for the digital age. These priority areas represent key societal challenges and in many, if not all, cases are expected to **require a multi** if not **interdisciplinary approach**.

The main accents of the policy debate on research and innovation focus on addressing societal challenges. The focus therefore has shifted from emphasising open science and collaboration to also prioritising innovation and uptake of excellent and cutting-edge research. The main and largest research and innovation programme, **Horizon Europe**, also reflects the priority areas and fields which the EU will pursue from 2020 – 2027. Horizon Europe is built around three pillars: 1) Excellent Science, 2) Global Challenges & European Industrial Competitiveness and 3) Innovative Europe. The second pillar is especially interesting as the programme support is divided across clusters of research fields which in many cases include several related, albeit different disciplines (e.g.: "culture, creativity and inclusive society" or "Climate, Energy and Mobility").

Trends at government and public organisations level: Concerning the evolution of the IDR debate, the previous **DG RTD strategy for 2014 – 2019** mentioned interdisciplinary research more frequently and explicitly, especially in connection with research themes like Open Science, (which featured strongly in the past R&I strategy). Breaking down disciplinary silos and promoting more and easier research collaboration in Europe was seen as an important approach to keeping the EU R&I system innovative and competitive in this previous strategy.

A 2019 report on the achievements of Horizon 2020 concluded that R&I in Europe has become increasingly interdisciplinary, bottom-up, and collaborative. The current **Horizon Europe programme itself reflects a changing emphasis**, namely on (large-scale) societal challenges instead of policy objectives. There is increasing recognition that this cannot be addressed solely through mono-disciplinary thinking. This can be observed in different programmes, such as the Future Emerging Technologies (FET) programme which is more focused on interdisciplinary research.

The EU is a different case to the other countries examined within our study as it operates at a different level of governance. In terms of approaches taken by EU actors which can stimulate IDR, the EU has many agencies and implementing bodies, such as the European Research Council (ERC), the European Research Executive Agency (REA), and newly established EU Innovation Council (EIC).

Within the Horizon programme, the **ERC is one of the main drivers of interdisciplinary research**, which is one of the executive agencies that fall under the pillar '*excellent science*'. Since the setup of the ERC in 2007, interdisciplinarity has been included in its definition of excellence. REA in turn, established in 2009, helps the Commission implement framework programmes, starting with FP7. By implementing Horizon Europe funding and research projects which tackle societal

challenges the agency plays a role in stimulating IDR though promoting interdisciplinary research approaches.

The European Commission works to facilitate IDR and there are various interesting examples at the **Member State level** which reflect a stronger IDR focus; the Max Planck Institute in Germany and the CNRS in France all have **IDR commissions** or **conduct IDR studies** for instance. The European Universities Initiative is another example, where the initiative creates **alliances between universities in Europe** to get Europeans to cooperate across language, borders and disciplines to address societal challenges and skills shortages in Europe.

Trends

The following section distils the main trends in approaches which could be observed from the case studies conducted. At **governmental and strategic level** IDR is pursued for several years now although rarely mentioned explicitly, but rather terms as "mission" or "challenge" led research are used instead. The need for increased collaboration in research is largely acknowledged. On a **public agency, research council and funding body level** reference to IDR is made, more often in terms of a research approach rather than an outcome or a key criterium for allocating funding. Indirectly IDR is stimulated also by providing collaborative spaces for researchers and research organisations. Tailored funding schemes are begin offered to better support IDR, this can be done by: offering longer timeframes for studies and higher budgets, providing funds and programmes which build in time for researchers to network in a consistent manner, and by adopting tailored review processes where experts from different discipline are brought together to evaluate project proposals. At **university level** some interesting practices stimulating IDR have emerged in our study: shared spaces can help in transcending disciplinary boundaries, which is further enabled with activities like workshops and events to promote networking and exchange of ideas. In the UK interdisciplinary bachelor and master programmes have been established in order to develop IDR skills and promote IDR subjects. Targeted stimulation of cooperation between industry and (fundamental) research, as is the case in Finland and the EU, is an important IDR driver as well. Key requirement for IDR is a strong disciplinary understanding in order to merge and unify disciplinary methods, definitions and research approaches.

Comparison Dutch context and potential lessons

Based on the practices identified in our research on different geographical contexts we have distilled several key lessons from the practices. It should be noted that the Netherlands already implements similar actions as the other national and EU contexts described above. In many respects it engages in activities which can stimulate IDR. At **governmental and strategic level** national strategies relating to science and research tend to focus more on thematic priorities and goals which form key challenges (climate change, AI and digitalisation) or mission areas (achieving higher (societal) impact of research and improving social equality) for a country. Similar topics and trends drive the debate in the Netherlands; hence it is not surprising that Dutch practices at the national governmental level regarding interdisciplinary research are very comparable with other contexts. In particular this can already be observed in the Dutch Research Agenda (NWA) which also identifies several main mission pillars within science and research to work towards.

Public agencies, research council and funding bodies level can turn national research priorities into more concrete strategies, including tailoring actions and practices in order to pursue those priorities. Should the Netherlands wish to further support and facilitate IDR, it would be good to consider offering funding programmes tailored to IDR, such as; requiring several disciplines in proposals, including flexible review panels with experts from multiple sectors, supporting researchers to connect with researchers from other disciplines and industries, and/or supporting interdisciplinary research teams in the planning of their research. Current efforts by actors from the Dutch research system could be further consolidated and extended. Collaboration is relatively common in the Netherlands, as can be observed through the Dutch Association of Universities (VSNU) and the Association of Universities of Applied Sciences (Vereniging Hogescholen, VH), as they facilitate cooperation and stimulate partnerships on topics such as AI and digitalisation. For historical reasons Dutch universities tend to house multiple disciplines and faculties. Establishing collaborative spaces within universities and organising activities to facilitate deeper exchanges of ideas could help to increase IDR taking place.

Potential lessons

- Political strategies have the capacity to create political will at the level of government, agency and research organisation. National strategies and programmes can influence the conditions in which research takes place, and by extension, facilitate conditions for interdisciplinary research.
- To establish more funding opportunities for thematic topics and key societal challenges, or to accommodate specific criteria in funding calls, such as the requirement to have multiple disciplines represented in a proposal.
- Flexible and tailored review processes involving panel experts from multiple disciplines are crucial to evaluating IDR proposals.
- The process of finding partners and setting up a research approach takes longer within IDR and should be accounted for in funding and support mechanisms.
- Training researchers in transversal skills such as project management, and other soft skills can contribute to both building teams for IDR projects and contribute to successful execution of IDR projects.

Conclusion

Although the cases and practices presented in this report offer insights and possible methods for addressing challenges related to IDR, not all challenges are addressed equally (e.g. the challenge related to riskier career prospects for IDR researchers). Nevertheless quite some similarities across contexts were observed. More research on these topics could be useful, although capturing the effect of IDR on specific actions and results remains complex. Moreover, to some extent IDR entails a natural evolution, where multiple disciplines gradually morph into one. This can for instance be observed in subjects related to climate, AI, data analysis, behavioural economics, etc. Finally, to embed the many and varied approaches that have been identified in this study a full exploration of existing Dutch practices could help to pinpoint areas and topics where the implementation of best practices would be most beneficial.

1 Introduction

1.1 Rationale behind the study

On behalf of the AWTI, Technopolis B.V. has conducted a study on public policy approaches to stimulating interdisciplinary research (IDR) in three countries and at the EU level. This study examined the EU context in general and specifically three national contexts and their policy approaches to stimulating interdisciplinary research. The AWTI has requested this study as input for its own reflection on interdisciplinary research and how to promote this further in the Netherlands through public policy actions. As part of this study three countries (United Kingdom, Finland and Germany) and the EU policies stimulating IDR have been compared with the Dutch context.

1.2 Research objectives

The research objectives and supplementary questions for this study are presented below. They include a series of supplementary questions added by Technopolis to provide useful information to the AWTI and add to the reflection on interdisciplinary research in the Netherlands.

Research objectives:

The request was to perform an analysis of three countries which are top performers in terms of interdisciplinary research collaboration, with an emphasis on the role which government policy has played therein. Core questions here are:

1. Do these countries have explicit public policies to stimulate IDR or not?
2. How are traditional disciplines positioned?
3. To what degree does the broader government policy on scientific, higher-education, or innovation policy stimulate or inhibit interdisciplinary research collaboration?

Supplementary research questions:

4. What rationale, or consideration, lie behind the policies in each of these three countries to stimulate IDR (in the cases where stimulation of IDR is the explicit aim of the policy)?
5. Which types of interdisciplinary research collaboration exist? Are new types of research and research cooperation involved in IDR collaboration?
6. What can the Netherlands learn from these aforementioned countries?

The objectives have been summarized as follows: 1) explore the public policy approach to stimulating interdisciplinary research in three countries which are similar to the Netherlands and 2) identify lessons and approaches which could be adopted in the Netherlands.

2 Research methods and analytical approach

2.1 Research methods

This explorative study aimed to strike a balance between systematic collection of (often comparable) information from different countries, whilst leaving intact relevant information about the national context.

The **approach** for this study was centred on a series of four case studies of the public policy approaches used to stimulate interdisciplinary and/or transdisciplinary research. Public policy approaches in this context include approaches and practices undertaken by public actors.

This study included the following research activities:

1. A succinct literature review of academic and policy literature available on stimulating interdisciplinary research.
2. Gathering the necessary information to decide which countries to select for the case studies
3. Carrying out three national level case studies as well as a case study at the EU level. Each case study was based on:
    a. Desk research (of both national and EU sources, including the use of EU data sources where relevant),
    b. In-depth semi-structured interviews with relevant actors: we conducted between three and five interviews with relevant actors in each of the case-study countries. We considered the following types of actors as relevant: universities and/or research institutions, research councils, advisory boards, and/or research funding organisations, policymakers involved with regulating science and research, and civic society organisations.
4. Analysis and reporting, including an examination of trends in national approaches and examples of practices used by different types of actors to stimulate interdisciplinary research. Additionally, the analysis distils a number of possible policy options for the Netherlands to consider.

To address the research objectives and explore how national approaches taken in other countries compare with that of the Netherlands, this study draws on work carried out by the AWTI on the Dutch context. A condensed version of this work has been presented in the Appendix A of this report, together with descriptions of the national approaches in our selected countries.

2.2 Analytical approach

To identify countries which could best offer an interesting comparison on the facilitation of interdisciplinary research, it was necessary to develop an approach to both identifying and exploring countries of interest. The process through which our analytical approach was developed is briefly explained in the following sections.

2.2.1 *Exploring national approaches to stimulating interdisciplinary research*

Based on the literature, a number of actors are particularly relevant in facilitating IDR from the public perspective. In this context, across the following **levels** a country's research system can be affected and by extension, IDR can be stimulated either indirectly or directly:

- **National government** and public policy can play a role in promoting, facilitating, or hindering IDR by setting up framework conditions or national conditions for research organisations and research councils and/or funding organisations to operate in. Actors in this category may include national or federal governments and ministries who can influence the research system through policies related to research, science, innovation, or education.
- **Public organisations** which implement national policy. Research councils and/or funding organisations also have a public policy role to play. These types of organisations translate government policy to policy strategies and priorities within the research domain. One way to do this is through conditions attached to research funding. These organisations also have an important role reporting back to the government on what is happening in the research sector(s) they are active in.
- **Research performing organisations** themselves play an important role. Organisations in this category may include universities, research institutes and centres, NGOs or other private organisations. The internal structure of these organisations, and how they organise their research influences IDR.

Research most often points to challenges and approaches to addressing said challenges at the research organisation level and at the research council and/or funding organisation levels.

2.2.2 *Analysing prevalence of IDR in countries*

Assessing the prevalence of interdisciplinary research in countries and getting a clear picture of how this level of interdisciplinary research was achieved was a significant challenge. Interdisciplinary research is not an outcome which governments or public organisations tend to monitor actively and as such indicators are rarely available. Moreover, the (indirect) information that is available was not always comparable. Considering these limitations this explorative study has focused on collecting information on different aspects, outputs or symptoms of a country's research environment. Examples of indicators which suggest a prevalence of interdisciplinary research can include research outputs (such as research publications or research projects), the presence of funding instruments tailored to interdisciplinary research, numbers of interdisciplinary research centres or universities, or specific public policy strategies which refer to interdisciplinary research.

In the absence of direct indicators for IDR, the selection of countries best suited for a comparison to the Dutch environment was based on the following criteria:

- R&D expenditure, reasoning that R&D expenditure reflects political commitment to a strong R&D sector, which may facilitate a higher level of IDR;

- the degree of participation in FP7 and Horizon2020 projects, as these projects tend to have a higher level of interdisciplinary research because they tend to involve organisations from multiple countries, across several disciplines;
- and finally the availability of financial instruments that have -to some extent- IDR as a precondition.

These indicators were operationalized as follows:

- **R&D expenditure** was based on Eurostat data on R&D expenditure as % of GDP
- The **number of FP7 and Horizon 2020 projects** was based on the data collected and analysed by the SHAPE-ID project (Shaping Interdisciplinary Research in Europe), which examines interdisciplinary in the EU[1] it has been possible to distil where IDR approaches were used between 2007 and 2020. The top performers in terms of numbers of projects with an interdisciplinary focus have been used to select candidate countries for further study[2].
- From a more qualitative perspective, via literature review we also examined **funding options** and other actions targeting, or at least facilitating, IDR by countries across the EU. Countries encountered with such funding options are presented in Table 1 below)

Table 1 Countries with funding options tailored to interdisciplinary research

Country	Organisation	Description of measure or initiative
Switzerland	Swiss National Science Foundation (SNSF)	Sinergia - an annual interdisciplinary programme call
Austria	Austrian Science Fund (FWF)	Young Independent Research Groups (YIRG) - an postdoc programme for innovative, interdisciplinary teams
Finland	Academy of Finland	Within the funding application procedures the Academy of Finland allows researchers to indicate several disciplinary fields which are covered by their research project. The Academy indirectly promotes multidisciplinary research in this way.[3]
France	The French National Research Agency	Experiments with interdisciplinary review approaches, drawing together experts from its 42 panels to put together 13 intersectoral review panels
Belgium, Flanders	Fonds Wetenschappelijk Onderzoek (FWO)	The FWO has one expert panel for interdisciplinary research besides is 7 disciplinary peer review panels[4]
UK	UK Research & Innovation (UKRI)	Provides tailored training for interdisciplinary reviewers and evaluators on IDR proposals, notably regarding bias.
Germany	DFG	Provides funding for interdisciplinary research projects

Authors, based on ScienceEurope Symposium on Interdisicplinarity[5]

[1] ShapeID, (2020), ShapeID: Shaping Interdisciplinary Practices in Europe, available at: https://www.shapeid.eu/.

[2] Based on data from: ShapeID, (2020), Inter- and transdisciplinary projects in FP7 and Horizon 2020 (2019), available at: https://www.shapeid.eu/research-data/ .

[3] Jokela, T., (2018), Multidisciplinarity in Funding Instruments at the Academy of Finland – Science Europe, November 2018, available at: https://www.scienceeurope.org/media/rigohfno/tiina_jokela_multidisciplinarity.pdf .

[4] https://www.fwo.be/nl/het-fwo/organisatie/fwo-expertpanels/panels-fundamenteel-onderzoek/interdisciplinair-onderzoek/interdisciplinair-expertpanel/

[5] ScienceEurope, (2019), Science Europe Symposium on Interdisciplinarity, June 25th, 2019, available at: https://www.scienceeurope.org/our-resources/science-europe-symposium-on-interdisciplinarity/ .

Based on the information gathered (an overview is provided in Table 2) we selected **Germany**, **Finland** and **United Kingdom** for further analysis via the case studies.

Table 2 Overview of how countries perform along different criteria

Country	IDR funding options	R&D expenditure, 2018 (those spending equal to or more than NL)	Number of FP7/H2020 IDR projects
Germany	yes	3,12%	218
France	yes	2,2%	152
Belgium	yes	2,67%	84
Finland	yes	2,76%	(31 – not in top 10)
Austria	yes	3,14%	(49 – not in top 10)
Sweden	yes	3,32%	(45 – not in top 10)
United Kingdom	yes	1,73%	417

Various sources

3 Literature review on interdisciplinary research policies in Europe

This section provides a summary of the most important findings from available literature on interdisciplinary research. It describes both the main obstacles and challenges to implementing IDR and provides an overview of policy responses to mitigate these challenges and simulate IDR. We start however, with a section clarifying the understanding of interdisciplinary research and its importance.

3.1 Defining interdisciplinary research

There does not appear to be one single, accepted definition of interdisciplinary research. The term is generally used in such a way that it describes research which is conducted across the boundaries of several disciplines. This involves bringing together expertise and knowledge, skills and competences, as well as information and data from different disciplinary fields to achieve new insights, understandings, scientific breakthroughs and achievements.

Due to its cross-cutting nature, this type of research is also often referred to as multidisciplinary research, transdisciplinary research and cross-disciplinary research. Various academic[6] and grey sources[7] point to the semantic confusion here and the fact that these **terms are often used interchangeably[8]**. The European Research Council, the ERC, made the same observation, indicating that these terms are used interchangeably, and that disentangling the definition is perhaps not strictly necessary for the purposes of facilitating and stimulating such research[9]. To illustrate this, the recent Country Specific Recommendations from the EU towards Member States on improving their R&I environments uses the terms multi-disciplinary, interdisciplinary, and cross-cutting research when referring to research which transcends the boundaries of single disciplinary fields[10]; the new EU communication on the European Research Area (ERA), does so as well.[11]

While many academic and grey publications choose not to distinguish between the terms interdisciplinarity multi-disciplinarity and transdisciplinarity, several authors have made attempts to disentangle this area. A commonly used set of definitions for these three terms in research on this topic is presented on the next page[12].

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[6] Gibson, et. Al. (2019), Challenge-led interdisciplinary research in practice: Program design, early career research, and a dialogic approach to building unlikely collaborations, Research Evaluation, 28(1), 2019, 51–62.

[7] Technopolis, (2016), Landscape Review of Interdisciplinary Research in the UK - Report to HEFCE and RCUK by Technopolis and the Science Policy Research Unit (SPRU), University of Sussex, available at: http://sro.sussex.ac.uk/id/eprint/65332/1/2016HEFCE_Landscape%20review%20of%20UK%20interdisciplinary%20research.pdf .

[8] Klein, J. T., (2008), Evaluation of Interdisciplinary and Transdisciplinary Research: A Literature Review, American Journal of Preventive Medicine, Volume 35, Issue 2, Supplement, August 2008, Pages S116-S123.

[9] ERC, (2019), SUPPORTING INTERDISCIPLINARITY, A CHALLENGING OBLIGATION, speech by ERC President Prof. Jean-Pierre Bourguignon, 18th September 2019, Lisbon, Portugal. Available at: https://erc.europa.eu/news/supporting-interdisciplinarity-challenging-obligation .

[10] European Commission, (2020), Research and Innovation analysis in the European Semester 2020 Country Reports – Compilation, available at: https://rio.jrc.ec.europa.eu/library/research-and-innovation-analysis-european-semester-2020-country-reports-compilation

[11] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS: A new ERA for Research and Innovation, Brussels, 30.9.2020 COM(2020) 628 final. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0628&from=EN .

[12] Toomey, A. H., Markusson, N., Adams, E., and Brocket, B., (2015), GSDR Brief, 2015: Inter- and Trans-disciplinary Research: A Critical Perspective, Lancaster Environment Centre, Lancaster University, available at:

"*Multidisciplinarity draws on knowledge from different disciplines but stays within their boundaries. Interdisciplinarity analyzes, synthesizes and harmonizes links between disciplines into a coordinated and coherent whole. Transdisciplinarity integrates the natural, social and health sciences in a humanities context, and transcends their traditional boundaries*."

The authors thus understand multidisciplinarity, interdisciplinarity and transdisciplinarity as being on the same continuum moving towards more integration. Indeed, the authors indicate that terms most often associated with each of these three strands are "additive, interactive, and holistic".[13]

Turning to definitions used in the Dutch research environment, the **Dutch KNAW** takes a similar understanding. According to the KNAW, interdisciplinarity involves the combination of knowledge from different disciplines to arrive at new scientific avenues and fields through a symbiosis of disciplinary questions, methods, and outputs. Multidisciplinarity describes research where individuals from different disciplines come together to research a given issue or problem, each working from their own disciplinary perspectives. Multi-disciplinarity thus seems to draw together different disciplinary perspectives while interdisciplinary research involves an integration of ideas, methods, and data from different disciplinary fields.[14] The KNAW, in a study on interdisciplinary research in 2015 indicated that much of the research examined in the context of that study resembled multi-disciplinary research than interdisciplinary or transdisciplinary research.[15]

In a document describing different concepts and definitions related to the Dutch research environment **AWTI** provides definitions for these three concepts as well[16]:

- **Multidisciplinary research collaboration**: when two or more disciplines are involved in a given research project, aiming to study and address a given problem by combining their disciplinary insights. In this type of research, researchers work from their own disciplinary definitions, principles, and methods. There is little to no interaction amongst the disciplines though the disciplines can be reliant on each other to address the research problem at hand.
- **Interdisciplinary research collaboration**: refers to research cooperation between one or more disciplines where there is interaction and exchange of ideas. This leads to the enrichment of understanding and insight, and to the addressing of complex problems and issues. During the research process, information, data, methods, instruments, theories, concepts and perspectives are exchanged to establish mutual understanding across the disciplines.
- **Transdisciplinary research cooperation**: this concept includes interaction between disciplines but goes beyond this, creating interaction and cooperation between research,

https://sustainabledevelopment.un.org/content/documents/612558-Inter-%20and%20Trans-disciplinary%20Research%20-%20A%20Critical%20Perspective.pdf .

[13] Choi, B.C.K. and Pak, A. W. P., (2006), Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness, Clin Invest Med. 2006 Dec;29(6):351-64. https://pubmed.ncbi.nlm.nih.gov/17330451/ .

[14] De Jonge Akademie (DJA), (2018), Grensverleggend: kansen en belemmeringen voor interdisciplinair onderzoek, available at: https://www.knaw.nl/nl/actueel/publicaties/grensoverstijgend/@@download/pdf_file/20180327-verkenning-grensoverstijgend-de-jonge-akademie-web.pdf .

