European Commission

Assessing European Partnerships against European policy priorities

Developing and illustrating a methodology for assessing the relevance of European Partnerships as instruments to address current and future European policy priorities.

Independent Expert Report

Research and Innovation

Assessing European Partnerships against European policy priorities.

European Commission
Directorate-General for Research and Innovation
Directorate G — COMMON POLICY CENTRE
Unit G.4 — COMMON MISSIONS & PARTNERSHIPS SERVICE
Contact Marion JAMARD
Email RTD-EUROPEAN-PARTNERSHIPS@ec.europa.eu
RTD-PUBLICATIONS@ec.europa.eu
European Commission
B-1049 Brussels

Manuscript completed in July 2023
1st edition

PDF ISBN978-92-68- 05346-1 Doi: 10.2777/62770 KI-04-23-697-EN-N

Luxembourg: Publications Office of the European Union, 2023

EUROPEAN COMMISSION

Assessing European Partnerships against European policy priorities

Developing and illustrating a methodology for assessing the relevance of European Partnerships as instruments to address current and future European policy priorities.

2023

Directorate-General for Research and Innovation
Horizon Europe European Partnerships

Table of contents

List of Figures

List of Tables

List of abbreviations

AC	*Associated Country*
BMR	*Biennial Monitoring Report*
COVID-19	*Coronavirus pandemic that started in 2019*
cPPP	*Contractual Public-Private Partnership*
CSA	*Coordination and Support Action*
DG RTD	*Directorate-General for Research and Innovation*
doi	*digital object identifier*
EC, EU	*European Commission, European Union*
EIT	*European Institute of Innovation & Technology*
EP	*European Partnership*
ERA	*European Research Area*
ERAC	*European Research Area and Innovation Committee*
FLI	*Forward-Looking Issue*
FP	*Framework Programme e.g., Horizon Europe, Horizon 2020*
GDP	*Gross Domestic Product*
HEU	*Horizon Europe*
IA	*Innovation Action*
IP	*Intellectual Property*
JRC	*Joint Research Centre*
KIC	*Knowledge and Innovation Community*
KPI	*Key Performance Indicator*
MoU	*Memorandum of Understanding*
MS	*Member State*
NGO	*Non-Governmental Organisation*
PM	*Portfolio Management*
PSIP	*Partnerships Specific Impact Pathway*
R&D	*Research and Development*
R&I	*Research and Innovation*
RIA	*Research and Innovation Action*
ROT	*Real Options Theory*
RRF	*Recovery and Resilience Facility*
SME	*Small and/or Medium-sized Enterprise*
SRIA	*Strategic Research and Innovation Agenda*
TFEU	*Treaty on the Functioning of the European Union*
TRL	*Technology Readiness Level*
WP	*Work Programme*
WS	*Workshop*

1. Introduction

The full effects of the research and innovation undertaken today will unfold only well into the 2030s and the ensuing economic and societal impact take some time to materialise. These long gestation periods require careful consideration when setting the priorities for the Framework Programme to respond to long-term challenges.

Horizon Europe introduces a more strategic, coherent, and impact-driven approach to European Partnerships, and orients the Partnerships towards the delivery of the EU priorities. A new governance framework for realising the strategic approach to EU R&I partnerships has been included in the Horizon Europe legal base and is referred to as the Strategic Coordinating Process[1]. A cornerstone of the Strategic Coordinating Process is to provide policymakers with evidence on the impacts and added value of the partnership approach. It should also provide feedback and advice to the partnerships themselves on cross-cutting issues, such as implementing synergies and increasing the visibility and transparency of information regarding the partnership landscape.

The main vehicle in this approach is the Biennial Monitoring Report (BMR) on the performance European partnerships. It provides the necessary evidence base to inform strategic discussions on the partnerships, including how they fit with the overall R&I system and development of the European Research Area. The first report was published in May 2022[2] and the second is planned for 2024.

The strategic coordinating process also aims to improve the intelligence used in launching new R&I programmes, including which topics can be better addressed by partnerships. To this end, 2023 is a particularly relevant milestone. The second strategic planning phase of Horizon Europe for 2025-2027 officially launched by Commissioner Mariya Gabriel during the European Research and Innovation days 2022[3] is on-going and expected to be adopted in 2024. Parallel to that, the review of the areas for the institutionalised European Partnerships based on Articles 185 and 187 TFEU will be concluded by the end of 2023.

The Strategic Plan sets out the policy priorities for Horizon Europe, as well as its expected impacts. It is the basis for the work programme covering Pillar II of Horizon Europe and its call topics. The Strategic Plan ensures alignment with other relevant Union programmes and consistency with Union priorities and commitments and facilitates increased complementarity and synergies with national and regional funding programmes and priorities. It notably contains key strategic orientations for research and innovation support, as well as the identification of co-programmed and co-funded European partnerships and missions.

Annex VI of the Horizon Europe Regulation lists the areas for possible missions and areas for possible Institutionalised European Partnerships established pursuant to Article 185 or

---

[1] Article 6(5) of the specific programme implementing Horizon Europe

[2] European Commission, Directorate-General for Research and Innovation, Performance of European Partnerships : Biennial Monitoring Report (BMR) 2022 on partnerships in Horizon Europe, 2022, https://data.europa.eu/doi/10.2777/144363

[3] https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/european-research-and-innovation-days-2019-06-13_en

187 TFEU. Article 11 of the Horizon Europe Regulation requires the Commission to carry out by 31 December 2023 a review of Annex VI as part of the overall monitoring of the Programme including these areas and present a report on the main findings to the European Parliament and to the Council.

At this critical time of reviewing and setting the strategic orientations for research and innovation support, the **Expert Group for support of the Strategic Coordination process for Partnerships**[4] was entrusted with three tasks:

1) Prepare evidence-based independent advice to the Commission on the development of the portfolio of European Partnerships, considering emerging R&I priorities, common challenges and EU political priorities that require orchestrated large-scale investments.
2) Support the drafting of the 2024 edition of the BMR on partnerships, and engage with European Partnerships, Member States (MS) and Associated Countries (AC) in the preparation of the report, including data collection.
3) Develop recommendations for next steps and required support for the strategic coordinating process.

The first task is related to the second strategic planning phase of Horizon Europe for 2025-2027, as well as the review of the areas for the institutionalised European Partnerships based on Articles 185 and 187 TFEU foreseen by the end of 2023 (to comply to Article 11 of the Horizon Europe Regulation). More precisely, the Expert Group was tasked to prepare evidence-based independent advice to the Commission on the development of the portfolio of European Partnerships, considering emerging European R&I priorities, emerging national R&I priorities, and programmes, but also common challenges and EU political orientations that require orchestrated large-scale investments, as well as strategic foresight exercises at international, EU and/or national levels.

Providing independent evidence-based advice to decision makers requires in-depth understanding of the underlying issues, sufficient knowledge of the various factors that shape the decision space, understanding what evidence is relevant for any decision to be made, how this evidence can be collected, and how it can be objectively and systematically analysed and assessed to reach the various options for the eventual decisions.

This is a challenging task, even when the underlying issues are understood, and the factors influencing the decision space are well known. Although corporations have developed and apply various methods to analyse and assess their investments and project portfolios regularly, including those in the space of R&D and innovation, this task is more challenging as the area of European Partnerships is the multidimensional decision space influenced by a large number of sometimes conflicting political priorities across EU, national, and regional levels. These are influenced by changing global geopolitical, environmental, etc. events, which further shape political priorities and thereby the decision space.

Yet, the Commission as well as national and regional governments make decisions about launching and participating in European Partnerships. These decisions are undoubtedly based on some form of evidence and a process in which this evidence is assessed. However,

[4] https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?lang=en&do=groupDetail.groupDetail&groupID=3738&news=1

there seems to be no established methodologies which would allow the identification and collection of relevant evidence, and its objective and systematic analysis and assessment.

Hence, rather than attempting to produce evidence-based advice to the Commission at this one-time exercise, the Expert Group saw more value in developing a methodology that will allow the creation of evidence-based decision support also in the future. The aim was to develop this methodology and illustrate how it can be used to analyse and assess the landscape of European Partnerships and particularly the Institutionalised partnerships as indicated in the Expert Group's mandate.

The parameters on which the methodology has been built, including specific dimensions and weighting of related criteria remains open to allow any adjustments (according to the current and future needs and requirements of the eventual decision-makers) as well as further developments.

The Expert Group decided not to provide any detailed recommendations nor give advice regarding the launch, ending, merging, etc. of any individual partnerships or parts of them. This would have required an interactive process together with the eventual decision makers, and key stakeholders to finalise the methodology (fix parameters, assign relative weights, etc.) which was not possible given the timeline and resources available within the current mandate of the Expert Group. Furthermore, arriving at recommendations which could be supported by strong evidence and argumentation would have also required access to thematic expertise beyond that available at the Expert Group.

Within this report, Chapter 2 describes shortly how the methodology was developed, what are the key elements, and how these elements were used individually and in combination to assess and answer questions relevant for strengthening the portfolio of European partnerships.

Chapter 3 presents examples of results that can be obtained using the methodology. The first group of examples is related to identifying possible new topical/thematic areas where European partnerships might be able to create significant impacts and added value. The second focuses on the assessment of the portfolio of Institutionalised Partnerships.

Chapter 4 concludes the report with a number of key points to carefully consider when using the methodology to produce the requested evidence to support actual decision making. It also highlights a number of areas and directions for future development.

2. Approach for assessing the European Partnerships against current and future European policy priorities.

European Partnerships are policy instruments with specific purpose and characteristics. Those are described in the **legal basis** for the partnership instruments. A gross simplification is that a European Partnership is a policy instrument which allows pooling European R&D and innovation competences, funding, and other resources to address jointly, and thereby more effectively and efficiently, existing and future socio-economic, environmental, etc. challenges and capture future socio-economic, environmental, etc. opportunities, compared to Member States or regions attempting to do so alone. There are also other objectives related to e.g., developing the European Research Area, and supporting cohesion, but joining resources for more effective and efficient R&D and innovation activities remain at the core of the partnership instrument.

R&D and innovation do not translate into socio-economic or environmental benefits immediately and require time. Therefore, identification of areas of anticipated high future political relevance where R&D and innovation are expected to produce significant contributions is of outmost importance. In this report, we call these areas **Forward-Looking Issues** (FLIs). The emergence, growth, decline, and disappearance of these FLIs are influenced by changes in the global geopolitical, environmental, etc. context. These changes are typically referred to as **Megatrends**. The other major influencing factors are the development and application of new knowledge and **Technologies**. These allow the development of new innovative solutions to address the underlying socio-economic, environmental, etc. challenges, or capture new opportunities.

Hence, Forward-Looking Issues, Megatrends, and Technologies form the relevant arena in which European Partnerships (together with other R&I policy instruments) can be analysed and assessed. Chapter 2.1 describes how this can be done by making use of the evidence already collected by the Commission (e.g., Megatrends) including the extensive pool of international foresight studies, complemented by evidence collected from Member States as well as relevant European R&D and innovation actors (in this case, representatives of existing European Partnerships). The consultation with the European partnerships that was done througn an online workshop aimed to provide at least some insight into the multidimensional political prioritisation across the identified Forward-Looking Issues, Megatrends and Technologies.

The approach described in Chapter 2.1 allows on the identification of potential relevant/important areas for joint European R&D and innovation effort. However, more evidence is needed to decide if the European Partnerships are the most optimal – or putting the question in a more practical terms, the best available – policy instrument to address a specific challenge and/or capture the opportunities related to the identified Forward-Looking Issue. This requires further insight into the specific characteristics of both the challenges and/or opportunities and the partnership instruments, the specific features/benefits of other types of R&I instruments, as well as what and how is already being addressed under the various initiatives.

The characteristics of the challenges and/or opportunities are and should be reflected in the rationales of the proposed and launched partnerships, i.e., why, and how is the proposed partnership the best available instrument in this case, and what outcomes and impacts can be expected from it. The characteristics of the partnership instrument are defined in the legal basis and are complemented by evidence emerging from impact evaluations of the partnership instrument.

The suggested methodology should also allow systematic and objective analysis and assessment of the **existing portfolio** of European Partnerships, to ensure it remains fit for purpose in a dynamic context. Changes in political priorities in the decision space over time as well as the emergence and decline of the various Forward-Looking Issues as they are addressed/captured, or reshaped, should be reflected in the portfolio of European Partnerships. This includes which partnerships should be strengthened, which require a new direction, where there is potential for capturing significant synergies between or across partnerships, which partnerships have completed their tasks and can therefore evolve towards a next phase, etc.

As stated previously, there is an ample pool of literature, methodologies, and experiences about managing portfolios of R&D and innovation activities in the corporate world. However, there are no established systematic and objective methodologies used across the nations, or regions for managing portfolios of public sector R&D and innovation investments, or portfolios of programmatic instruments. The approach described in Chapter 2.2 relies partially on the extensive experiences from the corporate world, partly on evidence found in impact evaluations of publicly funded partnerships, and partly on the insights collected from the European R&D and innovation actors (in this case, representatives of existing European Partnerships and Member states, and particularly how they manage their own portfolios). It focuses on identifying dimensions which are the most relevant in making decisions within the partnership portfolio, and how to operationalise the use of these dimensions in practical decision making.

Finally, Chapter 2.3 describes how the two approaches described in Chapters 2.1 and 2.2 can be used in combination to analyse and assess the portfolio of European Partnerships, whether the aim is to develop the portfolio by launching new partnerships or redesigning the existing ones. Thus, being able to produce evidence-based independent advice to the Commission on the development of the portfolio of European Partnerships, considering emerging European R&I priorities, emerging national R&I priorities, and programmes, but also common challenges and EU political priorities that require orchestrated large-scale investments, as requested. Examples and illustrations of how the developed methodology can be used in practice can be found in Chapter 3.

2.1. Identifying relevant policy priorities, and technological and socio-economic trends

There are many different approaches to identify future trends or emerging technologies. For the purpose of present study on identifying relevant European and national policy priorities, global scientific, technology and socio-economic trends for assessing the landscape of European Partnerships, a mixed approach inspired by "**technology landscape**" and "**horizon scanning**" was developed and implemented.

The "**technology landscape**" approach is one of the most popular, besides "technology mapping", methodology to identify emerging future trends or emerging technologies as an element of foresight studies. The "technology landscape" approach is used to identify wider technology areas[5], which makes it more relevant for the present study.

[5] Irene Spitsberg, Sudhir Brahmandam, Michael J. Verti & George W. Coulston (2013) Technology Landscape Mapping: At the Heart of Open Innovation, Research-Technology Management, 56:4, 27-35, https://www.tandfonline.com/doi/abs/10.5437/08956308X5604107

The academic literature[6], but also in business practices, identify several different forms/types of technology mapping or technology landscaping based on purpose, format, and use. Furthermore, technology maps can be shown in different forms. Those forms depend on the purpose of the roadmap. The most common one is the time-based chart which mostly includes commercial and technological perspectives, along with the linkages to any other related perspectives.

Our present approach was inspired from typical technology landscape maps, which connect technology drivers via specific dimension (e.g., Technology Readiness Level) with possible applications e.g., on the market. For the purpose of the study, this was translated into maps connecting global socio-economic trends, via technology areas in time-to-market space, with technology / R&I areas occupied by existing or future European Partnerships. It creates a framework to capture the results of the collection and review of a number of foresight studies and other forecast reports of future trends together with data and information collected on technology priorities of European Partnerships.

To complement the above approach and provide input for identification of emerging socio-economic trends and technologies, a "**horizon scanning**" approach was deployed. It builds on the methodology and the material produced in the framework of an expert contract to support the Joint Research Centre (JRC) in mapping forward-looking elements that can affect the EU long-term objectives in 2020. The task assigned by the JRC to the experts was to scan available sources of information and mark the way(s) they affect/relate to the JRC megatrends and the EU policy areas (EU green deal, Economy that works for all, EU way of life, EU digital age, Strong EU in the world, EU democracy). Our scanning activity involved a wide variety of documents were examined including e.g., academic papers, policy reports, posts in blogs or other sites, dedicated websites, etc. All different sources of information were analysed in a complementary way from the emergence of novel ideas to their implementation and policy implications.

Decoding how the issues addressed in the reports analysed, affected, or related to the megatrends and the current EU policies required an intelligent reading/scanning of the documents and other sources of information. Given the limitations of the scanning methods and the role of the human factor in creating, detecting, analysing, and interpreting emerging issues, the results need to be treated with caution and cross-checked with other validating sources.[7] The outcome of the expert work under the JRC project, in a form of the database collecting results of review of 60 forward looking reports, was a starting point and framework for the present study. In addition, the approach implemented for identification of relevant European and national policy priorities, global scientific, technology and socio-economic trends and other dimensions was organised as a multi-stage process with several well-defined steps (see Figure 1).

The detailed description of each step in the process is presented in ANNEX 1. The summary of results in each step is presented below.

---

[6] Based on reviews like Phaal, Farrukh and Probert (2004) 'Technology roadmapping—A planning framework for evolution and revolution', Technological Forecasting and Social Change, 71(1–2), pp. 5–26; and Technology Mapping: Definitions, Types, and Applications. Available from:https://www.researchgate.net/publication/340266926_Technology_Mapping_Definitions_Types_and_Applications

[7] (Amanatidou, et a. 2012)

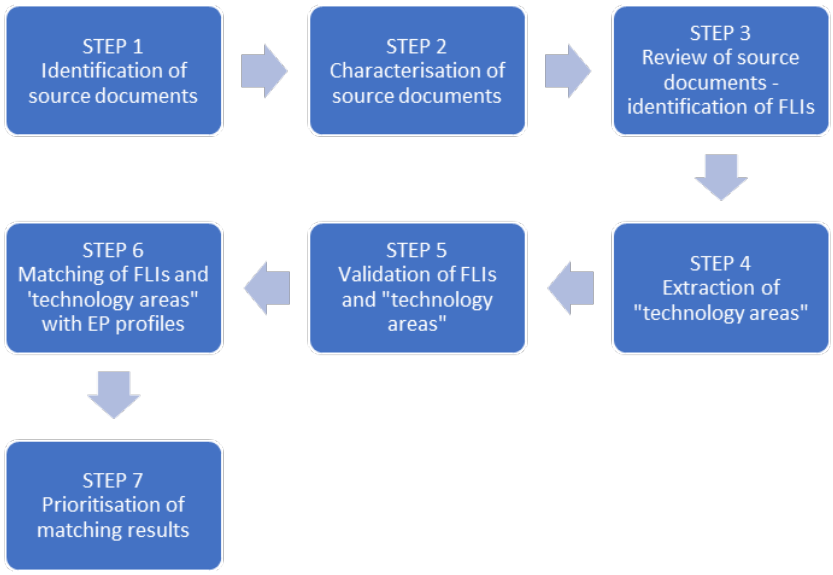


Figure 1. Multi-step process for analysing European and national priorities, global scientific, technological, and socio-economic trends, and identifying relevant forward-looking issues (FLIs) and technology areas. Source: Expert group (2023)

STEP 1 + 2

There were 76 relevant, trusted, and comprehensive documents reviewed - 60 originally reviewed under JRC projects and 16 identified under present study - and characterised by several parameters (e.g., title, web link, source type, time horizon, publisher, relation to the EU policies, etc.)

STEP 3

About 350 preliminary Forward Looking Issue (FLI) – policy, societal, economic, or technological topics – were identified and connected with the most relevant 14 Global Megatrends identified by the Megatrend Hub of the EC[8], and the most relate EU policy areas. Among them, there were 157 FLIs with technological relevance allowing to identify specific technology or technology area affected by the FLI. It implies a methodological bias, which results in underrepresentation of social and humanity issues among selected FLIs as well as underrepresentation of technologies and R&I topics related to those mentioned areas.

STEP 4

130 individual technology and R&I topics were identified and extracted from names and short descriptions of FLIs.

STEP 5

For the purpose of further analysis and graphical visualisation all FLIs and technology / R&I topics were reviewed to avoid duplication and connect similar topics. Final list of the 35

[8] The 14 Global Megatrends are listed and monitored under the Megatrend Hub run by the Knowledge4Policy (K4P), which is the EU Commission's platform for evidence-based policymaking. https://visitors-centre.jrc.ec.europa.eu/en/media/publications/megatrends-hub

Forward-Looking Issues (grouped in 15 Thematic Groups) and 118 technology and R&I topics (grouped in 14 Technology areas) were defined.

STEP 6

The 14 Global Megatrends (Table 1), 35 Forward-Looking Issues (Table 2) and 119 technologies and R&I topics (grouped in Technology areas, see Table 1) were matched through the Survey with the areas of interest of existing European Partnerships.

There were 34 European Partnerships (13 Co-funded, 8 Co-programmed, 9 Institutionalized, 3 EIT KICs) participating in the Survey, which provided a solid statistical base for further analysis.

To extend and validate the proposed methodology to other EU instruments the EU Missions were invited to participate in the Survey. There were 5 Missions participating.

Importantly, participation of Missions in the Survey allowed to test methodology and to check and analyse possible differences, which could be related to different nature of the instruments.

STEP 7

The Forward-Looking Issues, Thematic Groups of FLIs and Technology areas could be further prioritised against different dimensions, e.g., relevance and/or impact on the EU policies, urgency of the EU needs, level of development/integration on the EU market, maturity of technology or distance to the market. The purpose of the prioritisation should be to identify the top technological / challenge areas based on the dimensions described above, which is an important input for the decision-making process on the structure of the Partnership portfolio. It is particularly relevant in the context of identification of certain Groups of Areas as overpopulated or less addressed by the present European Partnership portfolio. Due to limited resources and time this step was not carried out by the Expert Group.

For the purpose of the present analysis, to illustrate results of the implemented approach the analysis focused only on coverage of identified Groups and Areas with interest of the Partnerships participating in the Survey.

Table 1. Megatrends and Technology Areas. Source: Expert Group (2023).

Megatrends

1. Accelerating technological change and hyperconnectivity
2. Aggravating resource scarcity
3. Changing nature of work
4. Changing security paradigm
5. Climate change and environmental degradation
6. Continuing urbanisation
7. Diversification of education and learning
8. Widening inequalities (in education, work, health and gender and territorial inequalities)
9. Expanding influence of east and south
10. Growing consumption
11. Increasing demographic imbalances
12. Increasing influence of new governing systems
13. Increasing significance of migration
14. Shifting health challenges

Technology areas

1. Medicine / pharma
2. Data and IT
3. Communication
4. Computing
5. Autonomous technologies
6. Cybersecurity
7. Energy
8. Farming / food
9. Space
10. Circularity
11. Social science
12. Transport
13. Biomaterials
14. Materials

Table 2. Forward-Looking Issues (FLI) and Thematic Groups of FLIs derived from them. Source: Expert Group (2023).

Forward Looking issues (FLI)	Thematic Groups of FLIs
1. Data security, cybersecurity and regulation 2. Changing nature of conflicts and warfare in the digital era 3. Privacy and autonomy in the era of AI and digitalisation 4. Disaster prevention in the digital era 5. Techonomic cold war between the East and the West 6. Increasing centrality of information for humanity and security 7. Digital disruption of democracy due to reality distortion and privacy breach	1. Digitalisation and security and privacy issues
8. New nature of work due to digitalisation, AI and automisation 9. Shifting migration flows due to virtual migrants and digital workers 10. Ai and automation in the economy	2. Digitalisation, AI and automation in the economy
11. Decarbonisation of the economy	3. Decarbonisation of the economy
12. Resource scarcity issues	4. Resource scarcity issues
13. Food and food system transformation for climate	5. Food and food systems transformation for climate
14. Renewables 15. Hydrogen 16. Unconventional hydrocarbons 17. Digitalisation of energy production and processes 18. Electrification and electric grid transformation 19. Rising energy demand	6. Alternative energy sources and systems transformation

20. Ai and Robotics in health services	7. AI and Robotics in health services
21. (Hyper)connectivity in life and the economy	8. (hyper)connectivity in life and the economy
22. Space and military technologies and defence issues	9. Space and military technologies and defence issues
23. Bioeconomy issues	10. Bioeconomy issues
24. Sustainable mobility for climate	11. Sustainable mobility for climate
25. Recyclability and reduction of plastics 26. Sustainability and the circular economy 27. Water systems transformation for climate 28. Reduction of waste	12. Recyclability, sustainability, and the circular economy
29. New health research and health approaches 30. Rising importance of tech companies as drivers of change 31. Connecting the human body, data and technology 32. Health risks 33. A new evolving biological age	13. Shifts in health research and healthcare approaches and systems
34. Changing production and consumption patterns	14. Changing life and consumption patterns
35. Increased importance of advanced manufacturing	15. increased importance of advanced manufacturing

Table 3. European Partnerships and Missions responding to the Expert Group Survey. Source: Expert Group (2023)

European Partnerships (survey respondents)

Pandemic Preparedness	Cluster 1	?
Accelerating farming systems transition	Cluster 6	Co-funded
Animal Health & Welfare	Cluster 6	Co-funded
Blue Economy	Cluster 6	Co-funded
Clean Energy Transition	Cluster 5	Co-funded
Driving Urban Transitions	Cluster 5	Co-funded
ERA for Health	Cluster 1	Co-funded
One-Health Antimicrobial Resistance	Cluster 1	Co-funded
Personalised Medicine	Cluster 1	Co-funded
Rare Diseases	Cluster 1	Co-funded
Risk Assessment of Chemicals	Cluster 1	Co-funded
Safe and Sustainable Food Systems	Cluster 6	Co-funded
Water4All	Cluster 6	Co-funded
Built4People	Cluster 5	Co-programmed
Connected, Cooperative and Automated Mobility	Cluster 5	Co-programmed
European Open Science Cloud	cross-pillar	Co-programmed
Made in Europe	Cluster 4	Co-programmed
Photonics	Cluster 4	Co-programmed
Processes4Planet	Cluster 4	Co-programmed
Zero-Emission Waterborne Transport	Cluster 5	Co-programmed
Zero-emmision Road Transport	Cluster 5	Co-programmed
Circular Bio-based Europe	Cluster 6	Institutionalised
Clean Aviation	Cluster 5	Institutionalised
Clean Hydrogen	Cluster 5	Institutionalised
Europe's Rail	Cluster 4	Institutionalised
European Metrology	Cluster 4	Institutionalised
Global Health EDCTP3	Cluster 1	Institutionalised
High Performance Computing	Cluster 4	Institutionalised
Innovative Health Initiative	Cluster 1	Institutionalised
Key Digital Technologies	Cluster 4	Institutionalised
Smart Networks and Services	Cluster 4	Institutionalised
EIT KIC Health	EIT	Institutionalised/EIT
EIT KIC Manufacturing	EIT	Institutionalised/EIT
EIT KIC Urban Mobility	EIT	Institutionalised/EIT

European Missions (survey respondents)

Cancer
A Soil Deal for Europe
Restore our Ocean and Waters
100 Climate-Neutral and Smart Cities
Adaptation to Climate Change

Limitations of the approach

There are several factors which could have a potential impact on results of proposed methodology:

- Human factor – it is important to remember that the results of any horizon scanning methodologies, including technology landscaping are shaped by the perceptions, interests and needs of the people involved in the identification and analysis of the documents. It adds diversity, which is positive to the process, but it could potentially create inconsistency and diverse ways of analysing and interpreting the results. Automated methods (e.g. AI-supported text analysis) could partly remedy this, although the final assessment of the results should be supported by certain areas of expertise still to be found among expert individuals. cation of FLIs, Technology Areas to prioritisation and interpretation of final results.

- Thematic bias – due to the fact, that emerging technologies and R&I topics are in the focus of the analysis, only FLIs with clear, explicit relation to them are selected and taken into consideration in further studies. It may lead to underrepresentation of FLIs related to social and economic issues connected with e.g., migration, humanitarian issues, creative industries, but also evolution of business models, consumer behaviour, sociological issues etc.

- Resource scarcity –for given limited time for analysis and limited number of experts engaged in the process, a limited number of, although extensive in their coverage, source materials could be reviewed and further analysed. This may create a risk of too narrow focus of studies. To overcome it, some elements of the proposed approach could be automatised or semi-automatised with use of machine learning and/or artificial intelligence tools, which could improve efficiency of reviewing and analysis process but also implies addition of new technological bias to the process.

- Precision of predictions – proposed methodology does not predict the future. It can give some indication about future trends and possible consequences, usually in form of different scenarios or through risk factors but it cannot predict when unexpected events e.g., COVID-19 pandemic, economic crisis or Russian invasion in Ukraine happen. On the other hand, forward-looking studies could give (and did in fact) an indication of possible upcoming events e.g., the fact that the civilisation access remote areas provokes risk of new diseases due to increased contacts with animals and new pathogens; or tensions between south and north or democratic and non-democratic countries rise to the level of possible conflict. Finally, the present methodology did not consider the effect of potential future disrupting events like crisis or technology breakthroughs, but this should be included in future forward-looking analysis of challenges and issues.

2.2. Identifying relevant dimensions for assessing portfolios of European Partnerships

The aim was to develop a portfolio analysis methodology supporting strategic decision-making on the development and continuation of partnerships. The challenge in doing so is best reflected in the quote from the ERAC (2018)[9] report: *"The current system is rather*

[9] ERAC (2018) final report of the ad-hoc working group on partnerships

oriented towards validation of a partnership instead of selection between possible partnerships. Criteria for the other stages of the R&I partnership lifecycle are often missing or not visible in a transparent manner".

In what follows, we offer a more structured assessment[10] on which dimensions or criteria at the strategic level of decision-making are potentially relevant to shape a more visible and transparent approach. We start from the basic definition and use of portfolio analysis within conventional strategic decision-making process contributing to resource allocation in organizations. At the same time we acknowledge that portfolio analysis frameworks are just one element of analysis that contributes to higher-level strategy decisions in organisations.

In a first step, from a top-down perspective, we translate the meaning and relevance of the traditional frameworks towards the context of decision-making on European Partnerships (as a portfolio of investments, or 'business units' in a complex organization). We argue that next to a top-down perspective, a bottom-up perspective needs to add and validate ideas emanating from both: the assessment of traditional portfolio literature, as well as an in-depth scientific literature review of portfolio-analysis applied to R&D and innovation problems (including a closer look on the application of Real Options Theory or Reasoning, which has regained popularity recently given the highly volatile external environment).

This bottom-up perspective essentially took place based on a survey, a workshop as well as an analysis of the SRIAs and ex-ante impact assessments performed by Technopolis[11]. These elements allowed us to converge towards a set of dimensions to be potentially deployed, as well as first insights into challenges of operationalization, which, not surprisingly, will mainly relate to the harmonization of quantitative measurement given the diverse and highly specific contexts in which European Partnerships in Research and Innovation operate. It is important to note that the particular context of EU partnerships as a portfolio managed by a supranational government in itself is a highly specific context, which has previously not been developed from a portfolio management perspective, while, in general, government-based portfolio approaches to R&D and innovation programming within both scientific and grey literature are also scant.

Finally, while technology and market readiness or 'fit' are straightforward dimensions (as partnerships need to align and react to changes in the external environment, and even contribute to shape these conditions), we shifted our focus more towards "internally" oriented dimensions, which are often overlooked, such as synergies, sunk costs, strategic flexibility, trust, and stakeholder inclusion. Also, the fit with the technological environment is largely the subject to the framework described in the previous chapter.

Figure 2 provides a full overview of the methodology followed for developing the portfolio analysis framework[12].

---

[10] A more detailed description of the full approach and work can be found in Annex 2

[11] Impact assessment for institutionalised European partnerships under Horizon Europe(2020) doi 10.2777/295096

[12] Given the time framework, the Expert Group had to move forward with the consultation while not completely having finished the literature analysis. This explains why there are 7 dimensions from the R&D literature review, but 9 dimensions analysed in the consultation (adding input from the Real Options Theory reviews). There are no inconsistencies between both sets.

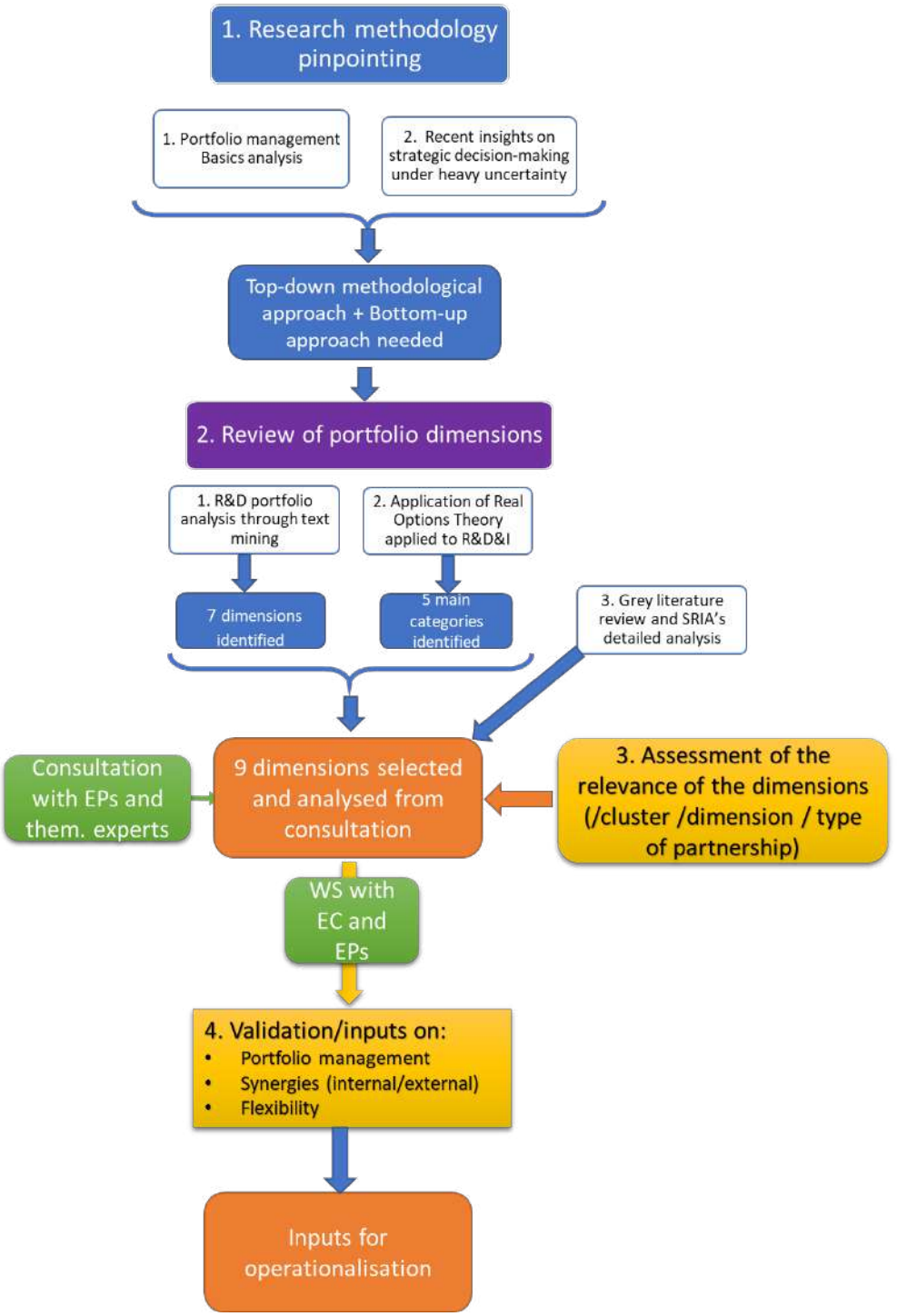


Figure 2. The approach for the development of the portfolio analysis framework. Source: Expert Group (2023)

Past and recent insights on portfolio analysis management

The basic idea behind (project) portfolio analysis and management stems from the corporate finance literature and was subsequently further developed within the strategic management literature to allow strategic decision-making, under uncertainty, within (larger) companies in terms of which products/services or business units would benefit from (dis)investment.

While the generic frameworks (e.g. Growth/Share Matrix, GE/McKinsey, Ashridge portfolio) bear only indirect relevance towards the case at hand *("develop a framework for the portfolio analysis of the European Partnerships"*), they clearly put forward, even at the level of highly complex organisations (such as large diversified technology firms like e.g. GE in the past, as well as the management of a diversified portfolio of European Partnerships) the need to develop a limited set of dimensions, leading to clear recommendations towards decision-makers in terms of where resources need to be allocated.

In the context of European partnerships, this means that a concept of portfolio analysis needs to provide guidance and input on:

- The need for a new partnership in a particular area
- The need to continue partnerships:
    - In their current form and resources ("Keep")
    - Upscale ("Keep and increase Investment")
    - Downscale ("Keep and decrease Investment")
    - Merge or split decisions ("Keep and reconfigure")
- The need to "re-shape" towards e.g., deployment or upscaling arrangements within other funding frameworks
- The need to disinvest / exit (without continuation under any form)

However, based on experience, even without EC co-funding, partnerships are likely to continue for a while as networks. Therefore, outright, and sudden exit decisions are or will remain seldom, as in reality there are most likely different forms of continuation – if which one option is to downscale a partnership or re-shape it under another funding framework in a different arrangement. Additionally, the question may also be answered whether the instrument applied to a certain partnership is the appropriate one. Of course, when it comes to making (dis)investment decisions, portfolio analysis as depicted above is only one input alongside other frameworks and information gathered.

The decision to invest in research and innovation programs, either from a public or a private perspective, is always bound to significant uncertainty. However, the use of past performance, as exemplified by the traditional portfolio frameworks from corporate literature, as a predictor for future success has lost its edge as one of the leading tools to formulate new strategies and support decision-making under uncertainty. Typically, such approaches work well under relative stable market and technology contexts. Since the 1980s, an increasing amount of volatility has been encountered in the external environment and has led to the development of additional tools and frameworks such as scenario planning, Monte Carlo simulation and real options analysis. However, most organizations continue applying traditional tools and frameworks either due to the cost and complexity of applying these more sophisticated tools, and/or the difficulty of explaining the methodology and outputs to decision makers. Recent articles from practitioner relevant literature (Mankins and Gottfredson,

2022[13]) has argued that strategic decision-making needs to be considered more as a continuous process, integrating more dynamic elements into planning. While this may go against the rather 'segmented' investments that European Partnerships entail over longer periods of time (7-year periods, or three-year cycles of strategic planning within Horizon Europe), it is worthwhile to consider some of the literature insights primarily gathered at large (technology) corporations in terms of practices, tools and criteria to use when allocating resources towards their often complex and investment-intense portfolios of activities.

Mankins and Gottfredson (2022) in their recent article highlight the following practices:

(1) Define extreme but plausible scenario's.

(2) Identify strategic hedges and options (i.e., adopt a Real Options Reasoning approach leading to strategic flexibility).

(3) Run experiments before locking in investment.

(4) Identify trigger points, signposts, and metrics.

(5) Provide prescriptive surveillance.

These practices have both value at the level of program-level decision-making, i.e., across the partnership portfolio, as well as within partnership decision-making in terms of allocating resources or reviewing innovation agendas. Examples of partnerships using 'signpost- type' decision-making as well as adaptation to technology circumstances, informing strategic decision-making during program execution are the Photonics market and supply chain studies[14] as well as the Technology Evaluator practice found within CleanAviation[15]. Similar, but broader approaches, are useful at the overall program level as well.

Top-down perspective: different ways to look at the partnership's portfolio.

Most scientific literature on R&D portfolio analysis uses projects within a program as the unit of analysis and not the programs themselves – where in the case of European Partnerships we are rather confronted with (complex) programs as the unit of analysis, further complicating the exercise at the higher strategic level.

When it comes to current European Partnerships, the following complexities need to be considered:

- The different inherent characteristics of partnerships, i.e., the different instruments used (cPPP, co-funded, institutionalized, …).
- The wide variety of societal goals that are covered.
- The different fields of technology(-ies) deployed.

---

[13] Mankins, M., & Gottfredson, M. (2022). Strategy-Making in Turbulent Times A dynamic new model. *Harvard Business Review*, *100*(9-10), 60-69.

[14] https://www.flipsnack.com/photonics21/key-data-market-research-study-photonics-2020/full-view.html and https://www.photonics21.org/download/ppp-services/photonics-downloads/230421_Supply_Chain_Report_Final_C3.pdf

[15] https://www.clean-aviation.eu/sites/default/files/2021-09/TE-FGA-syno_en.pdf

- The different industries targeted (if any).
- Market vs non-market orientations (concrete market potential & demand versus outright societal needs addressing market failures): this could also relate to the type of uptake envisaged: market, regulatory or policy (or a mix thereof).
- The impact of the existence of national regional and thematic strategies.