[15] KNAW, (2015), Grensverleggend: kansen en belemmeringen voor interdisciplinair onderzoek, available at: https://www.knaw.nl/shared/resources/actueel/bestanden/samenvatting-grensverleggend-kansen-en-belemmeringen-voor-interdisciplinair-onderzoek .

[16] AWTI, Interne Nota Terminologie.

industry, and society. The scientific frameworks are combined with the frameworks used by other types of stakeholders.

For the purposes of this study, the term "**interdisciplinary research**" (IDR) was adopted to reflect the understanding taken by the KNAW and which has also been adopted by the AWTI[17].

3.2 Main challenges to conducting IDR

The **value and relevance of IDR** has also been discussed frequently in academic and grey literature for its ability to address key societal challenges and cross-cutting issues which cannot be addressed from any one disciplinary perspective. In the face of issues such as climate change, digital transformations of societies, social exclusion, healthcare and medicine, to name a few, drawing together insights from different fields appears increasingly necessary. This perspective is shared by academics, researchers and scientists, and policymakers alike. Conducting IDR however can be (quite) challenging. From the literature review we can summarise six main challenges:

1. **Higher complexity and longer timeframes**: one of the first challenges to conducting IDR is the fact that such projects tend to be more complex in nature. When drawing together different fields and disciplines, designing, and implementing research becomes automatically more complex. Beyond that, IDR projects also tend to need a longer time frame before research outputs can be achieved as researchers need more time to align their research objectives and approaches[18] (see also the challenge below on disciplinary cultures). Indeed, the Global Research Council indicated in 2016 that time frames for starting up interdisciplinary research projects typically takes about two years[19]; therefore, a usual project duration of three to four years is too short a timeframe for interdisciplinary research. These aspects, together with the fact that IDR tends to pursue new scientific avenues, tend to make IDR projects riskier endeavours than mono-disciplinary research projects.
2. **Finding suitable research partners across disciplines:** finding suitable research partners is a challenge at the best of times within a research community. However, finding suitable research partners across research communities tends to be even more time-consuming for interdisciplinary researchers. Identifying and building up relationships in less familiar networks all cost more time. [20]
3. **Availability of appropriate IDR funding**: the availability of funding tailored to IDR projects is a third element which can inhibit IDR projects and is one of the most commonly cited challenges to IDR. As IDR tends to be more complex and follows lengthier time frames, the provision of funding opportunities by funding bodies tends to more complicated than for mono-disciplinary projects and this can limit the availability of appropriate funds. National

[17] AWTI, Interne Nota Terminologie.

[18] Bianca Vienni Baptista, Catherine Lyall, Jane Ohlmeyer, Jack Spaapen, Doireann Wallace and Christian Pohl, (2020) SHAPE-ID: Shaping Interdisciplinary Practices in Europe - Final Report on Understanding of Interdisciplinary and Transdisciplinary Research – Policy Brief, available at: https://zenodo.org/record/3824954#.YLi8ovkzZPZ .

[19] Global Research Council, (2016), Interdisciplinarity - Survey Report for the Global Research Council 2016, available at: https://www.globalresearchcouncil.org/fileadmin/documents/GRC_Publications/Interdisciplinarity_Report_for_GRC_DJS_Research.pdf .

[20] Technopolis, (2016), Landscape Review of Interdisciplinary Research in the UK - Report to HEFCE and RCUK by Technopolis and the Science Policy Research Unit (SPRU), University of Sussex, available at: http://sro.sussex.ac.uk/id/eprint/65332/1/2016HEFCE_Landscape%20review%20of%20UK%20interdisciplinary%20research.pdf .

research councils and research funding organisations are developing and implementing different mechanisms to provide more tailored and effective funding opportunities for IDR, but these calls require more time and resources to develop and implement. A key reason for this is that being able to properly understand and assess the quality of IDR proposals and applications requires a multi-disciplinary set of panel experts, as well as developing appropriate assessment and evaluation criteria[21].

4. **Disciplinary languages, data, and cultures**: when bringing together people from different backgrounds, finding a common language to speak in can be a challenge. Besides the challenge of establishing a common disciplinary language and jargon between researchers, different disciplines can also be characterised by different cultures of work and interaction between individuals[22]. Furthermore, bringing together different disciplinary approaches to collecting and analysing data is another issue which tends to be more difficult in interdisciplinary research projects[23]. Establishing research priorities, choices regarding what kind of data is needed, how to collect said data and how to analyse data in an interdisciplinary field make interdisciplinary research projects more complex[24].
5. **Skills and leadership qualities:** within IDR projects, disciplinary skills and knowledge are of course important. However, because these projects tend to be more complex, of a longer time frame, and involving more diverse actors from different professional backgrounds, different (soft) skills and leadership qualities are needed to effectively manage IDR projects[25]. Transversal leadership qualities and soft skills play a comparatively bigger role in IDR projects[26]. Stimulating these types of skills and research qualities amongst research project leaders forms another challenge to stimulating IDR.
6. **Research careers**: careers of researchers in interdisciplinary fields do not follow standard disciplinary career paths. Interdisciplinary researchers move between research communities and fields[27]. In practice it appears more challenging for employers of researchers to recognise the knowledge and expertise which interdisciplinary researchers have achieved and built up, which can make it difficult for such researchers to find

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[21] ERC, (2019), SUPPORTING INTERDISCIPLINARITY, A CHALLENGING OBLIGATION, speech by ERC President Prof. Jean-Pierre Bourguignon, 18th September 2019, Lisbon, Portugal. Available at: https://erc.europa.eu/news/supporting-interdisciplinarity-challenging-obligation .

[22] Science Europe, (2018), Symposium Report: Interdisciplinarity, available at: http://scieur.org/interdisc-symp

[23] ERC, (2019), SUPPORTING INTERDISCIPLINARITY, A CHALLENGING OBLIGATION, speech by ERC President Prof. Jean-Pierre Bourguignon, 18th September 2019, Lisbon, Portugal. Available at: https://erc.europa.eu/news/supporting-interdisciplinarity-challenging-obligation .

[24] Bianca Vienni Baptista, Maciej Maryl, Piotr Wciślik, Isabel Fletcher, Anna Buchner, Doireann Wallace and Christian Pohl, (2019), SHAPE-ID: Shaping Interdisciplinary Practices in Europe: Preliminary Report of Literature Review on Understandings of Interdisciplinary and Transdisciplinary Research, available at:

[25] Technopolis, (2016), Landscape Review of Interdisciplinary Research in the UK - Report to HEFCE and RCUK by Technopolis and the Science Policy Research Unit (SPRU), University of Sussex, available at: http://sro.sussex.ac.uk/id/eprint/65332/1/2016HEFCE_Landscape%20review%20of%20UK%20interdisciplinary%20research.pdf .

[26] Gibson, et. Al. (2019), Challenge-led interdisciplinary research in practice: Program design, early career research, and a dialogic approach to building unlikely collaborations, Research Evaluation, 28(1), 2019, 51–62.

[27] Technopolis, (2016), Landscape Review of Interdisciplinary Research in the UK - Report to HEFCE and RCUK by Technopolis and the Science Policy Research Unit (SPRU), University of Sussex, available at: http://sro.sussex.ac.uk/id/eprint/65332/1/2016HEFCE_Landscape%20review%20of%20UK%20interdisciplinary%20research.pdf .

employment and to grow in their careers. As such, there is more inherent risk in an interdisciplinary research career which in turn is an obstacle to the pursuit of further IDR[28].

3.3 Common approaches for addressing challenges to IDR

The literature reviewed for this study also shows how common challenges to facilitating interdisciplinary research could be addressed. Different types of actors can be involved in stimulating IDR bottom-up (research level) and the actors stimulating IDR top-down (national level), are sometime conceived in terms of push and pull forces. Based on the literature reviewed, a summary has been made. This is presented in Table 3, together with the key approaches and recommendations given by academic and grey literature on stimulating IDR.

It can be observed that interdisciplinary research is often not explicitly mentioned in national level policy documentation. This confirms the idea that most initiatives and approaches to stimulate IDR take place bottom-up, at the research organisation, RFO, research council, and researcher level. Looking at for example the Netherlands, France[29], and Sweden[30] interdisciplinary research is considered important as a means to an end, but not a goal by itself, perhaps explaining why it is often not explicitly mentioned in national strategies.

Table 3 Challenge areas and most common recommendations from literature

Challenge area	Recommendations and approaches from literature	Source
Higher complexity and longer timeframes	Incorporate more budget within IDR funding instruments for the extra time and complexity involved in IDR projects	SHAPE Policy Brief (2020); Technopolis (2016); Science Europe (2018)
	Allow for longer timeframes within funding programmes supporting IDR projects	SHAPE Policy Brief (2020); Technopolis (2016); Earnshaw (2020)
Finding suitable research partners across disciplines	Develop communal spaces where IDR researchers can find each other and network	SHAPE Policy Brief (2020); GRC (2016)
Availability of appropriate IDR funding	Establish more IDR funding calls and engage with IDR communities when designing and implementing IDR calls	SHAPE Policy Brief (2020); GRC (2016)
	Tying IDR funding calls to societal-challenges: framing calls as challenge-led projects can create more support from research communities, policymakers, and other actors	GRC (2016); Earnshaw (2020)
	Adapt proposal review mechanisms using mixed panels of experts, multiple review rounds (a screening round and an assessment round), more appropriate evaluation criteria.	SHAPE Policy Brief (2020); GRC (2016); ERC (2019), Science Europe (2018), Technopolis (2016); OECD (2020)

[28] Bianca Vienni Baptista, Catherine Lyall, Jane Ohlmeyer, Jack Spaapen, Doireann Wallace and Christian Pohl, (2020) SHAPE-ID: Shaping Interdisciplinary Practices in Europe - Final Report on Understanding of Interdisciplinary and Transdisciplinary Research – Policy Brief, available at: https://zenodo.org/record/3824954#.YLi8ovkzZPZ .

[29] https://www.enseignementsup-recherche.gouv.fr/pid25366/acces-thematique.html?theme=108&subtheme=397

[30] https://www.government.se/press-releases/2016/11/collaborating-for-knowledge--for-societys-challenges-and-strengthened-competitiveness/

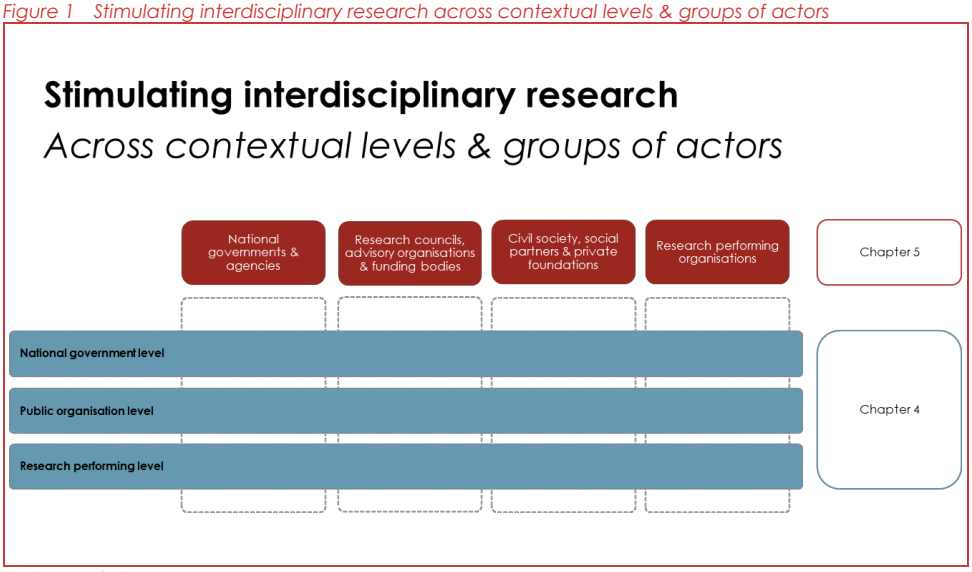
Challenge area	Recommendations and approaches from literature	Source
	Brief evaluators on good practices and evaluation frameworks for assessing IDR projects	SHAPE Policy Brief (2020); GRC (2016); Science Europe (2018)
Other skills and leadership qualities required & Different disciplinary languages, data, and cultures	Reflect on how best to train interdisciplinary researchers and design education and training programmes which cultivate these skills	Science Europe (2018)
	Support more development of appropriate leadership qualities and soft skills for IDR projects	GRC (2016); Technopolis (2016)
	Improve continued training of students and researchers in interdisciplinary skills (across disciplines, across different educational and research settings)	SHAPE Policy Brief (2020); ERC (2019); Earnshaw (2020)
	Policymakers can develop incentives to universities and research organisations to train researchers in interdisciplinary, transversal skills	SHAPE Policy Brief (2020); Earnshaw (2020); OECD (2020)
Research careers are comparatively riskier	Universities should be supported in trying to build capacity for IDR by training researchers more in IDR related skills and competences.	SHAPE Policy Brief (2020); Technopolis (2016)
	Universities and research organisations should be encouraged to review and adjust career progression policies to make IDR careers less risky	SHAPE Policy Brief (2020); Technopolis (2016)
Other recommendations	Across different challenge areas, a centralised space with good practices, tools, methods and materials could aid in researchers in navigating different challenges related to IDR	SHAPE Policy Brief (2020); Earnshaw (2020)
	Actively work towards highlighting the value and importance of IDR in the R&I, education, and policymaking communities	GRC (2016); ERC (2019)

Technopolis (2021), based on various sources

Zooming in on what has been observed in practice within the case studies, in the following two chapters we will focus on the **trends** in stimulating interdisciplinary research (chapter 4) and provide an **overview of main practices** and applicable insights (chapter 5).

The trends presented in chapter 4 are structured along the three contextual levels in terms of national government, public organisations and research performing organisations. To provide a clearer picture, on how groups of actors can influence and undertake practices to stimulate IDR within the different levels, in chapter 5 the practices are structured along the four different actor groups distinguished in this study (see figure 1).

Figure 1 Stimulating interdisciplinary research across contextual levels & groups of actors



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4 Trends in stimulating interdisciplinary research

To explore different approaches to stimulating interdisciplinary research, several in-depth case studies have been developed. The case studies on Germany, Finland, the United Kingdom, and the EU aim to explore the main public policy discussions regarding research and science in a country, the degree to which societal challenges and interdisciplinary research feature in current policy debates, and in how far policy priorities and actions have shifted during the last five to ten years.

In this chapter, findings from the four case studies are used in an overall analysis of the main trends. In addition, contributions by the AWTI regarding the Dutch context and the role of interdisciplinarity have been included as well. The summaries of all case studies are presented in Appendix A. In this chapter we examine the main trends which emerged from the case studies in terms of different national approaches to stimulating interdisciplinary research. We identified trends across three levels: 1) national government (i.e. political context), 2) public organisation , and 3) research performing organisation. We provide an overall reflection in section 4.4, together with a succinct commentary on how these trends compare with those we see in the Dutch context.

4.1 National government level

One of the main observations for Finland, the UK, and the EU is that at the political level, **policy strategies rarely mention interdisciplinary research** explicitly. This is perhaps not overly surprising given that interdisciplinary research can be considered more a means to an end than a research outcome in its own right. Germany forms an exception here as its *Excellence Initiative & Excellence Strategy* ("Exzellenzstrategie") refers explicitly to IDR as a priority area.

There is, however, a clear tendency in national policy to refer to **key thematic areas and societal challenges** as priorities within the national research strategy. The EU refers to large-scale, complex challenges ("wicked problems"). The UK, Finland, and Germany all have political strategies which intend to target similar issues such as climate change and sustainability, digitization and AI, as well as the need for more economic and social impact of research. At the EU strategic level, policies for science and research tend to focus on similar areas and avenues for science and research, namely topics related to climate change and sustainability, digitization, and enhancing the impact of research.

In response to these challenges research strategies do not tend to refer to interdisciplinary research but instead refer to **"mission" or "challenge" led research** (Germany, Finland, the EU). Policy strategies, which cite these types of complex, large-scale challenges or societal missions appear to invite interdisciplinary research approaches to tackle such challenges. Some experts in IDR note that this concept of challenge or mission-led research, and the role of interdisciplinary research in pursuing challenge or mission led research come and go off from political discourse as they become in or out of fashion.

Another trend is that many of the political strategies and policy debates described in the case studies acknowledge the need for **increased collaboration in research**. This is evident in the UK, the Finnish and the German cases. In the UK, the Finnish, and EU cases. Here calls are published targeted to increase impact of research and public private partnerships between enterprises, research centres and universities so that research findings can be scaled-up or built upon in order for society to be able to benefit more from research.

Looking at how the policy debates on IDR have changed and evolved during the last five to ten years, it becomes apparent that in Finland and Germany **interdisciplinary research has been pursued for several years now**:

- The Finnish Academy of Finland acknowledged the need for more research collaboration across disciplines as early as 2002.
- In German, policy debates on IDR have reportedly been part of political discussion for many years now. The German Science Council indicates that IDR has been a hot topic in the science policy discourse over the past decades and is not a new trend.
- In the UK, as of 2016 the need to enhance research impact and global collaboration became apparent, as well as the role which IDR could play in doing so.
- In the EU collaborative, bottom-up research which crosses disciplinary boundaries has been on the policy agenda for several years now, being cited in the previous EU Research and Innovation Strategy and being pursued through Framework Programme instruments such as the ERC and in Horizon 2020 (and Horizon Europe) programmes.

Put together, it appears that IDR has been part of the scientific policy debates for some time in these countries. This echoes observations by some of the interviewees for this study that challenge-led research and IDR are topics that come in and out of fashion.

Drivers of the current policy focus: the analysis above shows that similar challenges across different (national) contexts have had similar effects on policy strategies and priorities, with a role for IDR in tackling these challenges. There is rising awareness of challenges such as climate change, the use of digital technology and AI across societies and economies, and the response to infectious diseases such a Covid-19. This in turn has resulted in a call for better social equity from research.

Approaches in the Netherlands

In the Netherlands, the main strategic research agenda, the NWA, mentions IDR explicitly as an area of attention, however not in great detail. As such the Dutch approach to IDR at policy-level is comparable to approaches in other countries and the EU where interdisciplinary research is usually not mentioned extensively at this level of governance.

The Dutch strategies and priorities for science and research have similar drivers as the other countries examined in this study. Societal challenges are important topics in the Dutch policy debates. Unique to the Netherlands is the debate within the science and research policy about working conditions within science and academia. How to measure scientific outputs and research valorization, and the effects of how these are measured on academic careers together with its effects on equal opportunities are key topics in this debate which have not been observed in other countries to the same extent.

4.2 Public organisation level

IDR is more often mentioned more explicitly by research councils, advisory bodies, and funding organisations at the public organisation level. A variety of different actions have been observed at this level which directly or indirectly stimulate IDR.

A first trend is that some of the **countries studied have public agencies which do make explicitly references to IDR** as a means for addressing large, complex, societal challenges (which form part of national research and innovation priorities). In Finland for instance the main research funding agency, the Academy of Finland, refers specifically to IDR as an approach to carrying out societally important research. The Academy of Finland has since established the Strategic

Research Council in pursuit of supporting more cross-sectoral, collaborative research in Finland. In Germany, the Federal government set up the Excellence Initiative & Excellence Strategy in 2016 to strengthen cutting-edge university research. Funding is provided for clusters of excellence in specific research fields and universities of excellence as strategic support for outstanding university locations. Amongst other things, this strategy encourages collaboration and networking at the university level in pursuit of research excellence.

Interestingly however**, IDR is not always made explicit** at the level of public agencies and funding bodies. As a consequence, there is some variation in the approaches taken to stimulate an interdisciplinary approach. As IDR is more a research approach or process than an outcome, some organisations and **funding programmes seek to support the process more than the research outcome.** Programmes opt to facilitate an interdisciplinary and collaborative process rather than mention IDR as a key criterium for submitting a research proposal. For instance, the German Volkswagen fund does not specifically mention IDR but does refer to tackling large scale research challenges in AI and asks research teams to indicate how regularly they will meet and how their collaboration will take shape. The ERC too includes a face-to-face meeting with the research teams during the final stages of reviewing proposals for the Synergy Grant programme. The aim thereof is to gauge the collaborative spirit amongst researchers to ensure that the team is equipped to collaborate well throughout a long research project.

Public organisations can also **invest in providing collaborative spaces for researchers and research organisations** to come together in. Facilitating a collaborative, cross-disciplinary process therefore seems to be an approach to indirectly stimulating IDR as well. The German Centre for Interdisciplinary Research (ZiF) not only has researchers living at the institution to promote this sense of trust, but also organises regular workshops for the exchange of interdisciplinary ideas. At the EU level, the newly established European Innovation Council (The EIC), seeks to bring together researchers, institutions, enterprises, and civil society, to apply fundamental research in practice and raise its social and economic impact. The EIC reflects a growing emphasis at EU level to improve collaboration between private sector, enterprises and researchers and public bodies. In Finland, the Flagship Programme invites cooperation between universities and applied universities and enterprises as well, thereby facilitating collaborative spaces.

Approaches in the Netherlands

Public agencies and funding bodies in the Netherlands reflect a similar tendency to facilitate the conditions for IDR by removing obstacles to the interdisciplinary process. The NWO for instance organizes meetings and workshops to allow researchers to come together, converse and possibly collaborate.

Institutions can adopt a more **flexible approach to defining which research areas to fund**. Some of the organisations in Finland (Academy of Finland), Germany (Centre for Interdisciplinary Research (ZiF)), and the UK (thematic research centre approach) all offer room for research priorities to be established in both a top-down as well as a bottom-up manner: The organisations define broad research areas and priorities, and researchers can submit proposals combining disciplines which are relevant to those broad priorities. This illustrates that a certain degree of flexibility and responsiveness to ideas from the research community is important within funding programmes. The ERC programme grants try to emphasize IDR and tailor funding instruments to this type of research. They promote the research projects supported, facilitating bottom-up interdisciplinary research by making the grant money mobile. This means that grant money is attached to the individual rather than the institution.

A further common trend which can be observed at the public organisation level is **that funding programmes** are offered which have been more **tailored to interdisciplinary research**. Funding programmes tend to acknowledge the realities of interdisciplinary research and include differences to regular funding programmes by accommodating those specific challenges. This includes for instance:

- Offering **longer timeframes for studies and higher budgets** to accommodate the fact that research addressing complex societal challenges take longer and cost more money. The ERC for instance has specifically tailored funds, namely the Synergy Grants, which accommodate this aspect.
- **Finding suitable research partners** can be a very real challenge for IDR projects. As such another trend noted in the national approaches are that funds and programmes can be provided which build in time for researchers to network in a consistent manner. The Planning Grant offered by the German Volkswagen private research foundation is designed to help researchers plan their research proposal. In Finland, the Academy of Finland Flagship Programmes are also designed to embed collaboration between universities.
- Furthermore, once a team and an IDR project proposal has been developed, one of the key challenges is often **how best to review IDR proposals** and on how best to allocate funding. Tailored review processes where experts from different discipline are brought together to evaluate project proposals is a recommendation offered in the literature. Countries such as Finland and its Academy of Finland have a review approach which brings together experts from different disciplines in review panels. However, this can be challenging for disciplines which are fairly new and more niche; finding experts in a smaller research community with availability to review proposals can be a challenge. The ERC too has a tailored review process for all of its grant types, where individuals submitting a proposal can indicate the main disciplines their research will be focused on. Based on these indications specific combinations of experts examine the proposals and several review rounds are held. Within ERC instruments the Synergy Grants appear most tailored to interdisciplinary projects as the budgets and time frames are largest here and a different, more tailored review process takes place, drawing on more external panel experts to ensure a sound review of the proposal.

4.3 Research performing level

At the **university level**, **trends which stimulate IDR as less prevalent**. This is also a methodological issue related to our study scope and design, as examining individual policies and practices across universities was not feasible within the current study. However, some interesting practices exist which can stimulate IDR.

A first notable trend links back to **providing frameworks for collaboration across universities** and within different departments at universities. In the United Kingdom, virtual as well as physical research centres exist which are affiliated with universities. These research centres provide spaces for individuals from different universities to come together, meet and discuss about research avenues, which may transcend disciplinary boundaries as well. This national approach applies to various universities and specifically include: 1) physical research centres, which involve the co-location of different disciplinary expertise in one place and 2) virtual research centres where researchers situated in disciplinary departments and faculties but are also affiliated to thematic centres and networks sitting across one or several institutions.

In Finland, universities have undertaken more collaboration with universities of applied sciences through programmes such as the Flagship Programmes for researchers. Furthermore, several

years ago some universities merged, bringing together different disciplinary focuses into one institution. This, however, does not necessarily mean that more interdisciplinary work takes place. There have been some examples from Finnish researchers seeking to remedy the lack in actual cooperation within such universities housing multiple disciplines by setting up platforms and standing networks to provide a collaborative space for researchers to regularly come together.

Further university level actions include the recent establishment of **an interdisciplinary Bachelor programme in the UK,** the Bachelor for Arts and Sciences, where researchers receive training in interdisciplinary skills and can combine different disciplines within a given study. While this is one concrete example of an interdisciplinary degree in the countries under study, there is a methodological caveat to consider here, namely that as interdisciplinary topics become more accepted, they cease to be seen as interdisciplinary but rather as a new field in themselves. Environmental governance, conservation studies, design studies, or AI and data science studies, are all examples of fields for which degrees exist[31] suggesting that at undergraduate level the boundaries of traditional domains and faculties are less stringent than before.

A further trend which can be observed in some of the cases, namely in Finland and the EU, are **trends towards stimulating more cooperation between industry and (fundamental) research**. The funding offered by Business Finland, the Finnish agency for enterprises and innovation, is increasingly focused on interdisciplinary research. At the EU level, commercializing and scaling up research outputs is a popular element within the European Innovation Council Pathfinder Programme (building on its predecessor programme, the Future and Emerging Technologies programme within Horizon 2020).

Approaches in the Netherlands

At the research organisation level, Dutch universities are often interdisciplinary in the sense that they have traditional disciplinary faculties within the university, and separate affiliated interdisciplinary research institutes. Although it is unclear to what extent the existence of these institutes triggers interdisciplinary research, the proximity of different disciplines within a given university offers fertile ground for stimulating collaborative, interdisciplinary research.

Similar to the EU and Finland, there is a trend to connect researchers, universities, and research institutes with enterprises and to stimulate collaboration so that science and research can be applied and scaled-up. In this sense the importance of increasing the impact and benefits of research in society (and the facilitation of interdisciplinary research approaches as a means to this end) are also prevalent trends in the Netherlands.

A final interesting point at the research organisation level is the question of how the **relationship between mono and interdisciplinary research** is viewed by the research community. However, the relationship between these two research approaches was not a debate which was strongly evident across the national approaches explored in this study. Based on the research conducted it appears that there is some tension between traditional disciplines and monodisciplinary approaches in Germany and the UK, though this could be explored further. However, based on current information, it does not appear that this is a very dominant debate within the research communities in these countries. EU experts interviewed in turn highlight that this tension is fruitless and that to properly engage in interdisciplinary research, researchers involved must also have a strong disciplinary understanding. If such an understanding is not

[31] Keystone, Masters Programs in Interdisciplinary Studies in Europe 2021/2022, available at: https://www.masterstudies.com/Masters-Degree/Interdisciplinary-Studies/Europe/ .

present, it becomes difficult to merge and unify disciplinary methods, definitions, and research approaches as is require for interdisciplinary research.

4.4 Reflections on main trends

The previous paragraphs have summarised the main trends which can be observed from the approaches taken by different public actors in Germany, Finland, the UK and the EU. There are some reflections and remarks to be considered regarding those trends, including how these approaches compare to the Dutch approach.

Remarks and reflections on trends

One of the first remarks is that the level of interdisciplinarity remains difficult to measure. IDR is often not clearly defined or operationalized, and as a consequence is often not monitored by public organizations. While interdisciplinarity is on occasion explicitly mentioned as being important to pursue by governments and public agencies (in Germany for instance), this is rare. This is perhaps not surprising as an interdisciplinary approach is usually not a priority or an objective which must be achieved; instead, it is a process, or a means to an end and is often not measured for its own sake.

There are some exceptions to the monitoring of interdisciplinary research approaches (namely Finland's Academy of Finland uses interdisciplinarity as a criterion for certain types of funding, and the ERC maintains a database of funded projects which use interdisciplinary approaches). The question can be asked whether, if interdisciplinary research is more of a process than an end point, it is necessary to define concrete indicators. Defining the concept too rigidly may have a restrictive effect on the types of research which are ultimately supported.

Another clear caveat is that the attribution of IDR to specific actions at policy or organisational level is difficult. This is not only a consequence of the fact that IDR itself is not clearly defined, but equally because the contribution of approaches to interdisciplinarity is often difficult to gauge precisely.

Regarding the prevalence of IDR stimulating actions amongst public actors it should also be borne in mind that an overarching view has been taken to examine actor groups. It may well be that individual public institutions, funding programmes, research institutes or universities exist which do target interdisciplinarity but that these have not been discovered during the explorative activities of this study.

A final remark to make here is that, at the level of research organisations interdisciplinarity is increasingly hard to identify due to the normalization of interdisciplinary fields. Fields which were formed from a combination of disciplines may since have become accepted as new, subsects of other disciplines. This appears to be a natural evolution for new (inter)disciplinary fields and one which should be borne in mind when reflecting on approaches to interdisciplinarity at the level of research organisations.

The Dutch approach to stimulating IDR

Looking at how the Dutch context compares with the trends described above, it is evident that at the level of the national government there is substantial overlap in the approaches being taken to stimulate IDR. In this political context, the debates on Dutch science and research policy reflect similar themes and topics as those debates in the other countries and the EU. While there are few explicit mentions to IDR as a policy objective in all these countries, there is an emphasis on the need for more mission or challenge driven research. At the level of public organisations, the Netherlands appears to be comparatively active in trying to stimulate IDR along with the other countries studied here. For instance, Dutch research councils and funding

organisations are trying to provide broad funding opportunities inviting interdisciplinary research approaches. The national Knowledge and Innovation Covenants (KICs) on the other hand include mission based public private partnerships in research and innovation and the establishment of innovation networks for researchers.

Turning to the level of research organisations, the Netherlands is well positioned to further stimulate IDR. Universities tend to house multiple disciplinary faculties and often have affiliated research institutes which can focus on interdisciplinary domains of study. Where in other countries interdisciplinary research centres are incidentally present, in the Netherlands organisations who engage in IDR (universities and research centres alike) are much more common. These provide fertile ground for further stimulating bottom-up interdisciplinary cooperation.

5 Main practices and applicable insights

In this chapter we present an overview of the key individual practices identified in the case-study countries (Germany, Finland and the UK) and the EU. The summary of each practice mentioned is presented in Appendix B. The aim is to provide a reference guide for possible options with regard to facilitating IDR, including contextual factors which might be of importance.

The practices are grouped by the type of actor involved in implementing the practice; 1) National governments & agencies, 2) Research councils, advisory organisations & funding bodies, 3) Civil society, social partners & private foundations and 4) Research performing organisations). This chapter ends with an analysis of the main lessons learned and possible lessons to take from this study for the Netherlands.

The practices presented here do not always refer to or target interdisciplinary research specifically but may indirectly do so by contributing to the facilitation of this type of research or by targeting framework conditions for carrying out interdisciplinary research. To provide an impression of the types of practices collected and why they have been deemed relevant to this study, an overview is presented on the next page (Table 4).

Table 4 Overview of practice stimulating interdisciplinary research

Name of practice	Country	Responsible actor	Target of practice
1. National governments & agencies			
Excellence Initiative & Excellence Strategy	Germany	Federal Ministry of Education and Research	Universities and research institutes, Research framework conditions Universities and research institutes, Research framework conditions
2. Research councils, advisory organisations & funding bodies			
Strategic Priorities Fund	United Kingdom	UK Research and Innovation (UKRI), national public research agency	Researchers, Research Framework conditions, Government departments; non-governmental research funders; public sector research establishments
Requirement of multidisciplinary research for grand challenges by the Strategic Research Council (SRC)	Finland	Strategic Research Council (SRC) of the Academy of Finland, research council and funding agency	Researchers
The European Research Council (ERC) Synergy Grants	EU	The European Research Council, EU institution	Researchers across the EU
The European Research Council – Proposal Review System	EU	The European Research Council, EU institution	Researchers across the EU
Future Earth Townhall (and other events)	Finland	Future Earth Finland (FEF), public agency	Researchers, Different Finnish universities and universities of applied sciences Companies and organisations t Other actors: Government and funding sectors); Citizens, FEF secretariat (project coordination)
EU Future and Emerging Technologies Programme	EU	DG Research, within Horizon 2020	Researchers, research performing organisations, enterprises
3.Civil society, social partners & private foundations			
Initiative "Artificial Intelligence and the Society of the Future	Germany	VolkswagenStiftung, civil society foundation	Researchers Researchers
4. Research performing organisations			
Physical or virtual research centres across universities	United Kingdom	Universities across the UK	Researchers, research performing organisations, research framework
Center for Interdisciplinary Research (ZiF)	Germany	Bielefeld University	Researchers
Weizenbaum Institute for the Networked Society	Germany	Federal German Ministry of Education and Research, the city state of Berlin &	Researchers

		state of Brandenburg, and a consortium of research partners	Research performing institutions Research framework conditions
Bachelor of Arts and Science (BASc) degree in Interdisciplinary Problems & Methods	United Kingdom	London Interdisciplinary School (LIS)	Students, research performing organisations (i.e. universities and their departments), research framework conditions (i.e. engaging with regulators, higher education and research ecosystems to gain their support)

Technopolis Group, 2021

5.1 Key lessons from practices

Based on the summary of practices on national level (Appendix B) we have distilled several key lessons from the practices. In line with the previous sections in this report, these are presented at several levels. The insights and observations made regarding the practices in place across countries overlap to some extent with the key trends and observations made for national approaches in chapter 4.

It should be noted here that the Netherlands already implements similar actions as the other national and EU contexts described above. Internationally speaking the Netherlands is viewed by some experts as a good example of interdisciplinary research as it is. The Netherlands is also a top performer in terms of the number FP7 and Horizon 2020 projects it participates in which use an interdisciplinary approach[32]. It is also one of the top ten spenders on R&D as a percentage of GDP in the EU[33]. These aspects are important to bear in mind when reflecting on possible options for the Netherlands to consider because some of the options described below may already be underway.

5.1.1 National governments & agencies

As indicated in chapter 4, national strategies relating to science and research tend to focus more on thematic priorities and goals which form key challenges or mission areas for a country. Though exceptions exist, such as the German strategy for excellent research, for the most part national governments focus on thematic topics, and consider research as a means to approach these topics. An interesting note here is that across the case studies, the dominant themes and political priorities are very similar, namely: addressing climate change, AI and digitalisation, achieving higher (societal) impact of research, and improving social equality. Similar topics and trends drive the debate in the Netherlands; hence it is not surprising that Dutch practices at the national governmental level regarding interdisciplinary research are very comparable with other contexts.

Lesson from practices

What is evident from both the country-cases and the practices provided in this report is that political strategies have the capacity to create political will at the level of government, agency and research organisation. National strategies and programmes can influence the conditions in which research takes place, and by extension, facilitate conditions for interdisciplinary

[32] Shapeld.eu, (2020), https://www.shapeid.eu/research-data/ .

[33] Eurostat, (2018) https://ec.europa.eu/eurostat/databrowser/view/TSC00001/default/table .

research. The national approach in the UK for instance, of establishing research centres across universities is an instance of national level political strategies stimulating collaboration across disciplines within and between universities.

Possible options for the Netherlands: making mission or challenge led research part of national political strategies can help to facilitate political will and interest at other levels in the research system. It is not uncommon for national strategies to identify goals, which have to be implemented by public agencies and other implementing public actors. This trend can already by observed in the Netherlands in the NWA national strategy which also identify several main mission pillars within for science and research to work towards.

The UK example of setting up a national strategy to stimulate the establishment of virtual and physical research centres between universities is an interesting approach, highlighting how national strategies can create political will to improve conditions for research. However, with a multitude of existing (interdisciplinary) research centres in the Netherlands, adopting the same strategy as in the UK may not offer much added value.

5.1.2 Research councils, advisory organisations, and funding bodies

As indicated in the literature review and in the cases presented in this report, public organisations such as public agencies, research councils and funding bodies can play a more direct role in stimulating interdisciplinary research.

Public agencies, research councils and funding bodies can turn national research priorities into more concrete strategies. In doing so these public actors make national priorities more concrete and can tailor actions and practices to pursue those national level priorities.

Lessons from practices

Concrete ideas could be to have more funding opportunities for thematic topics and key societal challenges, or to accommodate specific criteria in funding calls, such as the requirement to have multiple disciplines represented in a proposal.

Another often mentioned challenge for IDR is the fair assessment of interdisciplinary proposals. Here the difficulty is both in finding reviewers that have enough expertise regarding the different fields involved in a proposal and finding reviewers that are experienced in the challenges related to taking questions, methods and data from one discipline to the next.

Lesson from practices

Flexible and tailored review processes involving panel experts from multiple disciplines are therefore crucial to evaluating IDR proposals. Both the ERC and the Finnish Academy of Finland provide space for this by allowing research proposals to designate several disciplines to which their proposal is relevant. These organisations then put together interdisciplinary review panels of experts to review those proposals.

A further important lesson here is that the panels of experts must also be willing and open to other disciplines and what they can contribute to addressing a given scientific research topic. This, however, is one of the more difficult challenges to address as availability of panel experts and recruiting desired experts can prove to be difficult. The Academy of Finland and the ERC both report this as a challenge, though in the case of the ERC, the remuneration and prestige which experts gain by being involved a in a review process are said to be high.

Once an interdisciplinary team has come together and developed a proposal, the complexity of these types of projects is invariably higher that monodisciplinary research projects. Researchers must arrive at common disciplinary languages, definitions, data sets and methodologies which marry several disciplines. This process is less prevalent in mono-disciplinary studies and is a key area in which these types of studies differ from IDR studies.

Lesson from practices

The lesson here is that the process of finding partners and setting up a research approach takes longer within IDR and should be accounted for in funding and support mechanisms. The ERC Synergy Grants for instance involve higher budgets and run for longer time periods for precisely this reason.

Beyond this, once an IDR project is underway or coming to an end, framing the research outcomes can be difficult. In which academic journal ought the results to be published? Are the impact factors high enough to make researchers want to publish there? How and where to present research results is important to researchers and their careers. The difficulty in contextualizing IDR outcomes is part of what makes this area of research risky for the careers of researchers. This is an area for which this study has encountered fewer lessons however from the countries studied above. Interestingly, the topic of evaluating research outcomes is under discussion in Dutch science policy arenas. The debate in the Netherlands concerns the relationship between research outputs, work pressure[34], diversity and work-life balance[35] more broadly. However, the issue of how research outputs are valued and the relationship with researcher careers is highly relevant to stimulating IDR. In this sense, the Netherlands is in a good position to arrive at novel approaches for this particular challenge to stimulating more IDR.

As an extension of the previous point, the broader valorisation and uptake of IDR results by other research organisations or enterprises can also prove a challenge for IDR. Which actors from which fields are best placed to build upon the outcomes of an interdisciplinary research project? For this challenge, the EU and Finland for instance demonstrate a growing focus on cooperation with industry.

Lesson from practices

A lesson here is to stimulate more cooperation across research and industry actors. The newly established European Innovation Council seeks to bring together actors to scale-up interdisciplinary, cutting-edge technology to benefit society. The Finnish Business Finland aims to improve ecosystems for businesses to innovate in. The Finnish case also points to growing cooperation between universities and businesses.

Possible options for the Netherlands: a number of the lessons above could be considered for the Dutch context. The Netherlands has a well-developed research system with multiple research performing actors, strong civil society (the Dutch VSNU and VH for instance), agencies and funding bodies. As such the Netherlands has a fertile research system with many actors who could implement options at this level of governance.

Should the Netherlands wish to further support and facilitate IDR, it would be good to consider offering funding programmes tailored to IDR. In doing so it would be good to incorporate lessons from above, such as making the inclusion of several disciplines in the research proposal

[34] Inspectie SZW, (2021), WOinActie, https://www.inspectieszw.nl/publicaties/rapporten/2021/07/08/woinactie

[35] Collective Labour Agreement Universities Sector, (2021), https://vsnu.nl/files/documenten/CAO/2021/CLA_agreement_2021-2022_(def)_eng.pdf .

a requirement. Flexible review panels with experts from multiple sectors would be needed to assess research proposals submitted for such funding calls. Funds for interdisciplinary research could also be given longer time frames and larger budgets as is the case with ERC Synergy Grants for instance.

The research and university sector could also reflect more on how to evaluate and assess research contributions by researchers who engage in interdisciplinary research. This could be an area for future research as few lessons have been yielded on this topic from the case studies. The VSNU, together with other organisations in the sector, has been reflecting on how to address this issue[36] and such efforts could be further consolidated and extended.

5.1.3 Civil society, social partners & private foundations

Actors from civil society, social partners and private foundations can influence IDR on different levels; by collaborating with for instance national associations (such as the VSNU) but also by funding and doing research. Actors working in the same discipline but within public or private sector may take quite different approaches. In the private sector we have observed pragmatic approaches which acknowledge the need to support commitment upfront. For the latter a valuable lesson can be learned from the German Volkswagen Stiftung foundation which offers a "Planning Grant" for researchers seeking to collaborate in the interdisciplinary area of AI. This way also the time needed to identifying valuable research partners is financially supported as well.

Possible options for the Netherlands: the Netherlands could consider (in so far as these are not already present and available), funding or grants designed to help researchers find researchers from other disciplines, also within the private sector, and/or to support interdisciplinary research teams in the planning of their research (as is the case with the Volkswagen Foundation Planning Grants).

5.1.4 Research performing organisations

Research organisations such as universities and research institutes, also have the capacity to stimulate IDR more directly.

The case studies show that within research organisation premises (though other public actors could also do so), actors can establish shared, collaborative spaces for research. This would help towards overcoming the challenge that researchers have trouble identifying possible collaboration partners for IDR projects. The UK and the university research centres approach, both virtual and in real-life aim to stimulate this type of collaboration. The German interdisciplinary research Centre, the ZiF, also provides a collaborative space and offers activities which promote genuine engagement between students and researchers (such as workshops and interdisciplinary research groups for instance).

Lesson from practices

Allowing accessible collaborative platforms and spaces for researchers from different institutions and/or disciplines to come together to engage and collaborate can stimulate the process of interdisciplinary research. These types of practices appear to contribute to trust and new ideas between researchers from different disciplines and can form a lesson in how to promote IDR at the research preforming level.

[36] VSNU, (2019), Erkennen en waarderen van wetenschappers, available at: https://www.vsnu.nl/nl_NL/Erkennen-en-waarderen-van-wetenschappers.html

Having the right, soft, transversal skills is also an important element of stimulating IDR. In connection with the on average higher complexity of IDR projects and the socio-cultural aspect of bringing together individuals from different national or disciplinary cultures, stronger leadership and project management skills are required. The newly established interdisciplinary bachelor in the United Kingdom is an example of a practice which helps to address this issue; students are taught skills which are relevant for interdisciplinary study and research.

Lesson from practices and literature review

Training researchers in transversal skills such as project management, and other soft skills can contribute to both building teams for IDR projects and contribute to successful execution of IDR projects.

Potential lessons for the Netherlands: the Netherlands is a country where collaboration is relatively common. Social partners such as the VSNU and Associations of Universities of Applied Sciences (VH), for instance already facilitate cooperation within the university sector. Universities also have found each other for partnerships on topics such as AI and digitalisation. There is a relatively high level of cooperation amongst universities and by extension, a sound basis for shared initiatives such as collaborative spaces for students and researchers. An inventory of existing collaborative spaces within and between universities, as well as within research institutes and enterprises could be conducted to establish the added value of more of such spaces. Making an inventory of research centres which focus on interdisciplinary fields could help to further promote their existence to research organisations, enterprises, and researchers.

For historical reasons Dutch universities tend to house multiple disciplines and faculties. Establishing collaborative spaces within universities and organising activities to facilitate deeper exchanges of ideas could help to increase IDR taking place. Workshops, events, or series of discussion sessions could all be considered to facilitate cross-disciplinary exchanges of ideas for instance.