In an expert report on coherence and synergies (October 2020)[16], the EC also puts forward other ways of looking at portfolio composition and confirms the need to apprehend the portfolio in different ways: *"For example, there are partnerships developing new technologies and methodologies (e.g., Photonics, Metrology, Batteries) that could team up with partnerships in industry or societal application areas (health, mobility, energy, agriculture)".* This is supported or reiterated by the Impact Assessment of the Institutionalised Partnerships under Horizon Europe: *"The European Partnerships can be categorised into two major groupings: 'horizontal' partnerships focused on the development of technologies, methods, infrastructures and resources/materials, and 'vertical' partnerships focused on the needs and development of a specific application area, be it industrial or societal".* Technopolis (2019) presents this (sub-portfolio) division in horizontal, vertical 'industrial' and vertical 'societal' partnerships (although some choices may not seem as distinctive or clear-cut).

Another way to look at partnerships from a coherence and synergies vantage point, is the distinction between partnerships that have a "natural" tendency to include cross-partnership collaboration: (1) Challenge based partnerships (2) Converging technology partnerships and (3) Cross-cutting challenge partnerships. Finally, other angles are offered to divide the partnerships into sub-portfolios, e.g., in terms of the distinct failures that underpin their existence: (1) market failures, (2) systemic failures or (3) transformational failures (or any 'weighted' combination). Therefore, it is likely that whenever portfolio analysis is applied, the entire portfolio of European Partnerships would need to be divided into a limited set of sub-portfolios to make any analysis more meaningful.

It needs to be made clear that any portfolio analysis will have its inherent limitations as information used, given the forward-looking perspective and uncertainties, will remain imperfect. Hence, portfolio analysis may only serve as a partial input to higher level administrative/political decision-making, which will need to integrate other tangible and non-tangible elements (e.g., from the Biennial Monitoring Report, Horizon Europe Evaluations, etc.). In sum, the proposed portfolio framework, based on results of evaluation of the proposed dimensions, may not be the subject of any direct normative interpretation on (dis)continuing a specific partnership, as other inputs need to be considered.

At a very high level of aggregation and building on the above, several types of portfolios may be developed based on the following dimensions:

<u>Externally</u> oriented dimensions:

(1) Fit of the European Partnership with the external environment
    a. Technology dimension (technology readiness or maturity)
    b. Market dimension (market readiness or maturity)

[16] https://research-and-innovation.ec.europa.eu/system/files/2020-10/ec_rtd_coherence-synergies-of-ep-under-he.pdf

c. Societal dimensions ('non-market' orientation i.e., responses to societal challenges/evolutions)

(2) Contribution of the European Partnerships to European global competitiveness (competition aspect with other global regions such as North America, Far East, … – relating to EU high-level policy priorities, sovereignty)[17]

Internally oriented dimensions:

(3) Fit of the European Partnership within the existing portfolio of European Partnerships (based on proven or intended synergies or leverage towards the rest of the portfolio and other EU programs)

(4) Sunk cost dimension: what are non-recuperable losses if the European Partnership is abandoned?

(5) Proven capabilities of trust creation among stakeholders and achieving results/impacts.

(6) Degree of (strategic) flexibility offered / demonstrated (cf. new insights on decision-making under uncertainty, see above).

The above dimensions may each be combined, either within the internal or external dimensions, or by combining any internal and external dimensions in meaningful 2x2 matrices (on low or high qualitative assessment) to develop the positioning and the implications for further investment. Examples of such meaningful combinations could be e.g., combining (1a) with (6), or (1c) with (5). A key challenge would be to develop and understand what positions in these matrices entail in terms of managerial recommendations on resource allocations.

In an ideal world, a harmonized scoring/indicator per portfolio dimension could be developed and rank the existing and new European Partnerships on the following dimensions (low to high), also considering the external elements (described in the previous chapter).

Based on this first reflection using the basic literature on corporate portfolio management, a further in-depth analysis of the **specific literature on R&D portfolio management**, using a significant number of queries on ScienceDirect and bringing back 14.000 entries to 90 articles, **eight main dimensions were identified** and manually revalidated by cross-referencing scientific article databases (the following elements were identified based on multiple sources[18]):

[17] Note that even if a European Partnership does not contribute significantly towards e.g., leadership in particular global markets for products and services, it may be highly conductive to create the investment environment to attract activities to the EU to facilitate this leadership. E.g., superior health systems or climate resilience through biodiversity may create a superior environment for Foreign Direct Investment in certain industries, as opposed to other world regions. The main challenge is to be able to measure and weigh these contributions.

[18] As there is no specific literature on similar programs as the Horizon Europe partnership program, we try to "translate" or "reinterpret" the literature on traditional R&D portfolio management, where inevitably some dimensions may have more or less relevance.

1. Risk management and risk mitigation within the partnership and links with the diversity of the portfolio

Identifying, assessing, and controlling risks that could potentially affect an organization is of primary importance in order to have a clear and easy roll out of a partnership planning and developing methods and options to reduce threats or risks to project objectives. This is even more important while dealing with partnerships that includes specific collaborations processes that are different from usual project management. Risk mitigation is a strategy used to reduce the impact of potential risks by developing a plan to manage, eliminate, or limit setbacks as much as possible. Usually, a project team might implement risk mitigation strategies to identify, monitor, and evaluate risks and consequences inherent to completing a specific project. Common usages are in risk mitigation strategies that can be used include avoidance, reduction, transference, and acceptance.

2. Innovation strategy statement and alignment with the goals of the partnerships

An innovation strategy is an organization's relative emphasis on different types of innovations and the associated pattern of resource allocation, in alignment with its strategy at the corporate and business unit levels[19]. To a maintain a continuous alignment of this strategy is of primary importance for an efficient steering of the partnership. Therefore, starting from a clear understanding of the partnership's goals, strategies and initiatives that are aligned with these goals can be developed. This may involve collaborating with other partners to identify areas of common interest and developing joint projects or initiatives. Regular communication and coordination with other partners are of primary importance to ensure that the activities are dynamically aligned with the partnership's overall objectives.

3. Monitoring and evaluation of the partnership portfolio

Monitoring and evaluation of a partnership portfolio involves assessing the performance of the partnership and its outcomes and impacts. This can be done at both the project and partnership levels. At the project level, monitoring and evaluation can provide information about scientific impacts, industrial leadership, and societal relevance. At the partnership level, it can offer insights about the effectiveness, efficiency, added value, or degree of achievement of the broader partnership objectives[20]. There are several challenges associated with monitoring and evaluation of partnerships. These include defining monitoring and evaluation to sufficiently capture or satisfy different partners' or stakeholder groups' concerns, managing the timeline for evaluation and communicating the results, and dealing with issues of attribution and unintended effects[21].

---

[19] Varadarajan, R. (2018), "Innovation, Innovation Strategy, and Strategic Innovation", *Innovation and Strategy* (*Review of Marketing Research, Vol. 15*), Emerald Publishing Limited, Bingley, pp. 143-166. https://doi.org/10.1108/S1548-643520180000015007

[20] Benefits of monitoring and evaluation of partnerships in R&I, ERA Learn, available at https://www.era-learn.eu/support-for-partnerships/governance-administration-legal-base/monitoring-and-assessment/r-i-partnership-evaluation-toolkit-ripe/using-the-results-of-the-evaluation-of-partnerships-in-r-i/benefits-of-monitoring-and-evaluation-of-partnerships-in-r-i

[21] Challenges of monitoring and evaluation of partnerships in R&I , ERA-Learn, Available at https://www.era-learn.eu/support-for-partnerships/governance-administration-legal-

4. **Importance of maintaining long-term perspectives: what are the underlying processes?**

Maintaining a long-term perspective is important in a partnership because it allows the partners to focus on their shared goals and objectives, and to develop strategies and initiatives that are aligned with these goals. This can help to ensure that the partnership is able to achieve its desired outcomes and impacts over the long term.

The underlying processes for maintaining a long-term perspective in a partnership may include several dimensions like regular communication and coordination among the partners, as well as ongoing monitoring and evaluation of the partnership's performance. This can help to identify areas where the partnership is performing well, as well as areas where improvements may be needed.

5. **Trust building: what are the drivers? What is the rationale to gain more efficient partnerships?**

Trust is a vital component of any partnership, including international partnerships. Building trust in an international partnership involves developing a strong relationship between the partners based on mutual respect, understanding, and cooperation. The effective communication and collaboration are also important for building trust in a partnership, as e.g., highlighted by the AGORA format within the DUT partnership. This is also relevant for cross-partnership collaboration and the development of synergies within a portfolio, as highlighted by the report on synergies and coherence.

Building trust in an international partnership is necessary to create a more efficient and effective partnership. When partners trust each other, they are more likely to work together effectively and achieve their shared goals. Trust can also help to reduce conflicts and misunderstandings and facilitate smoother decision-making processes.

Some of the key drivers of trust building in an international partnership include openness, transparency, loyalty, and a willingness to understand and address the needs of the other partner.

6. **Agility and ever-changing business environment (strategic flexibility)**

In today's rapidly changing business environment, adaptability is a crucial competitive advantage. Organizations that are adaptable and future-fit will be able to move quickly and adapt to changes in customer demands, technology advancements and disruptive competition better than those that rely on size and efficiency alone[22]. This degree of disruptive change and ability of adaptation is also a key parameter for R&I complex collaborations. The rationale to analyse the core arguments to switch or to step in a new organizational environment is important to monitor intrinsic parameters of a long-life R&I partnership and to have the performance indicators allowing to adapt quickly enough to survive accelerating

base/monitoring-and-assessment/r-i-partnership-evaluation-toolkit-ripe/using-the-results-of-the-evaluation-of-partnerships-in-r-i/benefits-of-monitoring-and-evaluation-of-partnerships-in-r-i

[22] Park, R., The importance of adaptability in an increasingly complex world, EY, available at https://www.ey.com/en_us/innovation/the-importance-of-adaptability-in-an-increasingly-complex-world

change. Measures of fitness will no longer apply – organizations need to reimagine how they will create and sustain value in the future.

7. Soft power – organisational skills analysis

Soft skills are critical for success in a partnership. Soft skills are commonly defined as non-technical skills that enable someone to interact effectively and harmoniously with others. These skills can impact culture, mindsets, leadership, attitudes, and behaviours[23]. Some key soft skills for successful partnerships include empathy, authenticity, communication, and interpersonal skills[24]. When dealing with organizational skills, they are important for successful partnerships. A partnership is a valuable instrument or "organizational" model to overcome weaknesses of the policy and governance framework. Nonetheless, partnerships face several obstacles: they are difficult to set up and maintain, they require political will and resources, and results are not likely to come overnight[25]. To consider and investigate about these issues is therefore of primary importance in order to maintain a common view and global shared perspectives.

8. Cultural/historical influences in partnerships

Even if a transformative value-driver approach can be estimable in a changing business environment, traditional point of view and historical value drivers can nevertheless subsist in a partnership thanks to cultural and historical influences. Cultural and historical influences can have therefore a significant impact on partnerships[26]. Cultural similarities and differences can affect the performance of partnerships. Some findings suggest that partners need to possess similar cultural characteristics in order to achieve success, while others show that cultural distance can have a positive effect on efficiency and competitiveness of partnerships. It is important for partners to understand and respect each other's cultural backgrounds and values in order to work together effectively[27], but it is also important, in some extents, to measure these potential influences and to monitor them in a way that they will be beneficial give competitive advantages or highlighting conditions under which they can be dysfunctional.

Based on initial literature review, we further identified a **large body of literature related to the application of Real Options Theory (ROT)** for decision-making under uncertainly in the context of Research and Development. An initial assessment made us believe that a more in-depth review, also in line with recent practitioner-based insights on the return of 'real options reasoning' (see Mankins and Gottfredson, 2022, discussed previously) might provide

---

[23] Avrane-Chopard, J., Muhlmann, D., How to develop soft skills? 2019, Available at https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/the-organization-blog/how-to-develop-soft-skills

[24] Hayes, C., 4 Essential Partnership Soft Skills, 04/2022, available at https://www.resonanceglobal.com/blog/partnership-soft-skills

[25] OECD – Succesfull Partnerships, a guide. 36279186.pdf (oecd.org)

[26] Meirovich, G. (2012), "Cultural Similarities and Differences: Impacts on Performance in Strategic Partnerships", Cooper, C.L. and Finkelstein, S. (Ed.) *Advances in Mergers and Acquisitions* (*Advances in Mergers and Acquisitions, Vol. 10*), Emerald Group Publishing Limited, Bingley, pp. 55-74. https://doi.org/10.1108/S1479-361X(2012)0000010007

[27] Adam B. Masters, Cultural Influences on Public-Private Partnerships in Global Governance, 2019, Palgrave Macmillan Cham, doi https://doi.org/10.1007/978-3-319-96782-0

interesting inputs an insight into portfolio-based thinking for R&D programs. Based on a standard Scholar Google search, we identified 26 scientific articles (Figure 3), theses and book chapters spanning the period 2000-2021 applying ROT both in public, private and public-private contexts of R&D investment. Each source was scanned in terms of dimensions used to shape the real options theory application and/or real options reasoning, both at the level of literature review and empirical application.

Based on our analysis, we grouped the dimensions into five principal categories:

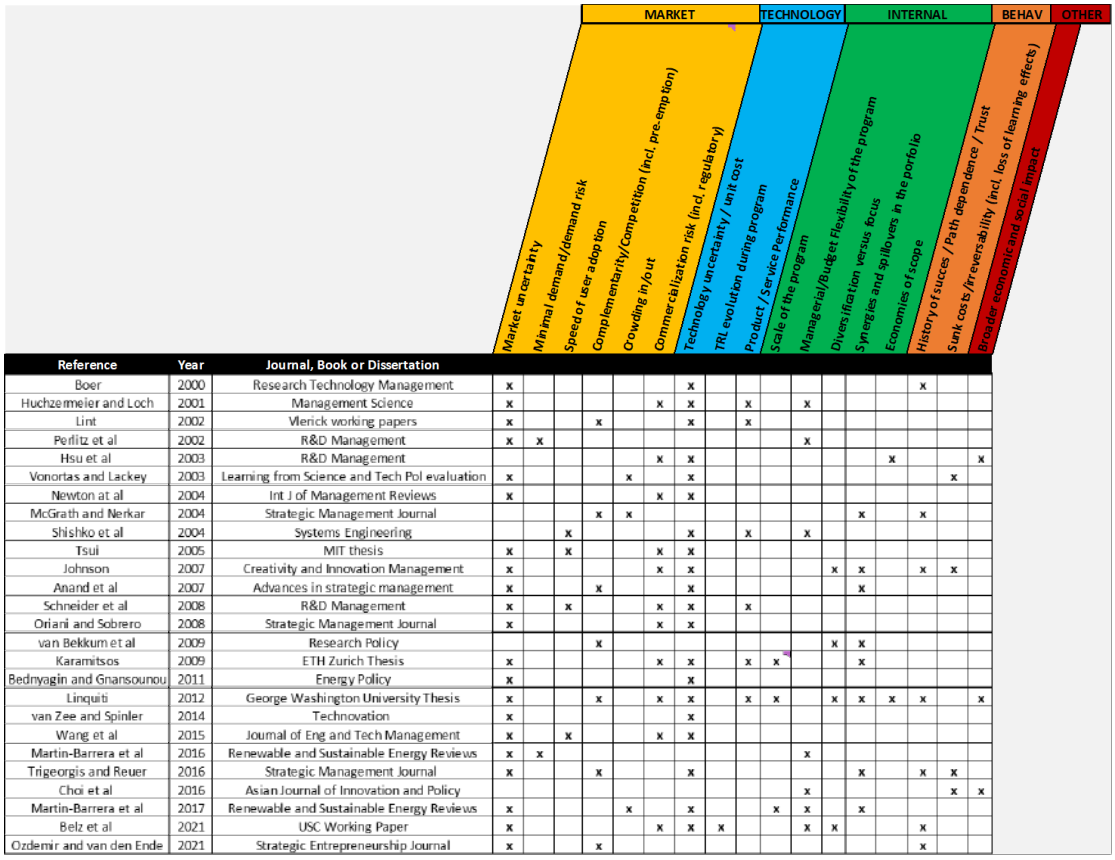
(1) Technology based dimensions.

(2) Market based dimensions.

(3) Internal portfolio dimensions.

(4) Behavioural dimensions (sunk costs, irreversibility).

(5) Other



			MARKET						TECHNOLOGY			INTERNAL				BEHAV	OTHER
Reference	Year	Journal, Book or Dissertation	Market uncertainty	Minimal demand/demand risk	Speed of user adoption	Complementarity/Competition (incl. pre-emption)	Crowding in/out	Commercialization risk (ind. regulatory)	Technology uncertainty / unit cost	TRL evolution during program	Product / Service Performance	Scale of the program	Managerial/Budget Flexibility of the program	Diversification versus focus	Synergies and spillovers in the porfolio	Economies of scope	History of succes / Path dependence / Trust	Sunk costs /irreversability (incl. loss of learning effects)	Broader economic and social impact
Boer	2000	Research Technology Management	x					x		x							x		
Huchzermeier and Loch	2001	Management Science	x				x	x		x		x							
Lint	2002	Vlerick working papers	x			x		x		x									
Perlitz et al	2002	R&D Management	x	x								x							
Hsu et al	2003	R&D Management					x	x							x				x
Vonortas and Lackey	2003	Learning from Science and Tech Pol evaluation	x				x		x									x	
Newton at al	2004	Int J of Management Reviews	x				x	x											
McGrath and Nerkar	2004	Strategic Management Journal				x	x							x		x			
Shishko et al	2004	Systems Engineering			x			x		x		x							
Tsui	2005	MIT thesis	x		x			x	x										
Johnson	2007	Creativity and Innovation Management	x					x	x				x	x		x	x		
Anand et al	2007	Advances in strategic management	x			x			x					x					
Schneider et al	2008	R&D Management	x		x			x	x		x								
Oriani and Sobrero	2008	Strategic Management Journal	x					x	x										
van Bekkum et al	2009	Research Policy				x							x	x					
Karamitsos	2009	ETH Zurich Thesis	x					x	x		x	x		x					
Bednyagin and Gnansounou	2011	Energy Policy	x						x										
Linquiti	2012	George Washington University Thesis	x			x		x	x		x	x		x	x	x	x		x
van Zee and Spinler	2014	Technovation	x						x										
Wang et al	2015	Journal of Eng and Tech Management	x		x			x	x										
Martin-Barrera et al	2016	Renewable and Sustainable Energy Reviews	x	x								x							
Trigeorgis and Reuer	2016	Strategic Management Journal	x			x			x					x		x	x		
Choi et al	2016	Asian Journal of Innovation and Policy										x						x	x
Martin-Barrera et al	2017	Renewable and Sustainable Energy Reviews	x				x		x		x	x		x					
Belz et al	2021	USC Working Paper	x				x	x	x			x	x			x			
Ozdemir and van den Ende	2021	Strategic Entrepreneurship Journal	x			x										x			

Figure 3. Analysis of literature applying Real Options Theory (ROT) to public and private R&D decision-making. Source: Expert Group (2023)

While technology and market dimensions are most frequently mentioned and applied (as on a case basis, they are more easily applicable given the existence of quantifiable indicators), our interest, from an 'internal' portfolio point of view, is more geared towards the dimensions related to internal and behavioural aspects. These elements stand out and are worth considering:

- (Positive) synergies and spillovers within a portfolio: how do the different projects and programs strengthen each other? Economies of scope relate to deployment potential beyond the particular case of innovation.
- The scale of a program is considered as important as smaller scale programs show more difficulty in correcting failures or mistakes.
- The presence of budget flexibility is valued.
- While diversification versus focus does not yield a certain direction in terms of which approach is best, a case-by-case approach seems appropriate to assess whether a focused program or a diversified is more suited to tackle the strategic challenge at hand.
- On the behavioural side, the importance of having a history of success and performance is important, while sunk costs and irreversibility of investments (including the loss of learning effects) made are criteria to be considered in decision-making.

This analysis confirms initial top-down observations with regard to the importance of both technology and market dimensions in portfolio analysis, but also highlights additional strategic dimensions such as the need to assess synergies, sunk costs/irreversibility, appropriate scale as well as the potential for budget and managerial flexibility. Finally, in particular from a public policy perspective, broader social and economic impacts of a program may need to be considered.

Bottom-up perspectives: analysis of SRIAs, grey literature and survey results

Based on a Python supported **text mining analysis of the SRIAs,** the main concerns regarding portfolio dimensions allow us to attest that agility, monitoring, and evaluation as well as risk mitigation are the dimensions that arose in top position while quoting the partnerships' priorities (see Figure 4). These dimensions are also followed by risk management. This confirms a real level of maturity of the various consortiums regarding their way of leading and managing projects as well as a desire to reinvent themselves and adapt to the constrained environments of today's world, considering the risks surrounding their activities.

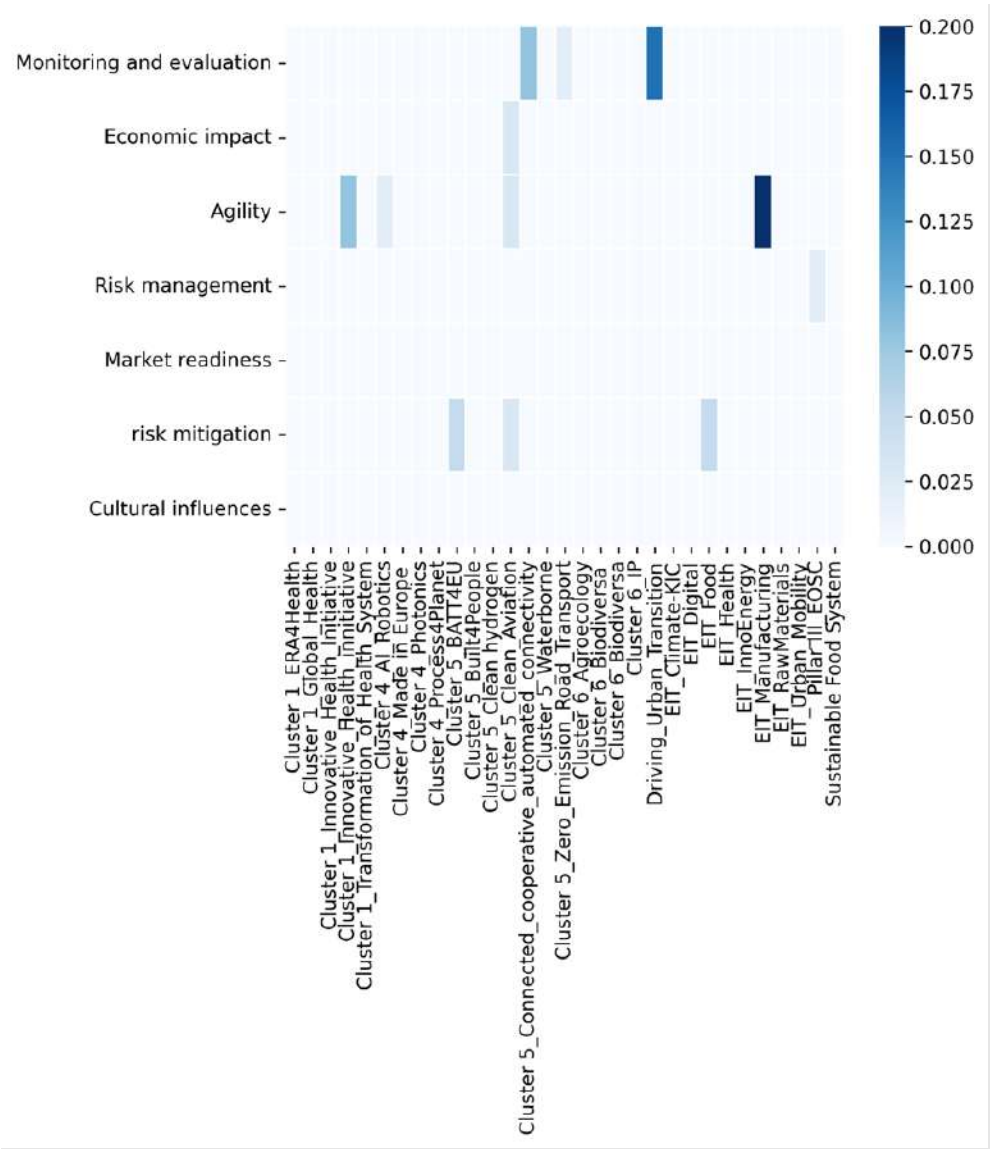


Figure 4. Heat map Portfolio dimensions based on SRIA text mining analysis. Source: Expert Group (2023)

Using primarily the Technopolis ex-ante impact assessment (2019) of the Institutionalized partnerships, as well as a set of other documents laying the groundwork for the partnerships, we assessed the content of these **grey literature reports against the dimensions identified by the ROT analysis**.

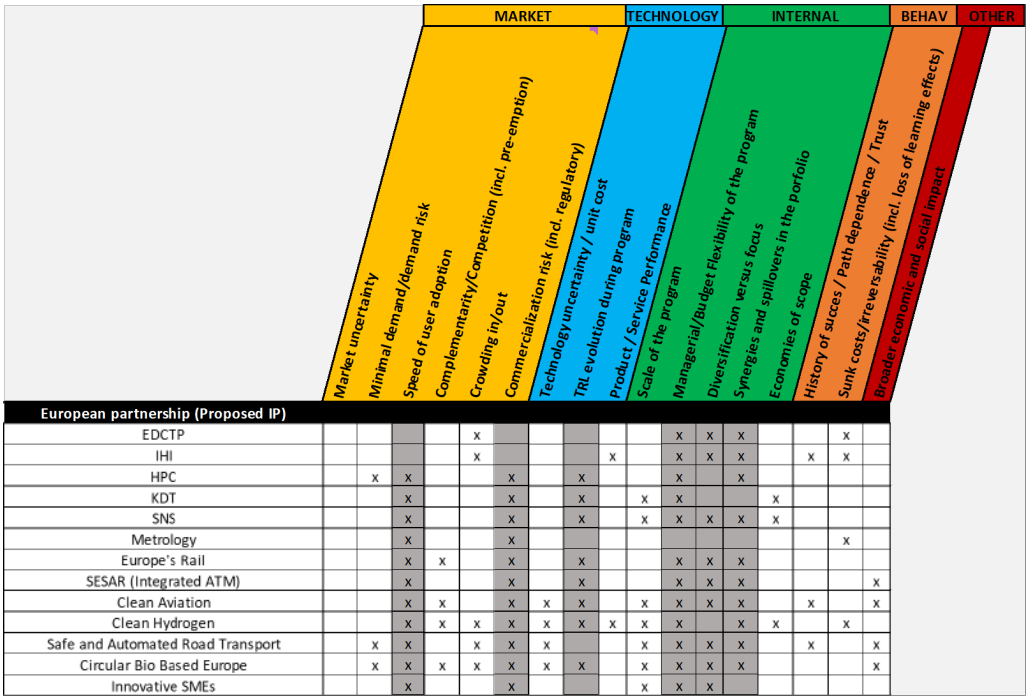


Figure 5. Assessing the ex-ante impact assessment against portfolio dimensions (based on the assessment of the Real Options Theory literature). Source: Expert Group (2023)-

Based on the textual analysis of the ex-ante impact assessments of candidate Institutionalised Partnerships (Technopolis, 2019), our analysis brought forward the following insights: Important dimensions touched upon in the Impact Assessments are:

- Speed of user adoption (through involvement and co-creation with end users)
- Commercialization risk i.e., regulation and standardisation
- TRL evolution during the program (including coverage)
- Managerial and budget flexibility (including participation)
- Diversification versus focus
- Synergies (internal and external)

Limited but sufficient attention is given towards evolution of unit costs of technology and/or crucial resources, as well as broader social and economic impacts. While all partnerships and their impact assessments touch upon these issues, we only considered those where there was an in-depth understanding of both technology and cost issues, as well as the broader economic and social impacts (outlined in a causal way). This can be explained by the different nature of the Institutionalised Partnerships where some are more oriented towards solving market failures, and/or towards the non-market environment.

Finally, scale seems a difficult dimension to develop (i.e., what is the minimum or optimum scale needed) as there are no convincing answers (expect some fragmented benchmarking e.g., with other global region's initiatives).

However, the assessment largely confirms the dimensions identified out of the various literature analyses (see supra).

Finally, the dimensions identified in the first part of the approach based on the R&D portfolio management literature and the initial ROT literature insights were assessed through a **survey sent to the European Partnerships** and appraised by more than 30 respondents.

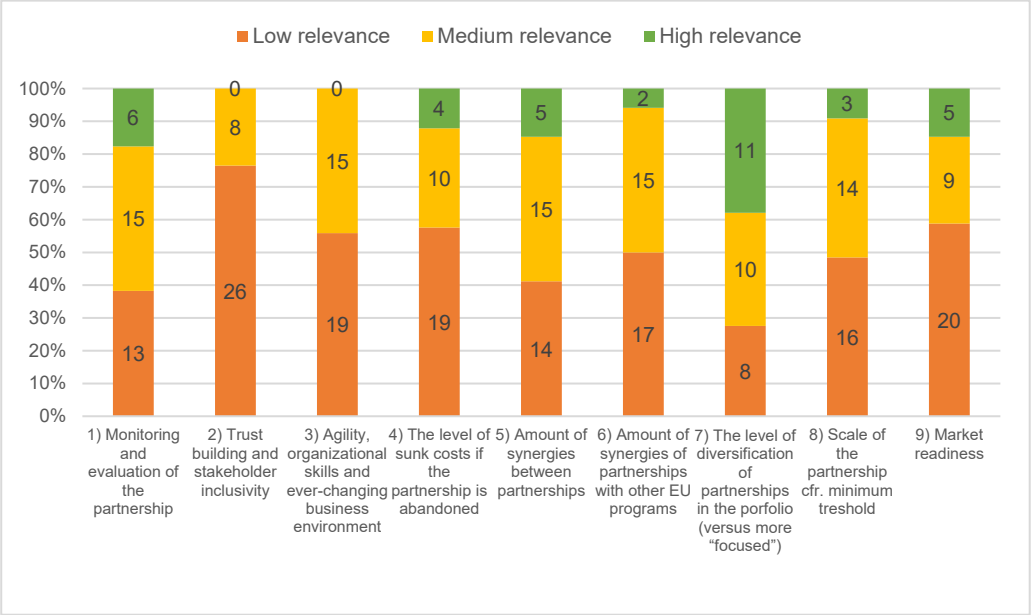


Figure 6. Global overview of the relevance of the proposed dimensions. Source: Expert Group (2023)

This first overview allows us to draw an initial balance sheet on the dimensions analysed. This makes possible to discern the relative importance of various dimensions, for which the medium/high relevance score exceeds 15. Dimensions 1 (Monitoring and evaluation of the partnership), 3 (Agility, organizational skills, and ever-changing business environment), 5 (Number of synergies between partnerships), 6 (Number of synergies of partnerships with other EU programs), 7 (Level of diversification of partnerships in the portfolio) and 8 (Scale of the partnership) are thus at the top of the list of concerns for the most relevant criteria.

The analysis carried out by cluster shows an overall homogeneity in the positioning of priorities. Even if, in a first overview, the study of the different dimensions did not seem to receive extraordinary support, but a detailed analysis nevertheless shows interesting perspectives.

First of all, the results of the detailed analyses for each dimension according to the cluster seem to be very homogeneous overall and do not allow for any particular trend to emerge: the distribution by taking the axis of analysis of the composition of relevance within each cluster is also rather homogeneous. This confirms the importance of specific aspects independently on the nature of the partnership. The diagrams reproduced are globally identical with a few adjustments concerning cluster 6 in particular.

This translates into a good alignment of the partnerships within their ecosystem in relation to these different dimensions. Regarding the study by dimension and type of partnership, more feedbacks can be obtained.

Dimension N°1, which considers monitoring and evaluation, seems to be well integrated overall. In particular, this reflects a certain maturity of the partnerships and a real acculturation

to the policy of continuous improvement through these monitoring and evaluation elements carried out on a regular basis.

Dimensions N°5 (Number of synergies between partnerships) and N°6 (Number of synergies of partnerships with other EU programs) (sometimes in a more limited way for the dimension 6) and to a lesser extent dimension N°3 (Agility, organizational skills, and ever-changing business environment) are also considered with a certain interest in the implementation of partnerships.

Dimension N°7 gathered in total (high + medium) 21 points confirming the value of a diversified set of partnerships at the level of the entire partnership programme.

Conclusion: summary of criteria to be considered and their operationalisation

Based on the previous sections, a number of criteria stand out as of common interest to assess European Partnerships from an internal portfolio perspective. While we consider these criteria, based on the various analyses performed in previous sections, all as **relevant** to assess (either in quantitative and/or qualitative ways) the portfolio of partnerships, in order to perform the actual portfolio analysis the **implementation feasibility** (i.e. are there specific quantitative indicators or sufficiently developed qualitative methodologies available to assess the partnerships on these dimensions) also plays an important role towards operationalization. Table 4 below summarizes these criteria and their priority in terms of potential short-term operationalization for portfolio assessment purposes, based on an initial assessment of both the difficulty as well as availability of data to make a harmonised assessment possible. Some important criteria, such as the 'sunk cost' (or irreversibility assessment) need significant additional research and analysis to suggest harmonized quantitative and qualitative approaches to allow for proper assessment and seems, while considered very relevant in decision-making, difficult to implement in the short term as there has not been an accepted and validated method developed yet. Further discussions are also needed to assess the criteria or dimensions against the types of partnerships (cf. the sub-portfolios) as depending on the sub-portfolio division, criteria may be more or less relevant (or even weighted). Below a high-level summarizing table shows the list of criteria and their operationalisation priority depending on both acceptance and feasibility. A more detailed table, containing ideas and comments related to the short-term operationalization of the criteria with a focus on implementation feasibility in a harmonized way, to develop the (sub-)portfolios can be found in Annex 2.

Table 4. Criteria and their priority in terms of operationalisation for portfolio assessment purposes Source: Expert Group Survey (2023).

Dimension / criterion	Priority
Agility and flexibility	High
Synergies (internal)	High
Synergies (external)	High
Market Readiness	High
TRL evolution	High
IP generation	High
Sunk costs / irreversibility	Medium

Trust and stakeholder flexibility	Medium
Scale	Medium
Diversified portfolio management	Low
Monitoring and evaluation	Low

2.3. Integrated methodology for assessing the landscape of European Partnerships

The set-up of European Partnerships is based on a series of consultation processes. It is initiated by the European Commission internally, involving thematic policy services that possess good insights on the areas covered by Horizon Europe work programmes, as well as the thematically specific research and innovation landscapes, their needs, and main stakeholders. Concept papers (or fiches) that outline main elements of possible candidate partnerships are developed and agreed on between services and validated internally at the highest political level. Once finalised, these concept papers are published on the Commission's website for transparency reasons. Following this internal identification phase, Members States and Associated Countries are invited to provide detailed feedback on new candidates and suggest additional priority areas for partnerships. The legal basis criteria are applied to the degree possible and as relevant throughout the process.

The methodology developed by the Expert Group is planned to be complementary to and support the process described briefly above, bringing an additional strategic overview in the light of policy priorities, societal challenges, and trends, and assessing the portfolio as a whole. It can help filter the results of the internal process of the EC and ensure that the first list is constituted by the most relevant candidates with the total set of criteria applied both in terms of the legal basis as well as the partnership-internal portfolio management.

The use of the developed methodology in context of the partnership processes – identification of new partnerships or assessment of existing partnerships – can inform a variety of decisions including for instance:

- In which potential new areas could partnerships be the optimal instrument?
- How should existing partnerships be continued?
  - In their current form and resources ("Keep")
  - Upscaled ("Keep and increase Investment")
  - Downscaled ("Keep and decrease Investment")
  - Merged or divided ("Keep and reconfigure")
- Could existing partnerships be better served with other instruments? ("re-shaping" towards e.g., deployment or upscaling arrangements within other funding frameworks)
- When should an existing partnership exit from the portfolio of European Partnerships? (need to disinvest / exit).

The application of the methodology should be a real-time assessment exercise and while the different tasks and steps can easily be identified (see Figure 7 below), ensuring transparency, openness, and inclusiveness, as well as legitimacy is not as straightforward. For instance,

the suggested methodology involves steps like 'prioritisation of matching results/gaps', or a series of consultations and workshops. Who is involved in these and who makes the decisions in relation to how potential identified gaps will be prioritised or how certain criteria will be weighed and applied needs careful consideration to avoid possible biases in favour or against existing or new partnerships (see also Chapter 4.1).

How to use the developed methodology is outlined based on the experience of the Expert Group from limited testing for the Institutionalised Partnerships. The resulting methodology consists of three main tasks (tasks A, B and C in the graph below).

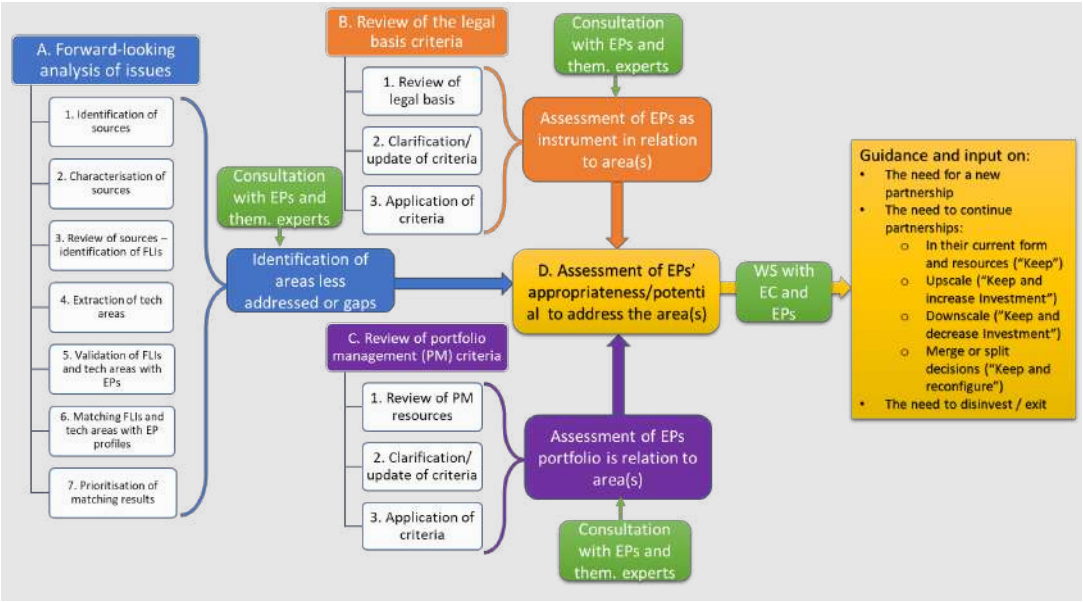


Figure 7: Suggested overall methodology for identifying emerging research areas with high future relevance/importance for the EU and Member states and assessing the appropriateness of the European Partnership instruments to address them. (*FLI=Forward-Looking Issue, EP=European Partnership, PM=Portfolio Management, WS=Workshop, EC=European Commission*). Source: Expert Group (2023)

Task A

First, emerging trends in science and research are identified based on relevant forward-looking reports as briefly presented in Chapter 2.1 and analytically explained in ANNEX 1. This was based on existing work carried out by a team of experts in 2020 for the JRC unit in the Commission. This helped the Expert Group draw a wider basis of documents and do similar analysis in newly identified documents. Identifying emerging FLIs and technological areas that are deemed important for the EU is the first step to take in applying the methodology. This step (A in the graph above) needs adequate resources and time. Although it does not need to be a lengthy exercise, it does require between 3-4 months as minimum. Collaboration with the Megatrends Hub at JRC/EC and the Common R&I Strategy and Foresight Service of the EC is important for this task as they regularly produce a wealth of forward-looking studies that are vital for identifying emerging issues as well as research areas of importance. Accessing relevant reports from credible and widely acknowledged sources such as international organisations, research organisations, consultancies, and certain countries is also key (e.g., US, China, etc.)

The survey that complemented the step A in the methodology enabled the characterisation of the partnerships in terms of FLIs and areas covered. This helped identify FLIs/areas that

were less addressed by some partnership types, or areas that were not addressed at all. A conclusion about how to cover such areas, if at all, is premature if not misleading at this point. Instead, explanations concerning why some partnerships cover certain areas and not others, or how a specific area should be best addressed are important here. This was enabled through a workshop where the representatives of institutionalised partnerships were invited to discuss the results of the step A in the methodology. The discussion provided useful explanations and resulted in a map (ideally) of the areas covered by all partnerships, missions and specifically Institutionalised Partnerships per megatrend. This concluded the first task in the methodology.