It should also be noted that at the research performing level, Dutch universities also offer interdisciplinary bachelors and masters. The Netherlands is also home to several University College faculties within universities and these help to teach a multi-disciplinary mindset, which can yield interdisciplinarity-orientated graduates and research. Beyond this, bachelor, and master programmes on interdisciplinary topics such as AI and data science as well as climate change are becoming increasingly prevalent. Offering interdisciplinary degrees therefore seems to be occurring organically in the Netherlands already.

A further potential option for the Netherlands would be for universities and research centres to provide more structural teaching of research and project management skills. This may already be underway in some research institutes in which case lessons learned in this regard should be shared amongst research organisations.

Although the cases and practices presented in this report offer insights and possible methods for addressing challenges related to IDR, not all challenges are addressed equally. As indicated, framing research results and the still comparatively risky career prospects associated with interdisciplinary research are major factors of influence, which are comparatively under-explored in this study. More research on these topics would be good.

Finally, to embed the many and varied approaches that have been identified in this study a full exploration of existing Dutch practice and approaches would be appropriate. This could help to pinpoint areas and topics where the implementation of best practices would be most beneficial.

6 Conclusions

The overarching goal of this study has been to explore how interdisciplinary research can be stimulated and to study the approaches taken in different countries with strong research sectors. This serves to provide insight into what sort of policy options could potentially be considered by the Netherlands. The study started out with several research objectives which will be addressed in turn.

Research objectives:

An analysis of three countries which are top performers in terms of interdisciplinary research collaboration, with an emphasis on the role which government policy has played therein. Core questions here are:

1. Do these countries have explicit public policies to stimulate IDR or not?
2. How are traditional disciplines positioned?
3. To what degree does the broader government policy on scientific, higher-education, or innovation policy stimulate or inhibit interdisciplinary research collaboration?

This report has sought to explore the public policy approaches taken by Germany, Finland, the UK and the EU to understand how these stimulate IDR.

Based on these findings, it appears that at the national level these countries tend to refer to IDR in national strategies for science and research but **rarely as an explicit policy priority**. Most activities to stimulate IDR appear to be taken at the level of public agencies, funding bodies, and research councils. In the EU, the ERC specifically stimulates interdisciplinary research through, amongst other things, a fund which addresses some of the challenges research teams experience with interdisciplinary research (Synergy Grants). Finland's funding agency, the Academy of Finland, follows a similar practice. The British agency, the UKRI, also promotes more focus on what it refers to as MIDRI (multi- and inter-disciplinary research and innovation), across research institutes in the country, by stipulating the importance of this type of research for addressing key societal challenges.

These public policy approaches aimed at stimulating IDR are not very different to what already happens in the Netherlands: the Dutch government does not explicitly refer to IDR in its research agenda, the NWA. Instead, IDR is referred to as a good practice.

The **role of traditional disciplines and monodisciplinary approaches** is not an active topic of discussions around science and research at the national level. The tension between these two types of research was cited in Germany and in the United Kingdom, but it is unclear whether this tension is a key feature of the policy debate. Yet, some of the EU level experts interviewed indicated that interdisciplinary research needs monodisciplinary research: bringing several disciplines together in a new conceptual and methodological framework requires a sound understanding amongst the research team of those disciplines to begin with.

When considering to what degree national public policies stimulate or inhibit IDR, the findings from this study suggests **that public policy can influence the conditions, i.e. in terms of research funding and strengthening collaborations,** in which research performing organisations and researchers carry out their work. Furthermore, national level strategies can influence the priorities and practices of public actors by **generating political** will for certain research priorities. This was the case in Germany for instance with its Excellence Strategy. The role of policy-implementing agencies is to translate national policy priorities to more specific strategies. This puts them in a good position to implement practices such as IDR-tailored grants and providing support to facilitate networking and collaboration between researchers.

Supplementary research questions:

4. *What are the rationales or main considerations which lead the three countries to stimulate IDR (or do they not stimulate this explicitly)?*
5. *Which forms of interdisciplinary research collaboration exist? Are new types of research and research cooperation involved in IDR collaboration?*
6. *What can the Netherlands learn from these aforementioned countries?*

As indicated, **interdisciplinary research is often not explicitly mentioned in national policy strategies** though this is not to say it goes unmentioned entirely. Policy discussions and debates tend to refer more to the need to address grand societal challenges or "wicked problems" such as climate change, AI and digitalisation, and social inequality, or to improve the excellence and impact of research on society. There is consensus that addressing these challenges necessitates cross-disciplinary and collaborative research, although attributing the impact of IDR to solving societal challenges remains difficult.

There are many 'best practices' which could offer lessons for promoting IDR. The majority of these practices should be implemented by actors within public agencies, funding bodies, research councils and research organisations. Their grant programmes could be designed to further promote IDR by e.g.:

- requiring a diversity of disciplines;
- increasing timeframes and budgets for IDR projects;
- improving the review process of interdisciplinary proposals;
- supporting researchers in building their network outside their discipline;
- supporting proposal development;
- improving the way interdisciplinary research outcomes and outputs are embedded and shared within the scientific and research community.

Research performing organisations on the other hand can offer trainings in transversal skills needed in managing and running interdisciplinary projects, or can provide activities which foster networking and exchange of ideas between researchers from different disciplines, and offer platforms or spaces for researchers to work and collaborate in.

Regarding possible options for the Netherlands, comparisons have been made in preceding chapters between the Dutch and other national contexts. The Dutch context is already viewed by some experts as a country where interdisciplinary research is relatively prevalent. Additionally R&D expenditure in the Netherlands is relatively high, combined with a high participation rate of Dutch researchers in EU framework research projects. Measured by these indicators there is reason to believe that the Netherlands already performs relatively well in stimulating interdisciplinary research. In terms of how IDR is framed in national debates, the approach taken in the Netherlands is comparable to those taken in other countries. Namely, few explicit references in national political strategies and agendas but more action and practices being undertaken at the public agency level. The Dutch NWO for instance tries to foster more activities which stimulate engagement and cooperation between researchers.

Areas where the Netherlands could consider some of the options presented here (in so far as such actions are not already underway), include tailoring funding options further to the realities of the interdisciplinary research and enhancing the approach of offering more collaborative

spaces to researchers. Interestingly, the Netherlands is also active in addressing the tension between research outputs, work pressure, and work-life balance in the research sector, an issue which also relates to interdisciplinary research. Risky research careers related to uncertain research outcomes are cited in literature as a deterrent for researchers to engage in IDR. Indirectly, by discussing the topic of research outcomes and a researcher's employment conditions, the Netherlands could address a challenge to IDR. Such discussions were not encountered during the exploratory research carried out in the other countries or at EU level.

At the research performing level, Dutch universities tend to house multiple disciplines as it stands, offering a good foundation for fostering further interdisciplinary research between researchers. The Netherlands also has a series of interdisciplinary research institutes and centres, often but not always affiliated with Dutch universities. In this sense at the research performing level there are systems in place which could be further built upon to further stimulate interdisciplinary research.

Appendix A Case study reports

A.1. Germany

A.1.1. National government

The German government's main policy priorities in research and innovation can be split in three groups:

- **Strengthening Germany's position as innovative country** in the global innovation competition (embodied in the High-tech Strategy 2025[37]). This is the umbrella strategy that is intended to ensure Germany's future viability. Three priorities can be highlighted: 1) meeting and solving societal challenges (by promoting specific fields of research), 2) developing future competences in education and research, 3) establishing a culture of innovation and risk-taking and ensure that the transfer of knowledge to society and the economy functions (entrepreneurial spirit). The strategy is now mission-oriented, highlighting aspects such as applicability, implementation and transformation through research. It is thus also to strengthen Germany's innovation position and to promote Germany as an attractive science and innovation location[38];
- Fostering excellence in education, research and innovation within the German system (embodied in the Pact for Research and Innovation ["Pakt für Forschung und Innovation"[39]] and the Strategy for Excellence ["Exzellenzstrategie"[40]]);
- Internationalization of research and innovation (see Strategy for Internationalization of Education, Science and Research).

Concerning policy debates and actions regarding science, research and innovation, a number of dominant themes can be distilled for the German context. Topics of **societal relevance** are currently omnipresent and shape the debate and discussion on research and innovation policy priorities. Thus, topics such as **digitalisation** (including aspects such as AI and emerging technologies), **climate change** and sustainability, **societal divide** and the future of democracy play important roles. Nevertheless, this is not a national phenomenon, but can be observed in a global context, considering the relevance of sustainable development goals and other strategies at international level.

According to interviews, one could perceive that **fundamental research** ("Grundlagenforschung") is **getting a little less attention in comparison to the past**. This is an observation that has been viewed critically in the past, highlighting that without fundamental research, applied or problem-oriented research cannot solve today's challenges. The German Science Council has recently published a detailed position paper highlighting how the focus on interdisciplinarity and thus the "neglect" of research within their own disciplines is creating

[37] https://www.hightech-forum.de/hightech-strategie-2025/

[38] Federal Report on Research and Innovation [Bundesbericht Forschung und Innovation; BUFI] 2020, chapter I. The Bundesbericht Forschung und Innovation is a report by the German federal government and the Länder. It is published every two years and gives an overview over German research policy and funding programs on federal and regional level as well as information on other institutions in the German research system. The Federal Ministry of Education and Science has the lead in creating the report.

[39] https://www.bmbf.de/bmbf/de/forschung/das-wissenschaftssystem/pakt-fuer-forschung-und-innovation/pakt-fuer-forschung-und-innovation_node.html

[40] https://www.bmbf.de/bmbf/de/forschung/das-wissenschaftssystem/die-exzellenzstrategie/die-exzellenzstrategie.html

considerable tensions within the research system and that high-performing, excellent disciplines are the prerequisite for IDR. [41]

Additionally, science, its role in society as well as science communication have gained more attention, especially during the pandemic and due to the climate change debate (including activities such as Fridays for Future).

Increasing the impact of research has been defined as very important[42] in the national context as transfer of innovative research into economic potential is considered to be suboptimal in Germany. Addressing societal challenges has become a very important goal[43], especially with regard to the pandemic and climate crisis It has also played major roles in the past, for example for the framing of the High-Tech Strategy (see above), which addresses different challenges from sustainability to health topics.

Stimulating IDR is **discussed in the scientific community** but also by funding institutions. Recently, different actors within the national research and innovation ecosystem have issued statements on the relevance and challenges of IDR. One example is a position paper by the Science Council highlighting the asymmetrical importance of disciplinarity and interdisciplinarity (in favour for the latter) in the science policy discourse[44]. Accordingly, the value of ID research is highlighted as the dominant perspective[45], while interdisciplinarity as a paradigm can also pose threats e.g., for researcher's careers.

The Federal Ministry of Education and Science (BMBF) contributes to the discussion on IDR by funding diverse research projects. Overall, IDR is mentioned in tenders on research funding and the connotation of IDR is usually positive. It does not appear to be a goal in itself but is referred to when addressing comprehensive analyses/ research questions that should be covered from different angels (problem-based research related to societal challenges).

A.1.2. *Historical development & drivers of change*

Shifts in interdisciplinary research within policies and actions

According to the Science Council, interdisciplinarity has had a high status in the science policy discourse of recent decades, therefore it is not a new trend of debates. The interviews confirmed this, but highlighted that IDR became more relevant in the last 5-10 years because of topics like climate change (in research on climate change interdisciplinarity is more common/ established) or the Covid pandemic. IDR has thus become more central in the debates as complex challenges need complex instruments and complexity is often equated with IDR (not only in Germany, but in the international context as well).

Interview partners highlighted that the current IDR narrative goes hand in hand with application orientation and knowledge transfer, thus IDR is to generate knowledge that is relevant to practice. Thus, the current IDR debate has moved towards the aim of making research more

[41] The German Science Council [Wissenschaftsrat, 2020: Wissenschaft im Spannungsfeld von Disziplinarität und Interdisziplinarität. Positionspapier. p. 5.]

[42] BUFI, 2020, chapter III, 3

[43] BUFI, 2020, chapter III, 1

[44] Wissenschaftsrat, 2020, p. 5.

[45] Wissenschaftsrat. 2020. p. 10: "structures" mean e.g., institutes, research clusters etc. that are transversely to the structure of faculties, which should support profile building of higher education institutions and was recommended by the Wissenschaftsrat. The Hochschulrektorenkonferenz, an interest representation group of higher education institutions, recommends as well to build grand "sub-disciplinary entities", because "interdisciplinary researchers (clusters, graduate schools, etc.) and interdisciplinary courses of study require larger research contexts" (all these details derive from the footnote on the same page).

problem-oriented, following the goal of solving concrete problems and not the further development of individual disciplinary stocks of knowledge (as an end in itself).

IDR has become more prevalent in Germany according to the Science Council[46]: According to the Federal Ministry of Education and Research (BMBF), 90 to 95 percent of its (the BMBF) funding activities are related to interdisciplinary collaborative projects. Even if mono- or interdisciplinarity are not usually explicit criteria in funding announcements, the funding programmes are generally based on the premise that answers to many social problems require the cooperation of several disciplines. require the cooperation of several disciplines.

Even if mono- or interdisciplinarity are usually not explicit criteria in funding announcements[47], the funding programs are generally based on the premise that answers to many societal problems require the cooperation of several disciplines. Application orientation, knowledge transfer and active problem solving are issues that are often centrally positioned in the tender specifications. Thus, although IDR is not directly demanded, it is indirectly implied. Interview partners have confirmed that there is not clear definition of interdisciplinarity within the BMBF, but that it is generally viewed as an omnipresent topic that does not need to be defined restrictively. This global challenge of defining IDR was also highlighted regularly in the interviews, in that what is defined as interdisciplinary research is sometimes "only" multi-disciplinary, meaning that different disciplines work on the same challenge/project, but mostly stay within their disciplinary boundaries. One can also see that various non-university research institutions that receive institutional funding from the federal and state governments are interdisciplinary to a smaller or larger extent. The interdisciplinary approach is especially evident in newly founded institutions such as the German Centers for Health Research and the Weizenbaum Institute for a Networked Society (see The Weizenbaum Institute for the Networked Society).

Drivers of change

As outlined above, (global) changes and political debates around topics such as climate change, technological development and the pandemic have been a stimulus to the relevance of IDR. Accordingly, the positive assessment of interdisciplinarity is related to its facilitation of researching complex problems that cannot be solved by one discipline. "Disciplinarity" has a rather stiff/ inflexible connotation of routine, while IDR is understood as open, cooperative and creative; and as having the ability to work on non-scientific (societal) problems[48].

The necessity for and relevance of third-party funding has increased as external demands on science have risen. Thus, tenders are becoming increasingly relevant for scientists (as they cannot cover their activities with public money) and thus the relevant topics (interdisciplinarity, innovation, problem-orientation) need to be covered.

Another relevant factor is that processes of profile building of higher education institutions often include the "development of big, interdisciplinary structures"[49]. This can be seen within the

[46] Wissenschaftsrat, 2020, p. 11, 45

[47] Two examples of BMBF programmes with explicit interdisciplinary requirement are the "Framework Programme for Research Funding in the Humanities, Cultural and Social Sciences" (2017) and the "Interdisciplinary Competence Building" competition for young researchers (2013).

[48] Ibid.

[49] Wissenschaftsrat, 2020, p.10 ff.

multi-universities' excellence clusters. (see practice on Excellence Initiative and Excellence Strategy in section B.1.1.).

A.1.3. *Prevalence of interdisciplinary research in organisation policies and activities*

Research councils, advisory organisations and funding bodies

As the organisation listed above have different roles within the German research and innovation system, their approach and the importance of IDR differs. Overall, the theme of interdisciplinary research has received growing attention by public bodies as it is seen as the basis for tackling – and potentially solving – the challenges of the current times. Interview partners have highlighted that especially topics such as the Covid crisis, but also climate change, the crisis of democracy, demographic challenges, etc. call for a more interdisciplinary approach.

As a result, interdisciplinary research projects, initiatives and networks have emerged increasingly in the last decades, supported by funding programmes of diverse actors such as the German Research Foundation (DFG) and the federal government or the state governments. Correspondingly, "strengthening interdisciplinary research" is one of five strategic cross-cutting goals of the DFG and around 60 percent of its funding went into interdisciplinary collaborative research in 2018.50 The Science Council (WR) has published position papers regarding the needs and tensions in relation to disciplinarity and interdisciplinarity in research, also showing the relevance of the topic. Another example is Leopoldina and its established research field "Interdisciplinary Science Reflection"51 (in the Centre for Science Research). In close coordination with the Department "Science - Politics - Society", this research field provides important impulses for the Leopoldina's role as a National Academy. They understand their task and IDR to be connected as it is of increasing importance to critically and reflectively examine the role of science and the relationship between science and politics in order to be able to conduct both free science that is committed only to itself and transparent and independent policy advice.

Civic society, social partners & private foundations

Private foundations being active in research funding are usually focusing on solving societal challenges through research. According to the Wissenschaftsrat (2020, p.43), interdisciplinarity has an important status in private research funding. For example, the Volkswagen Stiftung supports various funding initiatives that focus explicitly on IDR, usually by concentrating on topics which afford interdisciplinary teams, e.g., "Artificial Intelligence" or "Preventing pandemics" (see Funding Initiative Artificial Intelligence, the practice by the Volkswagen Foundation, section B.3.1). In its funding strategy the foundation formulates four guiding principles, two of them are "boundary crossing", and include interdisciplinarity, trans-disciplinarity and transnationality, as well as "societal transformations". The VolkswagenStiftung aims to support research different from the official DFG-funding, which they describe as rather disciplinary, and wants to give innovative impulses, be more experimental on topics. They can try to do this, because they do not use public money and describe themselves as more flexible. That is why they can for instance fund projects where researchers can explore without being too much restricted. This example shows that societal challenges and IDR are important to private foundations.

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[50] Wissenschaftsrat, 2020, p. 43

[51] www.leopoldina.org/ueber-uns/zentrum-fuer-wissenschaftsforschung/forschungsfeld-5/

Industrial research associations listed above highlight their contribution to solving societal challenge thought research – especially with regard to practical relevance and innovation (often of SMEs). Interdisciplinary research is partially supported, e.g., in the interdisciplinary and cross-industry cooperation of the research associations in the AiF network.

Research performing organisations

Just like in the international context, interdisciplinarity has become a "science policy priority" and a "major trend in universities and research funding agencies" in Germany. University leaders often consider it a priority to enable interdisciplinary research and to create framework conditions for it. In a recent survey, 95 per cent of university administrators said they wanted to expand interdisciplinary activities at their universities.52

In universities the departmental organisation is the dominant structural principle. Thus, interdisciplinary can be approached through the creation of specific institutes / centres, which cross departmental borders and open space for an institutional setting aimed at interdisciplinary research. Some examples are the Centre for Interdisciplinary Research at the University of Bielefeld (see the practice on the ZiF, in section B.4.2.), the House of Transdisciplinary Studies for practice-oriented teaching and learning (Hochschule Pforzheim) or the Forum for interdisciplinary research at the TU Darmstadt. While these examples are not the status quo in German universities, they can pose a solution to the strict departmental thinking and integrate knowledge, experience, and commitment of diverse departments (and ideally also of external partners from business and civil society). Next to institutional settings that encourage interdisciplinary research, there are also more individual ways to engage in ID research through projects, networks, or initiatives such as the Interdisciplinary postgraduate colloquium[53] of the University of Heidelberg or the Network Interdisciplinary Research (NiFo)[54] at the University Paderborn – just to mention two of many examples. IDR is thus often encouraged in university strategies through IDR projects, networking and even training of academics/researchers. Nevertheless, the reality of it can be more challenging as a tension between activity structures and organisational structure as well as the desire for IDR and reality exists further on.[55] Non-university research is described as tending to be less "structurally conservative", thus opening up avenues for IDR and at the same time also for new career paths related to IDR. These institutions are mostly built around themes and are organised in such a way that interdisciplinary cooperation and specialisation is the norm.

The private sector finances around two-thirds of annual R&D spending in Germany. It is mainly application-oriented and aims to develop commercially exploitable results, therefore a focus on high-tech sectors is prevalent (machinery, electronical, chemical, pharmacist industry). Most of the R&D expenditures of companies are invested internally (conducted by the companies themselves), 10% have been spent externally.

R&D departments of large corporations are described often as transdisciplinary and cross-sectoral because they combine practice and science. The research is mostly application- or product-oriented and thereby does not know the same organisational or structural boundaries existent in universities.

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[52] Wissenschaftsrat, 2020, p.11

[53] https://www.graduateacademy.uni-heidelberg.de/beratung/netzwerke/idk.html

[54] https://www.uni-paderborn.de/forschung/netzwerk-interdisziplinaere-forschung

[55] Wissenschaftsrat, 2020

A.2. Finland

Within Finland, national public funding for research and innovation comes primarily from the Ministry of Education and Culture, which allocates funds to universities, and implements national research policy through The **Academy of Finland**. A second important player in the field is the Ministry of the Economy and Employment, which is responsible for innovation, entrepreneurship, and growth policies. Research initiatives in this area are supported through **Business Finland**. Uniquely within Europe, Finland also has a relatively large private funding sector for research and innovation.

In addition to these national public funding sources fostering interdisciplinary research, there is also an important source for interdisciplinary research funding for researchers living in Finland, Sweden, Denmark or Norway, called the **NordForsk's initiative.** NordForsk provides funding for and facilitates Nordic cooperation on research and research infrastructure, and currently runs a *Nordic Programme for Interdisciplinary Research*. It is a collaborative effort of the Academy of Finland, the Independent Research Fund Denmark, the Swedish Research Council, the Research Council of Norway, and NordForsk.

A.2.1. National government

In 2020 the National Roadmap for Research, Development and Innovation 2030 was set out, describing the national research strategy. One of the objectives of this roadmap is to increase the intensity of RDI activities increasing Finland's expenditure-to-GDP ratio for research and development from the current 2.7 per cent to 4 per cent by 2030. To achieve this, the roadmap lays out new incentives to intensify public–private partnerships, with a focus on three interlinked strategic development areas: *competence*; a *new partnership model*; and an *innovative public sector*. The *new partnership* model describes several policy goals which are likely to result in increased interdisciplinary collaboration, such as encouraging risk-sharing between companies and the public sector, the aim of grouping research and research-networks into larger competence centres and ecosystems, and a number of actions to expand and support the joint use of research infrastructures.