Task B

Task B, which can be carried out in parallel with Task A, involved the review of the legal basis (for the Institutionalised Partnerships in this case) to reconfirm or better clarify the main criteria that need to be met in setting up partnerships and any specific type of them. This primarily involved desk research. In addition, talks with relevant EC official might be useful especially in clarifying how specific criteria should be applied. This was then followed by the application of the identified criteria (task B.3) by reviewing the available documentation and information available on the websites of the Institutionalised Partnerships (in this case). Given that the Institutionalised Partnerships reviewed were already set up, the available information and documentation included adequate information in response to the criteria although this was not the case for all.[28]

In a real-time assessment exercise, the desk research needs to be accompanied by workshops or interviews with experts on the partnership instrument accompanied by thematic experts. This will make possible the explanation of how the features of the partnership instrument and the different types fit or not with the particular characteristics of the area(s) examined to be addressed. In selecting such experts, it is important to ensure that there is no conflict of interest to avoid biases in maintaining / expanding existing partnerships for instance. The result of Task B is the actual assessment of the partnership instrument and/or any particular type in relation to its appropriateness in addressing the area(s) in question.

Task C

Task C then refers to the portfolio management criteria that also need to be assessed to make the case for the partnership instrument and a specific type. Given that there was no prior basis upon which to work on to set up portfolio management criteria for the partnerships, the Expert Group carried out an extensive review of the available literature as well as partnership documents (SRIAs), as summarised in Chapter 2.2 and analytically described in ANNEX 2, to identify an initial set of criteria. These were then commented by Institutionalised Partnerships in the survey (the same survey as mentioned in the first Task). Some of the resulting criteria were also addressed in a dedicated workshop with the Institutionalised Partnerships (the same workshop where also the results of the first Task were discussed). The resulting set of criteria were added to those related to the legal basis and this was the total set of criteria against which the Institutionalised Partnership documentation was then reviewed as a pilot application in the case of the Institutionalised Partnerships (Tasks B.3 and C.3).

[28] Experiences in applying the criteria in the case of the Institutionalised Partnerships are described in Chapter 3.2.

In a real-life assessment exercise, the portfolio management criteria do not need to be researched from scratch. The set suggested in this report can be the basis which can be reviewed/refined/updated depending on the specific aims of the assessment task and the type of partnerships targeted. In other words, this set is a starting point and while major changes might not be needed, some modifications may be relevant. Additionally, as noted above, the review of the Institutionalised Partnership documentation was adequate to pilot the methodology in the case of the Institutionalised Partnerships (Tasks B.3 and C.3). However, when addressing an identified gap, where there are no partnerships already or which is less addressed by the existing ones, such desk research will not suffice due to lack of information. In such a case, it is advisable to apply the methods suggested under each of the portfolio management criteria as described in Chapter 2.2 and more analytically in ANNEX 2.

Consultations and workshops

The workshop mentioned under Task A was carried out at a point in time when both the list of legal basis criteria and those associated with the portfolio management were drafted. Thus, it served not only for validating the gaps identified in Task A but also for checking the list of assessment criteria and drawing ideas on how they can be applied. In a real-life situation, assuming that the list is refined, such a workshop to get ideas on how to continue may not be necessary. Instead, it can be replaced with a workshop inviting the partnership community as well as EC officials to discuss and /or verify the conclusions of the assessment exercise.

Overall, it is important to ensure consultation with the partnership community and relevant EC services when important tasks are concluded, i.e., the “Identification of areas less addressed or gaps”, the “Assessment of European Partnerships as instrument in relation to area(s)” and the “Assessment of European Partnerships portfolio is relation to area(s)”. This will help embed transparency, openness, and inclusiveness in the process. However, neutrality also needs to be ensured by avoiding biases in favour or against existing or new partnerships. A way to do this is to involve thematic experts (EC officials or independent experts) that have no direct conflict of interests and members of the partnership community (partnership experts) that have no direct connections with partnerships that may be affected by any decisions resulting from the process. The results of such a consultation can then be presented and discussed in a final workshop with relevant EC officials and European Partnerships including those that may be affected by the decisions.

3. Example assessments using the developed methodology.

The examples presented in Chapters 3.1 and 3.2 are not to be taken as results of fully conducted in-depth analyses or assessments of European Partnerships, but only illustrations of how the developed objective and systematic methodology can be used to produce the requested independent advice for the Commission to support decisions how to improve and further strengthen the portfolio of European Partnerships.

The illustrations presented in Chapter 3.1 show how the developed methodology can be used to identify gaps, less addressed areas, overcrowding, etc. in the landscape of European Partnerships formed by global Megatrends, policy relevant Forward-Looking Issues, and important technologies and technology areas. The methodology does not provide clear answers but must be complemented with more in-depth analysis of each identified area of promise (gap or less addressed potentially relevant/important area) or concern (overcrowding). This follow-up analysis must focus on the in-depth understanding of the characteristics of the area (i.e., nature of the respective challenges and/or opportunities and how joint European R&D and innovation activity can contribute to it) and the viability of the partnership instruments to produce significant enough European added value (i.e., whether partnership is the best available policy instrument). Illustrations presented in Chapter 3.2 provide some indication of which dimensions can be used in this analysis.

Chapter 3.1 also illustrates how the methodology can be used to compare the alignment between and across different instruments, e.g., Partnerships vs. Missions, or non-institutionalised vs. Institutionalised partnerships. This can be used to identify areas of potential synergies and complementarities, areas of common future interests and thereby potential new research directions, as well as areas of potential overlaps and duplication of efforts. The same methodology can be extended to cover other instruments beyond European Partnerships and Missions to allow even better insight into the landscape and how it can be covered by joint European action.

Illustrations presented in Chapter 3.2 demonstrate how the developed methodology can be used to analyse and assess the portfolio of existing partnerships as well as how potential new partnerships would fit into the existing portfolio. The focus is on how to select and operationalise the most relevant dimensions describing the quality and value of the portfolio and partnerships in it. Chapter 3.2.1 presents the criteria for setting up Institutionalised Partnerships based on the legal framework, whereas Chapter 3.2.2 provides a review of Institutionalised Partnerships against the proposed portfolio analysis/assessment dimensions.

3.1. Overview of the European Partnership landscape

There are several assumptions and other relevant issues that must be considered while looking at the results of the assessment of the Partnership landscape:

- methodology limitations explained in Chapter 2.1
- input for analysis from the Survey of 34 out of 49 European Partnerships
- difference in approach to relation between Megatrends, FLIs and technologies / R&I topics in expert assessment of forward-looking reports and Partnership assessment in the Survey. Experts were able to identify links between mentioned elements, while Partnerships only prioritised their interest (coverage) in specific elements (without linking them).

The result of the expert review of forward-looking reports is the identification of factors shaping the landscape of current and future policy priorities. These factors are grouped in three categories (lists presented in Chapter 2.1):

- 14 Megatrends: longer term drivers causing changes in the global socio-economic, environmental, and political context identified by the Megatrend Hub of the EC,
- 35 Forward-looking issues (FLIs) – emerging issues to be increasingly aware of and address – extracted from reviewed reports and grouped in 15 Thematic Groups,
- 110 technologies and R&I topics – grouped in 14 emerging Technology Areas.

The Figure 8 summarises all identified factors and shows links between them. Density of connections (links) could be interpreted as relative importance of a particular factor. Of the emerging Technology Areas, the most connected (occupied) Technology Areas are Data and IT and Autonomous technologies, while Social Sciences and Medicine / Pharma are among the least connected. On the other hand, it is important to notice, that experts have not identified FLIs related to several megatrends like M6 Continuing urbanization, M7 Diversification of education and learning, M9 Expanding influence of east and south, M11 Increasing demographic imbalances, M12 Increasing influence of new governing systems. This observation is related to the fact, that only FLIs which allowed on identification of specific technologies and R&I topics were considered in the analysis. It relates to thematic bias described in the approach limitations in Chapter 2.1.

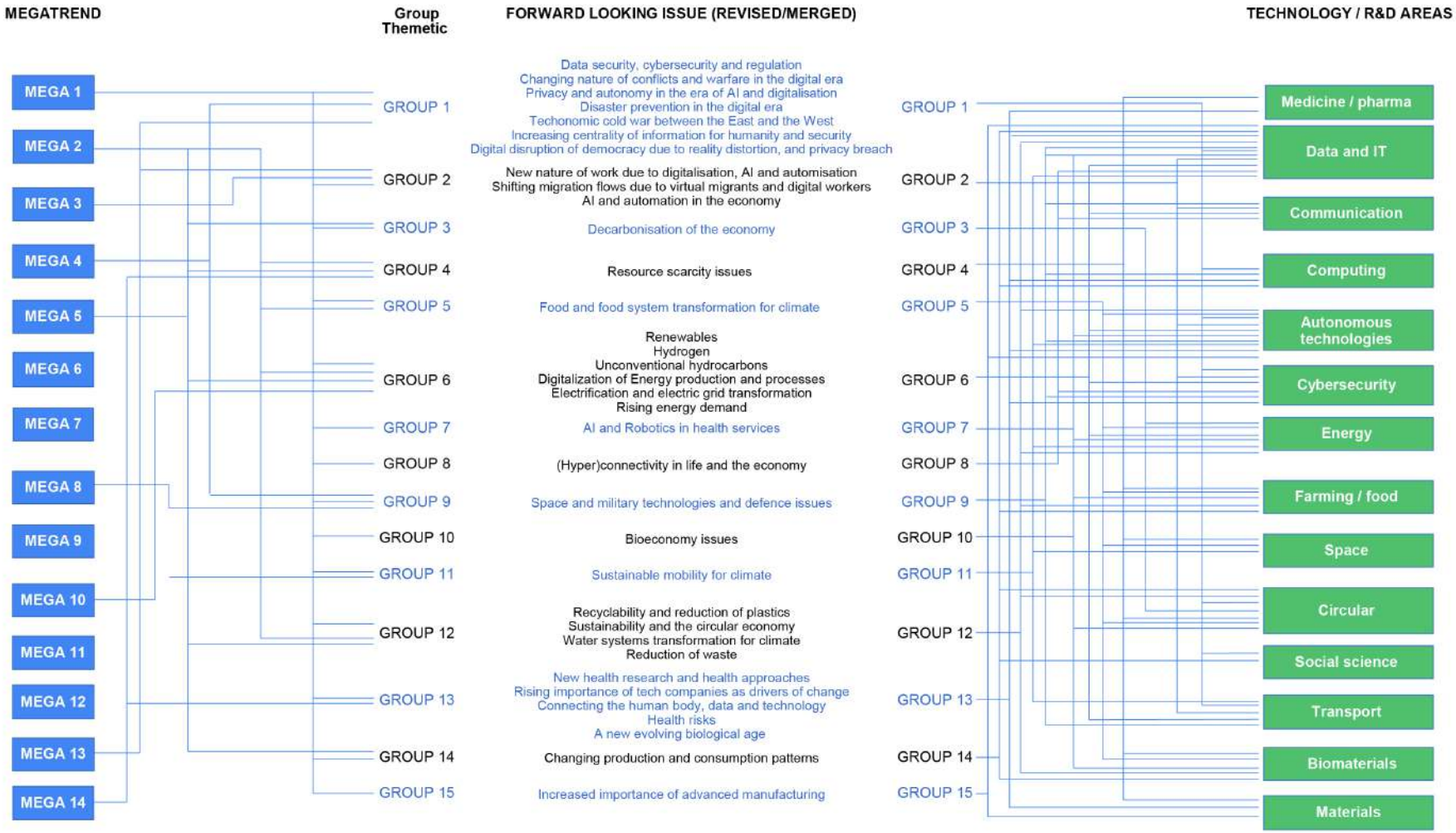


Figure 8. Connections between megatrends and identified forward-looking issues and technology areas. Source: Expert Group (2023)

To assess the European Partnership landscape against the results of the forward-looking analysis data must be confronted with output of the Partnership Survey. Figure 9 to Figure 15 present distribution of interest (coverage) of the surveyed 34 Partnerships on the level of each category of impacting factors: megatrends, FLIs and technologies.

The data collected from the survey could have different visual representations. Figure 9 allows to identify the distribution of Partnership interest (occupancy) between all 14 Megatrends. The highest interest (the highest occupancy) is in M5 Climate change and environmental degradation and M1 Accelerating technological change and hyperconnectivity, while the lowest interest (occupancy) is for social and human related megatrends e.g., M13 Increasing significance of migration, M12 Increasing influence of new governing systems, M11 Increasing demographic imbalances, but also M4 Changing security paradigm. Interestingly, some of the less occupied megatrends are the same or of the same nature as megatrends with not identified links to FLIs in expert review and analysis of forward-looking reports.

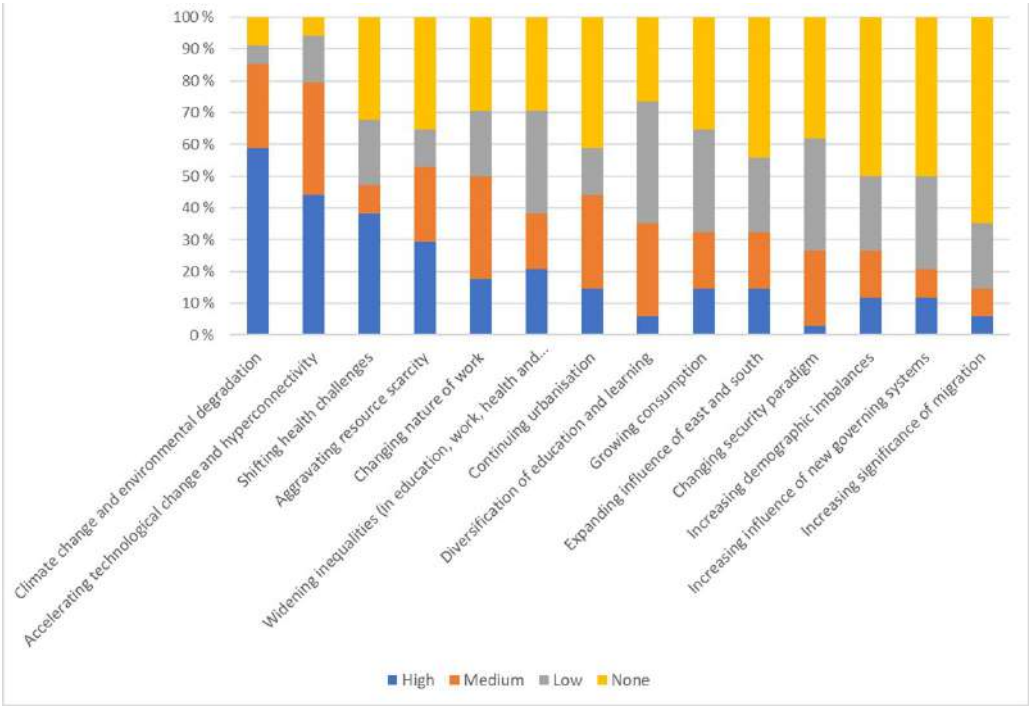


Figure 9. Relative importance of Megatrends to European Partnerships (*high, medium, or at least low relevance to several partnerships=left; high, medium, or even low relevance to few partnerships=right*). Source: Expert Group (2023)

The same results from the survey could be presented in different graphical representation allowing for easier interpretation of relative importance of megatrends or Partnerships measured by size and position of the box representing specific megatrend. Interpretation of the data in Figure 10 is that the megatrends with highest relative interest (occupancy) are located in upper-left corner, while the lowest in lower-right corner. Decreasing interest is represented first in vertical then horizontal position.

Figure 10. Relative importance of Megatrends to European Partnerships (*highest=upper left corner, descending=first down, then right, lowest=bottom right corner*). Source: Expert Group (2023)

The same type of graphical representation could be provided for Partnerships in relation to FLIs. Figure 11 shows survey data representing interest (occupancy) in all 35 FLIs. Significant differences could be observed between different FLIs, with very high interest (occupancy) for issues like Decarbonisation of economy, Sustainability, pollution mitigation and the circular economy, Health risks or Rising importance of tech companies as drivers of change, while the least or almost no interest (occupancy) is given to issues like Unconventional hydrocarbons, Digital disruption of democracy, changing nature of confects or Shifting migration.

The same data is presented in the “box format” in Figure 12. However, due to a relatively high number of forward-looking issues, and different number of issues per different thematic groups, more meaningful and explicit pattern could be observed, when data are presented at the level of Thematic FLI Groups (Figure 13).

When data are normalised to number of FLIs per Thematic Group, interestingly Thematic Groups like Decarbonisation of the economy, changing life and consumption patterns and Bioeconomy issues are the most occupied by the Partnership interest, while, Space and military, Digitalisation, security, and privacy issues as well as Alternative energy sources and systems transformation are very weakly occupied.

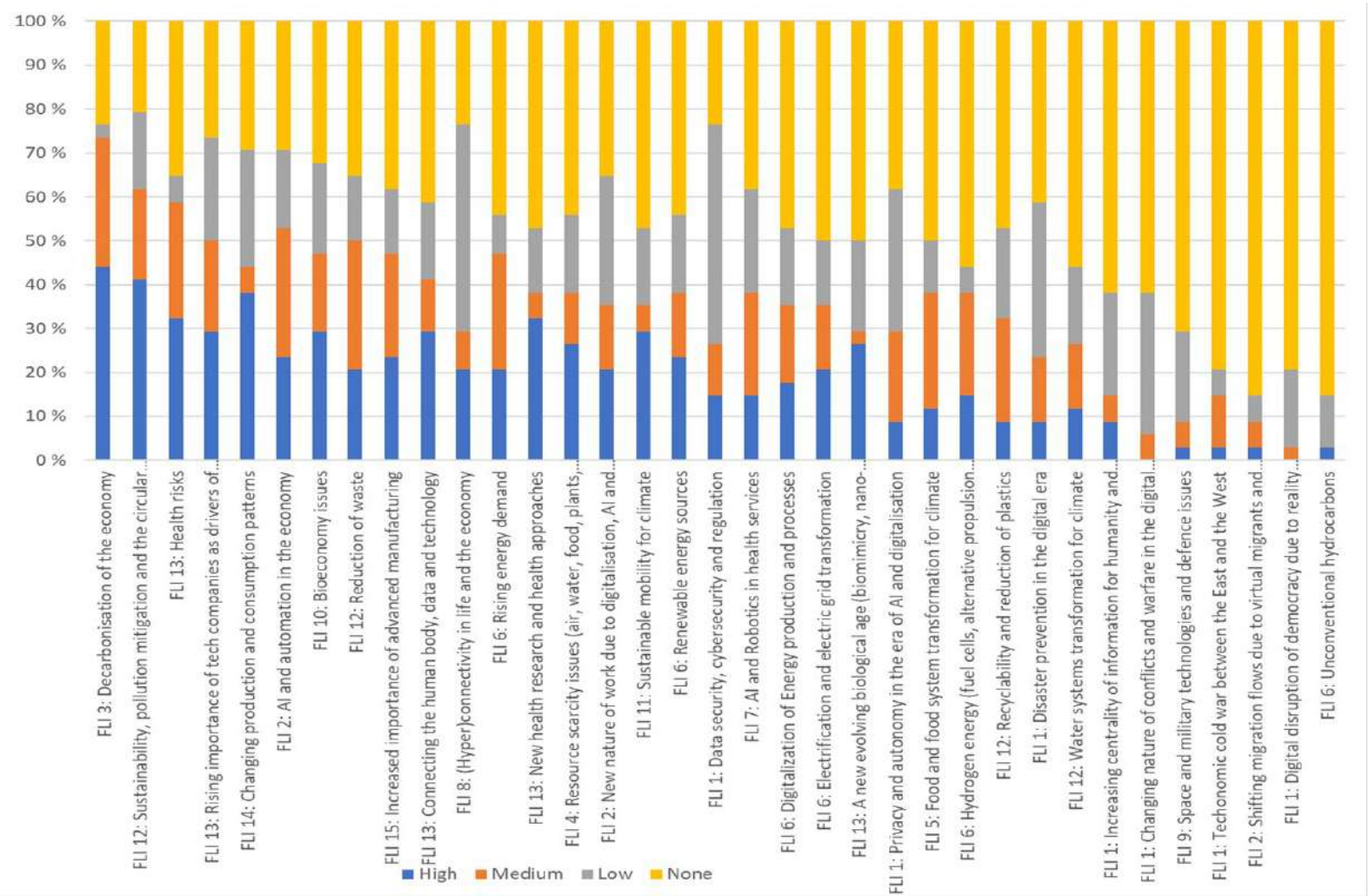


Figure 11. Relative importance of Forward-Looking Issues to European Partnerships (*high, medium, or at least low relevance to several partnerships=left; high, medium, or even low relevance to few partnerships=right*). Source: Expert Group (2023)

Figure 12. Relative importance of Forward-Looking Issues to European Partnerships (*highest=upper left corner, descending=first down, then right, lowest=bottom right corner*). Source: Expert Group (2023)

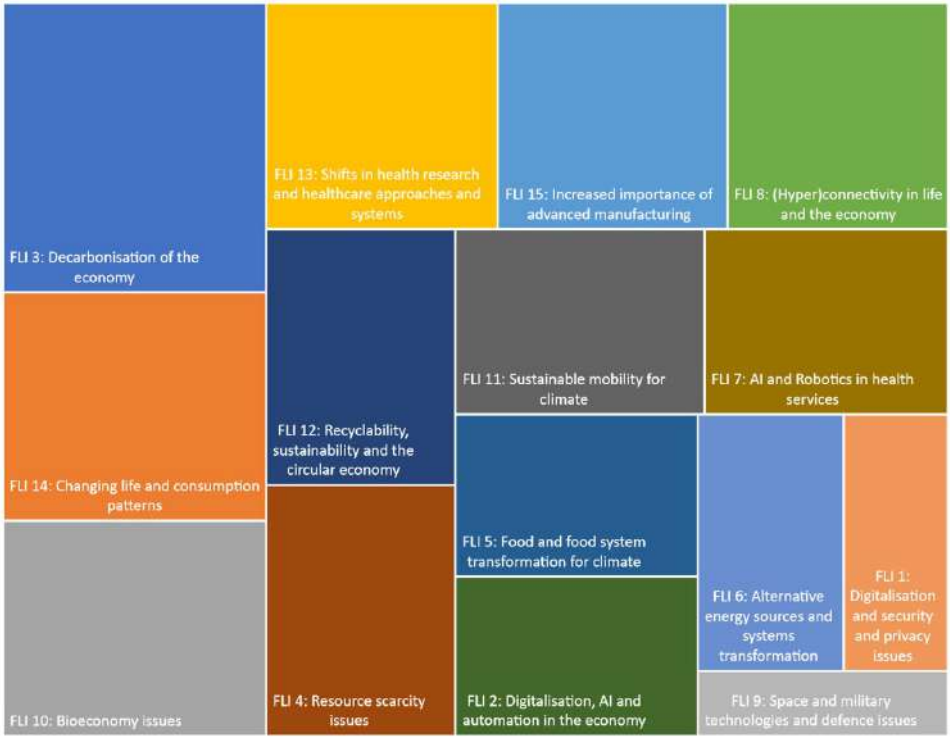


Figure 13. Relative importance of Thematic Forward-Looking Issue Groups to European Partnerships (*highest=upper left corner, descending=first down, then right, lowest=bottom right corner*). Source: Expert Group (2023)

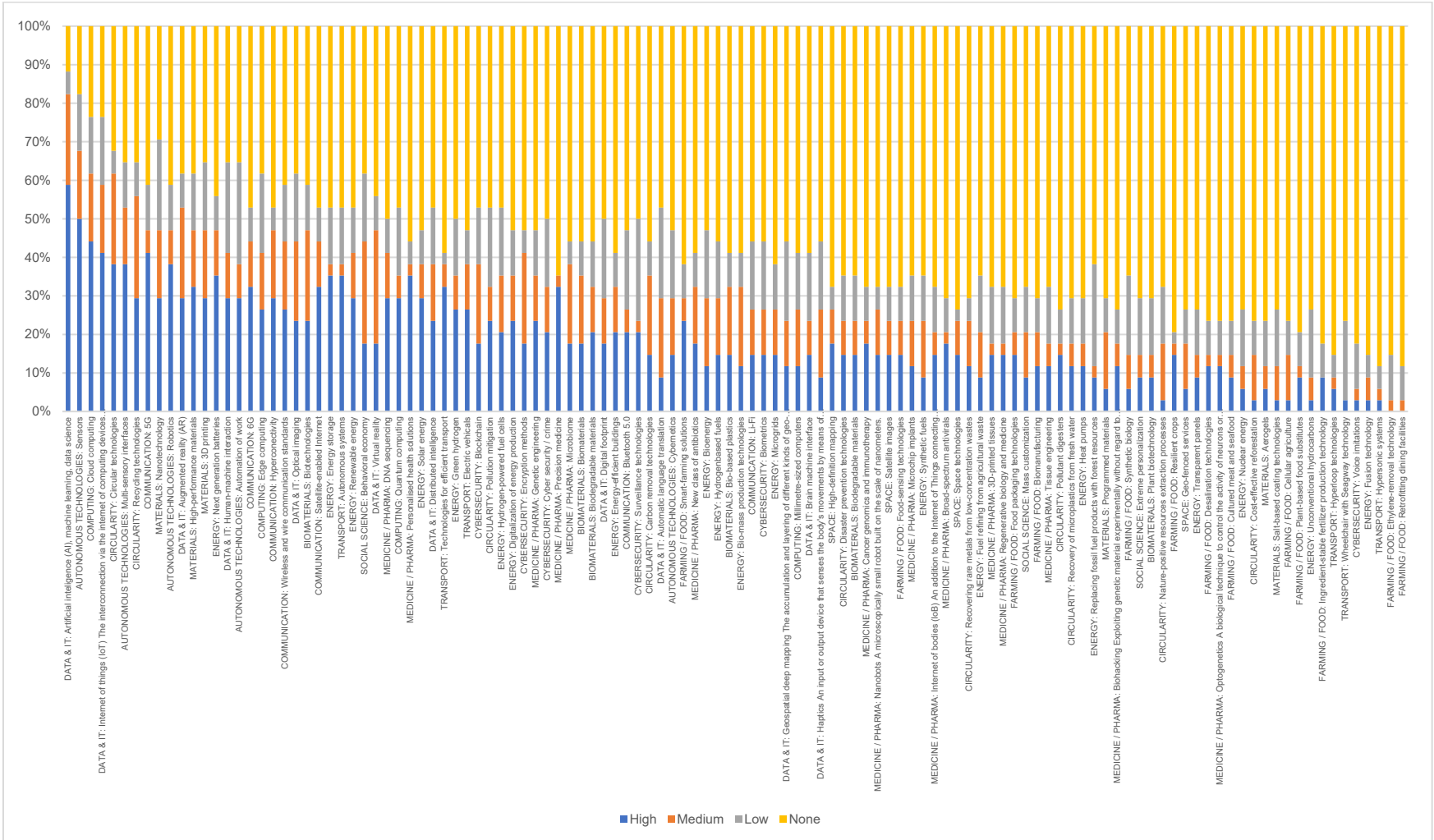


Figure 14. Relative importance of identified Technologies to European Partnerships (*high, medium, or at least low relevance to several partnerships=left; high, medium, or even low relevance to few partnerships=right*). Source: Expert Group (2023)

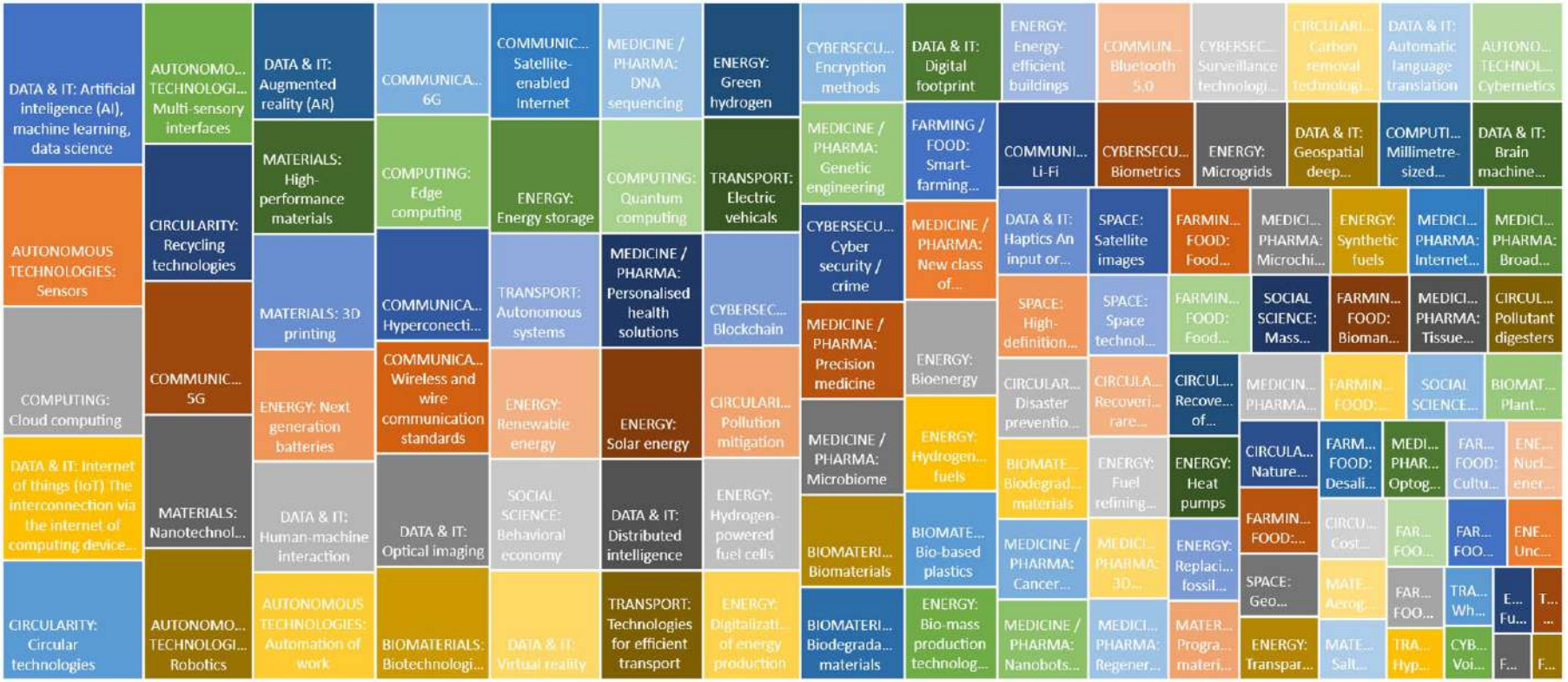


Figure 15. Relative importance of identified Technologies to European Partnerships (*highest=upper left corner, descending=first down, then right, lowest=bottom right corner*). Source: Expert Group (2023)

Figure 14 presents data from the Partnership Survey on the technology and technology Area level. The format of the graphics and high number of technologies only allows to observe an existence of significant differences in interest (occupancy) of particular technologies.

The change of the format in Figure 15 illustrates particularly the most interesting (occupied) technologies, e.g., Artificial Intelligence, Machine learning, Data science, Sensors, Cloud computing and Internet of Things, but only to show it on more aggregated level of Technology Areas (with normalisation to number of technologies per technology area) allows for more pronounced conclusions and further analysis.

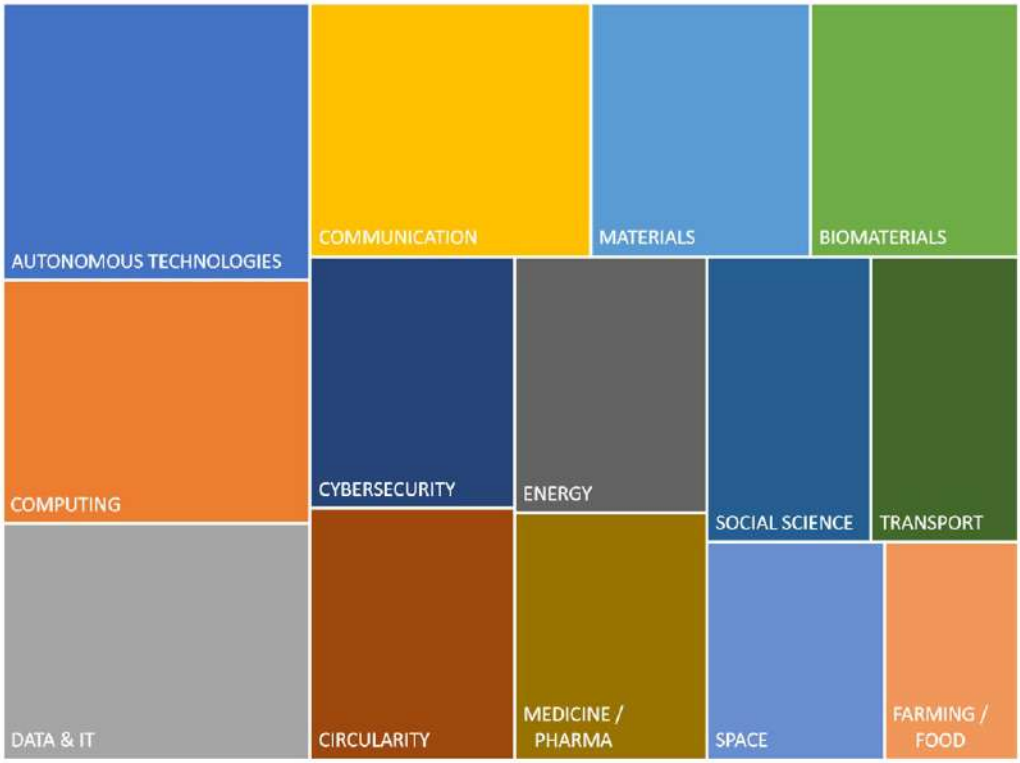


Figure 16. Relative importance of Technology areas to European Partnerships (*highest=upper left corner, descending=first down, then right, lowest=bottom right corner*). Source: Expert Group (2023)

On the level of Technology Areas, the interest (occupancy) of the Partnerships is strongly concentrated on different aspects of Information Technologies, like Autonomous technologies, Computing, Data and IT, Communication, with visibly less interest in Technology Areas like Farming /Food, Space and Transport. If IT related technologies were not arbitrarily distributed between different sub-areas, its dominance would be overwhelming.

For different purposes, collected data allows for presentation of similar figures for different types of partnerships, clusters of partnerships or individual partnerships, but also for different Partnership instruments. Created database and tools allow to create necessary figures almost “on-demand” basis.

To present possible ways of implementation of the proposed methodology, data were also collected through the same Survey from 5 Missions. They could be used for separate analysis of the Missions, but also it could be used for more comprehensive assessment of landscape of the EU instruments, beyond the Partnerships. For illustrative purpose, Figure 17 and

Figure 18 present comparison of interest (occupancy) of Megatrends and Technology Areas between surveyed Partnerships and Missions.

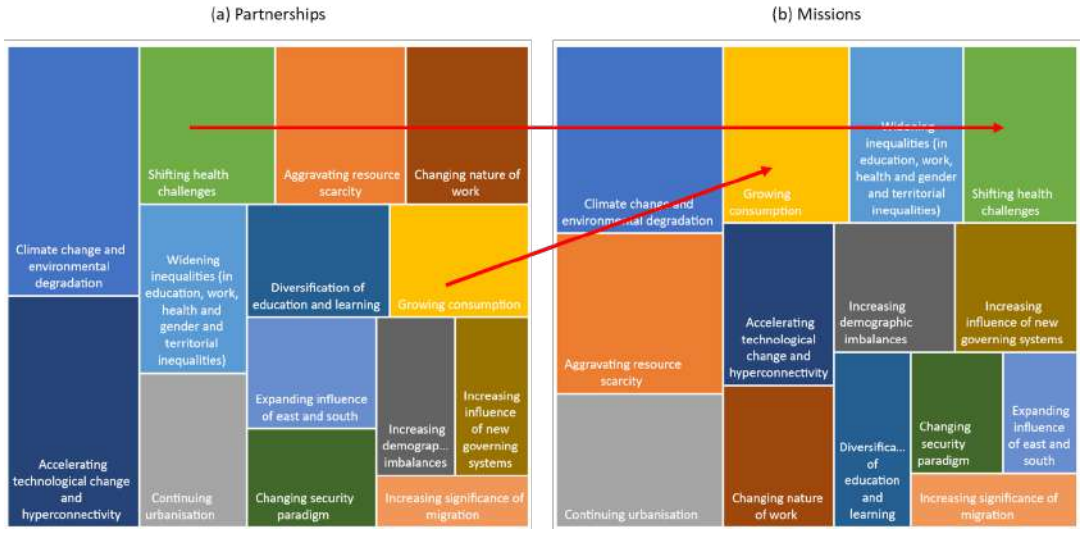


Figure 17. Relative importance of Megatrends to European Partnerships and Missions (*highest=upper left corner, descending=first down, then right, lowest=bottom right corner*). Source: Expert Group (2023)

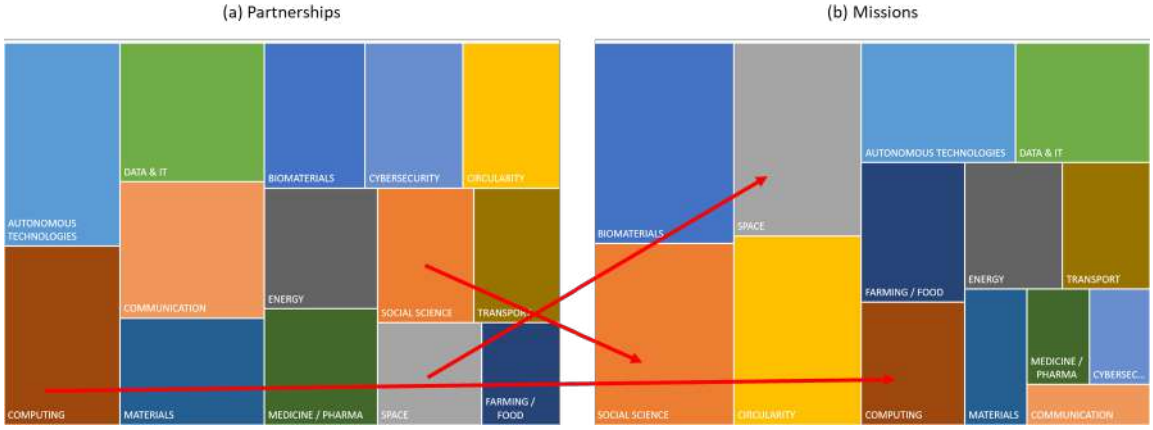


Figure 18. Relative importance of Technology areas to European Partnerships and Missions (*highest=upper left corner, descending=first down, then right, lowest=bottom right corner*). Source: Expert Group (2023)

It could be observed, that for both types of factors, the pattern is significantly different for Partnerships and Missions. For Megatrends, red arrows help to identify the most significant change of the size (intensity interest/occupancy) and position (change of relative interest / occupancy) for Shifting health challenges and Growing.

On the level of Technology Areas, the most significant change of size and position relates to the following Technology Areas: Computing, Space and Social Sciences. It could be concluded that importance of Social Sciences and Space related technologies is much higher for Missions, than for Partnerships. If the observation reflects real, strategic difference in focus of these two instruments, it as a strong argument for positive validation of proposed approach, which could be replicated through collected data and analysis existing facts.

The key element of assessment of the Partnership landscape against identified factors which could shape and influence the socio-economic and technology future is a comparison of results of expert review of forward-looking report with data from the survey. Figure 19 shows comparison of expert review results (green left column) with surveyed Partnership data (blue middle column) and the surveyed Missions (blue right column).

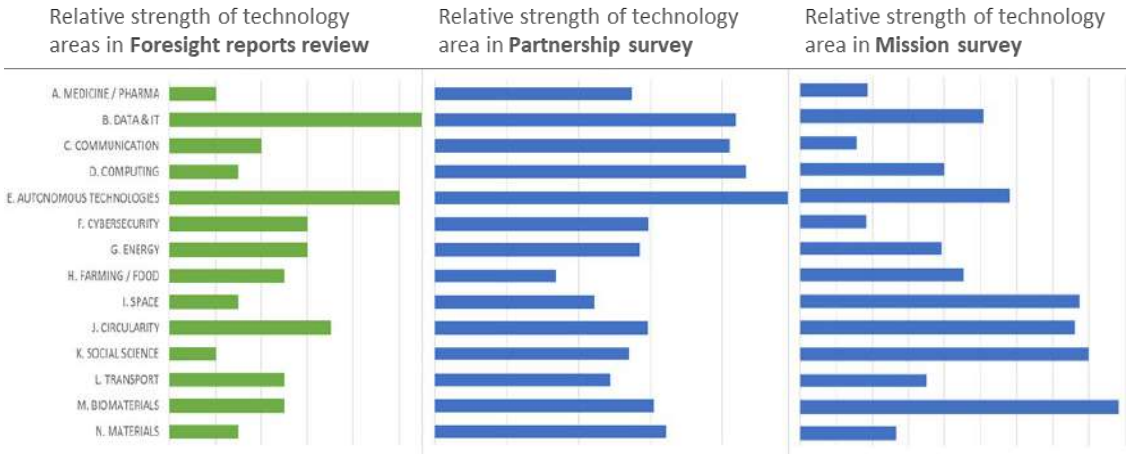


Figure 19. Relative importance of the identified Technology areas in foresight literature (green) compared to their importance indicated by the surveyed European Partnerships and Missions (blue). Source: Expert Group (2023)

The comparison shows that there is a relatively strong interest among Partnerships in Technology areas such as Medicine /pharma, Data & IT, Communication, Computing, and Autonomous systems, whereas Missions are more interested in Technology areas such as Space, Circularity, Social Science, and Biomaterials. This would seem to indicate a noticeable degree of complementarity between these instruments.