One area where this is explored is the closer interaction and collaboration between Business Finland ecosystems (in line with their roadmaps) and Finnish Flagship Programmes funded by Academy of Finland (in line with their research agendas), with pilot work on-going in the forest sector in the form of developing collaborative bridge projects between these initiatives.

Next to the focus on economic growth, there is increasing recognition of the importance of societal challenges. *Sustainable Development Goals*, the *green transition* and *digitalisation* have been featured in the recent and current debate, as well as *resilience* (partly because of COVID). National plans for the implementation of the EU Commission's Recovery and Resilience Facility[56] emphasize new more extensive partnerships which extend from basic research to end-user, driven by industrial and societal needs and opportunities. These so-called quintuple helix partnerships (university-industry-government-public-environment) are akin to the *new partnership approach* and are likely to result in, and rely on, IDR. However, here IDR is recognized as a means to this end, but not identified as a goal in its own right by policy makers.

Finally, the recent COVID pandemic has, as in many other countries, impacted the economy and increased pressures on the government budget. Awareness, preparation, and management of pandemics like COVID have been added as a focus area for policy. A decision has been made not to make any cuts in education but focus all necessary cuts in this

[56] https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en

sector on research, resulting in a €35m reduction in research funding beginning in 2023. From this €35m, €10m will come from the budget of the Academy of Finland, and €25m from the budget of the Strategic Research Council[57]. For the former this is a small cut, but for the latter, this means reducing the budget by almost 50%.

A.2.2. *Historical developments & drivers of change*

Compared to other (European) countries Finland has long had an agenda promoting the development of IDR: Already in 2002 IDR was mentioned in the strategy of the Academy of Finland. In 2004, the International Evaluation Panel of the Academy of Finland indicated that the Academy should develop its research policies, evaluation systems, and organization to encourage more interdisciplinary research. In response to this, the academy adopted a joint-evaluation panel approach to the review of multidisciplinary proposals from 2004 onward. Consequently, there is a lot of experience in the review of multidisciplinary proposals.

Over the last decade, the importance of IDR has gained further recognition. According to interviewees working at public funding bodies, there are two main reasons for this: Firstly, the growing prominence of **challenge-driven research**[58], primarily aimed a societal challenges, which has led to the ministry setting up the Strategic Research Council and the Finnish Flagships programme.

Secondly, the importance of **impact of research**[59] has increased over time, and this is visible in how the Ministry of Education and Culture allocates funds to universities (through a specific focus on the universities' third mission, knowledge transfer). This has also impacted the strategies of universities, which is visible in the various mergers of traditional universities with universities of Technology, and collaborative structures between universities and universities of applied sciences. The two major mergers – Aalto University and the Tampere University – have both explored new opportunities arising from IDR. Aalto Design Factory is possibly the most prominent and well-known example.

As in many countries, the current thinking is that research should have a purpose and it should yield exploitable results. The debate around the balance between fundamental ('blue sky') research and research which directly benefits society and the economy has recently been renewed because it was fundamental research that facilitated the fast development of COVID vaccines.

This increasing impetus for impact is also reflected in government funding decisions: The Finnish government presents on a yearly basis a plan for Analysis, Assessment, and Research Activities (VN-TEAS)[60], which allocates funding for studies which provide research-based evidence for political decision making both at the government and at the ministry levels. The resources available for implementing the plan amount to approximately EUR 10 million, which is spent,

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[57] Although on paper the Strategic Research Council is part of the Academy of Finland, in practice they operate independently, and have separate budgets.

[58] Challenge driven research is scientific research motivated by a pre-defined challenge, typically societal challenge or possibly a societal or industrial need. The research is designed to find solutions which can be used to address the pre-defined challenge. This is opposite to research motivated by academic interests, search for new knowledge, etc

[59] Impact of research refers to possible impacts of research activities and research results, both intended and unintended. They can originate from the use of knowledge and competences gained by participating in research activities, or use of the results of the research. Both need and challenge driven and academical interest motivated research can have both intended and untended impacts.

[60] https://tietokayttoon.fi/en/frontpage

amongst other things on analyses, impact assessments, evaluations and foresight reports. The analysis, research and assessment projects can span from a few months to three years.

Put together, the increasing focus on solving challenge-led problems such as societal challenges has fuelled innovation in the organization of R&D, one example being the founding of the Strategic Research Council. This has led to the increased recognition of the importance of IDR. At the same time, the increased emphasis on (societal) impact of research has had both positive and negative impacts on the prevalence of IDR: although it has resulted in some innovative mergers between traditional universities and universities of applied sciences, recent funding cuts in the budgets of the Academy of Finland illustrate the challenges faced by challenge-driven IDR projects as their time to impact is often long.

A.2.3. *Prevalence of interdisciplinary research in organisation policies and activities*

Public bodies which implement policies

the *Academy of Finland (AoF)* funds high quality basic scientific research in all disciplines and fields. It fosters interdisciplinary collaboration through its criteria for scientific quality, which includes 'quality of research environment and collaborative networks' More specifically, within the researcher-oriented funding branch, which makes up about 56% of the funding within the academy, multidisciplinary projects are very prevalent, with about 85% of the projects that are funded under Academy Projects being multidisciplinary. In addition, thematic funding, which makes up about 22.5% of all funding, includes *Strategic Research*, which has a requirement that projects must consist of researchers from at least three different research fields (with research fields defined by the AoF[61]) and two different organizations. The review of multidisciplinary proposals is adapted to this purpose: for each programme, the Academy assigns a steering group and an assessment panel. The members for the steering group and the assessment panel come for the review of a multi-disciplinary proposal come from one or two of the various standing, discipline-oriented research councils. The steering group and the assessment panel are typically interdisciplinary, especially for thematic programmes related to societal challenges or other interdisciplinary thematic areas. If the Academy finds it requires extra expertise to assess a multidisciplinary proposal, the Academy recruits external disciplinary experts to contribute to the review.

Another facilitator of IDR is funding offered by the Academy of Finland *for university profiling* which aims to support and speed up the strategic profiling of Finnish universities in order to improve the quality of research. According to a recent review of this instrument this funding has catalysed developments which are likely to strengthen the role of IDR in universities[62].

Business Finland provides funding for research, development, and innovation projects in leading companies' ecosystem themes. Funding is intended in particular for joint projects between companies and joint projects between companies and research organizations; however, funding may also be granted to individual companies or research organizations or to joint projects of research organizations. It has no explicit requirement for interdisciplinarity for research projects, however proposed research projects require international cooperation and at least three companies must participate in the project steering group. Interviewees from different funding bodies have reflected that the importance of IDR in this area is increasing, as

[61] https://www.aka.fi/en/research-funding/apply-for-funding/how-to-apply-for-funding/az-index-of-application-guidelines2/research-field-classification/

[62] https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/160948/OKM_27_2018.pdf (in Finnish)

this serves the interests of companies; however in the absence of data to confirm this observation it is not possible to attribute this to the funding offered by Business Finland.

Social partners

The Nordic Programme for Interdisciplinary Research is an ongoing programme (2018-2025) run by the NordForsk initiative which aims explicitly at interdisciplinary projects that combine disciplines, which are far removed from each other and rarely collaborate, or that pursue an original research question that demands the exact combination of competencies from different disciplines proposed in the application. Hence, projects within the Programme are required to encompass research within at least two of the three areas of science as defined by the European Research Council: Life science; Physical Sciences & Engineering; Social Sciences and Humanities. The research problems should be interdisciplinary and not just add a method from another area – it needs to add value to both scientific areas as well as to the interdisciplinary space.

The strategic research council also requires require participation of societal partners, and equally, funding decisions are in part based on societal relevance and expected impact. The types of societal partners vary between projects and cover ministries, governmental agencies and other bodies, cities and municipalities and their agencies and bodies, associations, NGOs, and others. Researchers are required to prepare a specific plan for interacting with societal partners during and after the project.

Research performing organisations

More than half of the 13 Universities make a statement about interdisciplinarity in their mission or on their homepage. This is not the case for the 22 Universities of Applied Science in Finland- none of these make explicit statements about interdisciplinarity.

The Ministry of Education and Culture does not steer universities thematically. IDR is featured in e.g., Strategic Research Council Funding, Doctoral Schools and Academy of Finland's Research Infrastructure funding. These and other initiatives featuring direct or embedded IDR are steering universities more towards IDR. It is not clear how the increased attention to IDR is reflected in higher education curricula.

As one interviewee remarked: 'The fundamental mission of the public sector research institutes is to do research on societal challenges. This also means that their research if often interdisciplinary, even if IDR is not necessarily used as a formal criterion'.

One observable development since universities were granted greater autonomy seems to be the gap that has started to form between professors and the more professional and strategically oriented university leadership. Increased autonomy amongst Finnish universities, the push for more strategic focus and specialisation, and the push for consolidation (mergers) to improve international recognition and research excellence and relevance have resulted in the university leadership becoming more professional and also inviting external people to participate in strategic management such as sit in university boards. With the management taking a more strategic role and e.g., developing new environments, platforms and arrangements towards IDR and more interaction and engagement across disciplines and with external actors, some tensions have arisen between management and faculty members do who not see these as positive developments. This trend illustrates how she universities are still in a state of transition from the traditional discipline oriented academic universities towards more inter-, trans-, and multidisciplinary and socio-economically integrated universities.

A.3. United Kingdom

A.3.1. National government

Main national political priorities science, research and innovation

UK R&I policy has been increasingly prioritised in recent years, with commitments to increase government investment and strategic initiatives to leverage the strong UK research base to boost productivity and economic growth. For instance, R&D spending for the year 2021-22 has been set to £14.6bn even against the backdrop of the economic shock presented by Covid-19.

The UK's 'Industrial strategy'[63] was a central document in UK R&I policymaking since it was published in December 2017 with the aim to boost UK productivity and prosperity. The Industrial Strategy has now been archived and was replaced in March by a new strategy,[64] '**Build Back Better: Our Plan for Growth**.' Developed in the backdrop of the COVID-19 crisis, the new strategy still emphasises the critical role of innovation and skills. The plan will support the UK's visions for Green Growth and Global Britain.

The Plan for Growth articulates the ambition to support productivity growth through high-quality skills and training by transforming further education and supporting apprenticeships. Innovation will be supported to drive economic growth and create jobs, building on the world-class universities and international reputation for science that the UK has. The £14.6 bn investment in R&I in 2021-22 will back the priorities set out in the government's R&D Roadmap (2020)[65] and drive progress towards the target for total UK investment in R&D (public and private) to reach 2.4% of GDP by 2027. The Plan provides a useful indication of where the UK has R&D strengths and an ambition to do more globally (e.g. sectors and technologies that will help shape the UK's future). These include life sciences, creative industries, clean energy, aerospace, financial services, defence, and digital and emerging industries such as artificial intelligence (AI), fintech, quantum computing and digital twins.

In **July 2020,** the government published the **'UK Research and Development Roadmap'**[66] setting out the country's vision and ambitions for research, development, and innovation and a starting point for the development a comprehensive R&D plan. Key themes include:

1. 'Raising research ambitions', including a commitment to increasing investment in R&D with particular focus on long-range efforts, and high-risk 'moon shot' ambitions to tackle specific challenges
2. 'Inspiring and enabling talented people and teams', including a new People and Culture Strategy and an improved ability to attract and retain global talent facilitated by a new 'Office for Talent' and a 'Global Talent Visa Reform'. There is also a desire to increase the

[63] HM Government. (2017). Industrial strategy: Building a Britain fit for the future. Retrieved from https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future

[64] HM Government. (2021). Build Back Better: Our Plan for Growth. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/968403/PfG_Final_Web_Accessible_Version.pdf

[65] HM Government. (2020). UK Research and Development Roadmap. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/896799/UK_Research_and_Development_Roadmap.pdf

[66] HM Government. (2020). UK Research and Development Roadmap. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/896799/UK_Research_and_Development_Roadmap.pdf

attractiveness and sustainability of careers throughout the R&D workforce – not just for researchers.

3. 'Driving up innovation and productivity' and securing economic and social benefits from research across the UK. This will be aided by strengthening the interactions between discovery research, applied research, innovation, commercialisation and deployment, providing support to ensure a healthy R&D system and exploiting UK's competitive and comparative advantage in key industries, technologies and ideas
4. 'Being at the forefront of global collaboration', including strategic collaboration with world leading nations as well as partnerships around Overseas Development Assistance (ODA) R&D to tackle Sustainable Development Goals (SDGs).
5. Long-term flexible investment into 'world-leading infrastructure and institutions' to support the agility and resilience of institutions and allow the UK to deliver cutting-edge R&I.

A.3.2. *Historical development & drivers of change*

Shifts in interdisciplinary research within policies and actions

The concept of research impact i.e. the notion that research can and should create impact is firmly embedded within the UK research ecosystem. Over the last five years especially, the policy narrative from the government is very explicitly around the desire to invest in research and innovation as a means to derive economic and societal impact (as conveyed in the 'Build back better' strategy and UK R&D roadmap discussed previously).

Policymakers and stakeholders in the UK are increasingly interested in understanding the potential for research and innovation to address complex challenges and missions, cutting across traditional disciplines and sectors, and the role of multi- and inter-disciplinary research and innovation (MIDRI – this is the term used by UK research councils, although other terminology is also used depending on stakeholder) in addressing these complex challenges including societal challenges (e.g., British Academy 2016[67], Global Research Council 2016[68]). This is because the knowledge generated within disciplinary boundaries may not fit the nature of the practical problems that individuals and societies encounter and addressing them is likely to require knowledge combinations that transcend disciplinary boundaries. The need for (supporting) interdisciplinary research has become even more prescient in recent years, in response to crises concerning climate change and COVID, which can only be tackled effectively through a combination of scientific, economic, and behavioural insights.

In the UK, the 2016 review of the Research Councils conducted by Sir Paul Nurse concluded that there was less appreciation than was desirable as regards the research priorities of different government departments and research councils, and that improved awareness and coordination would deliver an improvement in overall effectiveness in addressing these priorities. Based on the recommendations from the Nurse Review, UK Research and Innovation (UKRI) was created in 2018 among other things to increase coordination and support for cross-cutting initiatives across different discipline-oriented research councils. The role of interdisciplinary research in the Research Excellence Framework (REF) which assesses research in UK higher education institutions has also been closely scrutinised (e.g., Elsevier 2015[69]) and

[67] https://www.thebritishacademy.ac.uk/publications/crossing-paths/

[68] https://www.globalresearchcouncil.org/fileadmin/documents/GRC_Publications/Interdisciplinarity_Report_for_GRC_DJS_Research.pdf

[69] https://webarchive.nationalarchives.gov.uk/ukgwa/20170712122715/http:/www.hefce.ac.uk/pubs/rereports/Year/2015/interdisc/

the review of the REF led by Lord Stern (2016)[70] emphasised the essential role of interdisciplinarity and collaboration in the UK's research system.

It is difficult to say whether IDR is more or less prevalent than before as IDR has always been accommodated within normal funding mechanisms in the UK. There were successful examples of cross-council initiatives (e.g. Global Challenges Research Fund or GCRF) before UKRI came into existence – often led by one council and coordinated through the umbrella body, Research Councils UK. However, the Nurse review and the creation of UKRI have signified a step-change and led to significant investments in new cross-cutting initiatives that demand an IDR approach. These include the Industrial Strategy Challenge Fund (ISCF) and the Strategic Priorities Fund (SPF) which fund high quality MIDRI to respond to emerging strategic opportunities including societal challenges.

There are also increasing efforts from the REF 2014 and continuing to the new REF 2021 to ensure IDR is not disadvantaged in comparison to monodisciplinary research.

Drivers of change

Desire for impact (economic and societal) from publicly funded research as well as for tackling complex societal challenges are driving IDR in the UK.

In the past decade, UK funders have commissioned reviews of the position of IDR in the UK research ecosystem (e.g., British Academy 2016[71], Davé et al. 2016a[72] and b[73], Global Research Council 2016[74]). Several barriers have been identified in the funding system: It is generally acknowledged that IDR can be more demanding and time-consuming as it requires collaboration across disciplinary and organisational boundaries. Individual researchers face disincentives to undertake IDR, as it is often perceived to be riskier and less likely to lead to successful funding applications or publications in high-ranking journals. Relatedly, the capacity of peer review systems, traditionally organised around mono-disciplinary quality criteria, to assess IDR is a key concern.

This literature also contains several recommendations and examples of good practice on how best to support IDR which are being taken on board. These include:

- Designing funding initiatives (programmes, calls) in a way that is conducive to IDR, e.g., with a mix of bottom-up and top-down (challenge-led) initiatives, through collaboration between relevant funding organisations to address cut-cutting themes, set up dedicated funding streams for IDR, catalyse IDR proposals through seed-corn funding and other activities which allows the creation of new collaborative teams, allow for flexibility in time and budget for IDR-specific tasks.
- Organising peer review and evaluations in a way that can accommodate MIDRI, e.g., through review panel membership and guidance, and the definition of appropriate metrics for evaluating IDR projects, e.g., considering impact and contribution to challenges, rather than publication output alone.

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[70] https://www.gov.uk/government/publications/research-excellence-framework-review

[71] https://www.thebritishacademy.ac.uk/publications/crossing-paths/

[72] https://webarchive.nationalarchives.gov.uk/ukgwa/20170712122426/http:/www.hefce.ac.uk/pubs/rereports/year/2016/interdis/

[73] https://webarchive.nationalarchives.gov.uk/ukgwa/20170712122426/http:/www.hefce.ac.uk/pubs/rereports/year/2016/interdis/

[74] https://www.globalresearchcouncil.org/fileadmin/documents/GRC_Publications/Interdisciplinarity_Report_for_GRC_DJS_Research.pdf

- Building capacity longer term by supporting research careers and bringing early career researchers into IDR, and fostering a research culture conducive to collaborative and interdisciplinary approaches.

For instance, UKRI funds the aforementioned ISCF[75] and SPF where the former could be considered a top-down programme made up of 23 challenges covering themes such as clean growth, ageing society, future of mobility and artificial intelligence and data economy. The latter could be considered a bottom-up programme where UKRI constituent councils (which are discipline-oriented) collaborate with other councils, government departments, public sector research organisations, charities and/or foundations to design and implement a MIDRI-focussed initiative e.g. grant funding programme, infrastructure, etc.

Similarly, IDR funding programmes now commonly involve interdisciplinary peer review with individual reviewers or review panel members covering different disciplinary and/or sectoral expertise and often having interdisciplinary experience. Moreover, as already mentioned, steps are being taken to ensure that IDR is evaluated appropriately and is not disadvantaged in REF2021 by involving an Interdisciplinary Research Advisory Panel (IDAP) that includes experienced UK researchers with extensive interdisciplinary and research assessment experience.

A.3.3. *Prevalence of interdisciplinary research in organisation policies and activities*

Public agencies, advisory organisations and funding bodies

UKRI sees IDR as crucial to addressing complex societal challenges and addressing government priorities. Hence, it funds programmes specifically focussing on these areas where an IDR approach is often mandated or at least preferred (e.g. GCRF, SPF, ISCF; strategic-mode funding). In addition, IDR is also supported through responsive-mode funding for researcher-led grants, which are often curiosity-led. With both modes however, support for IDR is not to be provided at the expense of good quality monodisciplinary research. IDR is supported as a means to an end (e.g. tackling societal challenges) rather than as an end in itself.

The UKRI corporate plan for 2020-21[76] articulates UKRI's desire to support a positive, diverse, and interdisciplinary research culture going forward, with individual UKRI councils making commitments to support interdisciplinary and multidisciplinary research programmes related to challenges and themes such as infectious diseases, food security, adolescent mental health and sustainability.

Civil society organisations and foundations

These stakeholders also largely follow the same principle as the main public research funder, UKRI, i.e., IDR is supported as a means to an end and not at the expense of good quality monodisciplinary research. The Wellcome Trust, which is a private foundation aiming to improve health globally, has recently reviewed its strategy and will be supporting research in infectious diseases, mental health and at the interface between health and climate change. The latter is a relatively new area of research and is expected to require a transdisciplinary approach.

The Leverhulme Trust is also a private foundation, but much smaller than Wellcome. It funds most types of research except medical research. Grants are assessed primarily on the basis of originality, importance, significance (e.g. relevance outside single field) and merit (quality of

[75] https://www.ukri.org/our-work/our-main-funds/industrial-strategy-challenge-fund/

[76] https://www.ukri.org/wp-content/uploads/2020/10/UKRI-091020-CorporatePlan2020-21.pdf

the research design, methodology, researcher and institution). However, as secondary criteria, proposals that "transcend disciplinary boundaries" are particularly welcomed.

Research performing organisations

All universities support IDR to some degree. Some mechanisms at their disposal include:

1. Research centres focussing on societal challenges or interdisciplinary themes e.g. the Tyndall Centre for Climate Change Research, which a partnership of 4 UK universities and the Centre for Innovative Ageing at Swansea University. These can be physical centres that bring together researchers from different disciplines in one place (co-location) or 'virtual' centres where researchers are based in their own department but convene under the umbrella of a research centre or network e.g. the cross-departmental University Strategic Research Groups at the University of Southampton in areas such as clean carbon, autonomous systems and antimicrobial resistance.
2. Interdisciplinary research centres e.g. the Institute of Advanced Study at Durham University which convenes.
3. Support for faculty who are conducting IDR exclusively or as part of their research e.g. through collaborating with other departments or universities in inter- or multi-disciplinary projects.

Most universities have some research partnerships with business. However, these usually comprise applied research in the same discipline rather than interdisciplinary research. Moreover, the partnerships are usually between individual businesses and research groups. Nonetheless, IDR involving universities and businesses does happen.

A.4. European Union

A.4.1. European Commission

One of the recent policy developments in the areas of research is the new **Strategic Plan for 2020 – 2024** developed by DG RTD. The plan outlines six main priority areas to pursue which come from the current Commission's political guidelines. These include A stronger Europe in the world; Promoting our European way of life; An economy that works for people; A new push for European democracy; A European Green Deal; A Europe fit for the digital age.

Beyond these formal objectives and focus areas, the main and largest research and innovation programme, **Horizon Europe**, also reflects the priority areas and fields which the EU will pursue from 2020 – 2027. The new programme, Horizon Europe is built around three pillars: 1) Excellent Science, 2) Global Challenges and European Industrial Competitiveness, and 3) Innovative Europe. The second pillar is especially interesting as the programme support is divided across clusters of research fields which in many cases include several related, albeit different disciplines. For instance, "culture, creativity and inclusive society" form a cluster, as does "Climate, Energy and Mobility". The new form of the framework programme reflects the shift at the EU policy and programme level towards addressing societal and global challenges through excellent research, innovation, and mixes of related disciplines.[77]

Expert interviews also indicate that a further, though not explicit, theme at the EU level is to highlight the **importance of science to society**. With the rise of global, wicked challenges, as well as the declining status of objective fact and science, experts notice a desire at EU policy making level to make science more accessible to society and demonstrate its value. The Covid-19 pandemic has gone some way to creating a better awareness of the importance of science.[78]

The main accents of the policy debate on research and innovation focus on addressing societal challenges. Policy debate however has shifted from emphasising open science and collaboration to also prioritising innovation and uptake of excellent and cutting-edge research in order to address those societal challenges. The EU new policies and programmes launched in 2020 and 2021 reflect this debate. Achieving and consolidating an excellent, collaborative, and accessible research system form key elements in the EU's policy approach and the policy reflections which have taken place between the previous and current research and innovation strategies. [79,80]

There is much emphasis on cooperation across the EU Member States and across different types of actors, such as higher education institutes, research centres, enterprise, and government (public private partnerships), as well as on digitalisation and open science. Addressing climate issues is also an important accent (reflected in the EU policy strategies which focus more on societal challenges than on specific policy objectives).

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[77] European Commission, (no date), Horizon Europe, available at: https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en .

[78] Expert interview input.

[79] DG Research and Innovation, (2020), Strategic Plan 2020-2024, available at: https://ec.europa.eu/info/sites/default/files/rtd_sp_2020_2024_en.pdf .

[80] DG Research and Innovation, (2019), Open Europe - Policies, reforms and achievements in EU science and innovation 2014-2019 under EU Commissioner Carlos Moedas : open innovation, open science, open to the world, available at: https://op.europa.eu/en/publication-detail/-/publication/0dc27be9-de75-11e9-9c4e-01aa75ed71a1/language-en/format-PDF/source-search .

Furthermore, innovation and the application of fundamental research has gained increased attention; this is reflected for instance, in the launch of the European Innovation Council (EIC) in March 2021, as part of the Horizon Europe programme. The EIC aims to bring together enterprises, research institutes, and other innovation stakeholders and actors to "identify, develop and scale up breakthrough technologies and game changing innovations". Excellent research remains a key thematic area, as reflected in the Horizon Europe programme where this topic constitutes its own pillar.

EU research context and policy developments regarding IDR

The aforementioned six priority areas represent key societal challenges and in many, if not all, cases require a multi if not interdisciplinary approach to address. However, the **new Strategic Plan for 2020 – 2024** mentions interdisciplinary research only once. This reference to interdisciplinary research is made in connection with one of the specific objectives which the plan sets out. Specific objective 2.2 on revitalising the European Research Area to address societal, economic and ecological transitions in society and names interdisciplinary research as one of various approaches to achieving this specific objective.[81]

The previous **DG RTD strategy for 2014 – 2019** mentioned interdisciplinary research more often. It was mentioned especially in connection with other research themes, including that of Open Science, which featured strongly in the past R&I strategy. Open science and a more open Europe were key policy themes in previous EU R&I policy. This was described in the main policy strategy of the time, centred on three policy goals: open Europe, open science, open to the world. These goals formed the foundation of the previous DG RTD strategy from 2014 – 2019. Breaking down disciplinary silos and promoting more and easier research collaboration in Europe was seen as an important approach to keeping the EU R&I system innovative and competitive in this previous strategy.[82] This suggests that IDR was a more explicit theme in the previous strategy than the current one.

The **Horizon Europe** programme is a large funding programme and has been described as "the engine room" of EU research policy. Though it does not cite interdisciplinary research as a specific objective to pursue, programmes within Horizon Europe are more supportive of interdisciplinary research. For instance, the Future Emerging Technologies (FET) programme focused more on interdisciplinary research.

A.4.2. *Historical development & drivers of change*

Shifts in interdisciplinary research within policies and actions

A **2019 report** on "**Open Europe - Policies, reforms and achievements in EU science and innovation 2014-2019**" by DG RTD looks back at the achievements of the EU in the area of open science and shows how the debate regarding IDR and addressing societal challenges has shifted in the EU. In this report, the importance of the ERC in promoting research excellence is acknowledged as a means of tackling societal challenges. Similarly, tackling societal challenges requires EU research to have more impact. In connection with this need, more bottom-up, collaborative interdisciplinary research is again mentioned as an important approach to achieving higher research impact and, by extension, more effectively addressing

[81] DG Research and Innovation, (2020), Strategic Plan 2020-2024, available at: https://ec.europa.eu/info/sites/default/files/rtd_sp_2020_2024_en.pdf

[82] DG Research and Innovation, (2016), Open innovation, open science, open to the world A vision for Europe, available at: https://op.europa.eu/en/publication-detail/-/publication/3213b335-1cbc-11e6-ba9a-01aa75ed71a1 .

societal challenges.[83] This report goes on to look back at main outcomes and achievements, concluding that R&I in Europe has become increasingly interdisciplinary, bottom-up, and collaborative. Research infrastructure such as this, providing interoperable data, are described as being important to facilitating open, collaborative and interdisciplinary research.

In recommendations for the future of R&I in Europe the report suggested changes for the Horizon 2020 programme, now the Horizon Europe Programme. The report describes six main changes to Horizon 2020, include "increased interdisciplinary and collaborative work".

The current **Horizon Europe programme itself reflects a changing emphasis**, namely on societal challenges instead of policy objectives. This suggests a more concrete and specifically designed programme tailored towards addressing societal needs. In relation to this, the role of innovation and applied research appear to have become stronger as well (as suggested by the establishment of the EIC within Horizon Europe). Collaborations between fundamental or scientific research and applied research and commercialisation of research are recognised as increasingly important. These partnerships help the take-up and application of scientific research into use in sectors and society, thereby helping to increase the impact of science of societal challenges. To support this collaboration, the new version of the programme Horizon Europe reframes the second pillar on industrial leadership to stimulate more interdisciplinary research and cross-sector collaboration across EU policy domains.

Looking at the EU level policy strategies regarding interdisciplinary research, a shift can be recognised between the Strategic Plan for 2014 – 2019 and the Strategic Plan for 2020 – 2024. The change in focus on interdisciplinary research in EU policy strategies reflects **a move away from explicit mentions and references towards a more implicit pursuit and embedding of IDR** in EU research instruments, such as in the Horizon Europe, specific programmes within Horizon Europe and the European Research Council. Experts interviewed also confirm this move towards more implicit embedding of interdisciplinary research approaches in policies and support programmes for science and research[84]. This corresponds to a political drive to treat interdisciplinary research more as a normal research approach. However, a coherent approach to stimulating this type of research is not in place[85].

It should also be noted that expert interviews indicate that the notion of IDR has come and gone from EU policy focus in the last two decades under different names or synonyms. Interdisciplinary, multi-disciplinary, trans or cross-disciplinary, challenge-led research or mission-led research have all been terms which have been used to refer to the need for research which draws together Therefore it appears that IDR is enjoying an implicit resurgence in EU policy making, where collaboration across disciplines is not always referred to directly but is embedded in EU programmes and organisations supporting R&I.

Drivers of change

The main driver of the changing emphasis on interdisciplinary research appears to be tied to the rise in large-scale, societal challenges such as climate change, digitisation, globalisation and demands for higher global well-being have driven the increased emphasis on interdisciplinary research in EU policymaking. However, it should be noted that the emphasis is

[83] DG Research and Innovation, (2019), Open Europe - Policies, reforms and achievements in EU science and innovation 2014-2019 under EU Commissioner Carlos Moedas : open innovation, open science, open to the world, available at: https://op.europa.eu/en/publication-detail/-/publication/0dc27be9-de75-11e9-9c4e-01aa75ed71a1/language-en/format-PDF/source-search .

[84] Expert interviews.

[85] Expert interviews.

more on addressing societal challenges with IDR being used as a means to an end. Interdisciplinary research is not often mentioned explicitly in EU policy documentation and is referred to more, though not often necessarily, within Horizon 2020 and now Horizon Europe programmes and implementing bodies (such as the ERC and EIC). The EU takes a thematic focus when delineating policy priorities for science and research, where the themes outlined tend to relate to the aforementioned:" wicked problems".

As an extension of this effect, it appears that the EU making efforts to support interdisciplinary research and it normalise it as a research approach to help address the aforementioned "wicked problems" and grand. Societal challenges.; There is increasing recognition that this cannot be addressed solely through mono-disciplinary thinking. The emphasis in EU programmes tend to be on collaboration and addressing a given thematic challenge, where room is provided within a programme for research proposals to bring together different disciplines (such as within the ERC for instance – see question 8). De facto support and space is given for interdisciplinary research, but it is not always cited as a strict eligibility criteria for making use of EU research support.

A.4.3. *Prevalence of interdisciplinary research in organisation policies and activities*

Research councils, advisory organisations and funding bodies

The European Research Council (ERC): Within the Horizon programme, one of the main drivers of interdisciplinary research is the ERC, which is one of the executive agencies that fall under the pillar '*excellent science*'. Since the setup of the ERC in 2007, interdisciplinarity has been included in its definition of excellence[86].

ERC funds are allocated to "frontier research" being done, which includes fundamental as well as applied research; this is something which happens within all ERC grants. ERC funds frontier research, but interdisciplinary research is not a must in ERC grants. ERC funds are for individual researchers. Three types of grants exist: started, consolidator and advanced grants and each aim to push the boundaries of science and innovation.

In 2008/2009 there was a recognition that much scientific work was being done at the frontier in the EU, across fields. This type of transformative research was taking place and could be stimulated further. However, pushing research further is difficult to do as one person and is easier to achieve as a group.

This acknowledgement at the EU policy making level led to the "co-investigators scheme. In that time the ERC only had individual and advanced grants. The Council felt that some research needs were challenging to research and preventing it from moving forward. The Council observed that some ideas were not being taken up by researchers as a result (the obstacle and challenges were deemed too big). This gave rise to the Synergy Grant scheme.

The working of the ERC and its grants: A person applies for a research grant and this application goes to one of the 27 ERC panels across disciplinary domains. Applications are done using a Guidance Document prepare by the ERC. The Scientific Council of the ERC consists of 22 people, and these define the types of grants to be made available via the ERC. Each field and discipline has a number of descriptors and key words. These key words lead to overlapping fields being arising and to overlapping groups which check applications.

[86] https://erc.europa.eu/about-erc/mission

Synergy Grants on the other hand to do not go to fixed panels; these applications use key words to assign their application to a field. A first review is of an application is conducted by the ERC and then 5 panels are established which examine the application.

European Research Executive Agency (REA): REA was established in 2009 to help the Commission implement framework programmes, starting with FP7.[87] REA policy documentation, such as its Annual Activity Reports and Annual Activity reports focus on addressing societal challenges and benefiting society more than focusing on interdisciplinary research. REA as a whole is a more operational body, which implements nearly 20% of the Horizon 2020 budget[88] and now, Horizon Europe grants within the new programme cycle. In that sense REA implements research projects in line with Horizon 2020 and Horizon Europe[89] objectives and goals.

The current Research and Innovation strategy is organized around "societal challenges" as opposed to priority objectives. REA is involved in implementing Horizon Europe funding and research projects which tackle societal challenges. In this way the agency plays a role in stimulating IDR though promoting interdisciplinary research approaches are not mentioned as organisation mission or priorities in REA policy documentation.

Partners

ScienceEurope, a collection of research institutes and research funding organisations, does not mention IDR as a key area of focus for the organisation. In 2020 a conference was held, sharing experiences and good practices from countries which support IDR. ScienceEurope expects however to continue shifting its attention more towards IDR in the near future.[90]

The **LERU**, an association of 23 research universities from across 12 Member States, advocates for awareness regarding research and education and for an internationally competitive research environment. Within this context, the LERU has pushed for social sciences and humanities (SSH) and interdisciplinary research to be given more attention within Horizon 2020 and in EU universities generally. In 2013 and 2014 the LERU prepared an advisory paper and a policy brief respectively. The 2014 brief was on "The future of the Social Sciences and Humanities in Europe: collected LERU papers on the SSH research agenda"[91]. In 2016 to 2017 the LERU continued to voice support for more interdisciplinary research with its position paper "Interdisciplinarity and the 21st century research-intensive university"[92].

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[87] REA, (2019), Annual Work Programme 2019, available at: https://ec.europa.eu/info/sites/default/files/annual-work-programme-rea-2019_en.pdf .

[88] REA, (2019), Annual Work Programme 2019, available at: https://ec.europa.eu/info/sites/default/files/annual-work-programme-rea-2019_en.pdf .

[89] Where HorizonEurope Pillars include: 1) Excellent Science, 2) Global Challenges and European Industrial Competitiveness (and clusters of science), and 3) Innovative Europe

[90] Expert interview.

[91] LERU, (2014), Policy brief: SSH and interdisciplinary research, a showcase of excellent research projects from LERU universities, available at: https://www.leru.org/publications/ssh-and-interdisciplinary-research-a-showcase-of-excellent-research-projects-from-leru-universities .

[92] LERU, (Wernli, D. and Darbelly, F.), (2016), Interdisciplinarity and the 21st century research-intensive university, available at: https://www.leru.org/files/Interdisciplinarity-and-the-21st-Century-Research-Intensive-University-Full-paper.pdf

Research performing organisations

Examining the focus of the research performing organisations in the EU is difficult as the EU does not have many organisations carrying out research directly. The EU's role in the process is to facilitate and support research at the Member State level. The ERC for instance, does good work in trying to promote interdisciplinary research, indicate expert interviews. The European Commission works to facilitate IDR and there are various interesting examples at the Member State level which reflect a stronger IDR focus; the Max Planck Institute in Germany and the CNRS in France all have IDR commissions or conduct IDR studies for instance[93].

The European Universities Initiative is another example, where the initiative creates alliances between universities in Europe to get Europeans to cooperate across language, borders and disciplines to address societal challenges and skills shortages in Europe[94]. The cooperating universities will develop strategies focussing on sustainability, excellence, and European values, offer student centred curricula, and adopt challenge-based strategies to allow interdisciplinary teams of researchers, students and teachers to cooperate.

While the EU supports a variety of initiatives supporting research performing organisations at the Member State level, the actual research takes place in countries for the most part. The EU's Joint Research Council (JRC), carries out research for the EU though mainly regarding national developments and trends in EU Member States.

[93] Expert interview.

[94] European Commission, ( ), European Universities Initiative, available at: https://ec.europa.eu/education/education-in-the-eu/european-education-area/european-universities-initiative_en

A.5. Netherlands

In the Netherlands public funding for R&D comes primarily from The Ministry of Education, Culture and Science (OCW) and the Ministry of Economic Affairs (EZK). Between those ministries, funding linked to *innovation* comes primarily from the ministry of EZK, and *research funding* from the ministry of OCW. Of the research funding, one part is distributed through the **Dutch Research Council (NWO);** one part of this by means of competitive grants, and another part is directly allocated to research institutes which are either part of NWO, or part of the **Dutch Royal Society of Arts and Sciences (KNAW)**. Furthermore there are large tax benefits for R&D activities (about 15% of the total combined yearly expenditure of OCW and EZK, which was 6.2 bn in 2021 [95]) .

A.5.1. National government

IDR is one of the goals of the Dutch national science policy[96], and many strategic policy documents mention the importance of IDR, but there are few policies or funding opportunities directly aimed at (increasing) IDR. The main exception are funding and policies aimed at solving complex societal problems, where IDR is recognized as an important part of the solution. Examples are the National Research Agenda (NWA), which has been running since 2018, and the national Knowledge and Innovation Covenants (KIC).

The **NWA** has four main themes: *Research along Routes by Consortia* (ORC) encourages curiosity-driven research via open calls for research over a period of several years. It is aimed at broad, interdisciplinary, and transdisciplinary consortia with a (societal) objective on subjects relevant for science and/or society. The *Thematic Programming* covers programmes that are suitable for a broad approach and that are developed in consultation with government ministries; *Innovations and Networks* ensures innovation within the NWA is primarily aimed at facilitating consortia; finally, *Science Communication and Outreach* is responsible for the NWA promise of bringing science and society closer together by means of communication and outreach.

The **KICs** are aimed at facilitating public-private collaboration projects and are also organized along four lines: *Missions* are collaboration projects (also known as aimed specific topics, bundled in Knowledge and Innovation Agenda's (KIA's); *partnerships* refer to research questions from external private and/or public partners. Researchers can initiate or participate in projects in a partnership. *strategic collaborations* provide funding for a limited number of long-term programmes (LTP) with a term of ten years. The aim is to stimulate the development of a scientific field focused on a societal theme and/or key technologies. Finally *innovation networks* allow practice-oriented researchers to build up innovation networks and collaborate with regional partners and SMEs.

Outside these (large) funding instruments, there is freedom for research organizations to implement IDR if and how they see fit. Within Universities this has led to a bottom-up movement where IDR-institutes, research groups and focus areas are being created in parallel to existing organisational structures[97].

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[95] https://www.rathenau.nl/nl/wetenschap-cijfers/geld/wat-geeft-nederland-uit-aan-rd/overheidsfinanciering-van-rd

[96] https://www.nwo.nl/sites/nwo/files/documents/Wetenschapsvisie%202025.pdf

[97] https://www.rathenau.nl/sites/default/files/Feiten_en_cijfers_Universiteiten-Rathenau.pdf

A.5.2. Historical developments & drivers of change

There are several interlinked historical developments which have contributed to the increased prevalence of IDR in the Netherlands. **Societal developments** are a driving force, where science is increasingly required to provide answers for societal challenges; also, due to the shifting position of science in society **impact of science** is increasingly measured in terms of societal impact, or valorisation. Finally, developments within the world **of academic research** have had both positive and negative influence on IDR. These different historical developments are discussed below in more detail.

Firstly, increased societal welfare has resulted in a focus on broader, more complex problems which go beyond economic growth. These so called '**societal problems'** vary from topics such as climate change and new applications of Artificial intelligence to tackling inequality and infectious disease control. These large topics encompass many different areas of science and there is a general recognition of the fact that IDR is essential to address these problems. At the same time developments in the labour market such as the increased use of new technologies, and the increasing complexity of existing jobs mean that knowledge of interdisciplinary skills is more and more in demand and needed on order to succeed in a labour market which is increasingly employing people through flexible labour-contracts.

There are also important changes in the position of science within society. Where previously science was positioned at a certain distance from society taking place in independent, self-guiding, monodisciplinary institutes, in modern day society it is required that science has some form of **(societal) impact**: science needs to answer questions that come from society and bring the results back to society. This is visible in increased attention for 'missions' within the national science agenda, and an increase in collaborative projects around SDGs and the NWA. The so-called quadruple helix partnerships (university-industry-government-public) actively include the public(citizens) in their research, through joint problem formulation, and active participation in- and use of -research by citizens. Science valorisation is increasingly requested and required from universities (the so called 'third mission' of universities), and the development of practices in this area is seen as an important driver of IDR as it forces scientist to look beyond the boundaries of their own scientific discipline.

Finally, there are **trends within science itself** which relate to IDR. The growth of the scientific field as a whole over the last century has resulted in diversification and an increase in the number of scientific disciplines, making IDR increasingly hard. At the same time, technological developments such as for example the possibility to share large datasets, and remote communication possibilities, create opportunities for IDR. In recent years there is, under influence of interest representation groups, increased attention for working conditions within science and how scientific contributions are recognized. Topics such as how scientific output is measured, equal opportunities and different career paths within science have been put on the agenda. As a result, there is a lively discussion about careers within science which is likely to result in more diversity in career options, which in turn might boost IDR.

A.5.3. Prevalence of interdisciplinary research in organisation policies and activities

Research councils, advisory organisations & funding bodies

NWO is the main source of public research funding, distributing money from the ministry of OCW and other government ministries to the universities and national research institutes by means of competitive grants. Business and civil society organisations also provide financial support for research in their sphere of activity through NWO, typically in the form of jointly funded themed programmes.

Internally, NWO is organised into four 'pillars', which each encompass a scientific domain. Because of this organisational structure, funding calls, application procedures and funding decisions are domain specific. This organisation is a hurdle for IDR, as it means applications must transcend both disciplinary boundaries and domain boundaries.

The NWO-strategy 2019-2022 describes the intention to facilitate IDR: '*NWO connects researchers from various disciplines and across the entire knowledge chain and brings researchers and societal partners together*'

A large part of the contribution of NWO to stimulating IDR is through activities related to the **KIC**. From 2021, the calls for KIC funding are 'mission-oriented' and are aimed at challenges that cross disciplinary boundaries. To this end, NWO aims at *interdisciplinary programming*, organising meetings where IDR aspects of proposed missions are discussed before the calls are published; after the call is published it also organises so called '*matchmaking meetings*', which provide an opportunity for researchers from different disciplines, business and civil society organisations to meet. Finally, there is increasing attention, specifically in the context of the KIC-calls, for the challenges around the *review process of IDR proposals* with attention being paid to the choice of reviewers and the review criteria.

Programmes: **NWO Crossover programme. Started in 2018** Researchers from very diverse disciplines will join forces within these consortia with public and private partners. Besides research, they will strongly focus on facilitating the collaboration between various disciplines and making the connection with application-oriented research. The results will find their way, for example, into living labs, testing grounds, centres of expertise or smart data factories.

The Dutch Universities of applied science are represented by the Association of Universities of Applied Sciences (**VH**). Two key themes in the strategic agenda 2019-2023 formulated by the VH are '*working on social challenges*' and '*connecting to the labour market*'. Both these themes refer to research and education activities which reaches across disciplinary boundaries. The strategic agenda describes how applied universities plan to integrate the sustainable development goals (SDG's) into their teaching and research.

Research performing organisations

For historical reasons the 19 Dutch national research institutes are split between two governing bodies: the Dutch Research Council (NWO) and the Dutch Royal Society of Arts and Sciences (KNAW). As opposed to research at universities, research within these institutes is primarily aimed at long-term fundamental research. Their activities intertwine with research at universities through joint participation in research consortia, research programmes and joint financing of (senior) researchers.