Comparison of results from the expert review of forward-looking reports with distribution of Partnership interest in different technology Areas may lead to observation, that the general pattern is reflected well. However, distribution of Partnership's interest seems to be more balanced (flatter) than distribution of relative importance of Technology Areas in the surveyed forward-looking reports. Some discrepancies for Technology Areas like Circularity relatively stronger represented in forward looking reports than in interest of Partnerships could be also observed.

To illustrate another opportunity created by proposed methodology and collected information and data, the following Figure 20 shows a comparison of distribution of results of expert review of forward-looking report with data from the survey for different types of Partnerships. The following Figure shows comparison of expert review results (green left column) with surveyed non-Institutionalised Partnership data (blue middle column) and Institutionalised Partnership data (blue right column). The red arrows help to identify the Technology Ares where the most significant difference in patterns for different types of Partnerships occurs (e.g., Communication, Cybersecurity, Farming /Food, Space and Social Science). More interestingly, it could be observed, that structure of the pattern of interest / Technology Areas for the Institutionalised Partnerships reflects better the distribution resulted from expert review of forward-looking reports.

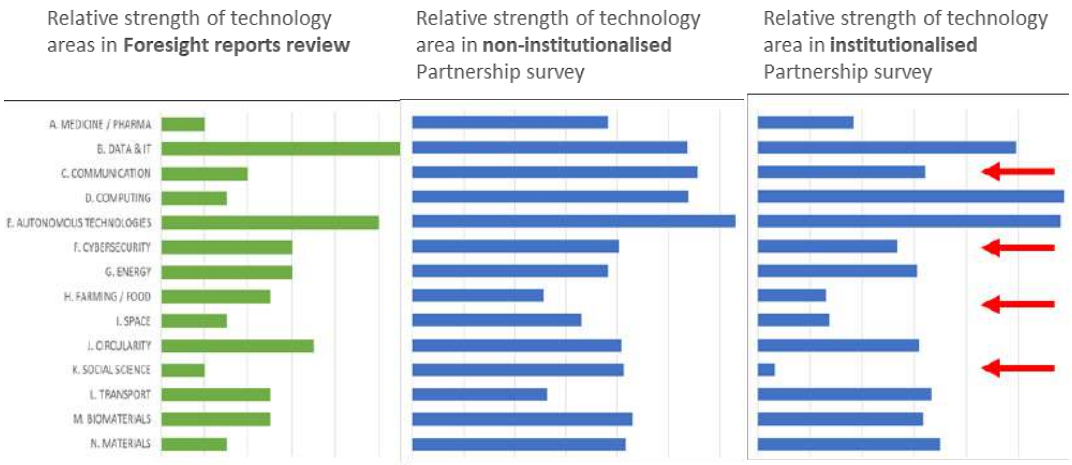


Figure 20. Relative importance of the identified Technology areas in foresight literature (green) compared to their importance indicated by the surveyed non-institutionalised and institutionalised European Partnerships (blue). Source: Expert Group (2023)

The last observation could be explained by the specific nature of Institutionalised Partnerships is considered. As it is also reflected in suggested criteria for assessment of the landscape of institutionalised partnerships (Chapter 3.2), the Institutionalised Partnerships are the right instrument when challenges targeted by partnerships go beyond national border and require integrated, multistakeholder response on the EU level. Moreover, the institutionalised partnerships come in place, when expected impact goes beyond other partnerships capacity. It is also in close relation to aspiration of the institutionalised partnership to enhance the EU's economic capacity and technological sovereignty. Summing up all above-mentioned elements, it makes the institutionalised partnerships more sensitive and more relevant to address global forward-looking issues and connected technology areas.

Specificity and need for contextual interpretation of the presented results for each type of partnerships was also expressed during the Workshop with partnership representatives conducted for validation and deepen understanding of Survey results. To strengthen this approach, in future development of the methodology, the Survey should allow partnerships not only to choose among Megatrends, forward-looking issues and technology areas, but also to make links between mentioned elements to create more comprehensive maps, as the one developed and elaborated by experts.

With present data it is also possible to analyse distribution and level of interest of a single or a group of partnerships in specific Megatrends, forward-looking issues (or its thematic groups, or technologies (or technology areas). An example of this type of analysis is presented on the Figure 21. Illustration of distribution of importance and its level for three Megatrends for group of Institutionalised Partnerships. Distribution of importance and its level from 0 – No importance to 3 – High importance is presented for group of Institutionalised Partnerships for three Megatrends.

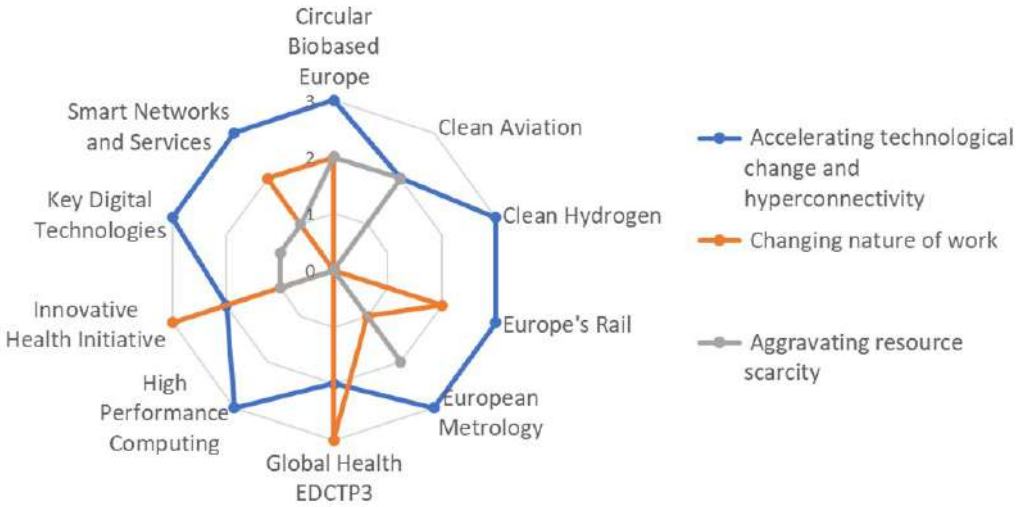
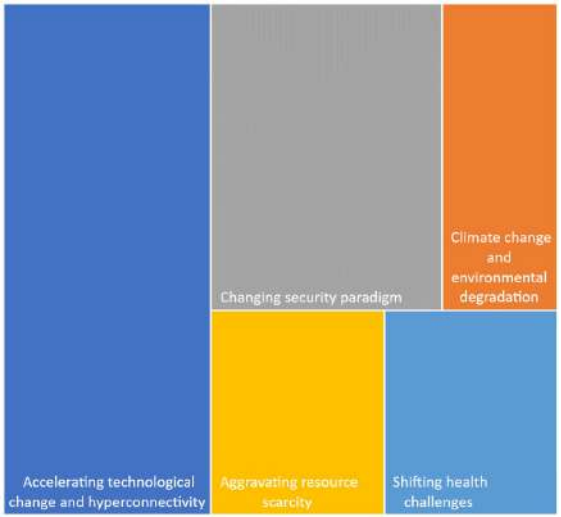
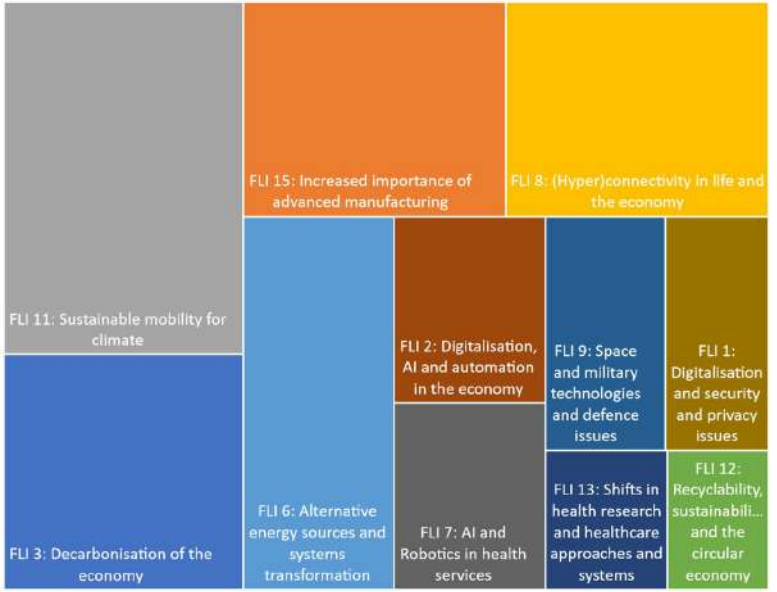


Figure 21. Illustration of distribution of importance and its level for three Megatrends for group of Non-institutionalised Partnerships. Source: Expert Group (2023)

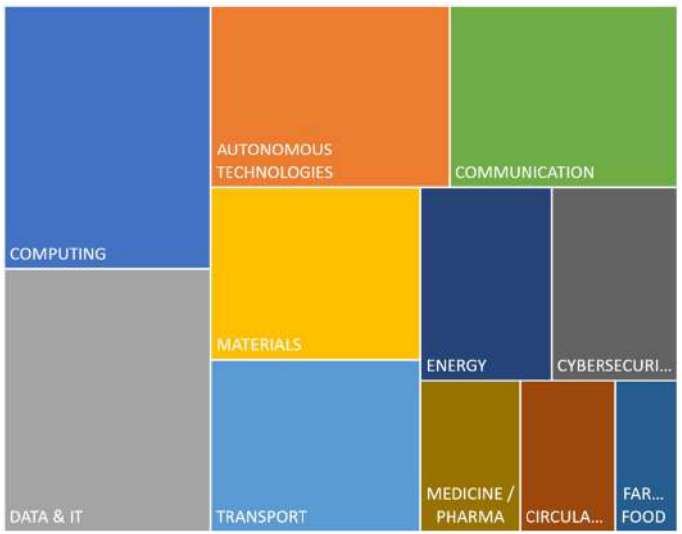
Available data allow also to study so called “Partnership fingerprints”, which is a partnership specific pattern of interest in megatrends, forward-looking issues, or technologies. Figure 22 provides an illustration of such fingerprints.



(a)



(b)



(c)

Figure 22. Illustration of “Partnership fingerprints” for a European Partnership: (a) Relevance/importance of Megatrends, (b) Relevance/importance of Groups of Forward-Looking Issues, and (c) Relevance/importance of Technology Areas. Source: Expert Group (2023).

3.2. Assessment of the landscape of institutionalised partnerships

The suggested methodology concluded with a set of criteria for assessing the landscape of the Institutionalised Partnerships drawing on the legal basis as well as the portfolio management literature and practice. The latter group, i.e., the portfolio management criteria are also ranked based on priority and are accompanied by suggested means of data and information collection.

Given the time constraints in the schedule of the Expert Group, it was decided to try to apply the criteria in the Institutionalised Partnerships by only reviewing the available documentation (i.e., the ex-ante Impact Assessment study carried out by Technopolis in 2020, the available SRIAs, and legal basis (Horizon Europe Regulation, etc.). In a full-scale assessment exercise, the applications of the methods suggested in the methodology together with interviews of members and beneficiaries of the Institutionalised Partnerships would be pertinent.

Below follows the insights gained from applying the suggested criteria by the Expert Group by reviewing the available documentation related to the set-up, content, and operation of the Institutionalised Partnerships. The point also needs to be made that this process excluded the EIT-KICs due to the time constraints faced and also given that they are not concerned by the revision of Annex VI (areas for institutionalised partnerships established under art 185-187)

3.2.1. The criteria for setting up Institutionalised Partnerships based on the legal framework.

1. Necessity for action at the EU level.

Based on the available documentation of existing Institutionalised Partnerships, this criterion is addressing the nature of the challenge(s) targeted by the partnership, and which includes going beyond national boarders, or requiring critical mass of resources and capacities that do not exist in individual countries. In other words, the scale and complexity of the research area in questions either demand resources and capacities that go beyond those available in individual countries, or requires better coordinated efforts across countries for standardisation, harmonisation or other purposes, etc. Such challenge cannot be tackled by other approaches like a 'regular' thematic call under the Framework Programme.

In the case of addressing a research gap, the application of this criterion would then mean to think about how the specific research area responds to the above elements, i.e. level of cross-country relevance, need for critical mass or increased investments that go beyond individual countries or sectors, need for research coordination across countries, need for coordination and joint investment in improving, need for coordination at the early stages of new ecosystem formation, need to develop capabilities in application areas of strategic socioeconomic importance, etc.

As an example, in the KDT partnership, mastering of essential technologies to guarantee access to secure and trusted components for strategic European infrastructures and sectors will strengthen the capabilities of companies in the target segments and will increase existing capacity by expanding or diversifying current companies or the arrival of companies from abroad.

The level of complexity encompassed as well as the level of the competitors and the pooling of resources (financial, infrastructures and human) set-up by these competitors implies a

massive answer. Thus, the highest possible leverage of resources (from industry, Member states…) under a shared vision is critical, to strengthen the scientific capabilities on emerging technologies (such as Collaborative and multidisciplinary research on software and algorithms for AI, semiconductor-based neuromorphic components, and quantum computing) and to accelerate the development of essential cross-cutting. To develop design capabilities in application areas of strategic socioeconomic importance, and to master essential technologies to guarantee access to secure and trusted components for strategic European infrastructures and sectors must be undertaken at the highest level to be achievable with the most efficient impact.

Similarly, the Innovative Health Initiative Partnership tackles the necessity to gather different industry sectors (pharmaceutical, digital, IT, medical devices, diagnostics, etc.) to address innovative, more integrated approach to health research and health care and overcome the issue of lost opportunities to integrate results from different sectors in a way that could really transform healthcare sector. The European Partnership on Metrology is another such example of an Institutionalised Partnership.

2. Aims/goals or impacts needed to address the challenges are not expected to be fully met by other types of Partnerships.

The format of Institutionalised Partnerships should be chosen only as the third option, i.e., when the other two types (Co-funded and Co-programmed) are not deemed appropriate to adequately achieve the objectives and impact needed to address the defined challenges. This is due to its complexity in the set-up and lack of flexibility given that any changes in the objectives / activities or memberships would require a change in legislation. Such a comparative assessment is done through an ex-ante Impact Assessment study comparing the different options. In the case of the Institutionalised Partnerships, this study was performed by Technopolis to accompany the Council decision for setting up the first wave of the Institutionalised Partnerships. This was a well-thought-out approach and assessment methodology leading to a score-card analysis of the evaluation dimensions of effectiveness, coherence, and efficiency across the three different types as well as regular Horizon Europe calls. As such this criterion seems to be clearly interpreted and implemented, albeit the onerous efforts needed in carrying out the respective comparative impact assessment study of the different options. The Technopolis study revealed important features distinguishing the one type from the other two that can be summarised as follows.

Table 5. Distinguishing features among the different types of European Partnerships. Source: Expert Group using Technopolis et al. (2020)

	Co-funded	Co-programmed	Institutionalised
Legal requirements	Grant agreement between members and EC	MoU / Contractual Agreement	Council Regulation (Art 187), European Parliament and Council Decision (Art 185) – DIS
Actors	EC and public actors at the core. Research actors, societal org, NGOs can also take part in partnership - industry	EC and public/private partners - diverse set of actors and/or value chains	EC and R&I governance bodies in MS/AC (Art 185) EC and a) industry associations, or individual private partners, or b) R&I governance bodies, funding

	Co-funded	Co-programmed	Institutionalised
	usually addressed by activities		agencies, and governmental research organisations in MS/AC, or c) a combination of the two above (Art 187)
Flexibility in obj./activities/members	High	High	Low – would require changes in legislation
Legally binding commitment	As prescribe by the Grant agreement	No expectations Based on 'best efforts'	Strong – long-term commitment needed more than other types
International partners	Usually no issues but excluded from EC fund	No restrictions	Non-associated Third Countries not foreseen
Rationale	Aligning national programmes and policies with EU policies / investments, helping to overcome fragmentation of the public research effort	Create a platform for 'concertation' across broader communities with diverse capacities and capabilities	Integration of national and EU funding, aligning national strategies to optimise the use of public resources and overcome fragmentation (Art 185) -break- Integrating the strategic R&I agendas of private and/or public actors and leveraging the partners' investments to tackle R&I/societal challenges and/or contribute to Europe's competitiveness (Art 187).
Call priorities	Decided by partnership members based on SRIAs	Proposed by members and agreed with EC	High degree of autonomy in developing SRIAs, annual WPs and call topics – subject to approval from EC
Instruments to use	Defined by the partnership – usually grants but also variety of other activities	integration in FP so all HEU (CSAs, RIAs, IAs, grants, prizes, procurement)	integration in FP so all HEU (CSAs, RIAs, IAs, grants, prizes, procurement)

This criterion received the most comments in the workshop question "To the best of your knowledge, and thinking about an area that is less addressed by partnerships, which of the above criteria would be the most difficult to apply in informing the decision of setting up an Institutionalised Partnership or not?"

The comments referred to difficulties to assess what other partnerships address, also given the different types of partnerships and the different time they are launched. It requires to have an umbrella view that only the European Commission is capable of having.

When asked about ways to apply the specific criterion the workshop participants noted or suggested the following:

- a regular mapping of each partnership's objectives, and a gap analysis, to demonstrate the added value and avoid overlap.
- Objectives should be clearly defined avoiding generalities (e.g., contributing to Green Deal);
- the need for regular iterations among partnerships at the preparation phase to discuss and avoid overlaps as well as identify potential activities to like.
- the key role of the Commission (e.g., the Policy Coordination Directorate in DG RTD) in gathering information from Partnerships, identify where they could not deliver and share the information with responsible services.
- This could also be one of the functions of the Partnership Stakeholder Forum, when considering the next Framework Programme.
- Avoidance of overlaps could be in the areas of market segments, sector specific objectives and TRL coverage.

Naturally the above suggestions are relevant in the case where a research area is less addressed by existing partnerships, rather than the case of an area where no partnerships exist. In the latter case, one would try to see if the specific area is covered by other instruments like Horizon Europe work-programmes, etc.

The above two criteria can be regarded as ‘exclusion’ criteria, the first one for setting up a partnership of any kind and the second one for setting up an Institutionalised Partnership. The ones that follow can be considered ‘enabling’ criteria or factors for an Institutionalised Partnership to exploit its full potential.

3. Need for a long-term perspective in addressing the defined challenges.

Setting up an Institutionalised Partnership is characterised by a strong legal binding commitment. To afford the heavy administrative efforts and legislative procedure that goes along with this, the candidate partners need to ensure a long-term, significant commitment. Accordingly, the challenges addressed by the candidate Institutionalised Partnership should be underlined by a research approach with a long-term perspective.

Overall, addressing this criterion draws upon the nature of the challenge being targeted and the particularities of the scientific and research fields being involved, as well as the objectives of the partnerships and the research approach suggested to be applied. For instance, the objective of the Metrology Partnership is to establish a sustainable coordinated world-class metrology system and enhance the metrology capabilities to meet the needs of emerging technologies and important policy domains in climate, environment, energy, and health. To achieve this requires long-term sustainable mechanisms to increase and deepen coordination and pool resources, not only among national metrology institutions in Europe, but also along the entire metrology value chain (Impact Assessment, Technopolis)

A typical period of coverage for all European Partnerships is the next 10 years, thus this criterion is not a particular feature of Institutionalised Partnerships alone. Yet, due to the legally binding commitment negotiated between the Institutionalised Partnership partners and the European Commission the stability of the committed funding is much higher than in a Co-funded Partnership where the yearly funding is dependent on a variable geometry of participating funding bodies and their interest in the respective funding opportunities agreed via yearly work plans.

4. Building on a higher degree of integration

Criterion 4 has two main interpretations. On the one hand, a higher degree of integration is relevant of national and EU funding, aligning national strategies to optimise the use of public resources and overcome fragmentation. This is particularly relevant for Art 185 initiatives. On the other hand, a higher degree of integration of strategic R&I agendas of private and/or public actors would be relevant for Art 187 initiatives aiming at leveraging the partners' investments to tackle R&I/societal challenges while also contributing to Europe's competitiveness.

Applying this criterion actually means assessing the research area being addressed. In areas where research is performed by dedicated national institutions, such as metrology for instance, cross-country coordination of R&I agendas and efforts would bring the needed harmonisation and contribute to multiplying the impact of metrology research. At the same time, areas of strategic importance for the European industry where a wide variety of private actors play an important role in R&I, also lend themselves for increased coordination and collaboration also with the public research sector to increase capacities and leverage the link between research and innovation.

For IHI, the innovation in healthcare is based on both use and convergence of established and innovative technologies. Fostering such convergence of technologies shall enable the development of cross-sectoral innovations that are better able to respond to people's needs. Such an approach should also facilitate the integration of health interventions developed by different industrial sectors along the healthcare pathway thus contributing to the higher degree of integration and joint undertaking.

5. Prospect for aligning R&I agendas, improving skills, and increasing absorption capacity of European businesses.

Aligning R&I agendas is important to find common ground for collaboration, and combine, otherwise isolated, resources in addressing identified challenges. This can help multiply the impact of efforts of public and/or private R&I actors. At the same time, building capacity of businesses and increasing their ability to absorb the knowledge / research results produced is key in advancing along the research-innovation continuum. This is critical for the Institutionalised Partnerships that are driven by private R&I actors.

Aligning R&I agendas was found difficult to achieve by the workshop participants as it requires good knowledge of the R&I agendas as well as their long-term directions which are not always evident or can be disrupted by changes in the political scene. At the same time, the comment was made that Partnerships can support to overcome the fragmentation of the R&I landscape in Europe but cannot achieve this alone.

This criterion is mainly addressed by the relevance of the activities planned by the partnership and the degree to which these are oriented towards alignment of R&I agendas and capacity building in the research but also the business communities. Examples of such activities may include for instance mapping activities to record the landscape of national policies and instruments in an area, workshops and/or consultation across the partnership members for the creation or update of SRIAs, joint foresight exercises, development of shared vision etc. Capacity building activities usually refer to PhDs, training visits, knowledge networks of researchers. They usually address the research community rather than businesses.

Alignment of R&I agendas within the business community is achieved at the level of the industry associations formed to be the private sector partners of partnerships. Typically,

businesses build together the SRIA and respective R&I programmes in a way that they remain in the pre-competitive space but allowing advancing the areas that are of common interest for the industry and of which outputs will be useful for the research community or society at large. At the same time, progress on specific milestones or common bottlenecks are identified by industry partners.

The alignment of R&I agendas goes beyond the “internal” alignment of involved parties but also encompasses other linked initiatives. For example, in the case of R&I areas and activities that potentially fall under the scope of both IHI and several other EU-funded initiatives, including the Health Emergency Preparedness and Response Authority (HERA) activities, it is agreed that calls should be launched under the initiative with the most relevant scope, composition and overall goal for the specific topic. Only when duly justified (e.g. pandemic outbreak), and in cases where specific complementarities between initiatives are needed, multiple initiatives can launch calls in the same thematic areas. To that end IHI plans to interact with other health-oriented initiatives, initially with partnerships to be created in Cluster 1 of Horizon Europe.

Before identifying the topics of each call for proposals referred to in paragraph 1, point (a), EURAMET shall publicly invite individuals or organisations, including SMEs, and the general metrology value chain to suggest potential research topics in a transparent manner.

6. Need for systematic engagement of stakeholders and end-users, including standardization bodies and international partners to achieve uptake of solutions.

The legal basis for European Partnerships highlights the importance of attracting a variety of stakeholders and in the case of Institutionalised Partnerships, these also include industry, small and medium-sized enterprises (SMEs) and various user organisations besides research actors and research funding organisations or national authorities. The criterion can be applied through a wide range of outreach activities, including for the dissemination and exploitation of results, promotional and awareness-raising activities but also actual engagement of user groups throughout the R&I process; from designing research strategies, through conducting collaborative research to enhanced and proactive dissemination of research outputs to facilitate their adoption. As an example, in the Metrology foresees the inclusion of individuals or organisations, including SMEs, and the general metrology value chain in the identification of the topics of each call for proposals in a transparent manner. Indicators for measuring the variety of attracted/targeted stakeholders can be the type of organisations involved in the partnership and the different roles they have.

For IHI, the fact that, (despite having leading healthcare systems and being a strong global actor in health research), the EU is still relatively weak in translating research results into tangible health products, services, and solutions, which are delivered to the market and taken up by healthcare systems in Europe, can partially be attributed to insufficient early consideration of societal and/or user needs. Therefore, IHI expects to involve patients and end-users need in all stages of research, from project design through to implementation, in order to develop meaningful innovations.

7. Addressing a set of systemic, market and transformational failures, which is a pre-condition for accelerating the development and diffusion of innovations.

The specific criterion was also commented by the workshop participants as problematic as it assumes that an impact assessment study can identify the systemic failures being addressed, which might not be as straightforward, or due to the difficulty to examine how markets evolve under high uncertainty and important geopolitical changes.

Accelerating the development and diffusion of innovations presupposes enhanced capacity for innovation, tackling systemic deficiencies of R&I systems by building bridges across actors and facilitating concerted, collaborative action, and deploying the necessary skills and resources for the later stages of research towards innovation. These are important elements to be shared by partnerships irrespective of the pre-competitive nature of research deployed, as the research – innovation journey includes a variety of intermediary phases. The level to which these conditions are met are usually reflected in the SRIAs and the different types of activities and actors involved in each of them. For instance the Metrology Partnership shall support a wide range of research and innovation activities by means of: (a) grants supporting (i) scientific and technical actions supporting fundamental scientific metrology (ii) metrology research to provide solutions for societal, economic and environmental challenges in the energy, digital and health sectors, as well as with regard to the environment and the climate; (iii) research to develop novel measurement instrumentation aiming to enhance the European industrial and commercial take-up of metrological technologies to stimulate innovation in industry; (iv) pre-normative and co-normative metrology research and development in support of policy implementation, regulations and acceleration of the market introduction and societal uptake of sustainable innovative products and services; (v) exchange of best practices on metrology research carried out at national level. In addition, the work-programme of the Metrology Partnership includes extended capacity building activities at different technological levels, actions for the dissemination and exploitation of results, including in industry and by SMEs, and activities to raise awareness and promote educational and dissemination activities and campaigns.

Similarly, the Circular Bio-based Europe partnership has also different type of activities and calls foreseen in their SRIA. For example, it includes innovation actions, flagship initiatives, research and innovation actions and coordinating and support actions. That illustrates well how the partnership has systematically created the pre-conditions for accelerating development and diffusion of innovations. According to the SRIA, the capacity and skills building activities should be integrated to all types of calls, meaning that additional support for accelerating innovations among different participants at different technology readiness levels has been foreseen.

8. Addressing the Union's economic capacities and its scientific and technological sovereignty.

The Institutionalised Partnership instrument highlights the importance of bringing together diverse research and innovation actors, across sectors and with a variety of competences spanning the whole value chains of sectors. It aspires to enhance the EU's economic capacity, by increasing the capabilities and competitiveness of European industries, and coordinating research and innovation resources in addressing common challenges. Technological sovereignty, as defined by Edler et al. (2023)29 is "the ability of a state or a federation of states to provide the technologies it deems critical for its welfare, competitive ness, and ability to act, and to be able to develop these or source them from other economic areas without one-sided structural dependency." put it "describes preserving options by developing and maintaining own capabilities and avoiding one-sided dependencies". According to the authors, there are specific steps that need to be taken to determine whether sovereignty exists or is indeed required for a specific technology:

[29] Technology sovereignty. From demand to concept (fraunhofer.de)

1. The first step is to analyse whether a technology is currently critical, meaning indispensable (or will be critical in future) and why, and to what extent access to it could be threatened by external shocks.

2. The second step is to differentiate precisely in which functional context a technology is critical, i.e., in terms of contribution to economic competitiveness, or meeting key societal needs such as in energy or healthcare, for example, or to sovereign tasks. The context can help identify if and what functional substitutes exist that can eliminate dependence on a specific technology.

3. The third step is to define the appropriate spatial-political system boundaries within which technological sovereignty should be achieved (i.e., national, European or other). The definition of the spatial-political system should be characterized by economic and political interdependences that can ensure the security of supply and can determine the degree of dependency on actors outside the system.

4. Finally, the factors needed to produce technology sovereignty should be considered involving existing own competencies and resources or the possibility to develop those if needed, and access to resources, competencies, and upstream services of third parties to secure supply. (Edler et al. 2023, p. 3)

The steps above provide a framework for assessing if technological sovereignty needs to be targeted in a particular (technological) area. The authors also provide a set of strategic recommendations highlighting that technological sovereignty is a necessary, but not sufficient condition for innovations which have wider goals as ensuring economic competitiveness and meeting society's needs. It should supplement but not replace what is required of a future-oriented innovation policy. (ibid.)

Based on the Impact Assessment of the first wave of Institutionalised Partnerships (Technopolis, 2020) the criterion was addressed rather indirectly. In the case of metrology, the latest SRIA notes that to address the challenges in energy, environment and health, new and reliable measurement technologies are needed with traceability that has to be accepted worldwide. At the heart of metrology are the (SI) and the (MRA) for global acceptance of measurements and traceability of results. Research and development in metrology are essential to support and develop the International System of Units and the Mutual Recognition Arrangement and thus to meet current and future requirements of industry, regulators, and policy makers alike. (EURAMET 2030 Strategy[30]) Considering that the areas addressed by the Metrology Partnership (energy, environment and health) are of significant importance for Europe and rather vulnerable due to external dependences as the recent Covid-19 crises and the Ukraine war have shown, research in these areas scores high in importance for European sovereignty, particularly as this also includes the development of a sustainable metrology infrastructure, and contributing significantly to global metrology and the setting of the future international metrology agenda.

The specific criterion was also discussed at the workshop. When asked about ways to apply the specific criterion the workshop participants noted technological sovereignty is important in areas of European strategic importance such digital infrastructures or Greek technologies.

[30] EURAMET_2030_Strategy.pdf

Addressing sovereignty means securing whole supply chains, while partnerships may only be covering parts of them. in relation to how sovereignty can be analysed, the workshop participants suggested:

- Monitoring of patents, publications, infrastructures, and production capacities in strategic technologies
- Mapping EU policy documents (covering strategic areas for EU) against private side priorities and operational models on having an impact on these policy/strategic areas.
- Monitoring the level of dependency of supply chains on the 14 industrial ecosystems
- International benchmark
- Reflect on investment in research and infrastructures globally to identify where the EU underinvests.

In relation to ways to achieve technological sovereignty participants suggested:

- Continue to support de-risking of research in breakthrough technologies reducing reliance on fossil based industrial processes, by rationalising the funding landscape and easing access to finance.
- Define political priorities and align consequent funding to address them from the whole value chain perspective, align different types of funding, so as to cover from R&I to deployment of the technologies in a smooth, seamless way.
- Steer development of key pilot projects that support the relevant value chains.
- Develop Regulations, Codes and Standards fit for Europe.
- Support strategic funding in R&I in the addressed areas of each partnership, across all TRLs.
- Try to find incentive mechanisms to align public interest with EU companies R&I and deployment agendas.

3.2.2. Review of Institutionalised Partnerships against internal portfolio analysis dimensions

1. Monitoring and evaluation of the partnership

The legal basis for all types of partnerships prescribes the requirements for the evaluation and monitoring that the partnerships should meet. These relate both to the context of Horizon Europe (mid-term not later than 2025 and final evaluation not later than 2030), as well as the individual partnerships that need to develop their own KPIs and monitoring and evaluation systems. In addition, all partnerships should develop “a clear life-cycle approach, be limited in time and include the conditions for phasing-out the funding under Horizon Europe. To that end, evaluations should assess the relevance and coherence of any possible renewal”. (Council Decision…) Institutionalised Partnerships are to be monitoring their activities and report on their progress on an annual basis.

The legal basis also prescribes the evaluation questions to be addressed including added value, effectiveness, efficiency, openness and transparency, the relevance of the activities pursued, including in industry and by SMEs, and their consistency and complementarity with relevant regional, national, and Union policies, including synergies with other parts of Horizon Europe, such as other partnerships, missions, clusters, thematic or specific programmes.

Addressing this criterion means assessing the level to which the partnership has developed the mechanisms, the structures and the system that is necessary for the monitoring and evaluation of the inputs, the activities, and the associated results and impacts along the specific evaluation questions. This would refer to the identification of partnership specific KPIs, the definition of the partnership specific impact pathways (PSIPs) as advised by the Expert Group, and appropriate data collection and analysis tools and methods.

2. Trust building and stakeholder inclusivity

As specified earlier, some of the key drivers of trust building in an international partnership include openness, transparency, loyalty, and a willingness to understand and address the needs of the other partners. These conditions can be assessed by examining the presence and quality of operation of certain structures and governance mechanisms. The way decisions are made, and the fairness reflected in the procedures are critical in building trust among those involved. The various bodies engaging the different stakeholders and the role/power they are assigned are also indicative of the openness and inclusivity of a partnership.

In the Institutionalised Partnerships examined, there are increased efforts to achieve broad engagement of stakeholders through the existence of steering committees, or stakeholders' advisory boards, or stakeholders' groups (open to all public and private stakeholders), key stakeholders' integration to the partnership's governance model, etc. This dimension is also reflected and measured through specific KPIs that help to adjust the interaction and/or direct collaboration with end-users, regulators, payers, and relevant European Research Infrastructures.

Decision-making is usually based on majority voting while the voting rights are usually equally spread rather than reflecting the levels of investments of countries or funding agencies. Means of assessing the level of trust and satisfaction among the partnership members may take the form of surveys. Inclusivity may be assessed by examining the types and origins of the partnership members, as well as intentions for expansion.

3. Agility, flexibility, organizational skills, and ever-changing business environment

Political changes, wild wars as wars or natural disasters or new types of challenges (e.g. pandemics) have affected the partnerships in the past. The increasing uncertainty about what will happen next or what the long-term impacts will be of these shocks on European societies is another condition that requires increased agility, flexibility, and adaptation in any long-term endeavour.

This criterion can be addressed by studying the governance structures of the partnerships and in particular how agile and flexible they can be in their organisation to respond to crises and changes in the wider environment.

The new Horizon Europe Partnerships are larger in scope and ambitions than their predecessors. The overall feeling of the members is that they are rather complicated to run and require large administrative efforts. This may limit the ability to be agile and flexible in their organisational format. However, it is possible to accommodate changes in the content as different needs arise by having steering groups or other advisory bodies that can alert about forthcoming changes in the research topics addressed. In the ex-ante Impact Assessment study by Technopolis, the idea of flexibility in responding to diverse research needs as they arise was highly stressed and the Institutionalised Partnerships as well as Co-programmed partnerships were expected to be the most suited formats to deploy (strategic)

flexibility, by redirecting SRIAs or making changes at the level of composition. One enabling factor to flexibility is also the high engagement of different (types) of stakeholders who are able to support with the expert knowledge to cope with uncertainties and emerging crisis.

As a case in point, although less prominently featuring in the impact assessment itself, the Steering Group of the Metrology Partnership is an advisory body that provides advice on the emerging technologies, innovations, markets, and industrial applications where metrology research and innovation could become relevant in the future, and on the overall priorities for its future work programmes.

Similar provisions feature in other Institutionalised Partnerships with Advisory Boards and implementation of public consultations. The critical importance of collaborative R&I is widely acknowledged to respond rapidly to emerging threats, as well as of the strategic value of public-private partnerships. However, more concrete measures of how this is tackled are not specified. The levels of agility are rather more visible when measured ex post. Discussions from the Institutionalised Partnership workshop provided inputs on how to tackle various dimensions of flexibility. The participants suggested that flexibility could be measured ex-post through various KPIs. For ex-ante measures, the governance of the Institutionalised Partnership is an area to examine and if/how agility is promoted compared to other type of partnerships. Considering the questions/concerns of the partnership stakeholders (MS, scientific community, businesses, etc.) in making changes was also suggested as a measure of the partnership's flexibility and how their suggestions are considered.

Overall, based on a confrontation of the impact assessments with this criterion (see figure 5 above, as well as Annex 2 for the basic content), 12 out of 13 impact assessments clearly put strategic flexibility, either at the level of redirecting resources and priorities (e.g., ECDTP), as well as partnership composition (e.g., SESAR) or governance/management (e.g., Clean Aviation), to the forefront.

4. The level of sunk costs if the partnership is abandoned.

Assessing the level of sunk costs is not as straightforward, but there are several ways one can estimate the value of a partnership. Reference can be made for instance to the impact achieved by the predecessor partnership, or the impact achieved by the time the discussion about winding down starts. This way of addressing the sunk costs assumes that the impacts achieved may be disrupted / lost if the partnership is abandoned. In several impact assessments, both explicit and implicit references to sunk costs are mentioned, such as advantages of building further on previous experience, the risk of a possible loss of expertise (EDCTP) or the creation of networks that avoids a 'cliff-edge' at the end of the partnership (Metrology).

In the case of the European Metrology Partnership, for instance, the predecessor initiatives have brought the national metrology institutes, the National Metrological Institutes (NMIs) and (Designated Institutes) (DIs), much closer together and have been very successful at coordinating research activities. Before these initiatives it was estimated that no more than 5% of research was conducted collaboratively amongst NMI/DIs. Now around 25% of national research budgets are aligned via the partnership. Country participation is broad with 28 participants (23 Member States and five non-Member States) and increasing links with the research base and measurement users in the industrial, standards and policymaking communities have improved and continue to grow. In addition, the European initiative played a key role in coordinating the European research that made a significant contribution to the recent internationally agreed redefinition of the seven measurement base units. (Staff Working Document)

In case of IHI a reference is to the overall expenditure on healthcare in EU (10% GDP, out of which 7% is public sector spending) translating into a challenge of the long-term sustainability of EU healthcare systems, which are under increasing fiscal and organisational pressure. Furthermore, Close to €5 billion has been committed to the two preceding initiatives between 2008 and 2020, making it one of the world's largest public-private partnerships (PPPs) to accelerate drug development.

The Circular Bio-based Europe Partnership has also a long history and is well established . In addition, it is well aligned with FP calls and European level thematic policies/initiatives. In case it would be abandoned, it would leave a significant cap to the European Research Area. It is stated by the partnership's SRIA that the impact of this partnership to European Research Area has been significant, as the structuring effect in organising the value chain across sectors has been very high and the innovation-driven mobilising effect of key stakeholders across sectors and across geographical areas has been significant. There is nothing analogous existing on EU R&I landscape for the bio-economy sector.

Besides quantifiable sunk costs, it is important to also assess elements of the partnerships that will be reduced or abandoned such as networks of knowledge, social capital, infrastructures/labs, etc. Although, the social capital and collaboration created may not disappear the costs of disruption or of changing into another format or shape need to be estimated. Overall, both a quantitative and qualitative (strategic) approach is needed in assessing this criterion.

5. Number of synergies between partnerships and between partnerships and other EU programs

Synergies play a more significant role than in the past. The legal basis explicitly suggests that European partnerships should establish synergies within the partnership portfolio as well as with other EU instruments such as Missions and different funding schemes like Cohesion Policy funds, RRFs, etc.

In the case of the European Metrology Partnership, for instance, the Council Decision prescribes that "Close collaboration, complementarity and synergies with other relevant programmes and initiatives at Union, national and regional level, including with the European Research Council and the European Innovation Council and in particular with other European Partnerships, will be key in fostering the innovation pipeline and research in other areas, achieving greater impact and ensuring that the results are used in all relevant areas where technological development is linked with metrology, such as digitalisation, artificial intelligence, energy, smart health, climate, autonomous traffic and the circular economy." (Council Decision)

The partnerships and other initiatives targeted to create synergies with (e.g., EU Missions) are also mentioned in the partnerships' proposals, while the SRIAs may also include suggestions in relation to the topic, specific Cluster of Horizon Europe. In addition, the Impact Assessment study by Technopolis specifies which are the instruments that Institutionalised Partnerships may collaborate with, while also making the distinction between 'vertical' and 'horizontal' nature of partnerships. In this distinction we may assume that the 'horizontal' ones may be prone to stronger or wider synergies than the 'vertical' ones. In the metrology case, which is an area with a variety of application areas, synergies are to be supported through the European Metrology Networks (EMNs), which will provide specialist 'nodes' for specific technical fields and applications. The climate and environment focused networks can interact and collaborate with the Climate, Energy and Transport Cluster in Pillar II, the health-focused networks with the Health Cluster and so on - with a particular focus on other Institutionalised

Partnerships as they provide access points to a wider community within their thematic coverage (Technopolis Impact Assessment). E.g., for rail the impact assessment explicitly refers to its predecessor S2R JU as having insufficiently exploited synergies, "in particular in view of application of key technologies such as digital across the transport sector and more broadly". Likewise, the lack of cross-modal perspective across the four prospective Art. 187 partnerships dealing with transport was mentioned.