Most of these institutes indicate in their strategy-documents that they actively participate in IDR. However, a recent evaluation has named IDR as a necessary condition for the added value of the institutes, thereby making IDR a requirement in their research agenda. The reason for this is that the long-term funding puts the institutes in a good position to respond to developments both in science and in society and the consensus is that IDR is required to address these challenges.

Many of the institutes have also played a large role in the development and implementation of the national research agenda (NWA), both influencing the NWA through their interdisciplinary outlook, and actively contributing to IDR in the execution of the NWA.

Although research within universities historically has been split along faculty – and departmental lines, making IDR difficult, almost all universities these days also have (inter-faculty) research institutes, bringing researcher from the university together on specific topics

or focus areas. These organisations, which exist in parallel to the traditional structures within the university, are drivers of IDR. Although these institutes often operate within the domain-boundaries (alfa, beta, gamma), IDR is often an explicit aim, as is also reflected in the domain-transcending topics, linked to global challenges.

Appendix B Practices for stimulating interdisciplinary research

This appendix offers a summary of twelve practices which stimulate interdisciplinary research in Finland, the UK, Germany and the EU. The practices have been categorised by level of responsible actor and follow a comparable structure. Each practice contains information on:

- Objective and description
- The outcomes of the practice and contribution to interdisciplinary research
- Challenges and success factors
- Sources

B.1. Practices by national government

B.1.1. Excellence Initiative & Excellence Strategy

Name of practice	**Excellence Initiative & Excellence Strategy**
Country	Germany
Responsible actor:	Federal Ministry of Education and Research, federal ministry
Main target of practice	Universities and research institutes, Research framework conditions
Objective and description	
The main aim of the Strategy is thus to strengthen Germany's long-term position as a centre of science and research in the international context and thereby also making Germany (and its research and education excellence) more visible internationally. The funding is intended to enable scientific excellence, sharpen the profiles of the universities, and encourage even stronger networking and cooperation in the science system. Within the framework of the **Excellence Initiative** (2007-2017), the Federal Government and the Länder expected applicant universities to submit an "overall concept for networking the disciplines" and at the same time to provide evidence of "added value through interdisciplinarity". The **Excellence Strategy** (since 2018) consists of two funding lines with different requirements/expectations regarding IDR: 1. The "**Clusters of Excellence**" provide project-related funding for internationally competitive research fields at universities or university networks. In the clusters of excellence, scientists from different disciplines and institutions work together on a research project. In the funding line Clusters of Excellence, interdisciplinary cooperation is defined as a funding criterion and seen in relation to "scientific excellence and coherence of the research concept for developing the thematic research field". 2. The funding line "**University of Excellence**" serves to strengthen the universities or a network of universities as an institution and to expand their international top position in research based on successful clusters of excellence. In the Excellence Universities funding line, interdisciplinarity is not explicitly defined as a funding criterion, but the applications submitted show that cross-disciplinary cooperation is considered an important field of action at the university-wide level. For each year, approximately 544 Mio. € is budgeted for these practices.	
Outcomes of the practice	
Regarding **hard outcomes**: The proportion of mono-disciplinary graduate schools (approx. 12%) and clusters of excellence (approx. 8%) that received funding under the Excellence Initiative was accordingly very low. In contrast, around 49% of the graduate schools and around 57% of the clusters of excellence with the integration of four or more disciplines were characterised by very broad interdisciplinarity. This can be related to the fact that although IDR was not a funding criterion, it was implicitly expected by applicants (see above). Regarding **soft outcomes:** The Excellence Initiative has contributed to outstanding research achievements, has strengthened cooperation between universities and non-university partners and has led to increasing networking between German universities and universities around the world (BMBF).	
Contribution to interdisciplinary research	

Under the Excellence Initiative, the Federal Government and the Länder expected applicant universities to submit an "overall concept for interlinking the disciplines" and at the same time to demonstrate "added value through interdisciplinarity". IDR has become a norm for those universities funded through the excellence initiative/strategy, which are also those universities that are nominated as "excellent". Through such funding formats diverse interdisciplinary structures have emerged in recent years that have the potential to bring about lasting structural change at universities (such structures can be the newly developed clusters that encourage cooperation between disciplines within and even across universities).
Challenges and success factors
Funded universities receive correspondingly high amounts of funding, which then become the basis for positions and structural developments at the universities. A critique is the reinforcing effect this has on large and successful universities. The development and implementation of the universities' concepts in the Excellence Initiative and the Excellence Strategy triggered profile-building processes for the universities: values, goals and unique selling points were reflected at the universities, institutional strengths were bundled, research priorities were further developed and synergies between research and teaching were more strongly developed.

Sources	• www.bmbf.de/bmbf/de/forschung/das-wissenschaftssystem/die-exzellenzstrategie/die-exzellenzstrategie.html • Wissenschaftsrat: Wissenschaft im Spannungsfeld von Disziplinarität und Interdisziplinarität, Positionspapier (2020) • Universitäten sind entscheidender Wirtschaftsfaktor: https://www.cicero.de/kultur/exzellenz-initiative-bildung-konstanz-wettbewerb-universitaet • Interview with the BBMF and the German Science Council.

B.2. Practices by research councils, advisory organisations and funding bodies

B.2.1. The Strategic Priorities Fund, UK

Name of practice	Strategic Priorities Fund
Country	United Kingdom
Responsible actor:	UK Research and Innovation (UKRI), national public research agency
Main target of practice	Researchers, Research Framework conditions, Government departments; non-governmental research funders; public sector research establishments
Objective and description	
The objective of the UKRI fund are twofold, namely to: 1. increase high-quality multi- and interdisciplinary research and innovation (MIDRI) 2. ensure UKRI investment links up effectively with government research and innovation priorities respond to strategic priorities and opportunities These are a variety of initiatives spanning across many different topics and disciplines. There are 34 programmes organised under eight themes: environment, biology and biomedicine, artificial intelligence, productivity, infrastructure, health, well-being and human rights, digital, and productivity and technical. The fund is implemented by a series of research performing actors and organisations facilitating research such as the independent charities and foundations e.g. British Heart Foundation, Wellcome Trust; UKRI Research Councils; UK government departments and public sector research establishments. The practice has a budget of approximately £830 million.	
Outcomes of the practice	
The main outcomes of this practice include: • Qualitative evidence that the research community is bringing forth more multi-disciplinary and interdisciplinary research (MIDRI) proposals • Increased collaboration between UKRI research councils	

- UKRI councils have put in place and improved mechanisms and actions to de-risk and assess MIDRI proposals which is flowing through to interdisciplinarity within projects and more MIDRI publications. These improved administrative practices are expected to flow through to other parts of the IDR ecosystem. A new KPI structure is also being trialled.
- Greater focus on government strategic priorities
- Support for IDR activities that otherwise would not be possible e.g. involvement in international initiatives, infrastructural investment
- Provides mechanism to fund research that addresses complex challenges, is multi-stakeholder and takes non-traditional approaches

Contribution to interdisciplinary research

Though the Fund helps to invite more MIDRI proposals, the actual level of IDR approaches in research is not measured specifically. However, this practice contributes to framework conditions which support IDR activities and, in this respect, is a relevant practice to stimulating IDR. There are indications that the programme does contribute to more IDR. For example, the Physics for Life programme has extra space in the proposal for applicants to explain how the MIDRI will be more than the sum of its parts and how this will be ensured/achieved.

Challenges and success factors

The main challenges involved in this practice include:

- They difficulty of involving government departments and to stimulate close cooperation.
- A lack of time to develop ideas, which has been remedied in Wave 2 of the Fund and its application calls. This has reinforced within UKRI the need for time to develop interdisciplinary networks not only among researchers for projects but also funders, government departments and other stakeholders for the programmes. Time is needed to germinate and support new ideas as well as establish relationships, trust and common objectives.
- There was a lack of clarity around the fund's priorities and intentions because process and criteria for assessment were not shared with bidders in advance

The success factors identified for this practice include:

- Requirement for involvement of more than one UKRI research council and focus on government strategic priorities in proposal
- Programmes for investment chosen based on significance of potential impact and whether programme could be funded through other means. Thus, the most important programmes that could not have been funded otherwise were funded
- The amount of investment and variety of topics funded signals to researchers and research performing organisations that IDR is desired and valued within the research system. It is incentivising researchers to undertake MIDRI.

Sources	• https://www.ukri.org/our-work/our-main-funds/strategic-priorities-fund/ • Interview with the UKRI

B.2.2. The Strategic Research Council (SRC)of the Academy of Finland Multidisciplinarity requirement

Name of practice	**Strategic Research Council (SRC)of the Academy of Finland Multidisciplinarity requirement**
Country	Finland
Responsible actor:	Strategic Research Council (SRC) of the Academy of Finland, public agency
Main target of practice	Researchers

Objective and description

The Strategic Research Council (SRC) funds solution-oriented and phenomenon-driven research for grand challenges. Through their wicked nature, multiple perspectives are needed to come to robust solutions. By

requiring multiple research fields for a proposed project, the SRC ensures that several perspectives are included in the research. To apply for research funding, the applying consortia must include at least two organisations and at least three research teams or work packages (WP). The research to be conducted in the consortium must belong to at least three research fields listed in the Academy of Finland's research field classification. This approach builds on dialogue between researchers and those who need research-based knowledge. In this way, due to this requirement, multidisciplinary, phenomenon-based research that spans several administrative domains. The funding committee of the SRC implements the practice with an annual funding budget of €55 million.
Outcomes of the practice
The four programmes of the SCR active between 2016 and 2019 were evaluated in 2021. The evaluation concluded that 'that the strategic research programmes and their projects have effectively supported scientific renewal and produced high-quality and multidisciplinary research. The programmes have been able to produce multidisciplinary research-based knowledge on the chosen themes, for example through new methods based on co-creation. In addition to scientific impact, the results achieved in the programmes and projects have thus provided strong and versatile research data to support policymaking.
Contribution to interdisciplinary research
The practice has contributed quite significantly to interdisciplinary research as a large budget is indirectly dedicated to the funding of multidisciplinary research.
Challenges and success factors
According to the evaluation of the past programmes, the shortness of the funding period set abnormal challenges for projects to develop their multidisciplinary activities and produce scientific and societal impact outputs. The main, key success factor is connecting funding with a multidisciplinary requirement. This requirement provides a significant stimulus for researchers to engage in multidisciplinary research.

Sources	• SRC report (2021), *Strategic Research Programmes 2016 – 2019: Ex-post evaluation of scientific activities* • SRC guidelines (2020): *Funding Principles of the Strategic Research Council* • Interview with Strategic Research Council, Academy of Finland.

B.2.3. The European Research Council - Synergy Grants

Name of practice	**The European Research Council - Synergy Grants**
Country	European Union
Responsible actor:	The European Research Council (ERC), EU research council and funding body
Main target of practice	Researchers across the EU
Objective and description	
The 2020 Work Programme for the ERC provides an overview of the objectives for each of the ERC's research grants. The Synergy Grants have the objective of providing "support for a small group of two to four Principal Investigators to jointly address ambitious research problems that could not be addressed by the individual Principal Investigators and their teams working alone."[98] **Synergy Grants:** The Synergy Grants offer research groups up to 10,000,000 € for a period of up to 6 years to carry out their research. It should be noted that this is the highest level of research funding offered by the ERC grant instruments and the longest time frame for the research to be carried out. Additional funding of up to 4,000,000 € can also be applied for within the Synergy Grants.	

[98] ERC WP 2020, https://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/erc/h2020-wp20-erc_en.pdf

The review process for Synergy Grants have been tailored to the interdisciplinary and cross-institutional nature of the research programmes it seeks to support.

The **Synergy Grant review process** consists of several steps. The process is different as the research being conducted is quite complex and it would be unfeasible to have one panel carry out a review. The process is as follows:

1. An applicant submits a proposal and adds key words, and abstract and a short synopsis of the proposal.
2. There are 87 reviewers who can be called upon to review a synergy grant proposal. Of this number, 3 or 4 experts review the proposal. These experts find additional experts from standing ERC panels if necessary. About 50% of applications are rejected at this stage.
3. Of the 87 reviewers, 11 then meet in Brussels to discuss the remaining applications. The 87 members are divided into 5 panels based on their expertise and the fields covered in the remaining applications. The panels are large, 16 – 18 people, covering 5 main disciplines (the humanities, social sciences, life sciences, physical sciences and engineering, and (?)). These panels then review the applications and remote expertise can be recruited if necessary.
4. The groups and their PIs must present their proposal and themselves and panels judge how a group interacts and behaves with one another. This is a very important aspect of the evaluation process because the team will be working together for several years.

The ERC's overall budget under Horizon 2020 was € 13 billion. In 2020, of 441 submitted proposals, 34 projects were funded. The total budget awarded to these projects in 2020 was € 352 million. In 2019, the ERC received 288 proposals for synergy grants, awarding 38 projects, with a total of € 369 million.

Outcomes of the practice

Outcomes of the projects have not been measured. However, looking at the publications published about funded projects, these tend to be in the opt 1% of journals for about 50 to 60% of the grants. The publications have high impact factors as well. Some Synergy Grants are only ending now (they are longer term after all). Synergy Grants in turn often lead to spin-off projects.[99]

While results and outcomes for Synergy Grants specifically are difficult to identify, the ERC website has made data available on the number of research projects it funds which use an interdisciplinary research approach.

Concerning softer outcomes, the synergy grants appear to help to reduce some of the operational and practical obstacles to IDR at the research level. For instance, many people underestimate the difficulty in reaching the same scientific language; this is genuine challenge to be tackled in synergy grant and IDR projects generally. This takes time and space and within synergy grants especially there is time to do this. It is very important and important to emphasis and communicate to others.[100]

Contribution to interdisciplinary research

Indicating exactly how the ERC and its various grants have contributed to increased IDR is challenging. Interdisciplinary research is not a policy priority for the ERC and as such this is not measured directly. Establishing a correlation between the ERC and interdisciplinary research is difficult. That being said, through its project database, the ERC can indicate that it has funded some 870 projects of interdisciplinary projects[101].

Challenges and success factors

A first question regarding the collaborative grants from the ERC was "what is the added value"? The answer to this question of added value came from the PIs themselves. The PIs indicated that the larger, complex issues and research topics need to be jointly tackled. They indicated that one cannot have one institution working on such issues, the issues are usually too big, and one needs more organisations and more people at the front of their fields.

A second challenge was choosing experts who think outside the box and in an open manner (who listen to individuals from outside their own field). This applies to the regular ERC review process as well as to the Synergy Grant process.

The Council is constantly updating the evaluation criteria and panellists to just proposals are recruited some 2 to 3 years before a call and receive financial remuneration for their efforts as well as the professional prestige of being

[99] Input from expert interview.

[100] Input from expert interview.

[101] ERC, (no date), Project database, available at: https://erc.europa.eu/projects-figures/project-database

an ERC panellist (where the prestige comes from the fact that the ERC funds "frontier" research, at the forefront of science and recruits' experts at the forefront of their fields to aid in the reviews).[102] For the synergy grants in particular the key success factors include: • Quality of experts and proper evaluation process, • The clear expectations for applicants, • The implicit acknowledgement of the nature of IDR in the scope of the synergy grants (i.e. the need to establish common languages between disciplines, that these projects tend to be more complex, take longer and therefore require more time and higher levels of funding).	
Sources	• ERC Scientific Council, (2020), Annual report on the ERC activities and achievements in 2020, available at: https://op.europa.eu/en/publication-detail/-/publication/09a3dcb6-9ccb-11eb-b85c-01aa75ed71a1/language-en/format-PDF/source-199814583 . • ERC Scientific Council, (2019), Annual report on the ERC activities and achievements in 2019, available at: https://op.europa.eu/en/publication-detail/-/publication/92905b4f-9652-11ea-aac4-01aa75ed71a1/language-en/format-PDF/source-221000641 . • ERC WP 2020, https://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/erc/h2020-wp20-erc_en.pdf • Interview with the ERC

B.2.4. The European Research Council – Proposal Review System

Name of practice	**The European Research Council – Proposal Review System**
Country	European Union
Responsible actor:	The European Research Council (ERC), EU research council and funding body
Main target of practice	Researchers across the EU
Objective and description	
The ERC was established within the framework programmes (now Horizon Europe), to help promote excellence in research at the forefront of knowledge in the EU. The organisation helps to implement researcher orientated funding from the EU framework programme for science and research. **General ERC grants and review processes**: the application processes for ERC grants are generally subject to several review rounds by tailored disciplinary review panels. It is worth noting here that the ERC has an approach which facilitates interdisciplinary research approaches throughout its various grants. This is rooted in the review process which it uses for evaluating research proposals: 1. For individual grants: a person or group submits an application and indicates with key words what the main disciplines in the research are. The applicant selects a first and a second review panel to review the application and these disciplines can overlap. 2. A first review is done by generalist experts from the selected disciplinary panels (usually by 3 or 4 people from one or two panels). The reviewers discuss their impressions. 3. After this the whole panel reviews the proposal application in Brussels. 4. The proposal is then sent to Remote Referees (outside the ERC) who are experts in their field for a specialized review of the application. 5. The applicant then presents the application to the whole panel in Brussels. Each given proposal goes through 6 or 7 reviews. Applicants are briefed on the outcomes of the evaluation at the end of the review process, be it upon receiving the grant or upon a rejection of their proposal. The ERC's overall budget under Horizon 2020 was € 13 billion.	
Outcomes of the practice	

[102] Input from expert interview.

The ERC has funded some 12143 project since its inception allocating some € 20.724 million to these research projects[103]. Of this number, 872 used an explicitly mentioned interdisciplinary approach (in and outside of Synergy Grants, mentioned in a separate practice), amounting to some € 1739 million of support[104].
Contribution to interdisciplinary research
While, it is difficult to establish a causality between increased levels of interdisciplinary research with the activities of the ERC, it is worth noting that many of the ERC's funded projects have an interdisciplinary approach. This suggests that the ERC does contribute to IDR but, as indicated in this practice, it is not a main objective for the ERC and not specifically measured.
Challenges and success factors
One of the main challenges related to the review process is the selection of experts. These experts must think outside the box and in an open manner (who listen to individuals from outside their own field). This applies to the regular ERC review process as well as to the Synergy Grant process. The Council has made specific efforts to address this challenge because pursuing a more collaborative research approach which combines differences helps to achieve the ERC mission. As indicated above in the practice on Synergy Grants, the ERC regularly updates its evaluation criteria for reviewers, recruits experts well in advance, and provides financial remuneration, along with the professional prestige and enjoyment an evaluator receives upon being recruited to the ERC process to evaluate research proposals at the forefront of their respective fields.[105] For the **ERC**, key success factors include: • the bottom-up, investigator driven approach • The flexibility and portability of grants for individuals (as opposed to host institutions) mean that researchers have more freedom to move and use their grant money as they deem most useful. • The high quality, reflexive review process for ERC grants[106]
Sources • ERC Project Database, https://erc.europa.eu/projects-figures/project-database • Interview with the ERC

B.2.5. The Future Earth Townhall (and other events)

Name of practice	**Future Earth Townhall (and other events)**
Country	Finland
Responsible actor:	Future Earth Finland (FEF), public fund
Main target of practice	Researchers, Different Finnish universities and universities of applied sciences (e.g., University of Helsinki, the University of Tampere, and Tampere University of Applied Sciences), Companies and organisations that provide supportive technology, virtual or physical space, and other necessary resources. Other actors: Government and funding sectors); Citizens, FEF secretariate (project coordination
Objective and description	
The objective of this fund is to engage a variety of stakeholders in co-creating societally relevant global change research in Finland via several consecutive events, where later events built on the previous ones. The reason for this practice was that the FEF recognised that the actors relevant to the co-creation of global change research are very diverse and that, although researchers have the main responsibility for research, other	

[103] ERC, Datahub of ERC funded projects, available at: https://erc.europa.eu/projects-figures/project-database

[104] ERC Project Database, https://erc.europa.eu/projects-figures/project-database

[105] Input from expert interview.

[106] Input from expert interview.

societal actors can bring in invaluable knowledge, networks, resources and data. The practice was set up to facilitate the collaboration between these actors.

The FEF entails the following activities:

- Facilitation of the process of co-creation by tackling common problems of conceptualisation, capacities (e.g., contacts and skills), and continuity (availability of resources and merits)
- Mainly facilitated through stakeholder events in three parts.
  - First part: creation of interaction spaces through seminars with brief plenary talks outlining the issues followed by small-group discussions
  - Second part: Increase capacities of participants by facilitating new contacts via training, networking events, and researcher and stakeholder workshops to plan joint research proposals
  - Third part: Embedding of new activities within existing institutional frameworks (continuity)

Two main events took place. During the first event the implementing actors consisted mainly researchers but also participants sectoral ministries, non-governmental organisations, interest groups, companies, municipalities, and research funders During the second event the same stakeholders were involved but with a special focus on the involvement of more private sector firms.

Outcomes of the practice

The main outcomes of this practice include:

- Over 60 participants and 40 participants in the events respectively
- The key outcome of the event was the identification of topical global change challenges from the Finnish perspective
- Soft outcomes were not measured as no follow up with participants took place

Contribution to interdisciplinary research

In terms of the contribution to interdisciplinarity, this was not monitored by researchers directly. Participant feedback was collected, and this indicated that participants were glad for opportunities to reach out to other stakeholders and hear about their views, needs, and opportunities. In this sense the events provided a forum for networking, exchanges, and the exploration of ideas for further collaboration across researchers, enterprises, civilians and government representatives.

Challenges and success factors

The main challenges involved here were:

- Cognitive barriers - different cognitive backgrounds can cause knowledge asymmetries and hinder effective communication
- Motivational barriers - actors' differing motivations or strategies can make collaboration and trust difficult, although not directly evident from the pilot
- The identification of relevant parties to participate posed a challenge that required coordination

The success factors in turn include:

- The events were communicated well and free of charge, lowering barriers to entry
- The topic which was discussed amongst the stakeholder groups was of interest to many and allowed for multiple points of view where all could contribute
- Consecutive events that are building on each other allowed for a continued engagement.

Sources	• Matschoss et al. (2020), *Co-creating transdisciplinary global change research agendas in Finland*, European Journal of Futures Research.

B.2.6. The EU Future Emerging Technologies Programme (FET), Horizon 2020

Name of practice	**Future Emerging Technologies Programme (FET)**
Country	DG RTD, European Commission
Responsible actor:	European level directorate general (public organisation)

Main target of practice	Researchers, research performing organisations, enterprises
Objective and description	
The objective of the FET programme is to supports "high risk, long term, multidisciplinary and collaborative frontier research, which lays the foundations for radically new, next generation technologies. It converts proofs of concept into industrial applications and systems".[107] This programme was set-up to allow European researchers and organisations to work towards nurturing new technological trends. The programme aims to help bring proof of concept research into industrial applications and systems.[108] The FET is a research innovation support programme which provides "a unique combination of high risk, long term, multidisciplinary and collaborative frontier research, which lays the foundations for radically new, next generation technologies. It converts proofs of concept into industrial applications and systems." The FET programme sits within the much larger EU research programme, Horizon 2020. FET is composed of three different schemes which support: • bottom-up research and innovation (FET Open), • top-down research and innovation (FET Proactive), • as well as large-scale initiatives which tackle grand scientific and technological challenges (FET Flagships).[109] It should be noted here that FET Open and FET Proactive have been continued under the new programme under Horizon Europe, as the EIC Pathfinder programme). Researchers and enterprises submit proposals within one of the three FET schemes and receive funding for research-driven innovations. The focus of the FET is to transform research into societal and technological impact to the benefit of economy and society. The Future Emerging Technologies department[110] within DG RTD, which is responsible for Horizon 2020 implements this practice; it does so in collaboration with the European Research Agency. Under H2020 the FET has been allocated € 2 696 million.[111]	
Outcomes of the practice	
The FET was found to have contribute to multi-disciplinary, cutting-edge technological research and projects and, along with several other Horizon2020 programmes, to have contributed directly to the development of skilled researchers in the EU. By 2017, the FET Programme had supported 1,278 participation projects for researchers from "world-class research teams pursuing grand interdisciplinary scientific and technological challenges". The FET Programme is also cited as contributing to open and innovative networks of researchers. The programme is said to contribute specifically to cutting edge and interdisciplinary science as well. [112] The Flagship component has also contribute to a number of large scale, cutting edge projects.	
Contribution to interdisciplinary research	
(Please see above)	

[107] European Commission, (archived), Future & Emerging Technologies (FET), available at: https://wayback.archive-it.org/12090/20210727010853/https://ec.europa.eu/digital-single-market/en/policies/future-and-emerging-technologies .

[108] European Commission, (archived), Future & Emerging Technologies (FET), available at: https://wayback.archive-it.org/12090/20210727010853/https://ec.europa.eu/digital-single-market/en/policies/future-and-emerging-technologies .

[109] European Commission, (2020), Future & Emerging Technologies (FET), available at: https://wayback.archive-it.org/12090/20210727010853/https://ec.europa.eu/digital-single-market/en/policies/future-and-emerging-technologies .

[110] European Commission, (2020), Future and Emerging Technologies (FET) (Unit C.3), available at: https://wayback.archive-it.org/12090/20210727010033/https://ec.europa.eu/digital-single-market/en/content/future-and-emerging-technologies-fet-unit-c3 .

[111] European Commission, (last update: 2021), Infographic on the participation in Horizon 2020 FET projects, available at: https://wayback.archive-it.org/12090/20210727081635/https://digital-strategy.ec.europa.eu/en/library/infographic-participation-horizon-2020-fet-projects .

[112] European Commission, (2017), Staff Working Document Horizon 2020 Interim Evaluation, SWD(2017) 221 final, available at: https://ec.europa.eu/transparency/documents-register/detail?ref=SWD(2017)221&lang=en .

Challenges and success factors	
The FET programme has been very popular. The interim evaluation noted how the number of successful applications, within the pool of high-quality proposals was about 10% (1 in 10 high quality proposals being funded). This points to insufficient funding for the demand for this programme. Furthermore, the feedback provide for unsuccessful applications was sometimes deemed insufficient and finding the balance between being too prescriptive versus too flexible took time to achieve as well.[113] A further weakness identified in the 2018 evaluation was that it did not have a tool for bringing innovations to market. This has been addressed to some degree with the introduction of the European Innovation Council which is designed to bring technological research and innovation into a scale-up phase. Main strengths of the FET programme as the combination of a prescriptive programme component (FET pillars) and an open programme component (FET-Open). This offers space for the EU to support research in key societal challenge and disruptive technologies as well as research consortia and researchers to submit proposals on areas they deem important or relevant.[114] Furthermore, the fact that the FET programme facilitates collaborative, bottom-up and open research is considered a key strength by virtue of its design and three programme components	
Sources	• European Commission, (2018), COMMISSION STAFF WORKING DOCUMENT IN-DEPTH INTERIM EVALUATION of HORIZON 2020 - SWD(2017) 220 final, available at: https://ec.europa.eu/transparency/documents-register/detail?ref=SWD(2017)220&lang=en . • European Commission, (2017), Staff Working Document Horizon 2020 Interim Evaluation, SWD(2017) 221 final, available at: https://ec.europa.eu/transparency/documents-register/detail?ref=SWD(2017)221&lang=en .

B.3. Practices by civil society, social partners and private foundations

B.3.1. Funding Initiative Artificial Intelligence, Volkswagen Foundation

Name of practice	Initiative "Artificial Intelligence and the Society of the Future"
Country	Germany
Responsible actor:	VolkswagenStiftung, civil society foundation
Main target of practice	Researchers
Objective and description	
The initiative aims at **joint, integrative research approaches of the social and technical sciences**. Against the backdrop of current and emerging developments under the term "artificial intelligence", new perspectives and insights shall be made possible with a view to shaping the future of society as well as technology, based on present-day diagnoses. VolkswagenStiftung wanted to set up an initiative that works on the important topic AI. But as the foundation tries to fund research in an innovative way that is not covered yet by other funding institutions, it looked for a specific aspect that needs funding. One of the starting points was an international workshop on "Robotics in the 21st Century: Challenges and Promises", where **technical scientists expressed their need to work with other disciplines (ethics, law social sciences) to assess the impacts of AI systems in society**. To capture the demand in the scientific community for such interdisciplinary research and its applicability, the foundation organized a one-week workshop with 50 scientists from the respective disciplines called "Artificial Intelligence and its Impact on Tomorrows World". The workshop illustrated challenges but also the need and potential of interdisciplinary research, which led to the initiation of the program.	

[113] European Commission, (2018), COMMISSION STAFF WORKING DOCUMENT IN-DEPTH INTERIM EVALUATION of HORIZON 2020 - SWD(2017) 220 final, available at: https://ec.europa.eu/transparency/documents-register/detail?ref=SWD(2017)220&lang=en .

[114] European Commission, (2018), COMMISSION STAFF WORKING DOCUMENT IN-DEPTH INTERIM EVALUATION of HORIZON 2020 - SWD(2017) 220 final, available at: https://ec.europa.eu/transparency/documents-register/detail?ref=SWD(2017)220&lang=en .

- **Planning Grants** are important to find partners in other disciplines and to find a joint research question (necessity of such a grant was outcome of the workshop). The foundation seeks to fund a "new quality" of interdisciplinary cooperation, which however is challenging. Therefore, they support the finding process, where applicants can find in a year a) a team, b) a common understanding of definitions, methods etc. (a common "language"), c) a connecting topic.
- **Full Grant**: Cooperation projects involving up to five working groups can be applied for with a total funding amount of up to 1.5 million euros for a term of up to four years.

In addition to collaborative projects, the foundation is open to project proposals from the thematic field of "Artificial Intelligence and Society" that cannot be assigned to the two above-mentioned offerings (e.g., science communication measures, symposia, public debates or publications).

Outcomes of the practice

Looking at the outcomes of this civil society fund, the following has been achieved:

- 71 projects funded (55 Planning Grants and 16 Full Grants, source: project list)
- More than 120 applications in the first round (surprisingly high demand)

It is difficult to assess if scientists - who would have not planned the project without this funding opportunity - have been motivated by it. An overall assessment is difficult, as projects are still running, feedback and first outcomes seem to be good, as first publications have been published.

Specific projects give a more concrete impression of the types of outcomes which this fund has helped to achieve:

- An example testimonial of the project "Bias and Discrimination in Big Data and Algorithmic Processing. Philosophical Assessments, Legal Dimensions and Technical Solutions" (granted Dec 2018, duration: 4 years, combining research of computational sciences, philosophy and law) describes the potential and challenges of IDR.
- Another example is the project "ReThiCare – Rethinking Care Robots", which combines sociology, human-computer interaction, design, and robotics and artificial intelligence (duration: Apr 2019-Apr 2022) and wants to explore the design space of non-anthropomorphic, robotic helper machines and devices for the context of care homes.

Contribution to interdisciplinary research

Concerning the contribution to interdisciplinary research, this can be difficult to gauge precisely as this is not a specific objective for the fund, but rather something which the fund facilitates as a means to an end. However, an interview from website gives some idea of the way this practice helps to stimulate interdisciplinary research: "We are getting feedback from the scientific community that the Foundation is hitting a nerve with the initiative and, with its interdisciplinary orientation, is creating an offer that is needed. The number of applications and enquiries so far impressively confirm this and encourage us to continue developing the initiative."

Challenges and success factors

Establishing this fund and its implementation came with several challenges:

- finding experts for selection of projects ("Gutachtergremium" – expert panel) in the assessment process. The expert panel has to be interdisciplinary and international (8-10 people). All involved disciplines have to be covered and experts have to have sufficient expertise on the specific topics of the applications
- it needs time to find partners for an interdisciplinary cooperation – solution: planning grants, that provide time to find partners
- getting **truly** interdisciplinary working project teams (not only joint application of separate working groups) – solution: reading the applications shows already how enthusiastic a group is about working interdisciplinary, how often they plan to meet etc. and asking explicitly for their strategy.

Key success factors in turn have been identified throughout the process. These include:

- Preliminary workshop before setting up the practice: they could assess the needs of the scientific community for more community building and planning grants;
- The existence of the Planning Grants;
- Enough time to work open-minded questions with other disciplines, without having to present findings immediately. This is made possible by the planning grants and by providing funding for up to 4 years. Also, a private foundation can be less restrictive about deliverables of projects.

Sources	• https://www.volkswagenstiftung.de/aktuelles-presse/geschichten-aus-der-foerderung/k%c3%bcnstliche-intelligenz-und-gesellschaft-wir-brauchen-interdisziplin%c3%a4re-zusammenarbeit-auf-augenh%c3%b6he

	• Interview with VolkswagenStiftung

B.4. Practices by research performing organisations: universities, research institutes and enterprises

B.4.1. University Research Centres in the UK

Name of practice	**Physical or virtual research centres across universities**
Country	United Kingdom
Responsible actor:	Universities, research performing organisations
Main target of practice	Researchers, research performing organisations, research framework conditions

Objective and description

The goal of this practice was and still is to support research in an interdisciplinary topic e.g. societal challenges, and to provide a space (physical or virtual) for researchers to collaborate.

The rationale behind this approach (which took place throughout the 1970s and 1980s) was that research centres were envisaged as a focus for researchers to combine and further develop their expertise in a common thematic area. As a result institutions set up such structures to grow research activity and critical mass of researchers in a particular challenge or topic area.

Currently, two different models for centres exist in the UK:

1. Co-location of different disciplinary expertise in one place (physical research centres)
2. Researchers situated in disciplinary departments and faculties, but are also affiliated to thematic centres and networks sitting across one or several institutions (virtual research centre)

Either mechanism can promote interdisciplinary working because of increased opportunities to mix formally and informally with experts from different disciplines. Centres can help to create an IDR-friendly research environment and culture. Most centres focus their IDR on a specific societal challenge or topic area.

Outcomes of the practice

The main outcomes of these types of research institutes include

- Increased cross-disciplinary collaboration; capacity building
- Impact from research
- New research areas or disciplines seeded and grown (e.g. health humanities)

Contribution to interdisciplinary research

The goal of this practice is to simulate research which transcends disciplines and addresses societal challenges by offering a collaborative space for researchers from different disciplines both across and within universities. Some of the main outcomes contribute to interdisciplinary research; there practice has yielded increased focus and attention for IDR, as well as increased activity into tackling specific challenges or interdisciplinary topics such climate change, health data, medical humanities etc.

Challenges and success factors

Success of the centre model is greatly dependent on institutional and researcher buy-in. Especially with virtual centres, lack of interest and motivations from researchers can result in failure. Key success factors for these research centres include:

- Availability of a networking space for stimulating new ideas and starting cross-disciplinary conversations
- Support for the interdisciplinary research centre from senior management signals that IDR is desired and valued encouraging more researchers to get involved
- Leadership at institutional and centre level – act as champions of IDR and the centre within the university and externally
- Enthusiasm of researchers to explore new ideas and establishment of trust between researchers from different disciplines

• Acquiring external funding provides legitimacy and long-term institutional support to centres. It also enables them to sustain and grow their research activity.	
Sources	• Dave et al. 2016. Case study review of interdisciplinary research in England • Interviews with 2 University Academics and IDR experts

B.4.2. The Center for Interdisciplinary Research (ZiF)

Name of practice	**Center for Interdisciplinary Research (ZiF), Bielefeld University**
Country	Germany
Responsible actor:	Bielefeld University
Main target of practice	Researchers

Objective and description

The ZiF is Bielefeld University's Institute for Advanced Study and fosters outstanding and innovative interdisciplinary research projects. The ZiF is an independent thematically open research institution and is open to scholars from all disciplines and all countries. It established in 1968 as the first Institute for Advanced Study in Germany and a nucleus of the new Bielefeld University

The Zif houses and funds interdisciplinary research projects from the natural sciences, humanities and social sciences and has served as a model for numerous similar institutions throughout the world.

The main ZiF funds:

i) Research groups aim at a long-term interdisciplinary collaboration. They provide the frame in which scholars from various disciplines work together on a broader research theme. They work and live at the ZiF for several months up to one year

ii) Cooperation groups offer a flexible funding format for interdisciplinary projects. Both the size of the group and the duration of the cooperation can be planned according to the requirements of the group's research questions (for a couple of weeks up to six months)

iii) Workshops allow for the interdisciplinary exchange of ideas. They range from colloquia on specific questions which assemble smaller circles of experts from neighbouring disciplines to larger-scale conferences which discuss the state of the art in a particular interdisciplinary field. The number of participants can differ accordingly.

iv) The Young ZiF is a promotion programme for junior scholars. Outstanding young academics are given a platform to practise and advance interdisciplinary discourse. The Fellows come together three times a year to discuss a self-chosen theme and exchange ideas about their individual research interests. In addition, the Fellows can organise interdisciplinary workshops. Fellowship in the Young ZiF is for four years and awarded after an open application procedure.

Outcomes of the practice

Regarding harder outcomes of this practice: hard outcomes: Around 1000 people are being supported through ZiF funds/activities per year, with around 1/3 of them having an international background

Concerning soft outcomes: Network building is the biggest outcome of ZiF activities. Many actors continue to work together after the funding. The thematic outcomes are also an important result.

Contribution to interdisciplinary research

The ZiF has directly contributed to stimulating IDR through directly funding interdisciplinary research groups of diverse fields. This has led to new interdisciplinary networks, methods and broadened the understanding of as well as the need for interdisciplinary research. Indirectly, the ZiF has become a role model for interdisciplinary research (centres) and was the reference point for many other, similar institutes that were developed in Germany (and in the world) in the last decades.

Challenges and success factors

The main challenge is related to the diverse actors having to find "a common language" as the basis for interdisciplinary research. In a next step, the actors have to find common ground related to the methodologies they will use, this is also described as challenging. These main challenges have been addressed in granting the research groups flexibility, space, and trust in finding their own way.

Indeed, success factors as reported by the ZiF: "*As funders, we don't know beforehand what will happen and whether/how the actors will fit together*", thus the biggest success factors are flexibility, openness, and trust in the involved actors / partnerships. A particularity of the ZiF is that the funded groups of academics/researchers live and work at the ZiF. Thus, they come together in different setting and get to know each other in private life as well as in the work/research context.	
Sources	• www.uni-bielefeld.de/ZiF • Interview with the Center for Interdisciplinary Research (ZiF)

B.4.3. The Weizenbaum Institute for the Networked Society

Name of practice	**Weizenbaum Institute for the Networked Society**
Country	Germany
Responsible actor:	Federal German Ministry of Education and Research (BMBF) provides funding City state of Berlin & state of Brandenburg 7 consortium partners coordinate the centre (Free University Berlin, Technical University Berlin, Humboldt-University Berlin, University of the Arts/UdK, WZB, Fraunhofer FOKUS, University of Potsdam)
Main target of practice	Researchers, Research performing institutions Research framework conditions
Objective and description	
The objective of this practice is to investigate from an interdisciplinary perspective the societal transformation caused by digitalisation. The rationale behind this practice was to establish a research hub on digitalisation in Germany ('the German Internet Institute') focusing not only on technical but mostly (but not only) social sciences perspectives. The research is structured in 4 research areas and 21 research groups. Most of these groups include researchers from at least two, often more, different research disciplines. In addition, there are horizontal groups focusing on particular topics: ethics and the political organisation of the relationship btw. technology and society. "Digitalisation is a highly complex process, which permeates all spheres of life, research questions can only be treated in an interdisciplinary manner. The Weizenbaum Institute brings together numerous relevant disciplines. In this way, a holistic perspective can be developed on the processes of digitalisation in the networked society."[115] The 7 aforementioned consortium partners have set up the institute jointly.	
Outcomes of the practice	
The main outcomes of the research institute include: • More than 100 researchers • More than 100 academic publications, research projects and non-academic publications • Organisation of two Weizenbaum Conferences • WI is increasingly recognised as one of the leading interdisciplinary research institutes in Germany in the area of internet/digitisation studies	
Contribution to interdisciplinary research	
Indirectly, the WI may have inspired other institutes to foster IDR. Several other research consortia responded to a call to host the 'German Internet Institute', some of these were set up despite not being successful in receiving BMBF funding, as well as other research institutes on digitalisation: Einstein Center Digital Future, Bidt, CAIS.	
Challenges and success factors	

[115] https://www.weizenbaum-institut.de/das-institut/

Concerning challenge areas, the multitude of disciplines and the complexity of the ever-evolving research subject of digital transformation pose challenges to maintaining an up to date and cohesive research agenda for the institute. On top of that, the complex governance of the institute with 7 consortia partners is still evolving and needs to be put on a more institutionalised footing in order for the institute to establish itself in the long term. Regarding success factors, the institute has established a rather strong vision that rests on the values of sustainability and individual self-determination. The research agenda has been developed jointly by the institute's directorate and its principal investigators. The institute has already had some success in entering into a dialogue with the political sphere with regards to the challenges in making sure that the digital transformation is unfolding in a sustainable way where society's and individual's self-determination is preserved. The institute has already developed some standing nation-wide and also to a lesser extent on the international level. It is well networked, benefitting from the location in Berlin as a major hub of digital research and innovation, with links to other research centres, politics.	
Sources	• www.weizenbaum-institut.de (incl. Annual Report)

B.4.4. New Bachelor of Arts and Science (BASc) degree in Interdisciplinary Problems & Methods

Name of practice	**Bachelor of Arts and Science (BASc) degree in Interdisciplinary Problems & Methods**
Country	United Kingdom
Responsible actor:	London Interdisciplinary School (LIS), research performing organisation
Main target of practice	Students, research performing organisations (i.e. universities and their departments), research framework conditions (i.e. engaging with regulators, higher education and research ecosystems to gain their support)

Objective and description

The objective of this practice is to adopt an interdisciplinary approach and teach students the most fundamental theories and models from across the arts and sciences, empowering them to make new connections and find new solutions to real-world problems

The rationale behind this new bachelor is centred on the idea that the future of education and the future of work are interdisciplinary. The problems facing humanity are more complex, interconnected and urgent than ever before. An interdisciplinary education will equip students with the knowledge and skills needed to address social and global problems in an increasingly interconnected world.

The course is designed to give students an understanding of a wide variety of knowledge areas from the arts, humanities, social sciences, sciences, and mathematics. Students will also study a range of qualitative methods (e.g. videography and ethnography), as well as key quantitative research methods (e.g. machine learning and data science).

As part of the degree, students will have the chance to take part in paid work experience each year across a range of industries. The style of teaching will include a mix of lectures and tutorials, mostly in person to the extent possible. LIS will also be using a blended learning approach. The student to faculty ratio will be 10:1 so students can expect to have a lot of access to faculty with many opportunities for feedback.

There will be a mix of formative and summative assessments that go beyond traditional essay writing and will help develop a range of skills.

Students can develop their own area of interdisciplinary expertise either by working in specific problem areas, module choices during the second and third years, and through their third year research project.

Though the total budget of this practice is not yet known, undergraduates will pay the usual £9000 tuition fee rate per year. About 100 undergraduates will form the first cohort.

Outcomes of the practice

As this practice is currently being initiated and implemented, outcomes are not available at present. By extension the contribution to interdisciplinary research is also not yet clear. That being said the assumption is that by providing an interdisciplinary education where interdisciplinary research and study skills are taught, graduates of this programme will more easily be able to engage in interdisciplinary work and research. This remains to be seen however.

Challenges and success factors

The main challenges in developing this bachelor relate to the fact that the LIS is a new type of university and LIS BASc is the first degree of its kind in the UK. The bachelor is dedicated to tackling real-world problems such as the

climate crisis, the ethics of AI, and COVID-19. Therefore, designing the curriculum and getting approval for the degree from the regulator (Office for Students) has been challenging. The institution and curriculum design involved meetings and discussions with leading academics and researchers who are taking on real-world challenges and support interdisciplinary and non-disciplinary approaches to thinking. Success factors are not yet known as the practice is being implemented.	
Sources	• https://www.londoninterdisciplinaryschool.org/ • Interviews with the UKRI, experts from the University of York and from Durham University

Appendix C List of interviewed organisations

Organisation name	Country
VolkswagenStiftung	Germany
The Centre for Interdisciplinary Research (ZiF)	Germany
The Federal German Ministry of Education and Research (BBMF)	Germany
The German Science Council	Germany
Strategic Research Council, Academy of Finland	Finland
Ministry of Education and Culture	Finland
Business Finland	Finland
The UK Research and Innovation Council (UKRI)	UK
The University of York	UK
Durham University	UK
The European Research Council (ERC)	EU level
ScienceEurope	EU level
Independent Expert Interdisciplinary Research	EU level

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