In the case of the KDT partnership, the Impact Assessment by Technopolis clearly specifies that the KDT initiative can benefit from, and contribute to, other initiatives targeting the user sectors. Among them, priority is coordination with other envisaged partnerships targeting enabling technologies, i.e., the Digital cluster (EuroHPC, and Smart Networks and Services), Photonics, AI, data, robotics, Global competitive space system and Made in Europe (MiE), together with the EIT Digital which will contribute to the development of skills and the boosting of the digital entrepreneurship. In addition, synergies with partnerships targeting application areas and other EIT KICs needs to be explored and cultivated.

Although intentions are strong, the descriptions of more concrete actions on how to create synergies or specific types of collaborations to develop are not as clearly defined. This may be explained by the fact that many partnerships and missions are new (in their scope and/or configuration) thus making more specific commitments to synergies difficult. This is confirmed by examples of partnerships, which are in their third consecutive period, such as Clean Aviation. Clean Aviation has clearly established concrete and quantitative targets related at both internal and external synergies (see e.g., the Partnership fiche in the BMR 2022). One would expect that (since the SRIAs are living documents) this will be updated and translated into more tangible activities and commitments at later stages. In addition, concrete examples of synergies among partnerships and other instruments are lacking or only now emerging. Sharing good practices is important to allow progress in this criterion.

6. The level of diversification of partnerships in the portfolio (versus more "focused")

This criterion may refer to both an individual partnership as well as the portfolio of partnerships possibly belonging to the same cluster. In any case, the level of 'accepted' diversification needs to be defined drawing on the relevant thematic expertise. Within an individual partnership, diversification may be reflected in the ways a particular topic is addressed, the level of multi-disciplinarity of the research approach, as well as the diversity in the types of activities designed.

In the case of a portfolio of partnerships in a given area/cluster, the idea behind this is to look at the full portfolio and to see whether it is too diversified and/or whether more focus is needed in terms of topics and areas addressed in the cluster. The level of synergies among the different partnerships also plays a role here as well as how 'vertical' or 'horizontal' the nature of a partnership is. In some cases, also the need for 'balance' in the portfolio is mentioned (CBBE), also in relation to flexibility in response to changing environments.

Based on the review of the Institutionalised Partnership available documentation, in the case of Metrology research is highly diversified by default. This is acknowledged and built upon in all documents supporting the setup of the partnership. The focus areas (energy, environment, and health) are broadly defined, thus allowing a number of different directions in call topics. There are also eleven European Metrology Networks (in Advanced Manufacturing, Climate and Ocean Observation, Energy Gases, Mathematics and Statistics, Pollution Monitoring, Quantum Technologies, Radiation Protection, Safe and Sustainable Food, Smart Electricity Grids, Smart Specialisation in Northern Europe, and Traceability in Laboratory Medicine). The networks will analyse the European and global metrology needs and address these

needs in a coordinated manner by formulating common metrology strategies including aspects such as research, infrastructure, knowledge transfer and services.

In the case of IHI, a "portfolio approach where project deliverables contribute to a subsequent integrated health solution" is explicitly recommended, as well "to integrate currently disparate technologies".

In the EDCTP partnership impact assessment, the portfolio funding model is mentioned as feature relevant to the partnership, in order to *"more rapidly switch resources over to more promising parts of the portfolio, diversifying risk and decreasing the likelihood of failure"*. This also shows the linkages of portfolio approaches as a support for strategic flexibility and risk reduction. Institutional partnerships are also expected to manage portfolio's in a more performant way than other instruments e.g., HPC's direct management of investments should "allow for stronger oversight of its project portfolio than would be possible with other options".

7. Scale of the partnership cf. minimum threshold (whether the scale of the partnership matches the ambitions)

This criterion draws on the ambitions and the consequent commitments made by the partnership members. The relevant information is included in the proposals and is to be monitored on a regular basis through the lifetime of the partnership. Baselines are key for the specific criterion. These can draw on the achievements of the predecessor partnerships or be set anew in the case of new partnerships.

In the case of metrology, the new partnership will extend its membership and links to direct users (national European policy communities, industries, and other relevant national or international bodies). While the predecessor, EMPIR has achieved an investment of €423.6 million, the new partnership will be co-funded by participating states (including nearly all EU Member States) and the EU with an expected budget of over €660 million.

For IHI the expected commitment is up to €1.2 billion provided by the European Union (from the Horizon Europe Health Cluster) and at least €1.0 billion provided by the member industry associations, plus up to €200 million from Contributing Partners. When compared with the commitments to previous programmes, this engagement seems relatively stable. In the case of IHI, scale and size are also linked to faster "pull through" of innovations (cf. market readiness below).

Other partnership impact assessments putting scale at the forefront as one of the criteria considered are KDT (its predecessor ECSEL JU having been able to support large-scale projects up to €100 million), SNS (large-scale pilots), Clean Aviation (limited amount of companies of sufficient size and capability to carry large risk-sharing projects), Clean Hydrogen (scale needed to improve the whole value chain), CCAM (Safe and Automated Road Transport) (Large scale demonstration needed and critical mass creation for the developed solutions), CBBE (the need for large installations) and Innovative SMEs (larger-scale directionality).

8. Market readiness

Uptake of innovation has been a significant consideration in the partnerships, both the new (Horizon Europe) and old (Horizon 2020) ones, although to a larger extent in the cases where businesses play a key role in driving the partnership (e.g., currently some Co-programmed and Institutionalised ones). This criterion can draw upon the level and type of involvement of

the private sector both in the governance structures of the partnership and as beneficiaries of the partnership activities/actions.

The uptake of innovations in the form of new projects/services/demonstrators/prototypes, etc. may not be that evident in the case of some partnerships. However, other ways of assessment are also possible. For instance, previous reports assessing the impact of metrology research in health, energy, environment, and industry have quantified the projected value of the tools and instruments developed by the partnership to €352.8 million.

Even for public-private initiatives like IHI the market readiness may not be considered as the main initial goal since the partnership fosters “translational research” and thus is not necessarily market-oriented. Yet, not delivering "products” as the main goal is also depending on what is being considered as “product”. When looking at the IHI set of KPIs it is expected that the partnership will deliver a number of tools (diagnosis, prediction, biomarkers, patients-stratification, etc.) but fosters rather proofs of concept TRLs. This can be explained by the fact that the partnership addresses the pre-competitive space to gather multiple industry partners in different projects of common interest.

Overall, based on the impact assessments, 11 out of 13 assessments (see figure 5) explicitly bring forward various elements contributing to market readiness, such end user involvement or outright co-creation, speed of user adoption, focus on higher TRLs or faster evolution through the TRLs, commercialization strategies and risks (e.g., through the need for standards and adapted regulation).

Some European Partnerships like Circular Bio-based Europe have included into their portfolio calls dedicated close to market solutions, e.g., the flagship initiatives. In Circular bio-based Europe partnership there are different types of calls planned: CSA, IA, RIA + flagships. The flagships are according to the partnership’s SRIA an important and specific type of IA which aim to support the first application/deployment in the EU market of an innovation that has already been demonstrated but not yet applied/deployed in the EU market (first-of-a-kind innovation).

Overall, based on the review of the available documentation of the Institutionalised Partnerships, the criteria referring to the internal portfolio management of the partnerships are either addressed with a variety of interpretations or with insufficient detail or inadequately. Naturally, a more detailed examination of each partnership complemented by interviews and relevant surveys, etc. would most possibly bring to light more evidence to assess the criteria specified above. The suggestion of methods on how to operationalise the internal portfolio management criteria and the prioritisation of certain criteria over others in section 2.2 may prove useful for the partnerships in implementing them, while the detailed discussions around them can help achieve shared understanding. Annex 2 also provides first concrete suggestions of indicators to adequately assess the criteria, in particular related to market readiness and uptake.

4. Concluding remarks

4.1. The use of the developed methodology

It is important to emphasise that the methodology described and illustrated in this report is not yet fully developed in all detail. Hence, the **use of the methodology requires a preparative step** in which the remaining details are identified and fixed. This refers to the definition, grouping, and selection of relevant Forward-Looking Issues, Groups of Forward-Looking Issues, Technologies, and Technology areas, possibly also a more detailed definition of Megatrends, should that be deemed necessary. This step will benefit from close collaboration with the Megatrends Hub and the Common R&I Strategy and Foresight service of the EC producing numerous resources on emerging issues and research areas that require attention. This step also refers to the identification and definition of possible further portfolio analysis dimensions, clarification, and operationalisation of the legal basis criteria, as well as the selection and sufficiently detailed definition of the relevant characteristics of the challenges and/or opportunities (related to the selected Forward-Looking Issues), which can be used for assessing what policy action and thereby instrument is the best available one.

This preparative step in which the development of the methodology is finalised **should be interactive and engage** representatives of relevant European R&D and innovation stakeholders, as well as the eventual decision makers. This is so that the eventual selections and definitions can be understandable, acceptable, and without unjustified biases, thus allowing as objective and systematic analysis/assessment as possible.

The methodology also requires further **input from the eventual decision makers** using it. They need to go through a process in which all relevant political priorities are ranked and prioritised against each other. This will allow the **ranking** of relevant Megatrends and Forward-Looking Issues, and if necessary, also technologies, e.g., should considerations such as technological sovereignty in specific areas prove to be high on the priority list without being directly linked to specific Forward-Looking Issues or Megatrends. A similar process should also be conducted for ranking of legal basis criteria and portfolio dimensions. This will allow the full implementation of the portfolio analysis/assessment.

The actual analysis/assessment of the current portfolio of European Partnerships and how it could be further improved to ensure even stronger socio-economic, environmental, and other desired policy impacts should be conducted **independently through a transparent process**. Transparency refers to the need to keep all stakeholders sufficiently informed throughout the process of what is being done and how, and eventually once the analysis/assessment is completed, it is accompanied with sufficiently detailed descriptions of the outcome and how it was achieved. This will allow all eventual decisions to be supported by accessible and understandable evidence and its transparent analysis/assessment. Should decision makers eventually end up making decisions that deviate from what the assessment/analysis suggests, transparency should ensure that they need to provide sufficient arguments for doing so.

Finally, the methodology developed and outlined in this report **may provide only part of the evidence base needed** to make the eventual decisions on how to further improve the portfolio of European Partnerships. Relying on this methodology alone might lead into biased evidence base and thereby wrong decisions, especially if the preparative step is skipped or strongly influenced by invested interests, or e.g., the actual analysis/assessment is not done independently. It is therefore important to **integrate the use of this methodology** – together

with possible other decision support methodologies – into the existing decision-making processes.

There are several stages within the various decision-making processes in which the developed methodology can be used:

- Identifying potential areas where new Partnerships (or Missions or other similar policy initiatives centred around pooling European R&D and innovation competences, funding, and other resources together to achieve bigger impacts or impacts not possible to achieve otherwise) might be launched. This could be conducted before or parallel to the process in which ideas for new partnerships are collected and developed.

- Analysing/assessing new Partnership proposals against the multidimensional landscape of political priorities and assessing how they would complement and strengthen the existing portfolio (e.g., filling in identified gaps, increase overcrowding, etc.). This could be conducted during or right after shortlisting the most potential proposals for new partnerships.

- Analysing/assessing how the existing portfolio of Partnerships (and possible other similar initiatives) is aligned with the changes in the multidimensional landscape of political priorities. This could be conducted periodically as part of the process preparing evidence for strategic planning and decision making regarding the Partnership portfolio (or more widely the Framework programme).

- Supporting the analysis/assessment of the portfolio of existing Partnerships in view of strengthening it through redesign, i.e., where to allocate more resources, where to scale down resources, where to redirect activities, where to merge activities, where to diversify, where to introduce new modalities, etc. This could be conducted periodically as part of the process preparing evidence for strategic planning and decision making regarding the Partnership portfolio (or more widely the Framework programme). This could also be done as part of an evaluation exercise.

- Some parts of the methodology may also be used in connection with periodical monitoring, specifically in preparing the Biennial Monitoring Reports of European Partnerships.

There is one further issue that needs to be taken into consideration when using the developed methodology. That is the possible **bias due to the intentional emphasis on Technologies** over other types of knowledge and competences. Indications of this bias can be seen e.g., in the perceived higher relevance and importance of Forward-Looking Issues and Megatrends in which technologies are applied rather than developed (ref. survey results). The data collected during the work, as well as the evidence from proposals, SRIA, and other documented information would also indicate that if there is such a bias towards technologies, this bias already exists strong in the current portfolio of European Partnerships. This may be due to earlier decisions to aim for integration of e.g., social sciences and humanities into more technologically oriented R&D and innovation activities rather than pursuing their development in dedicated programmes or partnerships. If there is a need to eliminate this possible bias, the concept of Technologies could possibly be replaced with a wider concept of Knowledge and Competences.

4.2. Further development of the proposed methodology

Identification of future trends and emerging technology areas plays a prominent role in the EU policy development process. It is natural, that this methodology should be also embarked in the process of assessing the landscape of European Partnerships. The proposed methodology could be implemented in the future for the purpose of continued monitoring of evolution of interest of individual or groups of Partnerships on the "technology landscape" identified in forward-looking studies, as well as for the purpose of identification of potential overlaps or gaps in existing Partnership portfolio.

There are two the most important elements, which could help to make this task actionable in efficient and effective manner, without creating unnecessary burden for the Partnerships and providing timely and reliable input for policy decisions:

1. Automatization of a review process with use of modern big data and language processing mechanisms present expert process of reviewing and assessing of forward-looking reports could be automatize. It should allow for permanent scanning of the internet for relevant research publications, patents documentations, reports, studies, and policy documents for identification of megatrends, forward-looking issues and related technologies. An 'artificial intelligence" tool should be also able to recognize links between mentioned elements and its relations with present or future policy objectives.

2. More advanced survey to collect Partnership feedback. As an extension of the survey implemented for this present study a more advanced solution should be developed to allow Partnerships not only confirm relevant megatrends, forward-looking issues and technologies, but also define links between mentioned elements. It will create a symmetric data set to obtain from a review of forward-looking reports and allow for more in-depth analysis and tracing of real connections between elements of interest.

3. Data management and visualisation dashboard for effective use of automatically collected data from the review of forward-looking document and the Partnership survey a dashboard type tool should be developed. It should allow to define a type of data, target group of Partnerships, type of elements for consideration, different dimensions of possible analysis and simplify the process of analysis and generation of visual representation of results.

Developing a portfolio analysis method to support decision-making from the vantage point of the European Commission in the context of the development of European Partnerships proves particularly challenging due to important divergences in terms of underlying rationales as well as different types of instruments (in contrast to traditional R&D portfolio analysis frameworks or portfolio management in general).

Therefore, several aspects may need to be further developed based on this initial, exploratory approach:

5. Developing the appropriate sets and dimensions to be used to define relevant sub-portfolios: in this analysis, all relevant dimensions to subdivide the full set have been inventoried and could provide a solid basis for further discussion, leading to an accepted set of meaningful sub-portfolios.

6. Linking the relevant dimensions to the diverse sub-portfolios: as we highlighted, not all dimensions (and associated indicators to operationalize the methodology) may prove to have the same relevance (or weight) depending on the sub-portfolio considered.

7. Based on the dimensions for different sub-portfolios put forward, selecting the appropriate combinations of dimensions to provide insights into partnership performance from a portfolio perspective.

8. Developing harmonized approaches to measure performance on the portfolio dimensions in order to position partnerships against each other within the portfolio or different sub-portfolios.

9. Developing policy recommendations based on obtained results from the sub-portfolio analysis, i.e., develop the linkages between positions in the (sub)portfolio and the policy recommendations that are resulting from a position.

Notwithstanding the fact that a full-fledged portfolio analysis methodology and its operationalisation, given the resources available for this assignment, lies beyond the work performed in this initial, explorative analysis, the analysis provides ground to assess more prominently the following elements when decision-making processes around new or existing partnerships take place:

- The degree of (strategic) flexibility and agility, both at the level of resource allocation, decisions within the partnership as well as composition of the partnership.
- Internal (i.e., within the portfolio) and external synergies (i.e., other EU programs as well as national and global programs).
- Market readiness as defined by uptake of innovation and private sector crowding in (note that for some partnerships this is less relevant)
- TRL evolution over the lifecycle
- Amount of IP generation

Finally, while only considered as medium priority, our analysis points to the dimension of sunk costs / irreversibility as an important element for which appropriate methodologies, both qualitative and quantitative, have to be developed in terms of resource allocations. This also resonates from the increased call, both from public and private perspectives, to integrate real options reasoning into decision-making under uncertainty in volatile environments. In sum, the value of exit, or delayed investment into an R&I partnership, should be better understood and defined.

- Other information and/or elements that could be integrated to the methodology to enrich the evidence for decision making.
- Etc.

ANNEX 1

The approach used for identifying relevant European and national policy priorities, global scientific, technology, and socio-economic trends, and other dimensions

Table of contents

1. Introduction

There are many different approaches to identify future trends or emerging technologies. For the purpose of present study on identifying relevant European and national policy priorities, global scientific, technology and socio-economic trends the mix approach inspired by technology landscape approach and horizon scanning approach was developed and implemented.

1.1. Technology landscape approach

There are many different approaches to identify future trends or emerging technologies. Among them, probably the most popular and often used as an element of foresight studies or company/product strategy development is "**technology mapping**" (often called also "technology roadmapping"). Similar, but dedicated more to the identification of wider technology areas is the "**technology landscape**" approach. "The technology landscape map is different from traditional technology or product roadmaps that describe major milestones in internal technology development to meet defined needs for new products[31]. Rather, technology landscape maps describe a wider territory, depicting the status of both internal and external technologies independently of internally defined needs. As Paap[32] points out, information from a technology landscape can be used not only to inform sourcing, but also to guide ideation and technology strategy."[33]

In academic papers[34], but also in business practices, there are several different forms/types of technology mapping based on purpose, format and use. Furthermore, technology maps can be shown in different forms. Those forms depend on the purpose of the roadmap. The most common one is the time-based chart which mostly includes commercial and technological perspectives, along with the linkages of any other related perspectives. The benefit of technology roadmaps is to have a time-based structured framework to develop, show and communicate strategic plans.

In a given context, a decision needs to be taken on the dimensions which will be used to draw a technology map (landscape). Usually, one dimension is clearly related to time. It could be expressed for each identified technology by 'time-to -the market", or the

---

[31] Based on reviews like Phaal, Farrukh and Probert (2004) 'Technology roadmapping — A planning framework for evolutionand revolution', Technological Forecasting and Social Change, 71(1–2), pp. 5–26; and Technology Mapping: Definitions, Types, and Applications. Available from: https://www.researchgate.net/publication/340266926_Technology_Mapping_Definitions_Types_and_Applications.

[32] Paap, J. E. 2010. Technology Scouting to Accelerate Innovation. Management Roundtable Executive Workshop, April 27–28, Cambridge, MA.

[33] Irene Spitsberg, Sudhir Brahmandam, Michael J. Verti & George W. Coulston (2013) Technology Landscape Mapping: At the Heart of Open Innovation, Research-Technology Management, 56:4, 27-35, https://www.tandfonline.com/doi/abs/10.5437/08956308X5604107

[34] Based on reviews like Phaal, Farrukh and Probert (2004) 'Technology roadmapping—A planning framework for evolutionand revolution', Technological Forecasting and Social Change, 71(1–2), pp. 5–26; and Technology Mapping: Definitions, Types, and Applications. Available from: https://www.researchgate.net/publication/340266926_Technology_Mapping_Definitions_Types_and_Applications

Technology Readiness Level (TRL), technology maturity, rate of adoption, etc. All the above mentioned “variables” are related in fact to the expected time for full industrial deployment of the emerging technology. The other dimension is usually related to importance, risk, relevance etc. and presents a parameter/variable which is the most appropriate for the context/purpose of analysis and expresses subjective opinion of analysts (experts). Several different examples to illustrate the most relevant approaches to visualisation of technology maps and technology landscape maps are presented below.

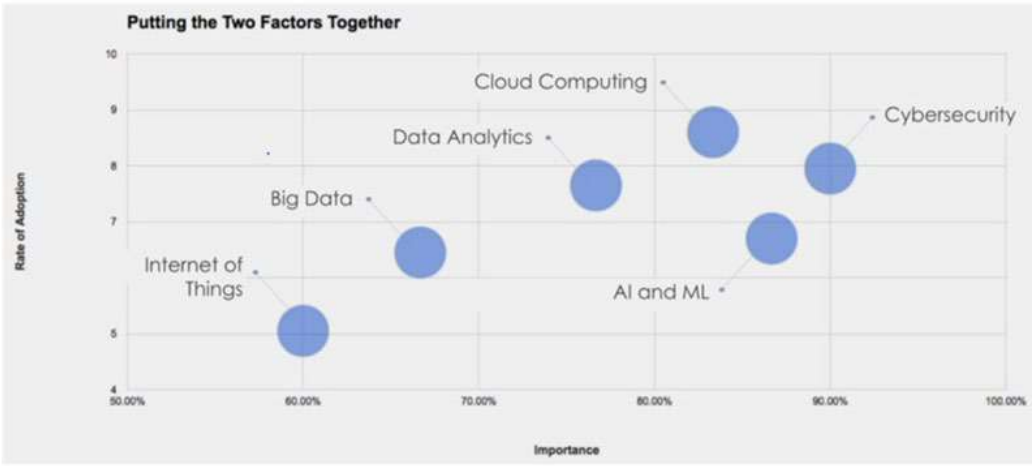


Figure A1-1. Emerging Technology Map. Source: Traction Technology Partners.

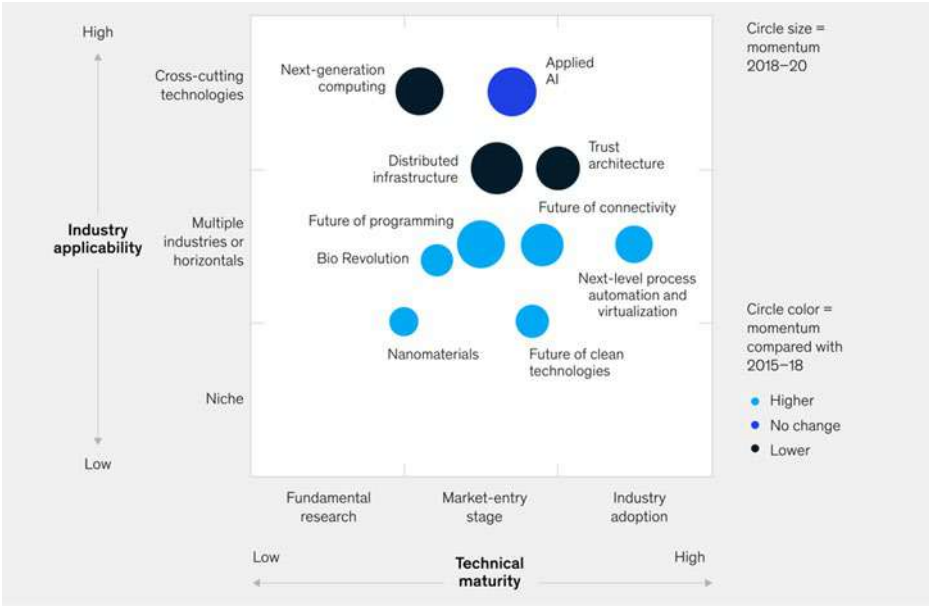


Figure A1-2. McKinsey tech trends index. Source: McKinsey.

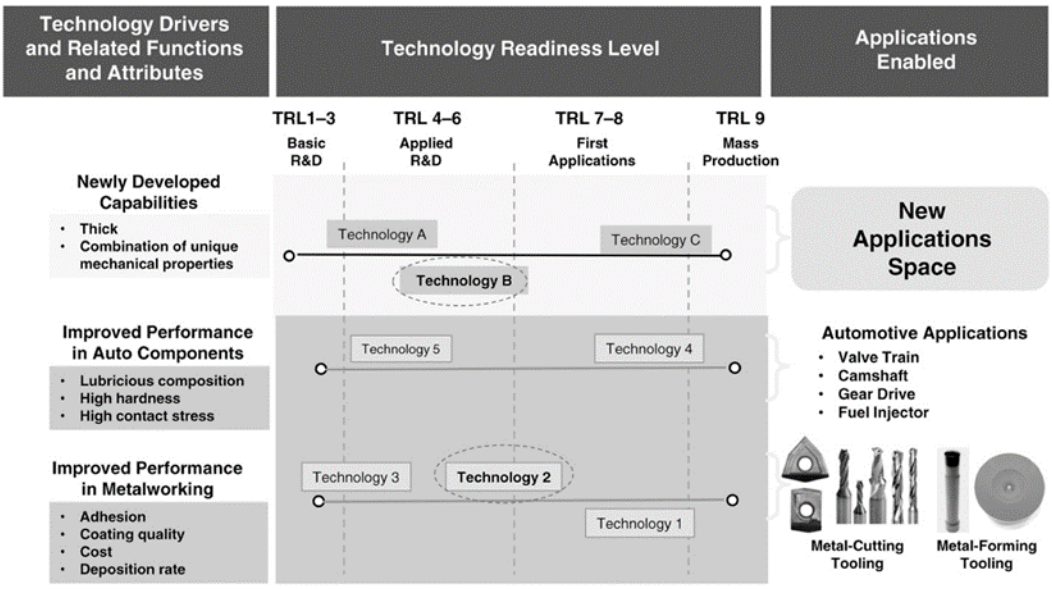


Figure A1-3. Example of a technology landscape map, based on a simplified version of a thin coatings TLM. Source: ?

Due to the nature of the study, it is impossible to focus on well defined, specific technologies, to create maps similar to those presented above. However, they inspired the interpretation and adaptation of the presented approach to the purpose of this work. **In particular, the logic and structure of the last Figure above could be translated into the current context, where the left column of "technology drivers etc." are interpreted as global trends, the middle column with technologies spanning over TRL scale could be translated as technology areas in time-to-market space, and the final right column "Application Enabled" could be interpreted as R&I areas occupied by existing or future Partnerships.** It creates a framework to capture the results of the collection and review of a number of foresight studies and other forecasts reports of future trends in a combined format.

1.2. Horizon scanning methodology

Complementing the above approach, we applied a horizon scanning methodology building on the methodology and the material produced in the framework of an expert contract to support the JRC in mapping forward-looking elements that can affect the EU long-term objectives in 2020. Horizon scanning methodologies can be exploratory or issue-specific in their approach and can include a variety of sources and scanning tools, e.g., automated, semi-automated, participatory, and less participatory.

The task assigned by the JRC to the experts was to scan available sources of information and mark the way(s) they affect/relate to the JRC megatrends and the EU policy areas (EU green deal, Economy that works for all, EU way of life, EU digital age, Strong EU in the world, EU democracy). During the scanning activity, a wide variety of documents were examined including e.g., academic papers, policy reports, posts in blogs or other sites, dedicated websites, etc. The reason for including as many different resources as this is because each source of information may provide insights about the different parts of the big picture of trends and developments both in foresight and global, societal, and technological trends. Whereas the academic papers may include novel theories, methodologies, or cases, reports from consultancy companies talk about trends, developments, weak signals, and sometimes wild cards, and thus give some early

indications of future developments. Blogs and websites often include information on technologies, new products, and markets. The advantage of the online media is that they are more up-to-date and are updated more often as their publication processes take much shorter compared to other types of publications. Finally, the policy reports and briefs talk about the position of national and regional or local governments as well as the international organizations. Therefore, all different sources of information should be analysed in a complementary way from the emergence of novel ideas to their implementation and policy implications.

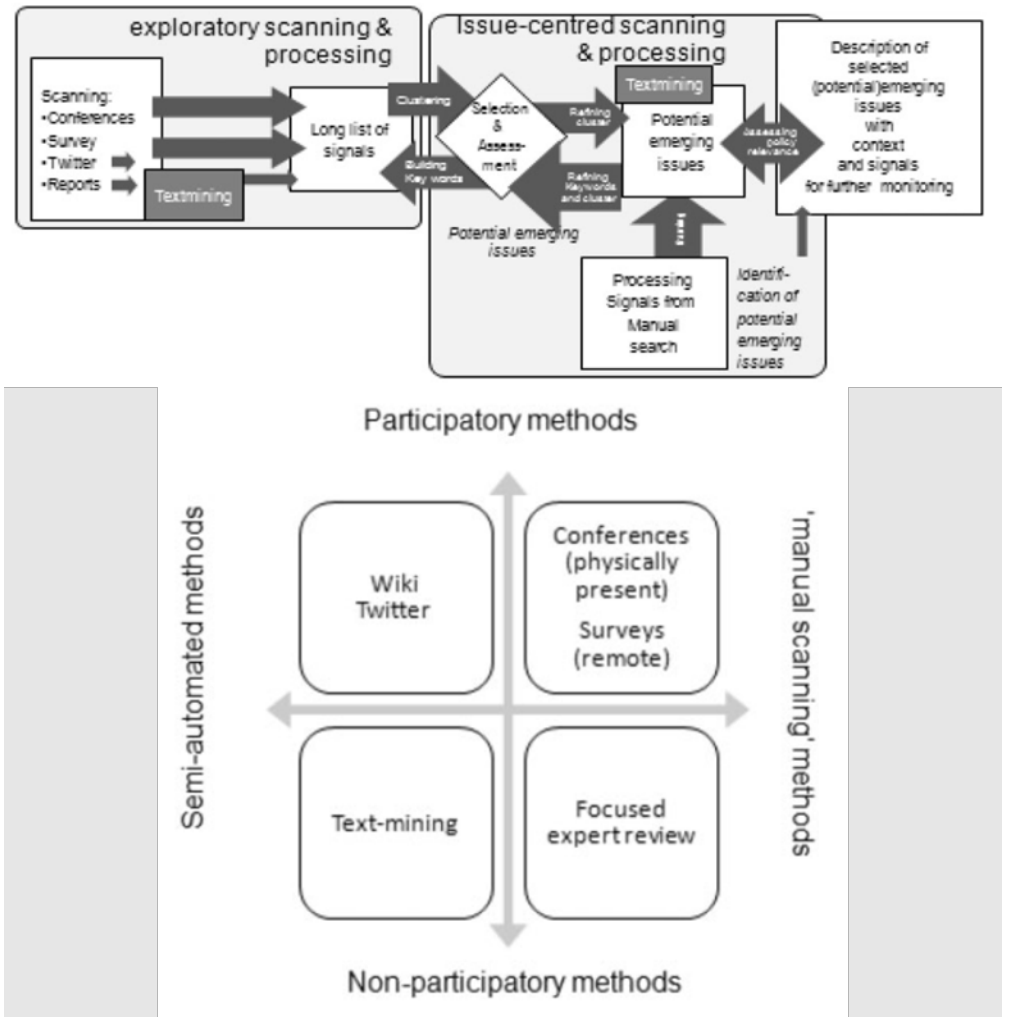


Figure A1-4. Horizon scanning methodology building on the methodology and the material produced in the framework of an expert contract to support the JRC in mapping forward-looking elements that can affect the EU long-term objectives in 2020. Source: JRC

The content of these sources of information is not the only important element to record. As Amanatidou et al. (2012) highlight it is also important to map the origin of the information as well as the target audience of the sources, which was not something that was explicitly stated. This was usually concluded from the type of the source (e.g., policy briefs target policymakers for instance) or the publisher (e.g., an international organisation like UN addresses policymakers, while a private consultancy would primarily address companies.

Selecting which sources to map was of key importance for the process and more importantly for the outcome. Sources need to be validated and usually this is done by checking the validity or reputation of publisher, i.e., sources coming from a well-known international organisation, or private entity of high reputation, or public organisation are usually selected as valid and trustworthy, albeit some degree of possible manipulation for legitimising policy decisions. In addition, there is a trade-off between validity and trying to find emerging trends that cannot be validated yet, but which may hide important weak signals or wild cards. Such information may be located in futurists blogs, social media posts, etc. Thus, a balance needs to be found between the different types of sources.

Decoding how the issues addressed in the reports analysed affected or related to the megatrends and the current EU policies required an intelligent reading/scanning of the documents and other sources of information. Yet, we need to bear in mind that this interpretation, and overall foresight intelligence, is (re)shaped by the perceptions, interests and needs of those people who are involved in the process. Given the limitations of the scanning methods (Amanatidou, et al. 2012) and the role of the human factor in creating, detecting, analysing, and interpreting emerging issues, the scanning results need to be treated with caution and cross-checked with other validating sources. (Amanatidou, et a. 2012)

Yet, as Könnölä et al. (2012) note horizon-scanning activities can collect future-oriented observations, but they can also extend to include creative and collective sense-making processes for synthesizing observations into cross-cutting challenges and also explore the policy implications of these challenges. The systematic 'bottom-up' scanning of issues and the consequent clustering and prioritization are feasible and useful even in contexts where there needs to be a shared understandings first about the prospects of cross-cutting coordination in support of systemic policy objectives.

Albeit the limitations of the process applied in the specific task, the results proved useful to build on in the framework. This is explained in the following section.

2. The approach – outline of a methodology

The approach used for the identification of relevant European and national policy priorities, global scientific, technology and socio-economic trends and other dimensions was a multi-step process with several well-defined steps.

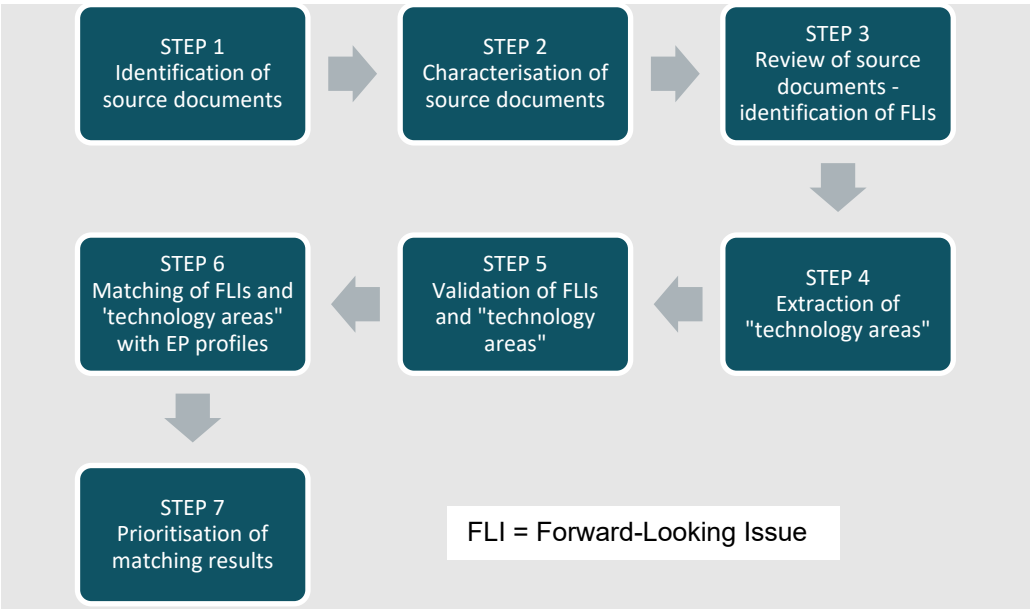


Figure A1-5. A multi-step process for the identification of relevant European and national policy priorities, global scientific, technology and socio-economic trends and other dimensions. Source: Expert Group (2023)

2.1. STEP 1 – Identification of source documents

Input:
limited sample of the most relevant, trusted or comprehensive reports of the foresight type

In traditional methodologies of technology mapping different bibliometric and patent databases analyses are used to identify emerging technologies and future trends. More modern approaches are based on data science methods and tools and more diversified sources of information are taken into consideration, including non-structured data from the Internet, social media etc.

However, given the very tight schedule and limited resources available for this task, it would not be realistic for the Expert Group to perform such an analysis. Additionally, given that the focus should expand beyond technological trends and identification of key technologies, over the area of wider socio-economic trends and challenges, a wider approach was applied in identifying and reviewing relevant sources. The implemented approach assumes, that there are many relevant analyses already performed and made public in the form of forward-looking reports, studies, and policy documents published by recognized public and private sources as well as international organisations. Indeed some 60 of these reports were reviewed by foresight experts in 2021 under an expert contract to support the JRC in mapping forward-looking elements that can affect the EU long-term objectives. Building on the findings of this task, which was explained above, and extending it to include also the most recent 13 reports, that were eventually reviewed by members of the Expert Group, we analysed a total of 76 reports that we considered the most relevant, trusted, and comprehensive reports of this type. The results are presented in a unified way.

The following list provides those documents reviewed by the Expert Group:

A. EU documents:
    a. Strategic documents:

i. Horizon Europe Strategic Plan 2021 – 2024

b. Foresight reports:

i. Strategic foresight report 2020

ii. Strategic foresight report 2021

iii. Strategic foresight report 2022

iv. Foresight newsletters

v. 14 Megatrends presented and monitored under the Megatrends Hub

vi. JRC Report: Towards green & digital Future: Key requirements for successful twin transitions in the European Union

vii. JRC Report: Shaping & securing THE EU'S OPEN STRATEGIC AUTONOMY by 2040 and beyond

B. US Government documents:

a. Global Trends 2040-Structural Forces – Technology

b. National Strategy for Critical and Emerging Technologies

c. National Strategy for Advanced Manufacturing

C. Private think-tanks or consultancy company reports:

a. McKinsey Technology Trends Outlook 2022

b. Top Strategic Technology Trends 2023

c. Deloitte Tech Trends 2023

Output:
List of selected forward-looking, foresight type of documents from STEP 1

2.2. STEP 2 – Characterisation of source documents

Input:
List of selected forward-looking, foresight type of documents

The Expert Group was given access to the results of the JRC review of forward-looking reports collected in the form of an Excel file database. In the "Collection template" worksheet each listed document from the STEP 1 was characterized by members of the Expert Group with the following parameters (fields of document record) identified:

- titles,
- web links,
- source type,
- time horizon,
- publication date,
- publisher,
- type of organisation,
- geographical coverage,

- specific countries covered,
- relation to EU policies (EU green deal, Economy that works for all, EU way of life, EU digital age, Strong EU in the world, EU democracy)

Detailed description of each column field of the “Collection template” worksheet:

A – suggested by – name of expert who suggested the document

B – mapped by – name of the assigned person who reviewed/mapped document

E – number – continues numbering of documents – it is important number as it is used for identification of the document in the next step.

F – title of the report

G – link – web link to the report – if available

H – type of report – to be selected from the dropdown list

I – time horizon

J – publication year

K – publisher

L – type of organization – to be selected from the dropdown list – there is a comment for L1 cell where codding from A to F is explained

M – geographical coverage and/or N – specific country covered – at least on of this filed should be filled in

O to T – relevance to EU policies – mark x where relevant (please be consistent with more elaborative information collected in the next STEP on the same issue).

Output:
Database (Excel “Collection template” worksheet)

2.3. STEP 3 – Review of source documents - identification of FLIs

Input:
List of selected forward-looking, foresight type of documents initially mapped in STEP 2

In the same Excel file database developed by the JRC experts, in the worksheet “revised mapping template (tran)” results of the in-depth review of the listed documents were collected. The aim of the review was to identify forward-looking issues (FLI) – policy, societal, economic, or technological topics and record which of the Global Megatrends identified by the Megatrend Hub of the EC[35], they mostly relate to and how they affect certain EU policy areas[36].

[35] The 14 Global Megatrends are listed and monitored under the Megatrend Hub run by the Knowledge4Policy (K4P), which is the EU Commission's platform for evidence-based policymaking. https://visitors-centre.jrc.ec.europa.eu/en/media/publications/megatrends-hub

[36] The EU policy areas include: EU Green Deal (Achieving climate-neutrality by 2050 and considering SDG targets, industries, circularity, biodiversity, waste and pollution, decarbonisation, food and health); Economy that works for all (social market economy, inclusion, poverty, social rights, gender, innovation, competition, employment and taxes); EU way of life

The results of the review (mapping) are collected according to the identified "forward-looking issues" (FLI) for each selected report. There might be (and usually are) much more than one FLI per reviewed document. The record of information in that worksheet (database) is a row, which starts with the name of the expert, who input data and is followed by the title of the FLI, its brief description and several other characterizations of the FLI. Filling in the following columns were obligatory:

A – expert – name of the expert who input data,

B – title of issue – please provide short title/name for identified forward-looking issue (FLI)

C – Brief description of issue – for the purpose of the study please identify here a R&I/technology areas affected/impacted or related by the identified FLI. Please be aware, that for the purpose of future analysis we need to link issue with single source (report). For technical reasons if there is similar or the same issue identified in different reports, please create a separate record (row) for it.

D – Source number 1 – provide a number from column E of the "Collection template" worksheet, which identifies revied report. Please ignore columns from E to H.

I – type of issue – select from the list (trends, wild cards, weak signal, drivers of change)

J – relevance to technology landscape map – choose yes/no from the list. This is column added for the purpose of our analysis to differentiate between FLI related and not related to R&I/technology areas.

K, L, M – Which Megatrends – select the most relevant (top 3) megatrends from defined list of 14 megatrends.

N, O, P – How it affects? – choose from the list (accelerate, diminish, disrupt, modify) how FLI affects megatrends identified in columns K, L, M.

R to W – Actual or potential policy implications – provide some short explanations in accordance to policy areas marked in the "Collection template" worksheet columns from O to T.

Output:
Database (Excel "revised mapping template (tran)" worksheet) with identified FLIs for each selected forward-looking document

2.4. STEP 4 – Extraction of "technology areas"

Input:
Database (Excel "revised mapping template (tran)" worksheet) with identified FLIs for each selected forward-looking document

---

(EU law, equality, tolerance, social fairness, migration and asylum, enlargement and Schengen Area); EU Digital Age (Shaping a digital Europe including standards, sovereignty in critical and next generation technologies including big data, AI and IoT, disruptive R&I , education, privacy, security, safety and ethics); Stronger EU in the world (including EU Open Strategic Autonomy, global leadership and standard setter, strategic alliances and partnerships such as with Africa, UK and WBC, defence and security, transparency and cooperation, climate change and labour protection, and EU resilience) EU democracy (Including participation in decision making, EU interinstitutional partnership, common approach to disinformation, and EU democracy action plan)

Based on the review of the titles of the FLIs (field B) and their brief descriptions (field C) a member of the Expert Group extracted all possible "technology / challenge areas"[37] for each FLI. There might be (and often is) more than one "technology / challenge area" for each reviewed title and brief description of an FLI. Each "technology / challenge area" must be collected in a separate cell (column) in the FLI record (row).

Output:
Database (Excel "revised mapping template (tran)" worksheet) with extracted "technology / challenge areas" for each identified FLI.

2.5. STEP 5 – Validation of FLIs and "technology areas"

Input:
Database (Excel "revised mapping template (tran)" worksheet) with extracted "technology / challenge areas" for each identified FLI.

As similar FLIs could emerge from different documents and similar, if not the same, "technology / challenge areas" could be extracted for different FLIs, the results of STEP 3 and STEP 4 had to be carefully assessed and validated to create two final lists of FLIs and "technology areas". This validation could be done by members of the Expert Group, but also external, thematic experts could be consulted to secure correct understanding and validation of terms.

Output:
List of validated FLIs and "technology / challenge areas"

2.6. STEP 6 – Matching of FLIs and 'technology / challenge areas" with European Partnership profiles.

Input:
List of validated FLIs and "technology / challenge areas"

In that STEP three lists (of the global megatrends, of forward-looking issues/challenges, and of technological areas or technologies per se), which summarize the findings from the STEP 3-5, must be confronted with the areas of coverage of existing European Partnerships. This was done through a survey prepared by the Expert Group requesting feedback from the Partnerships about which of these megatrends, technologies and issues they mostly relate to and reflect their own foci and scope. To make this possible, the Expert Group submitted for consultation the list of the 14 Global Megatrends, a list of 35 forward looking issues (aggregated from those identified in the foresight reports) and a list of 119 technologies and R&I areas.

In this Survey, the Partnerships were invited to answer the following questions:

1. Which of the following 14 Global Megatrends do you consider relevant to the types of challenges/issues your partnership is targeting? *(pick max 3 that are relevant - indicate for each whether it is of high, medium or low relevance - drop-down box with these three options for each of the megatrends picked)*

[37] the term is used to refer to all technological and non-technological areas including social and economic ones?

2. Which of the following issues/challenges does your partnership address? *(pick max 5 that are most relevant for your partnership - indicate for each whether it is of high, medium or low relevance - drop-down box with these three options for each of the issues picked)*

3. Which of the following (technological) areas does your partnership consider relevant for addressing the issue(s) previously selected? (max 15) *(pick max 15 that are most relevant for your partnership - indicate for each whether it is of high, medium or low relevance - drop-down box with these three options for each of the technologies picked)*

The survey allowed to map the results of the more "top-down" based approach defining megatrends, FLIs and "technology areas" based on the literature against the results of a more "bottom-up" self-assessment of the Partnerships. As a result, maps of the coverage of the megatrends, FLIs and emerging technology areas by the areas and technologies addressed by the Partnerships could be created. This enabled to locate the concentration of interest and led to the identification of overpopulated areas or areas that are less addressed by the present Partnership portfolio.

Output:
Matching/coverage maps of megatrends, FLIs and "technology areas"

2.7. STEP 7 – Prioritisation of matching results

Input:
Matching/coverage maps of megatrends, FLIs and "technology areas"

The "technology / challenge areas" identified as overpopulated or less addressed by the present Partnership portfolio must be prioritised against different dimensions, e.g. relevance and/or impact on the EU policies, urgency of the EU needs, level of development/integration on the EU market, maturity of technology or distance to the market. The purpose of the prioritisation is to identify the top technological / challenge areas based on the dimensions described above, which is an important input for the decision-making process on the structure of the Partnership portfolio.

Output:

Prioritisation of FLIs and "technology / challenge areas" against different dimensions

ANNEX 2

Framework for portfolio analysis of the European Partnership landscape – extensive paper with results from the literature analysis and consultation

Table of contents

1. Introduction and overall methodology

The aim was to develop a portfolio analysis methodology supporting strategic decision-making on the development and continuation of partnerships. The challenge at hand is best put forward by this quote from the ERAC (2018)[38] report: *"The current system is rather oriented towards validation of a partnership instead of selection between possible partnerships. Criteria for the other stages of the R&I partnership life cycle are often missing or not visible in a transparent manner".*

In what follows, we offer a more structured assessment on which dimensions or criteria are potentially relevant to shape a more visible and transparent approach. We start from the basic definition and uses of portfolio analysis within conventional strategic decision-making on resource-allocation in organizations, acknowledging that portfolio analysis frameworks are just one element of analysis that contributes to strategic decision-making in organisations.

In a first step, from a top-down perspective, we translate the meaning and relevance of the traditional frameworks towards the context of decision-making on European Partnerships (as a portfolio of investments, or 'business units' in a complex organization). We argue that next to a top-down perspective, a bottom-up perspective needs to add and validate ideas emanating from both the assessment of traditional portfolio literature as well as an in-depth scientific literature review of both portfolio-analysis applied to R&D and Innovation problems (including a zoom on the application of Real Options Theory or Reasoning, which has regained popularity recently given the highly volatile external environment).

This bottom-up perspective essentially took place based on a survey, a workshop as well as analysis of the SRIAs and ex-ante impact assessments performed by Technopolis. These elements allowed us to converge to a set of dimensions to be potentially deployed, as well as first insights into challenges of operationalization, which, not surprisingly, will mainly relate to the harmonization of quantitative measurement given the diverse and highly specific contexts in which EU partnerships in Research and Innovation operate. Note that the particular context of EU partnerships as a portfolio managed by a supranational government in itself is a highly specific context which has not been developed from a portfolio management perspective (and government-based portfolio approaches to R&D and Innovation programming within both scientific and grey literature are also scant).

Finally, while technology and market readiness or 'fit' are straightforward dimensions (as partnerships need to align and react to changes in the external environment, and even contribute to shape these conditions), we shifted our focus more towards "internally" oriented dimensions, which are often overlooked, such as synergies, sunk costs, strategic flexibility, trust and stakeholder management. Also, the fit with the technological environment is largely the subject of the external factors (see Chapter 2.1, and ANNEX 1).

Figure A2-1 provides a full overview of the methodology followed for developing the portfolio analysis framework.

[38] ERAC (2018) final report of the ad-hoc working group on partnerships

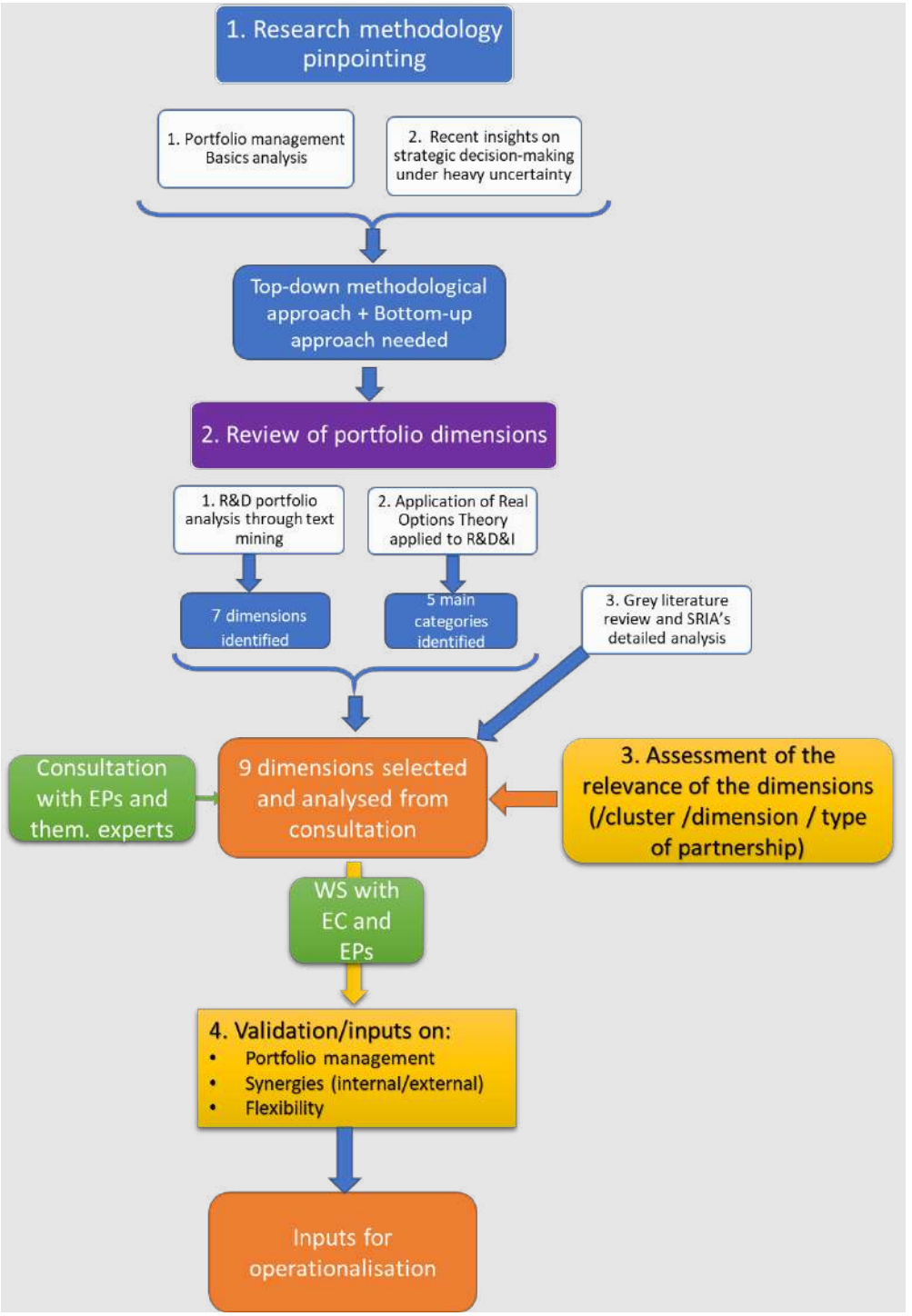


Figure A2-1. The approach for the development of the portfolio analysis framework. Source: Expert Group (2023)

1.1. Portfolio management basics

The basic idea behind (project) portfolio analysis and management stems from the corporate finance literature and was subsequently further developed within the strategic management literature to allow strategic decision-making, under uncertainty, within (larger) companies in terms of which products/services or business units would benefit from (dis)investment. Both quantitative and qualitative approaches were developed over time, with the most well-known framework being the "Boston Consulting Group" or "Growth/Share" matrix (Henderson, 1970, see also Reeves et al. (2014) for a renewed perspective), which also implicitly is linked to the lifecycle of products/business units. Typically, products/services (innovations) either start from a dog or question mark position (introduction) and if they succeed to move beyond the question mark, turn into stars (growth) which over time become mature (cash cows) to eventually become obsolete and return to dog status.

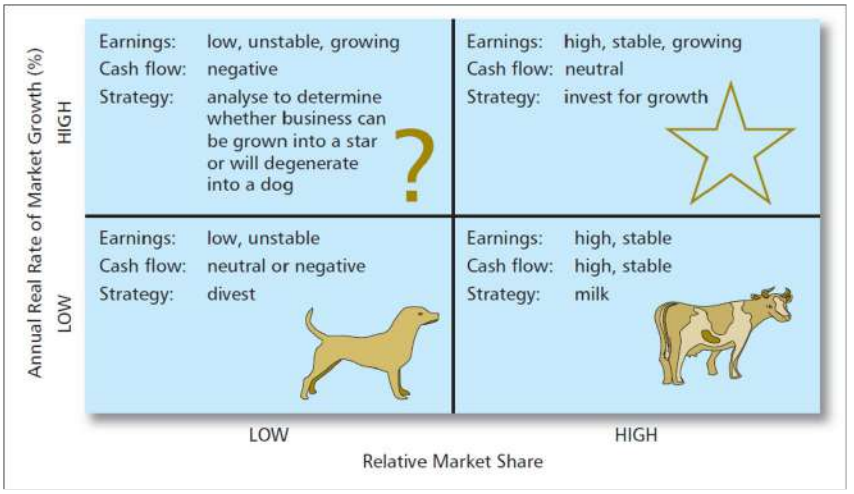


Figure A2-2. Boston Consulting Group matrix. Source: Grant & Jordan (2010)

While there are inherent, and historically documented limitations to the basic framework and traditional portfolio management in general (e.g. the predictive value is low given mainly based on historical performance data; it does not contain certain external evolutions in terms of technology or competition either), and the applicability to European Partnerships seems limited (see infra), the basic principles behind a portfolio approach towards decision-making is to provide a limited set of dimensions or criteria to position business units, products or projects towards each other within a portfolio matrix. Following the positioning, strategic decision-making can take place, or, at least, the particular portfolio framework used serves as an input into the decision-making process considering other types of analysis or elements. Note that more sophistication can be added, e.g. there have been additions of e.g. the environmental performance of products or units towards the original BCG framework (Illinitch & Schaltegger, 1995), or the integration of industry attractiveness bringing in the (external) competition aspect (e.g. the GE/McKinsey Matrix).

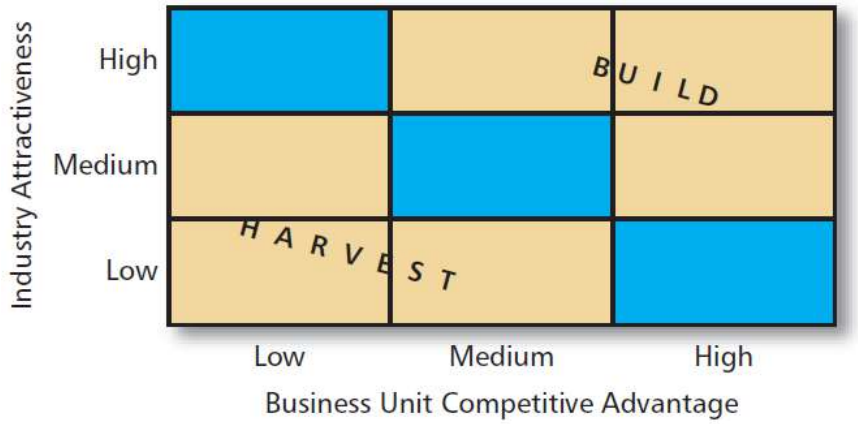


Figure A2-3. General Electric/McKinsey matrix. Source: Grant & Jordan (2010)

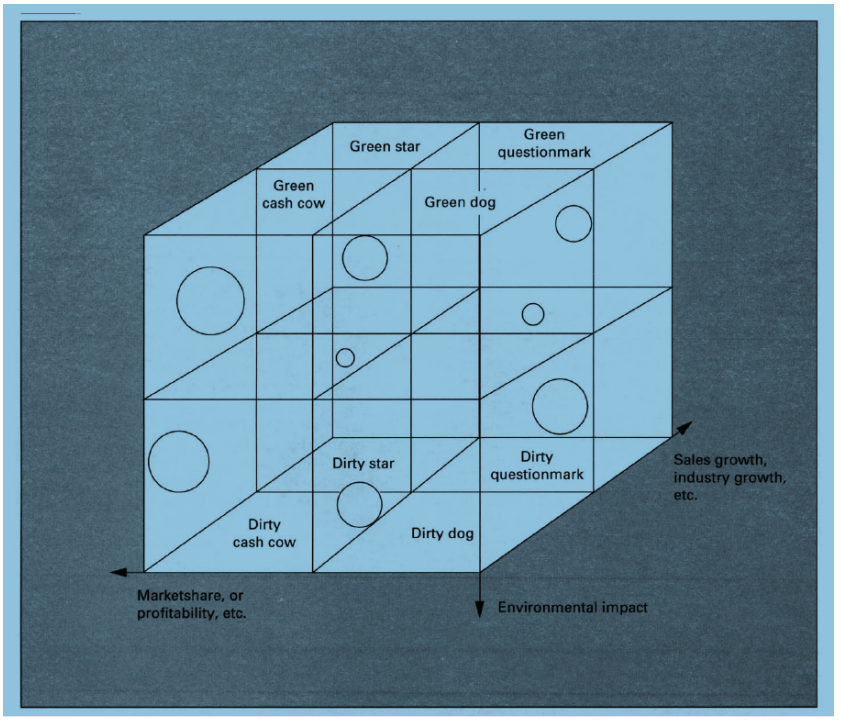


Figure A2-4. Integration of environmental performance in portfolio analysis. Source: Illinitch and Schaltegger (1995)

Many other frameworks have been developed since, also integrating more qualitative/strategic approaches, which also consider other relevant elements in terms of e.g. complementarity of the product or business unit within the entire portfolio (and not looking exclusively to individual performance excluding the impact on the entire portfolio), e.g. when the development of new units and/or acquisition is considered – thus a more 'internal' perspective (e.g. see Figure A2-5: Ashridge portfolio framework). A key element of any portfolio analysis and management framework is the availability of quality data and information to inform/determine the position of the unit of analysis (project, business unit, product, program, …) into the matrix.

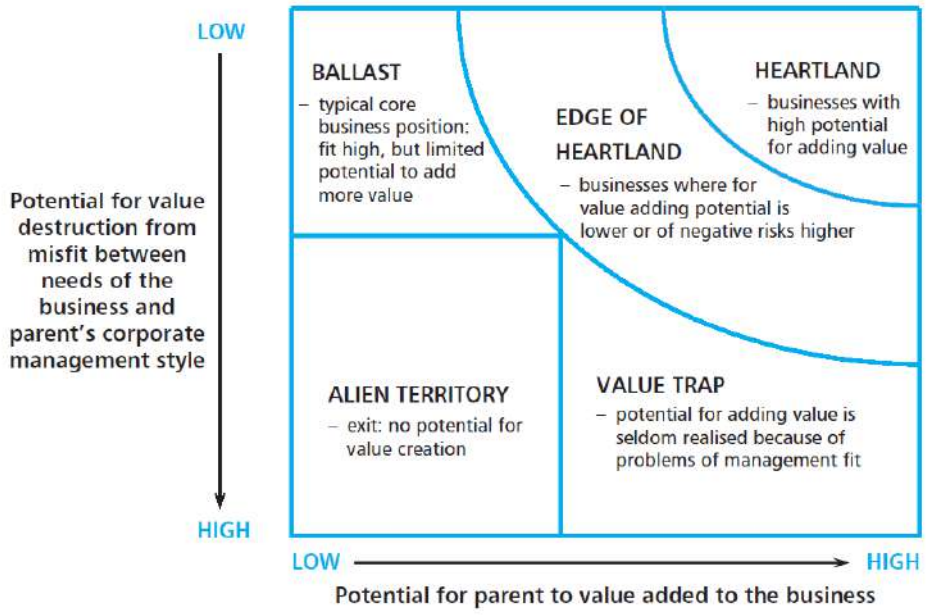


Figure A2-5. Ashridge portfolio framework. Source: Ashridge Strategic Management Centre (taken from Grant & Jordan, 2010)

In sum, while the above mentioned frameworks bear only indirect relevance towards the case at hand *("develop a framework for the portfolio analysis of the European Partnerships"*), they clearly put forward, even at the level of highly complex organisations (such as large diversified technology firms such as GE in the past, as well as the management of a diversified portfolio of European Partnerships) the need to develop a limited set of dimensions, leading to clear recommendations towards decision-makers in terms of where resources need to be allocated.

In the context of European partnerships, this means that a concept of portfolio analysis needs to provide guidance and input on:

- The need for a new partnership in a particular area
- The need to continue partnerships:
  - In their current form and resources ("Keep")
  - Upscale ("Keep and increase Investment")
  - Downscale ("Keep and decrease Investment")
  - Merge or split decisions ("Keep and reconfigure")
- The need to disinvest / exit (without continuation under any form)

However, based on experience, even without EC co-funding, partnerships are likely to continue for a while as networks. Therefore, outright, and sudden exit decisions are seldom, as in reality there are most likely different forms of continuation – if which one option is to downscale a partnership.

Additionally, the question may also be answered whether the instrument applied to a certain partnership is the appropriate one.

Of course, when it comes to making (dis)investment decisions, portfolio analysis as depicted above is only one input alongside other frameworks and information gathered.

1.2. Recent insights on strategic decision-making under heavy uncertainty

The decision to invest in research and innovation programs, either from a public or a private perspective, is always bound to significant uncertainty. However, the use of past performance, as exemplified by the traditional portfolio frameworks from corporate literature, as a predictor for future success has lost its edge as one of the leading tools to formulate new strategies and support decision-making under uncertainty. Typically, such approaches work well under relative stable market and technology contexts. Since the 1980s, an increasing amount of volatility has been encountered in the external environment and has led to the development of additional tools and frameworks such as scenario planning, Monte Carlo simulation and real options analysis. However, most organizations have been applying traditional tools and frameworks either due to the cost and complexity of applying these more sophisticated tools, and/or the difficulty of explaining the methodology and outputs to decision makers. Recent articles from practitioner relevant literature (Mankins and Gottfredson, 2022 in HBR) has argued that strategic decision-making needs to be considered more as a continuous process, integrating more dynamic elements into planning. While this may go against the rather 'chunky' or 'lumpy' investments that EU R&D partnerships entail over longer periods of time (7-year periods, or three-year cycles of strategic planning within Horizon Europe), it is worthwhile to consider some of the insights primarily gathered at large (technology) corporations in terms of practices, tools, and criteria to use when allocating resources towards their often complex and investment-intense portfolios of activities.

Mankins and Gottfredson (2022) in their recent article highlight the following practices:

(1) Define extreme but plausible scenario's: in the context of EU partnerships, this relates to solid technology forecasting, alongside monitoring key developments on the social, economic, and political level and translating these into scenario's which are sufficiently divergent and also prevent 'incremental' or 'status-quo' thinking, which is often problematic.
(2) Identify strategic hedges and options: this relates to the question of introducing flexibility into strategic decision-making, based on 'real options reasoning', i.e. not only looking at deterministic ways to calculate/quantify options (and the need to choose parameters for quantification limiting the value of the exercise) but rather valuing in relative or more qualitative ways the strategic flexibility of choosing a particular project/program against another alternative.
(3) Run experiments before locking in investment: in the context of R&D programs, this refers to applying a 'test and learn' culture, e.g., by first developing 'lighthouse' projects (smaller scale but 'big picture' projects) before engaging in a larger program.
(4) Identify trigger points, signposts and metrics: this relates to defining, e.g., within technology forecasts, certain trigger points beyond which action will be taken to set-up an initiative (or alternatively, halt an initiative). This implies a dynamic watch on key indicators related to technology development, as well as key social and economic developments.
(5) Provide prescriptive surveillance: this relates to performance monitoring that is more forward looking rather than backward looking. When particular signposts are not achieved, discussion is rather focused towards course alterations (acceleration or deceleration of programs in the context of EU partnerships) instead of getting existing indicators back on track.

These practices have both value at the level of program-level decision-making as well as within partnership decision-making. Examples of partnerships using 'signpost- type' decision-making as well as adaptation to technology circumstances, informing strategic decision-making during program execution are the Photonics market and supply chain

studies[39] as well as the Technology Evaluator practice found within CleanAviation[40]. Similar approaches are useful at the overall program level as well.

Technology mapping provides an attempt towards technology monitoring over the whole partnership landscape.

1.3. Implications for portfolio analysis and management for European Partnerships: top-down perspective

A quick-scan of the scientific literature on R&D portfolio management reveals a broad plethora of approaches, often developed from a corporate vantage point (individual organizations), and less from a public perspective (or public-private collaboration). More than often, more complex mathematical / multi-criteria-based approaches are developed, within specific context (energy, pharma, …). Literature on government or public expenditure explicitly linked to R&D program portfolio approaches is scant but offers interesting perspectives nonetheless as other dimensions are to be included given the more ad-hoc nature of decision-making and broader type of objectives and impacts to be considered (e.g., capacity building). Quite a number of these papers take the basic frameworks from the strategic management literature as a basis for their reasoning. Also, most literature uses projects within a program as the unit of analysis and not the programs themselves – where in the case of European Partnerships we are rather confronted with (complex) programs as the unit of analysis, further complicating the exercise at the higher strategic level.

When it comes to current European Partnerships, the following complexities need to be considered, such as:

- The different inherent characteristics of partnerships, i.e., the different instruments used (cPPP, co-funded, institutionalized, …).
- The wide variety of societal goals that are covered.
- The different fields of technology(-ies) deployed.
- The different industries targeted (if any).
- Market vs non-market orientations (concrete market potential & demand versus outright societal needs addressing market failures): this could also relate to the type of uptake envisaged: market, regulatory or policy (or a mix thereof).
- The impact of the existence of national regional and thematic strategies

In an expert report on coherence and synergies (October 2020)[41], the EC also puts forward other ways of looking at portfolio composition, and confirms the need to look towards the portfolio in different ways: *"For example, there are partnerships developing new technologies and methodologies (e.g. Photonics, Metrology, Batteries) that could team up with partnerships in industry or societal application areas (health, mobility, energy, agriculture)"*. This is supported or reiterated by the Impact Assessment of the Institutionalised Partnerships under Horizon Europe: *"The European Partnerships can be categorised into two major groupings: 'horizontal' partnerships focused on the development of technologies, methods,*

[39] https://www.flipsnack.com/photonics21/key-data-market-research-study-photonics-2020/full-view.html and https://www.photonics21.org/download/ppp-services/photonics-downloads/230421_Supply_Chain_Report_Final_C3.pdf

[40] https://www.clean-aviation.eu/sites/default/files/2021-09/TE-FGA-syno_en.pdf

[41] https://research-and-innovation.ec.europa.eu/system/files/2020-10/ec_rtd_coherence-synergies-of-ep-under-he.pdf

infrastructures and resources/materials, and 'vertical' partnerships focused on the needs and development of a specific application area, be it industrial or societal".

Figure A2-6 presents this (sub-portfolio) division in horizontal, vertical 'industrial' and vertical 'societal' partnerships (although some choices may not seem as distinctive or clear-cut).

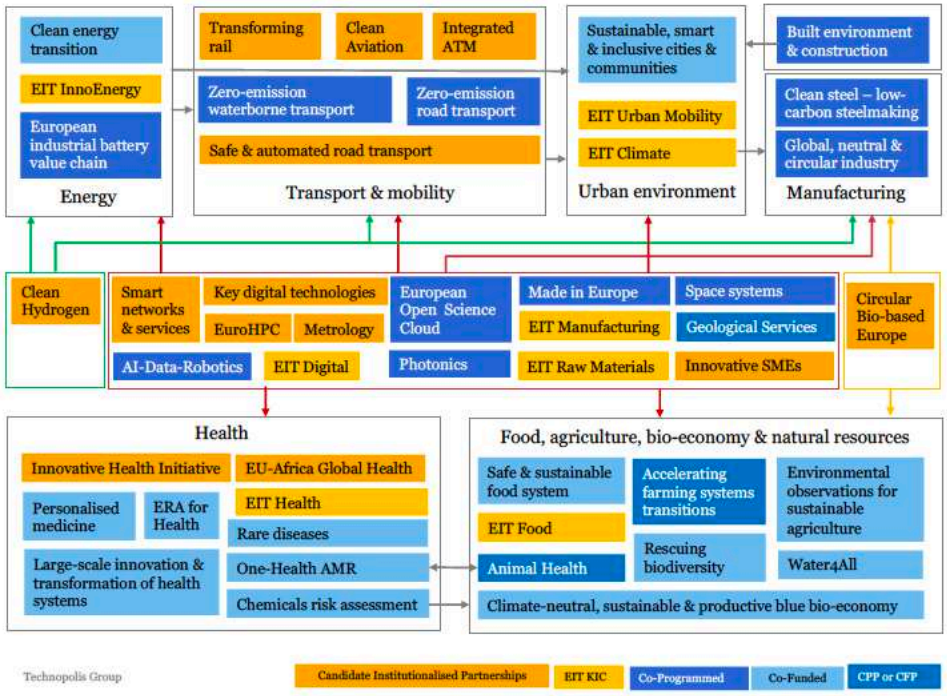


Figure A2-6. Portfolio division according to Technopolis. Source: Technopolis (2019)

Another way to look at partnerships from a coherence and synergies vantage point, is the distinction between partnerships that have a "natural" tendency to include cross-partnership collaboration: (1) Challenge based partnerships (2) Converging technology partnerships and (3) Cross-cutting challenge partnerships.

Finally, other angles are offered to divide the partnerships into sub-portfolio, e.g., in terms of the distinct failures that underpin their existence: (1) market failures, (2) systemic failures or (3) transformational failures (or any 'weighted' combination).

Therefore, it is likely that as a starting point, the entire portfolio of European Partnerships would need to be divided into a limited set of sub-portfolios to make any analysis more meaningful.

Additionally, a wider ramification is that any framework to be used for European Partnership portfolio analysis both at the highest level of portfolio aggregation (division into subsets) as well as within the subsets needs to be validated by stakeholders (European Partnership representatives and MS), in order to accept the role, the eventual portfolio framework developed by the Expert Group will play in the decision-making process. The most prominent characteristics at the outset are the type of instrument as well as the cluster to which the partnership belongs to ("broader thematic area"), but evidence from the grey literature (notably the Technopolis impact assessment) brings forward several other dimensions along which partnerships can be differentiated within portfolio's (see above).

Finally, it needs to be made clear that any portfolio analysis will have its inherent limitations (as information used, given the forward-looking perspective and uncertainties, will remain

imperfect), and thus only serve as a partial input to higher level administrative/political decision-making, which will need to integrate other tangible and non-tangible elements (e.g., from the Biennial Monitoring Report, Horizon Europe Evaluations, etc.). In sum, the proposed portfolio framework may not be the subject of any direct normative interpretation on (dis)continuing a specific partnership, as other inputs need to be considered.

As a general starting point to divide the European Partnership portfolio in subsets, and in line with a quick-scan of the literature as well as the inputs from the generic portfolio analysis literature, considering the specific nature of European Partnerships, we propose to further explore the following two high-level dimensions (additional dimensions to be added later, or dimensions to be disaggregated) which seem sufficiently at the strategic level, and have both an external and an internal dimension:

1) The level of technology and market readiness of outcomes:
    a. What is the level of readiness of the technologies used/deployed/ developed? This is a particular question that can be answered by the approach described in ANNEX 1.
    b. Do the outcomes respond to a structural, longer-term market demand (i.e., can market uptake be defined or present? Will demand remain or be temporary (e.g., some energy transition solutions may have a more temporary character in terms of demand)? Is there sufficient existing or future internal European demand that can act as a platform for global expansion/markets? E.g., one could assume that demand for all kinds of air transport will remain high). A similar approach could be developed for 'non-market' demand or towards market failures, which warrant a regulatory or policy-driven approach.
2) The level of sunk costs if the program is abandoned (i.e., are there significant losses of knowledge, capacity, networks if the European Partnership is abandoned?)

Note that a lower (relative) score on both dimensions does not imply that a program cannot continue, rather, the dimensions allow for subsets to be defined, which will then be further subject to define appropriate dimensions to assess their place within the subset. E.g. one could imagine that public/public partnerships (e.g. Biodiversa+ or others) may not have a high score on either dimension (in the case where only market would be considered), but within the subset of the 'low-low' quadrant of the matrix a reflection will take place on the appropriate dimensions (these could relate to broader or supporting elements of EU global competitiveness, e.g. the value of Biodiversity to achieve/support global leadership due to a higher level of wellbeing of the population, criteria with increased importance for global investors) to assess the position in the subset and the subsequent advice on whether or under which format the program needs be revised for future purposes. This confirms the importance, as for corporations, to keep a 'balanced' portfolio from the viewpoint of the European Commission.

At a very high level of aggregation and building on the above, several types of portfolios may be developed based on the following dimensions:

<u>Externally</u> oriented dimensions:

(1) Fit of the European Partnership with the external environment
    a. Technology dimension (technology readiness or maturity)
    b. Market dimension (market readiness or maturity)
    c. Societal challenges ('non-market' orientation)

(2) Contribution of the European Partnership to European global competitiveness (competition aspect with other global regions such as North America, Far East, … – relating to EU high-level policy priorities, sovereignty)[42]

Internally oriented dimensions:

(3) Fit of the European Partnership within the existing portfolio of European Partnerships (based on proven or intended synergies or leverage towards the rest of the portfolio)
(4) Sunk cost dimension: what are non-recuperable losses if the European Partnership is abandoned?

The following dimensions can each be combined in 2x2 matrices (on low or high qualitative assessment) to develop the positioning and the implications for further investment.

In an ideal world, a harmonized scoring/indicator per portfolio dimension could be developed and rank the existing and new European Partnerships on the following dimensions (low to high), also considering the external elements (see Chapter 2.1 and ANNEX 1):

1. (1) Fit with the technological environment / technology uncertainty risk reduction
2. (2) Fit with the market (or ”policy”?) environment / market uncertainty risk reduction
3. (3) Fit within the existing portfolio of European Partnerships (and the broader framework for implementation through other EU programs) i.e., synergy creation
4. (4) Proven capabilities of trust creation among stakeholders and achieving results/impacts
5. (5) Degree of (strategic) flexibility offered / demonstrated
6. (6) Sunk costs and irreversibility

Several 2x2 matrices could be created based on the rankings.

7. E.g. (1) and (2) combined, or (3) and (4) combined.

Figure A2-7 shows an illustrative example for either general or sub-portfolio-based analysis (see supra for potential sub-portfolio divisions).

[42] Note that even if an European Partnership does not contribute significantly towards e.g. leadership in particular global markets for products and services, it may be highly conductive to create the investment environment to attract activities to the EU to facilitate this leadership. E.g., superior health systems or climate resilience through biodiversity may create a superior environment for Foreign Direct Investment in certain industries, as opposed to other world regions. The main challenge is to be able to measure and weigh these contributions.

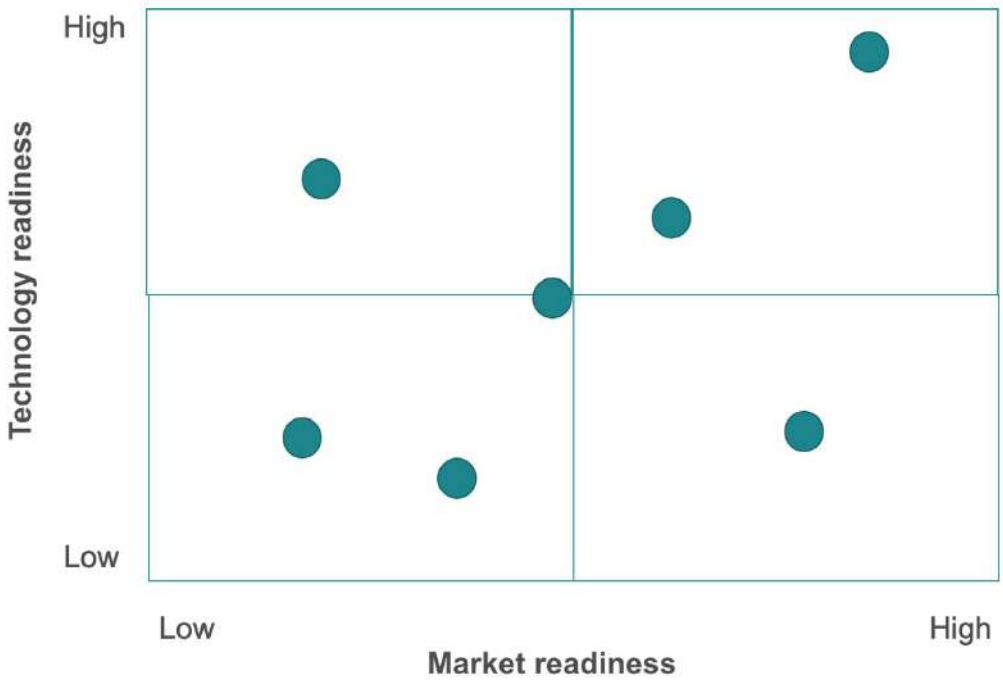


Figure A2-7. Illustrative portfolio chart. Source: Expert Group (2023).

1.4. The need for a bottom-up perspective

The previous sections have presented a top-down perspective on an approach towards analysing and managing the portfolio of European partnerships, translating the traditional approaches from the strategic management literature towards the EU partnership landscape. In what follows, we provide further research and analysis to shape potential dimensions, and where possible, their operationalization towards a portfolio analysis methodology.

The following exercises were performed to find either confirmation and specification of the top-down approach, as well as identify new elements:

- A broad analysis of the scientific literature on R&D portfolio analysis and management (2.1.)
- A broad analysis of the scientific literature on the application of Real Options Theory in R&D policy and management (2.2.)
- An analysis of the SRIA and selected grey literature references, notably the impact assessments of the Institutionalised Partnerships (section 3)
- An analysis of the results of the consultation, including a survey. Note that the survey was launched after the completion of 2.1. and based on initial insights of 2.2. and may thus not have captured all identified sub-criteria.

2. Scientific literature analysis

2.1. Literature on R&D Portfolio Analysis

2.1.1. Methodology

To build the methodology allowing us to isolate the key concepts to be investigated, we used a classical text mining method from a corpus of scientific articles.

We therefore built a secondary corpus from scientific databases with a set of documents suitable for analysis, in order to avoid the problem of selection bias, bearing in mind that, however vast they may be, they are neither exhaustive nor totally representative (Meng, 2018).

Then, a phase of work on the raw corpus, integrating a tokenisation action, allowed a phase of smoothing/cleaning of the data which aims at defining the object of the analysis. This manual or semi-automated tokenisation consisted in identifying the initial text units and then isolating the common terms in the scientific articles identified. To do this, an analysis of the frequency of occurrence of the terms by their number of occurrences in all the documents to be processed was carried out. This analysis of the data to understand patterns, trends via the use of semi-automated learning to extract information from the data from the article analysis matched the identified concepts from a general point of view. This validation of these proofs of concepts was further enhanced by the analysis of grey literature.

2.1.2. Results

Based on the methodology presented above, a significant number of queries on ScienceDirect from 14.000 entries leading to 90 articles which led to more or less the same set of papers surfacing. Hence, eight main factors were identified and manually revalidated by cross-referencing scientific article databases, the following elements were identified based on multiple sources[43]:

1. **Risk management and risk mitigation within the partnership and links with the diversity of the portfolio**

Identifying, assessing, and controlling risks that could potentially affect an organization is of primary importance in order to have a clear and easy roll out of a partnership. planning and developing methods and options to reduce threats or risks to project objectives. This is even more important while dealing with partnerships that includes specific collaborations processes that are different from usual project management. Risk mitigation is a strategy used to reduce the impact of potential risks by developing a plan to manage, eliminate, or limit setbacks as much as possible. Usually, a project team might implement risk mitigation strategies to identify, monitor, and evaluate risks and consequences inherent to completing a specific project. Common usages are in risk mitigation strategies that can be used include avoidance, reduction, transference, and acceptance.

2. **Innovation strategy statement and alignment with the goals of the partnerships**

An innovation strategy is an organization's relative emphasis on different types of innovations and the associated pattern of resource allocation, in alignment with its strategy at the

[43] As there is no specific literature on similar programs as the Horizon Europe partnership program, we try to "translate" or "reinterpret" the literature on traditional R&D portfolio management, where inevitably some dimensions may have more or less relevance.

corporate and business unit levels[44]. To a maintain a continuous alignment of this strategy is of primary importance for an efficient steering of the partnership. Therefore, starting from a clear understanding of the partnership's goals, strategies and initiatives that are aligned with these goals can be developed. This may involve collaborating with other partners to identify areas of common interest and developing joint projects or initiatives. Regular communication and coordination with other partners are of primary importance to ensure that the activities are dynamically aligned with the partnership's overall objectives.

3. Monitoring and evaluation of the partnership portfolio

Monitoring and evaluation of a partnership portfolio involves assessing the performance of the partnership and its outcomes and impacts. This can be done at both the project and partnership levels. At the project level, monitoring and evaluation can provide information about scientific impacts, industrial leadership, and societal relevance. At the partnership level, it can offer insights about the effectiveness, efficiency, added value, or degree of achievement of the broader partnership objectives[45]. There are several challenges associated with monitoring and evaluation of partnerships. These include defining monitoring and evaluation to sufficiently capture or satisfy different partners' or stakeholder groups' concerns, managing the timeline for evaluation and communicating the results, and dealing with issues of attribution and unintended effects[46].

4. Importance of maintaining long-term perspectives: what are the underlying processes?

Maintaining a long-term perspective is important in a partnership because it allows the partners to focus on their shared goals and objectives, and to develop strategies and initiatives that are aligned with these goals. This can help to ensure that the partnership is able to achieve its desired outcomes and impacts over the long term.

The underlying processes for maintaining a long-term perspective in a partnership may include several dimensions like regular communication and coordination among the partners, as well as ongoing monitoring and evaluation of the partnership's performance. This can help to identify areas where the partnership is performing well, as well as areas where improvements may be needed.

5. Trust building : what are the drivers? What is the rationale to gain more efficient partnerships?

Trust is a vital component of any partnership, including international partnerships. Building trust in an international partnership involves developing a strong relationship between the partners based on mutual respect, understanding, and cooperation. The effective communication and collaboration are also important for building trust in a partnership, as e.g.

---

[44] Varadarajan, R. (2018), "Innovation, Innovation Strategy, and Strategic Innovation", *Innovation and Strategy* (*Review of Marketing Research, Vol. 15*), Emerald Publishing Limited, Bingley, pp. 143-166. https://doi.org/10.1108/S1548-643520180000015007

[45] Benefits of monitoring and evaluation of partnerships in R&I, ERA Learn, available at https://www.era-learn.eu/support-for-partnerships/governance-administration-legal-base/monitoring-and-assessment/r-i-partnership-evaluation-toolkit-ripe/using-the-results-of-the-evaluation-of-partnerships-in-r-i/benefits-of-monitoring-and-evaluation-of-partnerships-in-r-i

[46] Challenges of monitoring and evaluation of partnerships in R&I , ERA-Learn, Available at https://www.era-learn.eu/support-for-partnerships/governance-administration-legal-base/monitoring-and-assessment/r-i-partnership-evaluation-toolkit-ripe/using-the-results-of-the-evaluation-of-partnerships-in-r-i/benefits-of-monitoring-and-evaluation-of-partnerships-in-r-i

highlighted by the AGORA format within the DUT partnership. This is also relevant for cross-partnership collaboration and the development of synergies within a portfolio, as highlighted by the report on synergies and coherence.

Building trust in an international partnership is necessary to create a more efficient and effective partnership. When partners trust each other, they are more likely to work together effectively and achieve their shared goals. Trust can also help to reduce conflicts and misunderstandings and facilitate smoother decision-making processes.

Some of the key drivers of trust building in an international partnership include openness, transparency, loyalty, and a willingness to understand and address the needs of the other partner.

6. Agility and ever-changing business environment

In today's rapidly changing business environment, adaptability is a crucial competitive advantage. Organizations that are adaptable and future-fit will be able to move quickly and adapt to changes in customer demands, technology advancements and disruptive competition better than those that rely on size and efficiency alone[47]. This degree of disruptive change and ability of adaptation is also a key parameter for R&I complex collaborations. The rationale to analyse the core arguments to switch or to step in a new organizational environment is important to monitor intrinsic parameters of a long-life R&I partnership and to have the performance indicators allowing to adapt quickly enough to survive accelerating change. Measures of fitness will no longer apply – organizations need to reimagine how they will create and sustain value in the future.

7. Soft power – organizational skills analysis

Soft skills are critical for success in a partnership. Soft skills are commonly defined as non-technical skills that enable someone to interact effectively and harmoniously with others. These skills can impact culture, mindsets, leadership, attitudes, and behaviours[48]. Some key soft skills for successful partnerships include empathy, authenticity, communication, and interpersonal skills[49]. When dealing with organizational skills, they are important for successful partnerships. A partnership is a valuable instrument or "organizational" model to overcome weaknesses of the policy and governance framework. Nonetheless, partnerships face several obstacles: they are difficult to set up and maintain, they require political will and resources, and results are not likely to come overnight[50]. To take into account and investigate about these issues is therefore of primary importance in order to maintain a common view and global shared perspectives.

8. Cultural/historical influences in partnerships

Even if a transformative value-driver approach can be estimable in a changing business environment, traditional point of view and historical value drivers can nevertheless subsist in

---

[47]Park, R., The importance of adaptability in an increasingly complex world, EY, available at https://www.ey.com/en_us/innovation/the-importance-of-adaptability-in-an-increasingly-complex-world

[48] Avrane-Chopard, J., Muhlmann, D., How to develop soft skills? 2019, Available at https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/the-organization-blog/how-to-develop-soft-skills

[49] Hayes, C., 4 Essential Partnership Soft Skills, 04/2022, available at https://www.resonanceglobal.com/blog/partnership-soft-skills

[50] OECD – Succesfull Partnerships, a guide. 36279186.pdf (oecd.org)

a partnership thanks to cultural and historical influences. Cultural and historical influences can have therefore a significant impact on partnerships[51]. Cultural similarities and differences can affect the performance of partnerships. Some findings suggest that partners need to possess similar cultural characteristics in order to achieve success, while others show that cultural distance can have a positive effect on efficiency and competitiveness of partnerships. It is important for partners to understand and respect each other's cultural backgrounds and values in order to work together effectively[52], but it is also important, in some extents, to measure these potential influences and to monitor them in a way that they will be beneficial give competitive advantages or highlighting conditions under which they can be dysfunctional.

2.2. Application of Real Options Theory in the context of R&D strategies and portfolio management

2.2.1. Methodology

Based on initial literature review, we identified a large body of literature related to the application of Real Options Theory (ROT) for decision-making under uncertainly in the context of Research and Development. An initial assessment made us believe that a more in-depth review, also in line with recent practitioner-based insights on the return of 'real options reasoning' might provide interesting inputs an insight into portfolio-based thinking for R&D programs. Based on a standard Scholar Google search, we identified 26 scientific articles, theses and book chapters spanning the period 2000-2021 applying ROT both in public, private and public-private contexts of R&D investment. Each article was scanned in terms of dimensions used to shape the real options theory application and/or real options reasoning, both at the level of literature review and empirical application. Papers treated a wide variety of cases, with applications in health (pharmaceuticals) and energy sectors somewhat dominating. All mentioned dimensions were captured, beyond the ones actually operationalized in the empirical cases (as these often-required quantification whereas qualitative dimensions seem equally important from a strategic level).

2.2.2. Results

We constructed a summarizing table with all identified dimensions throughout the analysis of all 26 references. While frequency of the dimensions is an interesting element towards prioritization, lower frequencies of a dimension across the papers do not mean that there is less interest from the vantage point of EU partnership portfolio development or evaluation (e.g. TRL evolution during the program in a recent reference seemed particularly relevant, as this is also mentioned under the advantages of partnerships in the 2020 Impact Assessment of the Institutionalised Partnerships under HE: *"Ability to scale up technology (in terms of TRL) through collaboration").*

Based on our analysis, we grouped the dimensions into five principal categories:

(1) Technology based dimensions.
(2) Market based dimensions.
(3) Internal portfolio dimensions.

---

[51] Meirovich, G. (2012), "Cultural Similarities and Differences: Impacts on Performance in Strategic Partnerships", Cooper, C.L. and Finkelstein, S. (Ed.) *Advances in Mergers and Acquisitions* (*Advances in Mergers and Acquisitions, Vol. 10*), Emerald Group Publishing Limited, Bingley, pp. 55-74. https://doi.org/10.1108/S1479-361X(2012)0000010007

[52] Adam B. Masters, Cultural Influences on Public-Private Partnerships in Global Governance, 2019, Palgrave Macmillan Cham, DOI https://doi.org/10.1007/978-3-319-96782-0

(4) Behavioural dimensions (sunk costs, irreversibility)
(5) Other

			MARKET						TECHNOLOGY		INTERNAL				BEHAV	OTHER
Reference	Year	Journal, Book or Dissertation	Market uncertainty	Minimal demand/demand risk	Speed of user adoption	Complementarity/Competition (incl. pre-emption)	Crowding in/out	Commercialization risk (ind./regulatory)	Technology uncertainty / unit cost	TRL evolution during program	Product / Service Performance	Scale of the program	Managerial/Budget Flexibility of the program	Diversification versus focus	Synergies and spillovers in the portfolio	Economies of scope	History of succes / Path dependence / Trust	Sunk costs/irreversibility (incl. loss of learning effects)	Broader economic and social impact
Boer	2000	Research Technology Management	x					x									x		
Huchzermeier and Loch	2001	Management Science	x				x	x		x		x							
Lint	2002	Vlerick working papers	x			x		x		x									
Perlitz et al	2002	R&D Management	x	x								x							
Hsu et al	2003	R&D Management					x	x							x				x
Vonortas and Lackey	2003	Learning from Science and Tech Pol evaluation	x			x		x										x	
Newton at al	2004	Int J of Management Reviews	x				x	x											
McGrath and Nerkar	2004	Strategic Management Journal				x	x							x		x			
Shishko et al	2004	Systems Engineering			x			x		x		x							
Tsui	2005	MIT thesis	x		x			x	x										
Johnson	2007	Creativity and Innovation Management	x					x	x					x	x		x	x	
Anand et al	2007	Advances in strategic management	x			x			x						x				
Schneider et al	2008	R&D Management	x		x			x	x		x								
Oriani and Sobrero	2008	Strategic Management Journal	x					x	x										
van Bekkum et al	2009	Research Policy				x								x	x				
Karamitsos	2009	ETH Zurich Thesis	x					x	x		x	x			x				
Bednyagin and Gnansounou	2011	Energy Policy	x						x										
Linquiti	2012	George Washington University Thesis	x			x		x	x		x	x		x	x	x	x		x
van Zee and Spinler	2014	Technovation	x						x										
Wang et al	2015	Journal of Eng and Tech Management	x		x			x	x										
Martin-Barrera et al	2016	Renewable and Sustainable Energy Reviews	x	x									x						
Trigeorgis and Reuer	2016	Strategic Management Journal	x			x			x						x		x	x	
Choi et al	2016	Asian Journal of Innovation and Policy											x					x	x
Martin-Barrera et al	2017	Renewable and Sustainable Energy Reviews	x				x		x		x		x		x				
Belz et al	2021	USC Working Paper	x					x	x	x			x	x			x		
Ozdemir and van den Ende	2021	Strategic Entrepreneurship Journal	x			x											x		

Figure A2-8. Analysis of literature applying ROT to public and private R&D decision-making. Source: Expert Group (2023)

While technology and market dimensions are most frequently mentioned and applied (as on a case basis, they are more easily applicable given the existence of quantifiable indicators), our interest, from an 'internal' portfolio point of view, is more geared towards the dimensions related to internal and behavioural aspects. These elements stand out and are worth considering:

- (Positive) synergies and spillovers within a portfolio: how do the different projects and programs strengthen each other? Economies of scope relate to deployment potential beyond the particular case of innovation.
- The scale of a program is considered as important as smaller scale programs show more difficulty in correcting failures or mistakes.
- The presence of budget flexibility is valued.
- While diversification versus focus does not yield a certain direction in terms of which approach is best, a case-by-case approach seems appropriate to assess whether a focused program or a diversified is more suited to tackle the strategic challenge at hand.
- On the behavioural side, the importance of having a history of success and performance is important, while sunk costs and irreversibility of investments (including the loss of learning effects) made are criteria to be considered in decision-making.

2.2.3. Conclusion: dimensions identified

This analysis confirms initial top-down observations with regard to the importance of both technology and market dimensions in portfolio analysis, but also highlights additional strategic dimensions such as the need to assess synergies, sunk costs/irreversibility, appropriate scale as well as the potential for budget and managerial flexibility.

Finally, in particular from a public policy perspective, broader social and economic impacts of a program may need to be considered.

3. Analysis of SRIAs / Proposals / Legal Base / Commission documents

3.1. Analysis of SRIAs (and proposals)

3.1.1. Methodology

In order to carry out our analysis on SRIA's and proposals, we have set up a methodology based on topic modelling and topic analysis usually used in text mining.

Python is a popular programming language used for text analysis and mining because it has a variety of libraries and tools available for natural language processing (NLP). NLP is a component of text mining that performs a special kind of linguistic analysis that essentially helps a machine to "read" text.

We defined a python script dedicated to this exploratory analysis following the various steps:

1. Data wrangling:

Data wrangling, sometimes referred to as data cleaning, data munging and pre-processing, is the process of cleaning and structuring data so that it can be utilized by a model. It is the process of converting and mapping raw data and getting it ready for analysis. The goal of data wrangling is to assure quality and useful data. In our case, this step consisted in removing the punctuations, stop words and normalize the corpus while parsing and preparing the pdf files in such a way as to make them operable by the program. In this way, we used the common tokenization process called whitespace/unigram tokenization, consisting in splitting the entire text into words by splitting them from whitespace.

2. Data processing/ text mining:

Following the cleaning of the data, we performed a text mining analysis. This component of data mining, dealing specifically with unstructured text data, involves the use of natural language processing (NLP) techniques to extract useful information and insights from large amounts of unstructured text data. In our case, text mining was used as a pre-processing step for data mining and data presentation of the importance of each *megatrend*/*Forward looking issue*/*technology*/*dimension of portfolio management.*

3. Data presentation:

Considering the diversity of volume of data existing in the various documents, we use a normalization process while taken into account the number of iterations of each keyword qualifying each *megatrend* / *Forward looking issue* /*technology*/*dimension of portfolio management* per 1000 words.

In order to present a clear view upon the results and further analyses that can be undertaken from this data analysis, we used 2 kinds of data presentations: heat maps and cluster maps. A heat map is a visualization of data that represents the magnitude of a value in a colour code ranging from minor to major intensity. A cluster map is a way to visualize hierarchical clustering using a heat map. Heat maps and cluster maps are interesting in text mining results presentation because they allow for data visualization and quality control. Heat maps visualize a data matrix by drawing a rectangular grid corresponding to rows and columns in the matrix and colouring the cells by their values in the data matrix. Cluster maps allow us to simultaneously visualize clusters of samples and features.

3.1.2. Results

This section presents the results built upon the quantitative parameters analysis following the previous methodology.

General characterization

The quantitative analysis of the *megatrend* / *Forward looking issue* /*technology*/*dimension of portfolio management* fulfilled within this study allows us to pinpoint some key issues regarding the centre of interests quoted in the SRIA's. The overall focus points are dealing with environmental issues; autonomous and cybersecurity/data security as well as agility and risk management.

Study of categories (cf. Chapter 7)

In Chapter 7, various sub-categories of the themes used as promising technologies have been individually studied. This allow to see, in a particular sub-domain, what are the technologies that are the most quoted.

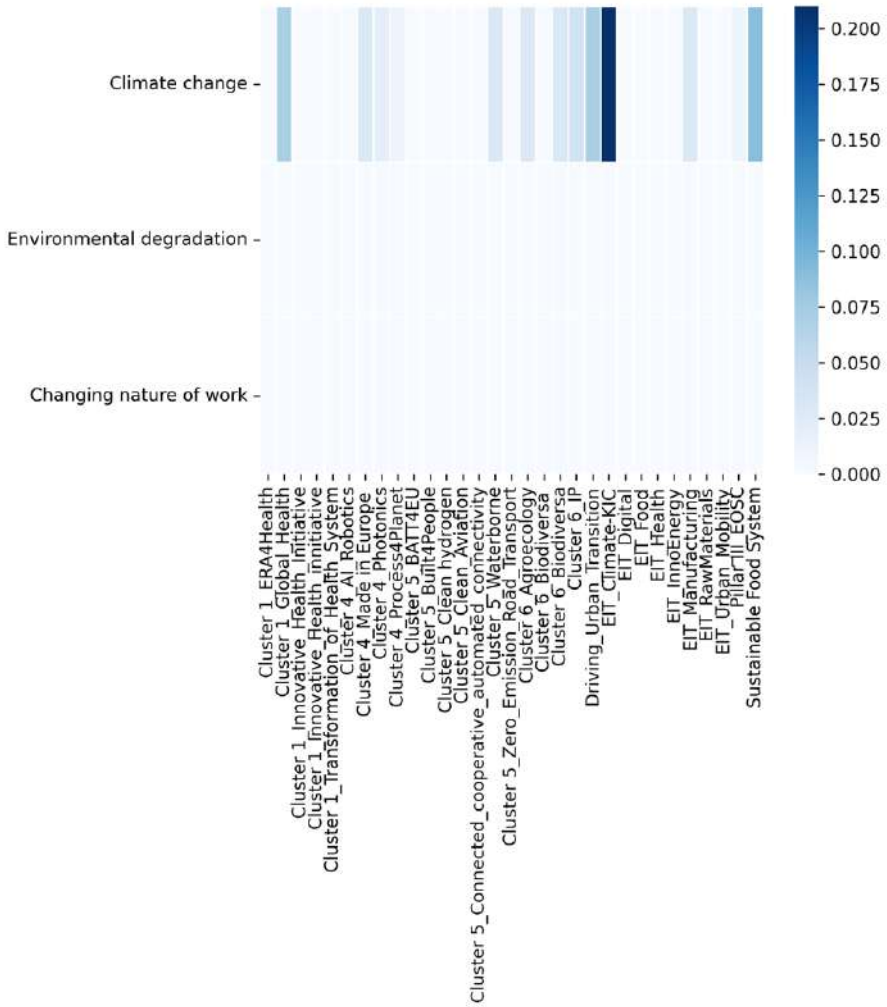


Figure A2-9. Heat map Megatrends. Source: Expert Group (2023)

The analysis of the megatrends shows a clear orientation of the SRIAs towards the areas of climate change and other environmental dimensions. These dimensions are present in almost all the SRIAs.

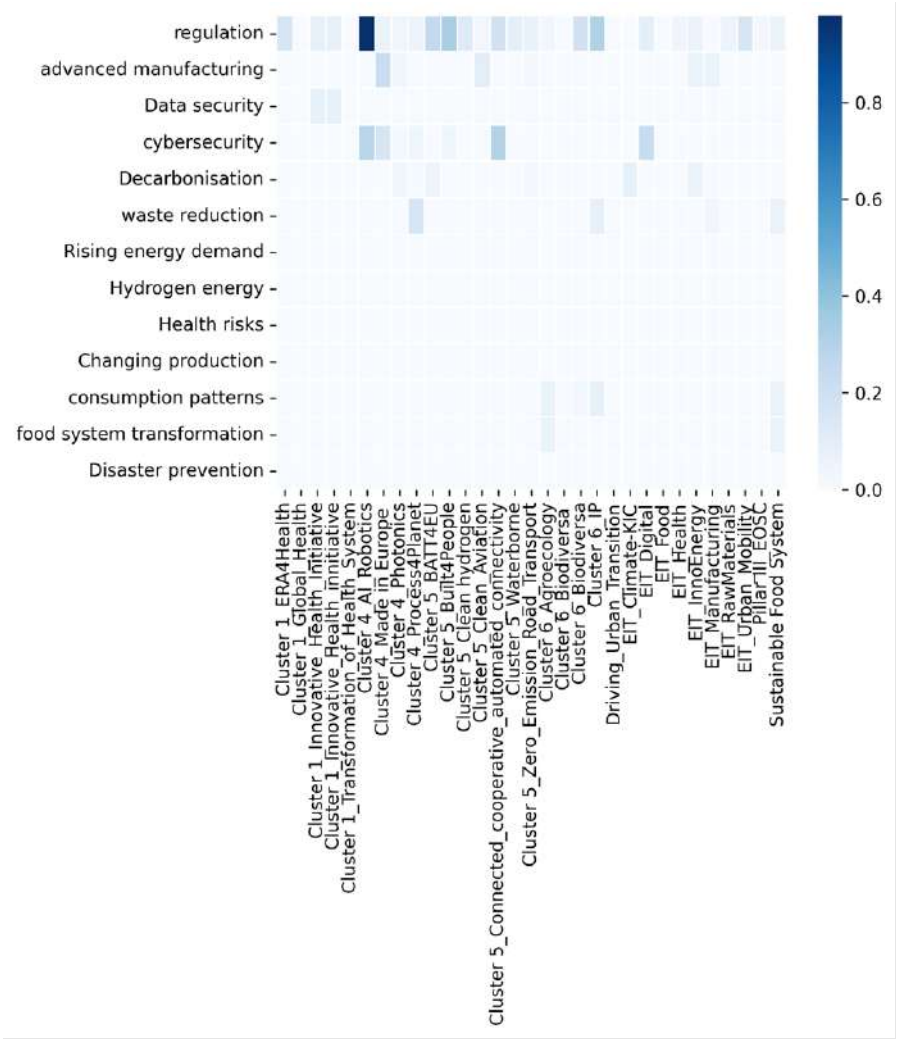


Figure A2-10. Heat map Forward-Looking Issues. Source: Expert Group (2023)

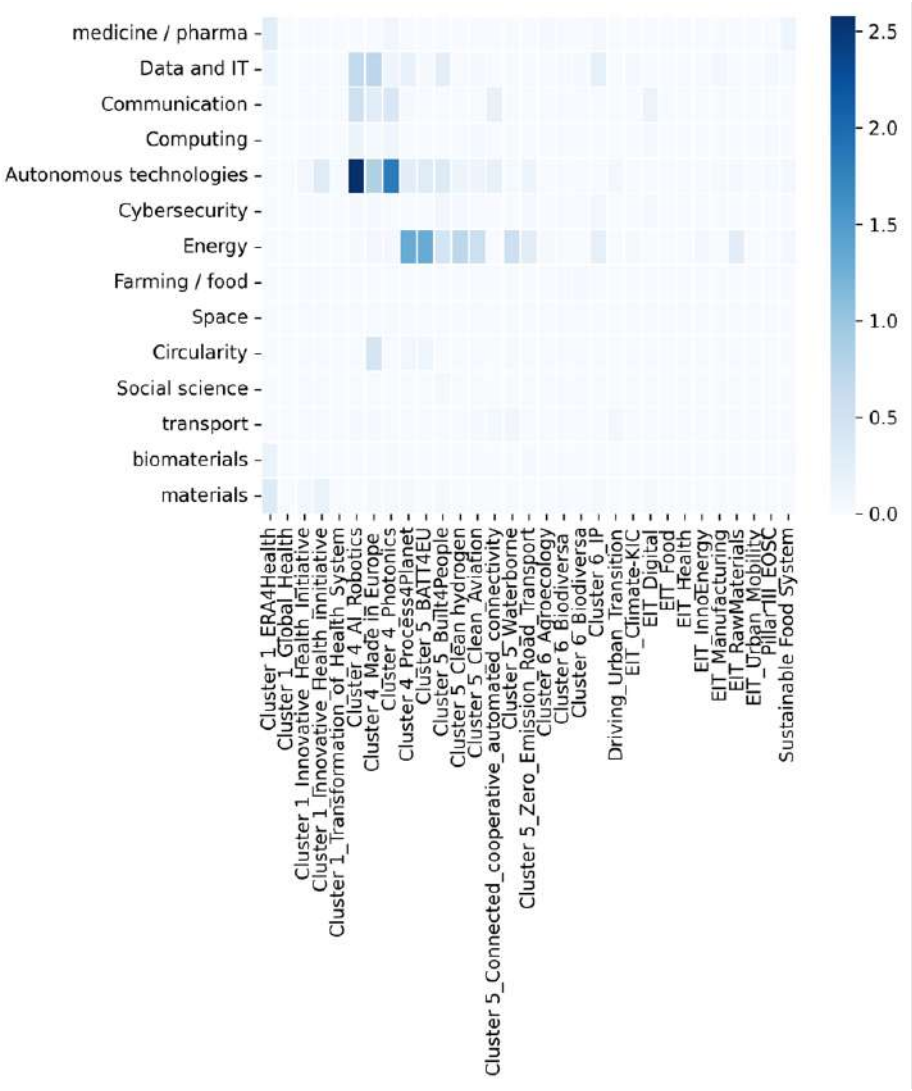


Figure A2-11. Heat map Technology areas. Source: Expert Group (2023)

Regarding the promising technologies, the ones that are most studied in the partnerships are those relating to autonomous technologies, followed by energy and topics relating to data science/cybersecurity/I and communication. This trend is relatively clear in the various partnerships studied. This is also fully in line with the results of (Husiev et al., 2023)[53] on H2020 projects analysis.

[53] Husiev, O., Ukar, O., Santocildes, M.E., What does Horizon 2020 contribute to? Analysing and visualising the community practices of Europe's largest research and innovation programme, January 2023, Energy Research & Social Science 95:102879, DOI: 10.1016/j.erss.2022.102879

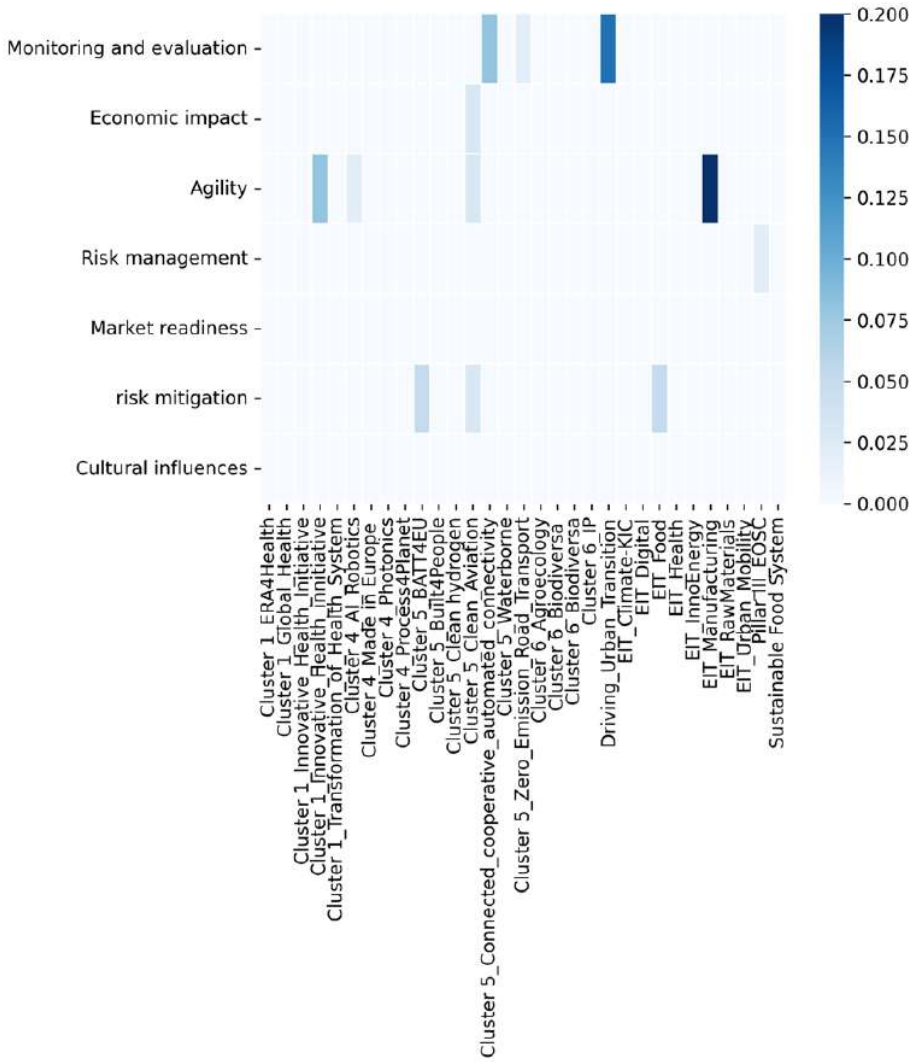


Figure A2-12. Heat map Portfolio analysis dimensions. Source: Expert Group (2023)

The analysis of the main concerns regarding portfolio dimensions allows us to attest that Agility, monitoring, and evaluation as well as risk mitigation are the dimensions that arose in top position while quoting the partnerships' priorities. These dimensions are also followed by risk management. This confirms a real level of maturity of the various consortiums regarding their way of leading and managing projects as well as a desire to reinvent themselves and adapt to the constrained environments of today's world, considering the risks surrounding their activities.

3.2. Legal base and EC policy (supporting) documents.

The *Report on coherence and synergies of candidate partnerships (October 2020)* provides a strategic framework to increase synergies and coherence across the partnership portfolio, at several levels. The following four elements warrant particular attention:

- Ex -ante: envisaged collaborations with other partnerships and synergies with other programmes at European, national, and regional level need to be defined.

- Reporting and monitoring of synergies and collaborations is expected through the analysis of following indicators and tools: joint contributions to EU policy objectives, joint calls, joint R&I portfolio management.
- Particular attention is needed towards synergies with other EU programs aimed more towards deployment and commercialization.
- In terms of synergies with national and regional funds, a contribution to smart regional specialization is envisaged.

The report provides a first mapping, based on mentioned synergies and collaboration within the SRIAs, of the European partnerships. In particular ex-ante bilaterally mentioned synergies and collaborations are of significance, and the document shows in a qualitative way the 'collaboration' or 'synergy' intensity across partnerships and clusters, which could be considered as a baseline for measurement. The report also suggests potential synergies. It may be advisable to develop metrics in terms of evolution of synergies and coherence through a mid-term and final review through an update of the document. Of course, intrinsic limitations are present as there is little evidence both on the quantitative nature (i.e., joint resources deployed or leveraged) as well as the qualitative nature of the intended collaboration (i.e. was a higher path of impact achieved?). As any indicator, harmonization of the measurement across partnerships seems particularly challenging in the context of synergies and coherence. One potential solution could be to define an ex-ante baseline for each partnership and set out a path of objectives to be reached towards the end of the lifecycle (including concrete impacts). The report offers potential to create those baselines on a partnership level.

In general, the *arguments for EU partnerships in R&I* relate to the following, with highlighting of the key dimensions (including the updated objectives):

- Avoidance of fragmentation in particular areas (relates to scale and focus)
- Creating a critical mass of funding (relates to scale) – very prominent dimension within all consulted documents.
- Lack of private investment (to address market failures, within all levels and particularly towards deployment and uptake)
- Impact oriented approach
- More emphasis on synergies
- Focus on fewer and larger partnerships.
- Directionality to Green & Digital
- Improve openness and transparency, engage a broader set of stakeholders.

The *ERAC (2018) final report of the Ad-Hoc WG on partnerships* provides additional insights and requirements/recommendations from a portfolio management perspective (i.e., considering the life cycle of the partnership), in particular from the viewpoint of implementation and monitoring, and phasing out (bold emphasis added for dimensions with particular relevance to portfolio analysis):

"Implementation:

- ***implementation of joint actions going beyond joint calls to ensure achievement of the desired higher impacts of the R&I partnership, including those related to regulatory or policy uptake.***
- *appropriate measures to ensure continuous openness and transparency during implementation, e.g., for the priority setting, for participation in projects submitted to calls for proposals, communication and outreach measures, clear open access/user strategy, etc.*

- ***options to ensure flexibility of implementation and regular adjustments responding to changing policy or market needs.***

Monitoring:

- *achievement of specific policy goals/ objectives, deliverables and KPIs allowing for a more systematic assessment of achievements, impacts, and potential needs for corrective measures, including possible revision or termination of a R&I partnership funded from the FP in case KPIs are not met.*
- ***coordination and joint activities with other relevant R&I initiatives ensuring coherence.***
- *additional activities beyond R&I calls to ensure impacts, openness and transparency of the R&I partnership.*
- *dedicated reporting on quantitative and qualitative leverage effects, including on financial and non-financial contributions, visibility and positioning in the international context, reduced R&I related risks of private sector investments, etc.*

Phasing-Out:

- *appropriate measures ensuring orderly phasing-out from the Framework Programme funding, according to the foreseen conditions and timeline, without prejudice of continued transnational funding by MS/AC or other EU programmes.*
- *assess the achieved impacts at EU and national level in relation to defined targets and KPIs as well as additional coordination and administration efforts.*
- ***position any potential renewal of an R&I partnership in the overall R&I partnership landscape and its policy priorities.***
- *assess the most effective policy intervention mode for any future action."*

The following additional recommendations from specific fields, and scattered resolutions from meetings of the ad-hoc WG warrant attention towards a portfolio assessment:

- *"The **scale and scope** of the topics differ strongly – from many partners and large budgets to fewer partners and smaller budgets, from very general topics to rather specific topics, presenting a challenge for ensuring the most appropriate level of analysis for rationalisation.*
- *Ensure that the set-up of partnerships is limited to cases, where **the (potential) future benefits clearly outweigh the added complexity of cooperation**.*
- ***'Variable geometry'** shall remain the key approach, and partnerships initiatives must remain open to newcomers at programme and at project level.*
- *EC to provide the necessary provisions in the relevant programmes ensuring **meaningful synergies between different EU funding programmes** for the support of R&I partnerships."*

The *2019 report on the European Partnerships under Horizon Europe: results of the structured consultation of Member States* mentions the following with regard to portfolio management:

- *"For the portfolio of partnerships compared to Horizon 2020 some remark on the **good balance of continuity with the past, building upon success stories, and innovation and adaptation** to the new challenges, with in many cases clear renewals and reforms compared to current partnerships. Others point out that the proposed landscape rather shows a concentration (and not a reduction) of the partnerships".*

From the *2020 Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe*, the following elements emerge from a general perspective (emphasis **in bold** added):

- *The Horizon Europe Regulation (common understanding) also stipulates that the European Partnerships are expected to adhere to the "principles of Union added value, transparency, openness, impact within and for Europe, strong leverage effect on sufficient scale, long-term commitments of all the involved parties, **flexibility in implementation**, coherence, coordination and complementarity with Union, local, regional, national and, where relevant, international initiatives or other partnerships and missions."*
- *The focus is on major long-term strategic challenges and priorities beyond the framework of a single Framework Programme where collective action – by private and/or public sectors – is necessary to **achieve critical mass** and address the full extent of **the complexities of the ecosystem** concerned.*
- With regard to selection criteria, linking the dimensions to a more 'internal' view of portfolio development, the **coherence, and synergies** criterium stands out, as well as, within additionality and directionality, approaches *"to ensure **flexibility of implementation** and to adjust to changing policy, societal and/or market needs, or scientific advances, to increase policy coherence between regional, national and EU level"*. Next to openness and coherence and synergies, the dimension of flexibility was put forward in the impact assessment as 'key distinguishing features'.
- A cost comparison was executed, with "winding down" costs as a sub-criterium, for which the Institutionalised Partnership art. 187 scored highest compared to the baseline, which indicates the potential high sunk costs as well (but is albeit a different concept).

The individual impact assessments reveal the following insights (emphasis in **bold** added):

(EDCTP):

- *"In relation to the allocation of funding to research and innovation actions, lessons could be learned from the **portfolio funding model commonly applied in the context of Product Development Partnerships**. Here, funders opt to not support a single research project but rather a portfolio of activities. This allows the PDPs to **more rapidly switch resources over to more promising parts of the portfolio, diversifying risk and decreasing the likelihood of failure.** Accommodating similar forms of portfolio funding in the candidate initiative would allow for more flexibility and adaptiveness to scientific developments than project grant funding only and would allow the initiative to work together more effectively with PDPs.*
- *However, the **possible loss of expertise** compared to an Art 185 partnership could be particularly problematic for effective coordination and implementation of such support activities, which depend highly on good relationships with institutions in Africa.*
- *Among those who expressed a preference for a co-funded or co-programmed option, the reasons given related to **a need for flexibility**, inclusiveness of the partnership, and lower costs.*
- *The institutionalised partnership option will be better placed to deliver this than the baseline option because it can take a **somewhat more flexible approach** to the criteria of the calls.*
- *It should be noted that the potential for the **creation of crowding-in effects for industry** has been taken into account.*
- *the Art. 185 form has the added advantage of being able **to build upon the experience gained** under EDCTP and the relations built with other important*

initiatives, at the EC level as well as internationally and with national-level stakeholders. This form would thus allow for least disruption of operations and maximum synergies".

(IHI):

- *"It is therefore important to have R&I themes where such interaction can accelerate innovation: either directly through project co-design and co-delivery or indirectly through a* ***portfolio-approach where project deliverables contribute to a subsequent integrated health solution****.*
- *The leverage effects relate to spillover effects from the knowledge gained as well as* ***the crowding-in effects on private investments*** *in R&I*
- *The work programme could build on* ***learnings and achievements of the IMI JU****, but not be constrained by the current programme, to ensure new technology areas can be effectively integrated to achieve maximum impact for the initiative.*
- *With high level of directionality, the strategic and potentially* ***a 'portfolio-level' approach*** *enhances the chance to integrate the currently disparate technologies of the various industry sectors and create a multistakeholder initiative that shares expertise, resources, and knowledge for health innovation. The Institutionalised Partnership thus has a unique opportunity to* ***break down silos across the entire value chain****.*
- *There is also* ***prior experience*** *with public-private partnerships through the IMI and ECSEL. These JUs have the capacity to mobilise resources quickly to respond to changing challenges and create new tools and platforms.*
- *Interviewees indicated* ***that investors would have more confidence*** *contributing to a* ***partnership with a higher degree of integration*** *as seen in the Institutionalised Partnerships.*
- *The* ***scale and size of Institutionalised Partnership projects*** *have the potential to enable faster 'pull through' of breakthrough discoveries towards societal impacts.*
- *During the open public consultation, the majority of the 91 respondents across the stakeholder groups reported that it would be possible to rationalise the candidate IHI and its activities, and/or to better link it with other comparable initiatives. This contrasted with EU citizens where a large proportion of the 16 respondents did not feel this would be possible. A common explanation for this response was that it could increase the* ***complexity of the partnership****.*
- *Regarding internal coherence, there is a clear trend of improvement from Option 0 through Option 1 to Option 3, as policy options increasingly enhance the initiative's strategic focus and* ***ability to create cross-project synergies through a portfolio approach.***
- *We consider however that much management learning can be transferred from the current IMI JU experience to optimise the set-up, running and discontinuation processes. In addition, Option 3 is best placed* ***to carry forward and extend the know-how, visibility and brand*** *that had been built during the IMI JU period".*
- *The transition from a weak industry to a globally competitive one will require major additional investment in for example the development and* ***scaling up of new (niche) technologies*** *where Europe has a comparative advantage."*

(HPC)

- *"We considered its large-scale integrated strategy most likely to deliver substantially greater social and economic benefits. We also judged it to be the preferred option in terms of its European added value and its* ***strategic flexibility****.*
- *The data also show rather small* ***numbers of intellectual property rights (IPRs)*** *(fewer than 10 in total) associated with Horizon 2020 HPC projects, which suggests that industrial engagement has not been as central as the participation data would suggest.*
- *Even if the main stakeholders at European level are involved, it is important that the* ***partnership remains open to new actors****, both domestically (e.g. new-to-HPC economic*
- *sectors, new HPC actors including SMEs) and internationally (e.g. leading scientific collaborations and private industry, possibly including UK firms post-Brexit).*
- *The HPC Institutionalised Partnership will also make use of the ability of this type of European Partnership to fund so-called 'additional activities,' financed by its private members – without matching Union funds – and* ***involving higher-TRL activities*** *than would be feasible typically for Horizon Europe.*
- *The partnership will work in* ***synergy with Horizon Europe****, where a sub-set of more fundamental research questions (those that are highly interesting but rather uncertain in terms of their feasibility or those interesting but less critical) will be funded through HEU calls.*
- *With all funding under the supervision of the partnership, this policy option should result in a more controlled investment than for each of the other Policy Options. That should result in a* ***stronger and more coherent research portfolio****.*
- *There is however a risk that the partnership would choose to focus heavily* ***on higher TRLs*** *and innovation procurement in an effort to make progress quickly on its most pressing problems and related objectives (underinvestment, digital autonomy, digital divide, etc). This would need to be monitored to ensure an* ***adequate balance between the partnership's short- and long-term priorities****.*
- *There will be a substantial* ***level of engagement with end users*** *– public and private – that are already working with peta-scale and pre-exa-scale technologies and have their own roadmaps relating to their demand for / development of next generation compute and storage.*
- *The partnership's direct management of its investments should allow for stronger oversight of its* ***project portfolio*** *than would be possible with any of the other three Policy Options and especially Policy Options 0 and 1 that have to rely on the non-specialists within the Executive Agencies for project support.*
- *The HEU application guidelines invite bidders to reflect on such issues too and the evaluation panels will also be invited to at least give some consideration to the extent to which bids have understood their position in the broader HEU portfolio and have made a good argument as to where they might (or should not) look to* ***cooperate and coordinate with other HEU activities****.*
- *The Institutionalised Partnership will be set up to provide a* ***reasonable degree of flexibility as regards the capacity to include new member****s.*
- *On the issue of* ***flexibility****, the HPC Institutionalised Partnership will have certain limits defined in its legislation, which may reduce its absolute capacity for being radically altered. However, there are various precedents where other partnerships have gone through major changes and have been able to adapt the underlying legislation (at a cost). In practice, the scope of the objectives and the partnership will be framed*

*broadly and there should be no immediate requirement for change. More pertinent, the HPC Institutionalised Partnership SRIA and biennial work programmes will provide a **high degree of adaptability** as regards major technological breakthroughs or changing market circumstances.*

- *We concluded that Horizon Europe would perform a little more strongly than either Option 1 or Option 3, on this criterion, with the central role played by industry within either the Co-Programmed or Institutionalised Partnership options likely to result in relatively greater emphasis being placed on **work at higher TRLs**.*
- *The preferred option presents the most coherent choice to **maximise synergies within the EU research and innovation landscape**. Policy makers are committed to strengthening HPC in the EU, as it is increasingly critical for EU industry, science and citizens, and an HPC IA would work closely with the Digital Europe Programme and the Connecting Europe Facility, amongst others. An HPC IA would also be more coherent with other parts of Horizon Europe.*
- *An institutionalised partnership in HPC would, ex-ante, provide a better approach to **ensure flexibility of implementation** and to adjust to changing policy, societal and/or market needs, or scientific advances."*

(KDT)

- *"Risk of failure associated with new technological trends is high and the **level of critical mass** is increasing for financial and human resources.*
- ***Shortening of the innovation cycle** and the **fast uptake of innovations** by markets demand closer and more effective links among stakeholders and increased involvement of industry in early stages of research.*
- *ECSEL JU has been able to **support large-scale projects** (up to €60-100 million) that no*
- *single MS would otherwise have been able to support by itself, (…)*
- *The risk of failure associated with these investments is high, and the required critical.*
- *mass of financial and human resources exceeds the capacity of individual companies or countries. What is more, **the speed of reaction and time** are of the essence due to the shortening of the innovation cycle.*
- *In this context, interviewees also remarked that problems with market size and business models also limit the **uptake of innovations.***
- *An overall majority of consulted SMEs, universities, RTOs, industry associations and public authorities and more than half of large companies commented that a stronger focus is needed on the development and effective deployment of technology in KDT. Research results produced in RTOs **needs to be absorbed fast by companies** and microelectronics and software developers from various levels of the value networks need **to interact directly and cooperate with end-product producers** in order to define, develop and test new solutions.*
- *Thus, the building of the ecosystem is expected to contribute to **the acceleration of the market readiness** of edge AI and other emerging technologies, and to the development of capabilities for integrating technologies, stronger cooperation, and knowledge-sharing among the different segments of the ecosystem, as well as the coordination of research agendas and priorities across countries and sectors.*
- *The **scope** of the current initiative in terms of technology coverage is even broader than ECSEL JU, and therefore the need to integrate various stakeholders is even more relevant. According to the report prepared by the Electronics Leader Group, the **shortening of the innovation cycle** in KDTs and the need for the **fast uptake of***

innovation by the market *requires close collaboration among technology developers and downstream links in the chain, as well as their involvement in* ***lower TRLs*** *in collaborations with RTOs.*

- *The Co-programmed Partnership was found to allow the* ***highest level of flexibility and agility*** *in the organisation and involvement KDT associations can provide a coordination service or function to consortia in order to further build on the research results of previous projects and* ***transfer them from low to high TRLs****.*
- *If needed, the Institutionalised Art 187 offers* ***flexibility*** *to design specific activities for SMEs. Therefore, in terms of the participation of the necessary mix of actors, the potential is high. Therefore, transferring results from low TRL projects to projects combining* ***high TRL activities*** *(up to 7 or 9) is important.*
- *Number of supported projects at TRLs 1 – 4 with a documented strategy for progressing to TRLs 5 – 8*
- *Number of* ***IP rights****, new products or services developed in the segments selected for support."*

(SNS)

- *"A future initiative would have to address the* ***slow speed of take up*** *of such platforms in Europe to ensure competitiveness of European industry. In particular, the current deployment of the initial 5G infrastructure in Europe is not as fast as in other regions, due to non-uniform regulations and legislation as well as uncoordinated efforts of both industries and institutional initiatives.*
- *The Smart Networks and Services field is a sector that relies heavily on* ***standardization,*** *and ensuring a strong presence in Standardization requires a coordinated approach at the European level to ensure a critical mass of European contributions.*
- *The interviews of stakeholders' further support this view of a risk prone R&D in the sector, and more importantly that R&D efforts need to be sustained overtime at all stage of the innovation process: from long-term R&D with* ***low Technology Readiness Levels (TRL)*** *(which prepare future generations of communication equipment and investigate very long term technological vision), to mid-term R&D (necessary to investigate how identified technology opportunities can transform into potential products), to short-term R&D (which investigate deployment issues and the future services enabled by the new infrastructure).*
- *As a consequence, interviewees insist on the necessity to* ***involve a wide variety of players*** *in the structure of the research program, which is key to understand and to take into account the diversity of verticals' requirements like security, network coverage, energy consumption, ultra-low latency round trip.*
- *This raises a significant risk of an uneven availability of the future communication networks and services throughout Europe, leading to limited and fragmented* ***adoption of new digital services*** *by EU industries.*
- *As such the initiative should ensure coordination and support to activities aiming at* ***accelerating the deployment*** *of the communication infrastructure.*
- *As such, it appears as important to allow a significant involvement of SME and an* ***ability to welcome new players*** *in the initiative. These new entrants could indeed be essential in building up future European leaders. There is a need to have a combination of different categories of players including universities and SMEs which are vital in the research program.*
- *A future initiative should be able to support* ***activities all across the spectrum of TRLs*** *and with perspective at long, medium, and short term.*

- *At the same time, it would offer the **flexibility to change the profile of participation** over time, with new partners joining to support new areas of activity in response to emerging results and changing priorities.*
- ***Participation would be less flexible** than under other options, but it might nevertheless be possible to change the profile of participation over time, with new partners joining to support new areas of activity in response emerging results and changing priorities.*
- *There are **strong synergies** with national/regional programmes and activities, and they can be ensured by the MS. Synergies with other European programmes or industrial strategies are limited.*
- *The **scale and scope** of the initiative is limited and depends on the participating programmes. The resulting funded R&I actions are typically smaller in scale than FP projects.*
- *The partnership would be responsible for specifying a work programme fully in line with the R&I priorities identified by the industry, **combining activity across the TRLs** (including key demonstration programmes) and with application in different vertical industries (e.g. automotive, manufacturing, transport, health, energy).*
- *Furthermore, the participation of vertical industry stakeholders in calls can be achieved (as shown in the more recent calls of the 5GPPP) increasing the potential for **adoption of the innovation**. However, the co-programmed partnership may miss some additional impacts that could be brought by **more synergies** and coordination with deployment-oriented initiatives and by a stronger commitment of the industry.*
- *The stronger focus on **large scale pilots'** activities, involvement of vertical industries and potential liaison with deployment activities would enable to strengthen the access of European citizens and industries to a critical infrastructure.*
- *Regarding the ability to have a **strong strategic focus**, this option would not allow for a strong cooperation and coordination between the funded projects, limiting the ability to have a strong and sound strategic focus shared at the level of a European industrial ecosystem.*
- ***Number of** publications, **patents** and standardization contributions achieved by the partnership and related to beyond 5G capabilities.*
- ***Take-up** of digital solutions in vertical industries"*

(Metrology)

- *"Interviews with industry stakeholders highlighted that the metrology community was less likely to **engage directly with industry end-users** in the broadest sense, with the majority of their connections being with instrumentation manufacturing sector.*
- *As a result, the stakeholders from within the metrology community also noted that the metrology system was **not well connected to the regulatory/policy making system**.*
- *The majority of stakeholders responding to the open consultation agreed that a lack of understanding or knowledge about metrology was a key problem, and a majority also agreed this was a key barrier to the **uptake of metrology innovations**.*
- *Supporting **greater engagement of industry and end-users** was noted by many stakeholders from industry and policymakers and the ministries responsible for metrology, as well as by the NMIs and DIs themselves.*
- *In this sense, most stakeholders agreed that the A185 Institutionalised Partnership model would provide the best mechanism for **engaging with end-users**.*

- *Lasting beyond the programme, these networks ensure impact into the future and an **'exit strategy' that avoids a 'cliff-edge'** at the end of the partnership."*

(Europe's Rail)

- *"One option would be to structure future R&I activity around the concept of 'mega projects', defined by reference to the benefits of new technologies for the **whole rail system** rather than according to the boundaries of specific sub-systems. In addition, there is a need for greater emphasis on demonstration projects to **improve market take-up of R&I outputs**. This requires a **move towards more R&I programmes at TRL 7-9, a significant change from the focus on TRL 1-6 under Horizon 2020**.*
- *There has been **insufficient exploitation of synergies between the S2R JU and other JUs**, particularly in view of application of key technologies such as digital across the transport sector and more broadly.*
- *There is less evidence of coordination and consolidation among the mobility-related partnerships. For example, there is **a lack of a cross-modal perspective** across the four prospective A187/CP partnerships as their titles imply different objectives and stakeholders.*
- *we suggest that the **lack of focus** on both freight and urban transport markets evident before Horizon 2020 would be likely to re-emerge under the baseline scenario.*
- *Third, there is fragmentation along the innovation life cycle, with research projects focusing on **low TRLs frequently coming to an end without any plan for follow-up activity leading to market take-up**.*
- *During the interview exercise some stakeholders noted that, more generally, the rail transport industry **is resistant to change**.*
- *In particular, the **number of registered industrial designs and patents** generated by the RSI is partly a function of the level of more fundamental research undertaken in the past to which suppliers have had access, either through formal collaboration with research-based organisations or because of a significant in-house research capability. As already noted, the **extent to which the industry can maintain intellectual property** of this kind is an important determinant of its technological lead, and hence its competitiveness, in global markets.*
- *A majority of all these groups similarly considered the **market take-up of innovations to be slow, either because of deployment issues or as a result of the regulatory framework**.*
- *These and other stakeholders, including EU citizens, also emphasised the importance of ensuring that investment in R&I activity made a difference to the rail industry and its customers through **more extensive and rapid take-up of innovation**.*
- *The coordination of wider stakeholder participation, including all the actors identified in Table 37, providing them with the mechanisms and incentives to support the specification and delivery of the full range of R&I activity according to their capabilities and objectives – this could be demonstrated by **an increase in the number of stakeholders within different categories** participating in R&I projects by the end of Horizon Europe.*
- *Strengthening collaboration **across the industry value chain**, such that fundamental research is translated into productive development effort and, ultimately, market focused innovation through demonstration and deployment.*
- *Mitigating the risks of R&I investment for organisations within the RSI and the rail industry seeking to **develop and deploy new products and services – this could be by a measurable increase in the level and intensity of such investment.***

- ***R&I activity at TRL 1-3*** *is particularly important in generating a pipeline of new ideas that could have practical applications in the future.*
- *A majority of the stakeholders interviewed agreed that it was* ***important to undertake projects across the TRLs*** *to build the scientific knowledge base and secure the future pipeline of potential innovation. They identified a wide range of research needs, many focusing on the exploitation of digital technology to improve both the quality and efficiency of rail services. Many interviewees, particularly train operators, infrastructure managers and representatives of the RSI, emphasised the importance of programming sufficient development and demonstration projects to ensure market take-up of R&I results. Some also highlighted the need to ensure transparency and better dissemination of results to maximise the impacts of the initiative.*
- *Overall, we would expect this objective to lead to a* ***more market-focused approach to R&I, with a higher proportion of projects leading directly to innovations that are taken up by the rail transport industry*** *in Europe and/or incorporated into products and services that are offered in global markets by the RSI.*
- *There may also be a need to change the profile of stakeholder participation over the life of the initiative, for example by providing for successive 'waves' of participation (with members selected according to their potential contribution to an evolving R&I agenda), and/or* ***more flexibility in the rules governing participation*** *to ensure that specific gaps in expertise can be filled effectively and efficiently.*
- ***Participation would be less flexible*** *than under other options, but it might nevertheless be possible to change the profile of participation over time, with new partners joining to support new areas of activity in response emerging results and changing priorities.*
- *The S2R JU itself stated that, in view of the higher cost of establishing a JU and the additional resources available to it, such a partnership should* ***target a market take-up rate of between 50% and 100%.*** *In estimating the impacts of this option, we have assumed a take-up rate of between 50% and 75% and that the efficiency targets set for the current JU are achieved by 2031.*
- *At the same time, several noted the importance of* ***providing for greater flexibility in the programming of individual projects and modifying the profile of participation.*** *Echoing the concerns of a limited number of interviewees mentioned above, one EU citizen suggested that the major and rapid innovation needed to transform the rail industry would not necessarily be achieved under a framework in which major suppliers with an interest in promoting particular technologies and systems had undue influence over the R&I agenda.*
- *In responding to the OPC, a majority of stakeholders stated that the legal structure underpinning an institutionalised partnership was either relevant or very relevant to the facilitation of collaboration with other partnerships under Horizon Europe. Support for this view was particularly strong among large business organisations and business associations, but it was also held by most SMEs, academic and research institutions, public authorities, and EU citizens. A substantial majority in each of the same stakeholder groups confirmed that there would be* ***scope for rationalising the activities of the candidate partnership for rail and to link it with other initiatives under Horizon Europe****.*
- *More generally, as the partnership would be more visible than either of the other options, it would be* ***likely to facilitate links with a wider range of EU institutions, agencies and initiatives.*** *This would support more efficient use of overall EU funding of transport projects and potentially lead to even wider participation in the R&I programme for rail".*

(SESAR) Integrated ATM

- *"Whilst the proposal is largely based on solutions from current R&I referred to in the European ATM Master Plan, it also represents a step change in ambition, requiring both more transformational technologies and* ***faster deployment of digital enablers*** *to support enhanced automation and virtualisation.*

- *Another question is the extent to which the national/regional R&I funding agencies would be prepared to participate directly in partnership projects as this could enable* ***better commercialisation*** *links between the generally the projects with technology readiness levels (TRL) that are funded by the public sector and provide a* ***stronger market pull.***

- *Agreed standards enable any manufacturer to produce interoperable and harmonised solutions that can then be certified according to the related regulations. The coordinated research and innovation actions that take into account the development of standards and regulations, facilitate the* ***acceleration of the innovation deployment****.*

- *The results of the open public consultations reveal that majority of individual stakeholders consider the* ***absence of standards as one of the problems in uptake of air traffic management innovations****.*

- *A stronger involvement of standardisation bodies (e.g. EUROCAE) and EASA (as a regulator) in the R&I was cited as a way of* ***accelerating the innovation upta****ke by airspace users, ANSPs, U-space community, ATM institutions, suppliers, SMEs, and staff.*

- *Innovation processes in ATM are long, and during those extended time periods the solution under development evolves, due to the changing environment (i.e., economy, price of fuel, travel demand****). Innovations that are "robust", in the sense of being solutions that address the changing requirements have the best chance of reaching deployment.***

- *Realising the benefits will largely depend on the ability of the sector to create the conditions to* ***shorten the innovation life cycle*** *for infrastructure modernisation.*

- *It is also necessary, to ensure that the outputs of the R&I are supported by safety, security, human factors, performance, environmental, and business cases demonstrating that they are mature for transfer to the deployment (potentially via the* ***Connecting Europe Facility****).*

- *The* ***economic impacts*** *have been evaluated as part of the recent European ATM Master Plan update campaign and are summarised.*

- *An* ***agile process*** *is also required to support the transition of ATM solutions across TRL levels and forms of R&I depending on the success or otherwise of projects.*

- *The R&I management process needs to understand the interdependencies and select the most promising solutions depending on the overall performance achievable by the best combination of solutions. This decision cannot be made by the individual projects but rather requires a* ***coordination process across all the solutions*** *being investigated. As digitalisation proceeds, the level of interaction between solutions increases, along with the* ***need for a performance-based approach to management interdependencies between projects.***

- *Participation would be less flexible than under other options, but it might nevertheless be possible to* ***change the profile of participation over time****, with new partners joining to support new areas of activity in response emerging results and changing priorities.*

- *There should be **flexibility in the partnership** to involve different stakeholders especially in topics where they can add significant value, as is the case in the drone sector. In order to reach the highest magnitude of impacts, **the acceleration of R&I deployment** is needed.*

- *This is best achieved by air navigation service providers working closely with the suppliers with **inputs from the end users** (e.g., airspace users).*

- *Open calls, due to the low ability of prioritisation and directed development across TRL levels, risk diverging interest from the industry leading **to insufficient focus of their efforts** (in terms of resources and financing) into this topic.*

- *This option also provides the R&I initiative with the best mechanisms to work with international efforts, such as the FAA's NextGen in the USA to **ensure that solutions are globally interoperable** and to support these solutions within ICAO.*

- *Internal coherence to ensure that useful results from other R&I programmes are successfully integrated within the ATM R&I – this is particularly important in areas such as AI and cybersecurity **where ATM needs to re-use solutions from other R&I initiatives**. External coherence to ensure that successful results are presented and accepted at ICAO and therefore become part of the global plan to modernise ATM."*

(Clean Aviation)

- *Compared to its key competitor (the USA), the European aeronautics industry has fewer companies of **sufficient size and capability** for large risk-sharing projects, and crucially does not benefit to the same extent as US companies (such as Boeing, Lockheed Martin, General Electric) from government-funded military and space research spill-over effects. R&D investments in the US (from industry and government) are generally higher than in Europe (four times higher in 2017).*

- *This can be realised through **speeding up the development** of cleaner air transport technologies for earliest possible deployment, and in particular the integration, demonstration, and validation of technologies capable of: (…)*

- *The lack of involvement of EASA in Clean Sky may have an impact on the "time to market" which benefits from an **early assessment of potential safety risks** and other issues related to certification of new products and technologies.*

- *There is arguably a **need for greater flexibility** and for reduction in the administrative burden. There are also some communication improvements that could be made.*

- *A **detailed analysis of synergies** for the envisaged and candidate Partnerships that are related to this cluster is shown in Figure 2.*

- *Four of these can be considered **as 'application' sector partnerships** with the other (clean hydrogen) being **more 'technology' orientated.***

- *Many business stakeholders also expressed the need for the industry to deliver **cost-efficient products** that would be **affordable for their airline customers.***

- *The research, technology and product development of a new aircraft type from conception phase (Technology Readiness Level 1) through all the steps of maturing the technologies to "fit-to-fly" (**Technology Readiness Level** 9) take between 10 and 20 years*

- *Technology maturation requires an exponential increase in resources, rather than a linear one, as the technological maturity increases. In particular, it arises from the fact that European aviation industry stakeholders, whether acting alone or in commercially driven consortia,* ***do not have sufficient size to fund*** *the types of projects required to significantly reduce the environmental impact of aviation without resorting to risk sharing: the high costs of demonstration of innovative solutions act as a barrier to commercialisation.*

- *Given the* ***complexity and scale of the challenge****, the common roadmap will allow stakeholders to* ***focus*** *on the tasks at hand.*

- *Furthermore, R&I activity at TRL 1-3 is particularly important in generating a pipeline of new ideas that could have practical applications in the future (whether in Clean Aviation or beyond).*

- *In the sub-sections of the OPC, the following impacts received high relevance scores: increased industrial leadership and uptake of new technologies; the* ***acceleration of key technologies*** *through selected demonstrators.*

- *There may be a need for punctual amendments to the profile of stakeholder participation, for example with members selected according to their potential contribution to an evolving R&I agenda, particularly as new technologies develop/are shelved, and/or* ***more flexibility in the rules governing participation*** *to ensure that specific gaps in expertise can be filled effectively and efficiently.*

- *(…) under Horizon Europe Candidate Institutionalised European Partnership on Clean Aviation remains relevant and* ***responsive to new market, industry and technological developments****.*

- *(…) activities will necessarily need to focus heavily* ***on high TRLs*** *(4 to 6), so that demonstration activities can provide firm evidence of the potential benefits of innovations. However, these technologies will be so emerging for most of them, that it would be helpful to also have a small share of activities focused on low TRLs (1 to 3), (…)*

- *An* ***exit-strategy and measures for phasing-out*** *from the Programme should be expected to be a functionality of any partnership, including Clean Aviation. However, as the general objective on climate change neutrality by 2050 for the aviation industry significantly exceeds the scope of the programming period (seven years), this should be taken into consideration when the exit-strategy is set up.*

- ***End-user acceptance*** *will also be a key factor.*

- *This would support more efficient use of overall EU funding of transport projects and potentially lead to even* ***wider participation in the R&I programme*** *for aeronautics. In addition, with the important involvement of the Commission on the Board of the institutionalised partnerships, it would be in a good position to be aware and inform the partnership of the opportunities for parallel, related activity funded through* ***EIB loans or under ERDF or CEF*** *and other international initiatives.*

- *This form of partnership will provide a* ***stable framework for encouraging the participation of organisations*** *from different stakeholder groups, including organisations outside the traditional aeronautical industry, securing and allocating resources, managing a wide range of R&I projects across the TRLs and building relationships with other partnerships and initiatives within the Climate, Energy and Mobility cluster and more generally.*

(Clean Hydrogen)

- *In upcoming years it will be important for hydrogen applications at **higher technology readiness levels to reach market scale** in their respective sectors. Once hydrogen value chains are well-established and an EU-wide hydrogen ecosystem is developed, it will be easier for these applications to achieve **cost reductions** and be further integrated into existing industries. Wide adoption will prompt larger-scale hydrogen product industrialisation, which will in turn reduce their costs.*

- *There are clearly many opportunities for **collaboration between partnerships and across clusters for the delivery and end-use of hydrogen**. Though the Clean Hydrogen initiative would be the only partnership focused on addressing hydrogen production.*

- *Those at higher TRLs – including stationary fuel cells, light FCEVs, fuel cell buses and electrolysers – are ready for market deployment; however, they remain **comparatively more expensive** than competitor technologies.*

- ***Market-enabling regulatory frameworks** to govern the production and use of key clean hydrogen applications are currently not adequate.*

- *Similarly with regard to the uptake in innovation problems, market failures due to **inadequate industry investment** has the least amount of very relevant answers.*

- *This will require continued research into **innovative technologies at lower TRLs**, which could potentially enhance or augment technologies currently on the market. The FCH JU and FCH 2 JU primarily supported the development of key hydrogen applications to higher TRLs.*

- *There have been **too few large-scale demonstration projects** on clean hydrogen production, especially in large scale-scale coupling with renewable power plants to generate necessary investments in mass manufacturing capacity for production equipment.*

- ***Harmonised regulatory frameworks** would encourage investors and enable more hydrogen applications to be deployed at larger scales.*

- *While funding at the national level provides an important contribution**, the scale of the research, innovation and funding** that is required for improving the whole value chains and the important number of applications is bigger than what can be achieved by a single Member State alone or by private companies alone.*

- *This objective can be achieved by **setting explicit technical goals** for research projects and adapting these goals as improvements are achieved. Scientifically enhancing clean hydrogen applications will mature existing technologies and will give rise to new technologies; if costs can be cut, efficiency gained, and quality guaranteed through scientific advancement, hydrogen applications will be more competitive within EU and international markets.*

- *Finally, the **creation of market uptake conditions** and FCH competitiveness can only be achieved with appropriate regulatory support, which is not currently in place, as stated in the interim evaluation of the FCH 2 JU.*

- *The importance of the **long-term commitment** of a wide range of relevant stakeholders.*

- *Finally, the initiative could act as a platform for coordination of relevant international cooperation efforts in the hydrogen economy, in order to create **synergies**, avoid*

duplications and anticipate market developments, when not interfering with European competitiveness

- *Whilst the general objectives can be expected to remain the same throughout the programming period, the RD&I development cannot expect to be planned once and for all at the outset as there is no clear understanding, nor a clear roadmap based on identified scientific and/or technological solutions to this day.* ***Flexibility in the selection of projects, implementation and possibly membership*** *will be crucial to ensure that Clean Hydrogen is empowered enough to deliver. At the same time, there should also be some* ***flexibility in the allocation of budget*** *so that as technologies develop or market needs evolve, funding can be adapted to handle emerging topics.*

- *Awareness will need to be increased among potential end users (industry, transport operators, building owners, utilities), among local and regional authorities and train them to strengthen their facilitating role.* ***Co-creating solutions with end-users****, emphasising* ***the importance of flexibility*** *in addressing different target groups over time.*

- *The initiative should be able to recycle lessons from higher TRL development projects to lower TRL in order to maximise the capitalisation of efforts. Therefore,* ***driving the agenda of low TRL applications*** *should be mainstreamed within a broader agenda encompassing all stages of maturity evolution.*

- *The programme office of the current JU has experts on FCH technology able to monitor KPIs across projects and make sure the upcoming calls can support a real improvement in KPIs. This type of good technical knowledge will allow the initiative to adequately assess projects in the selection process, to provide technical assistance where needed and even to challenge the industries that might remain conservative, in order to increase the speed of development.* ***Knowledge management of this kind is an important asset and only exists in this option****.*

- *It is important to address all levels of technological readiness in the RD&I agenda, but also to prioritise some over others. Most stakeholders interviewed, from both the industry and research organisations, but mainly from the industry, agree that over the next ten years,* ***RD&I should be concentrated on technologies at high, nearly market-ready levels and at low, potentially innovative levels****. EU contributions should decrease when addressing higher TRL projects, to ensure higher private contributions for demonstration projects.*

- *EU economic growth will depend more on* ***market uptake*** *than on RD&I activities. The option's ability to deliver depends on its* ***ability to create market conditions*** *and contribute to the excellence of the different clean hydrogen applications.*

- *In the frame of the Open Public Consultation, the following activities were considered relevant: a joint R&D programme, collaborative R&D projects, deployment and piloting activities, input to regulatory aspects and* ***co-creation of solutions with end-users.***

(Safe and Automated Road Transport)

- *Uncertainty over* ***the future cost of high autonomy CCAM solutions*** *leading to low confidence in business models to support* ***commercial deployment.***

- *More specifically in relation to self-driving vehicles the European Patents Office released a report in November 20189 summarising* ***patent applications*** *in Europe. Filed patents between 2011 and 2017 from companies based in European countries had the highest proportion at 37.2%, with the United States second with 33.7%.*

- *The Knowledgebase shall support the identification of gaps, overlaps and potential* ***synergies*** *between projects. A next step is to derive lessons learned and best practices.*

- *A lack of **shared strategic planning** of CCAM research and pre-deployment programmes was particularly recognised with 86 out of 102 respondents stating the problem was either relevant or very relevant to be addressed through R&I,*

- *Advanced CCAM solutions are **not mature for take up yet** and current investment levels in CCAM R&I in the EU are insufficient to maintain and extend EU industrial leadership.*

- ***Large scale demonstration activities** are proposed to integrate with the wider transport system and support **wider take-up.***

- *This shows that H2020 projects tend to cover a narrow range of R&I areas, **focussing on specific objectives and research targets** within the CCAM field. For this approach to target and support systemic and interoperable solutions, **strong coordination is required between projects** to help ensure learnings are shared between projects, partners and stakeholders. Furthermore, greater efforts could be made to identify overlaps at an early stage when defining the calls for proposals to **avoid duplication of efforts and leverage synergies** where appropriate.*

- *For example, the JRC previously referenced on the Future of Road Transport propose to go beyond pilots and develop regulatory sandboxes and Living Labs where new technologies and mobility solutions can be tested with the **engagement of citizens and other stakeholders**, allowing them to observe and influence any possible implications.*

- *The successful implementation of the initiative is also expected to ensure enough **critical mass** in Europe for the development of solutions to improve road safety and to improving maintaining and extending the industrial leadership of European industry in CCAM.*

- *In particular ensuring strong feedback between the technology development activities and the service design, demonstration, and impacts activities. Due to this strong feedback, and consequently an **ability to be agile and adjust the technological development and/or the societal impact analysis**, direction in the R&I agenda would benefit from regular review and be flexible enough to alter direction based on previous and emerging results.*

- *This **fluid R&I agenda** will also mean new actors will need to be introduced over the course of the initiative, and similarly some actors may reduce their involvement as requirements change.*

- *A number of existing R&I partnerships have been identified that would be **complimentary** to the initiative's R&I agenda.*

- *The initiative's **objectives are quite broad**, covering successful technical development, **accelerated market take-up**, and positive societal impacts.*

- *In order to support and accelerate market take-up of CCAM there needs to be strong linkage between the R&I activities and the **emerging regulatory framework** and its use (in particular for highly automated vehicles).*

- *The institutionalised partnership will create a **more stable set of actors** than the co-programmed partnership, with fewer new participants, and fewer partners leaving.*

- *It should be noted that the potential for the creation of **crowding-in effects for industry** has been taken into account when assessing the effectiveness of the policy options, above.*

- *There is concern amongst the majority of stakeholders that the institutionalised partnership could lead to a closed group of key partners and **leave little room for***

flexibility in terms of organic and evolving membership, adaptive R&I agenda, and innovative research. *These aspects will be needed whilst the technology is developing rapidly, and wider societal impacts need to be monitored, understood, and planned for. Therefore, it is deemed most appropriate to recommend the co-programmed partnership as the preferred option. The co-programmed partnership will provide significant improvements on directionality over the baseline, whilst allowing for* ***flexibility of approach over time*** *which the institutionalised partnership cannot guarantee.*

(Circular Bio Based Europe)

- *At the same time, only a small number of respondents across various groups see* ***Intellectual Property Rights (IPR) licencing*** *as 'very relevant' and 'relevant' barriers for exploitation of innovations in the circular bio-based field.*

- ***Weak linkages and trust*** *among economic actors from various sectors.*

- ***Uncertainty around availability and sustainability of biomass feedstock*** *(e.g. side/secondary streams).*

- ***Insufficient level of contributions secured from industry partners*** *compared to what was initially committed. The auditors see a high risk that the industry members will not achieve the minimum amount of operational financial contributions by the end of the programme.*

- *Need for* ***better coordination*** *with other EU initiatives. The cluster should exploit* ***synergies with R&I activities and envisaged partnerships in other clusters****.*

- *This is evidenced in the* ***declining number of patents*** *and is due to the huge diversity of the sectors and applications involved.*

- *One of the reasons for the insufficient competitiveness of the European bio-based industry has been the relatively* ***slow cross-sectoral transfer of knowledge*** *and bio-based solutions, and a* ***slow uptake of research*** *by the industry.*

- *Consulted stakeholders reiterated that there has been a* ***lack of economic and regulatory incentives*** *for bio-based products and producers.*

- *Research results with high potential also remain unexploited because* ***of legislative issues and patenting.***

- *One of the reasons for the limited deployment of demonstration and flagship facilities is their* ***cost and the level of risk*** *they bring.*

- *The need to* ***focus on high TRL*** *was reinstated in open answers regarding "other needs" to be addressed, especially by companies.*

- *This will also ensure that the* ***regulatory framework*** *for the bio-based industries, as part of the bioeconomy, is well harmonised, an essential condition for its success*

- *Investments in research, but also in market deployment,* ***must match those of other countries*** *(especially China and South Korea) to ensure EU competitiveness in the long term.*

- *Significant attention should be given to securing feedstock for the bio-based industry that is sufficient, environmentally sustainable* ***and available at a competitive price****.* ***End-users should also be involved*** *in order to complete the value chain and trigger higher awareness and the associated increase in demand for bio-based products.*

- *While **large installations** are necessary, but harder to finance, because of the size of the projects and the need for extensive quantities of sustainable feedstock, it would be easier to deploy and also replicate successful technological solutions in **smaller installations**.*

- *In this context, the CBE initiative will **benefit from cooperation** among a broad set of actors in a **flexible setting.***

- *Furthermore, in order to ensure that developments in these industries evolve along the circular economy principles, research and innovation must be supported along all segments of the value chains and **covering all TRLs.***

- *Within a dynamically changing environment, the **balance among various types of projects** needs to be ensured via a **higher level of flexibility in the research agenda** setting.*

- *Finally, it is important that the initiative scales up its impact by **securing large private investments** and contributions complementing the public investment provided by the Commission.*

- *It is paramount that the proposed initiative looks for **synergies, complementarities, coordination, collaboration and, if needed, co-creation with other ongoing initiatives** in order to contribute to achieving the sustainability, social and economic goals in a more efficient way. It should anchor firmly on the EU Bioeconomy Strategy, the Circular Economy Action Plan, the European Green Deal and Sustainable Development Goals, and should seek coherence and synergies (…)*

- *As there is a **higher flexibility** as to the types of activities that can be funded, it is likely that raising the awareness of different actors involved in circular and environmentally sustainable bio-based solutions is also likely to be achieved.*

- *It should be noted that consulted stakeholders acknowledged the aspect of **co-creation of solutions with end-users** as highly relevant.*

- *The possibility to fund flagship projects (and/or leverage other EU funding) is of significant importance for the future partnership, as venture capital would not support them as they are not bankable. This would lead to **more uptake of research results into commercialised products and processes** and ultimately enhance the competitiveness of European bio-based industry.*

- *Industry partners, including SMEs, will be motivated by the opportunity for more active participation especially given the **flexibility** and relatively low administrative barriers.*

- *This should include improving the governance model and process in the partnership by allowing a **better representation of other types of stakeholders** in agenda setting in order to ensure stronger coverage of non-economic objectives, better synergies with national and regional developments, and more **balanced decision-making** in which diverse stakeholder voices can be heard and considered in shaping the research agenda.*

(Innovative SMEs)

From the **horizontal study 1** on coherence and synergies, and efficiency and effectiveness in the impact assessment, the following elements emerge:

- *"Co-programmed and Institutionalised Partnerships under Art. 187 typically indicate the need for a **strengthened and large-scale directionality** of the R&I efforts in order to integrate ecosystems and value chains, and/or to ensure alignment with public service stakeholders and research communities.*

- *Finally, in some instances, the European Partnerships may gather actors along the value chains. More specifically, it can be relevant to stimulate further interactions between researchers and innovators, on the one side, and consumers and end-users, on the other. System transitions indeed require* ***demand articulation*** *to ensure that innovative solutions have* ***potential for uptake and large diffusion****.*
- *Regarding the governance of Article 187s partnerships and their JUs recurring issues reported by stakeholders are related to their* ***complex set up****,* ***their (lack of) flexibility and agility****, the (lack of) influence of various types of stakeholders and problems with transparency and openness.*
- *As top-level objectives, commitments and partners are set in a legally binding documents at the start of an institutionalised partnership, it is* ***difficult to change the direction*** *of these partnerships.*
- ***Flexibility of implementation*** *should be an essential part of a partnership. The ability to change direction if dominant trends in technology, markets and societies ask for this keeps R&I policies relevant.*
- ***More flexibility*** *can be assured if the SRIA is regularly updated and reviewed. Data analysis on the pipeline and portfolio of projects should be conducted regularly to assess is specific sub-domains of the SRIA should be phased out or rather expanded. The time cycle of renewing the SRIA will vary from topic by topic depending on the* ***speed of technology, market or societal changes*** *that affect the roadmap.*
- *The literature on complex PPPs also has examples that* ***too much openness*** *(or in the phrasing of the aforementioned MLE report: lack of connectivity) in the development of SRIA strategies* ***could hamper their effectiveness.***
- *It is clear that the advantages of increased openness and transparency should be considered to having significant weight to enhance and widen the political support for Institutionalised European Partnerships. Considering between advantages and disadvantages is a matter of* ***finding the right balance*** *so that all partners are willing to commit for the long term.*
- *Again, a* ***balance*** *needs to be found* ***between a focused strategy*** *with clear set of objectives* ***for the members that have committed themselves for the long term*** *on the one hand, while* ***on the other hand*** *allowing other stakeholders, whether from the* ***value chain, potential users, regulators or policymakers from national and regional governments*** *to have an influence on the problem definition used to build an SRIA as well as on selecting the priorities of the agenda.*
- *It is also expected that partnerships take on board a wider set of stakeholders, including those that can* ***enhance deployment"****.*

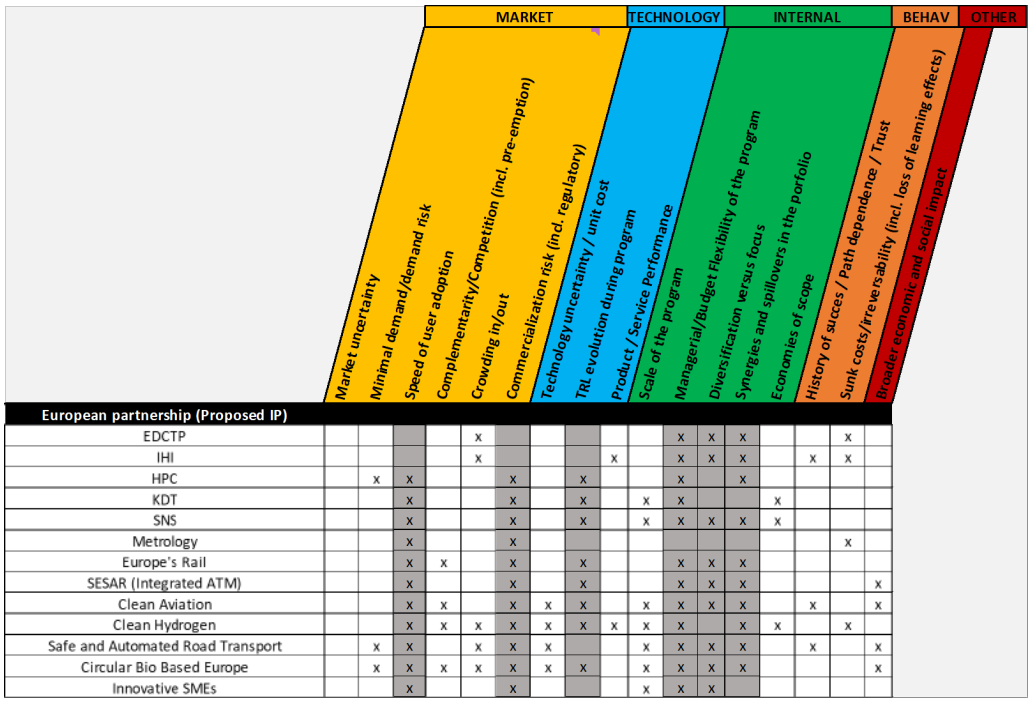
From the 2021 *ex-ante impact assessment of institutionalized EU partnerships (IHI)*, the following elements are relevant in the context of a portfolio approach, both from a general as well as a partnership specific perspective (IHI) (emphasis **in bold** added).

- *"Regarding the composition of the partnership most respondents indicated that for the proposed European Partnership to meet its objectives the* ***composition of partners needs to be flexible over time*** *and that a broad range of partners, including across disciplines and sectors, should be involved.*
- *(…) called for* ***flexibility*** *in various aspects of the partnership: topic generation process, funding models, in-kind contributions from industry, legal framework for intellectual property management, and better involvement of SMEs.*
- *The majority of interviewees felt that Institutionalised Partnership would be the most effective option of delivering scientific, economic, and societal impacts. Commonly given reasons for this were the broader range of stakeholders engaged, stronger*

*commitment from all parties, **flexibility on setting research agendas** and the longer-term outlook.*

- ***Co-programming** was seen as **suitable** for a partnership structure where a more flexible arrangement was desirable such as involving pre-existing partnerships or **for projects of a smaller scope**. There were, however, **concerns over co-programming** delivering an in-depth partnership of diverse stakeholders. It was felt that the commitment under this option would not deliver **the security needed to invest in truly innovative and risky ideas** and may therefore not be attractive to some partners.*
- *The most frequently discussed advantage of Institutionalised Partnerships over the other policy options was that this structure would attract and enable a broader set of actors to engage. **Diversity of stakeholders along the value chain** was seen as an essential component to achieve impacts.*
- *It was discussed that this integrated approach would also enable a more detailed discussion around intellectual property upfront, further increasing confidence in the partnership from the outset. This in turn could lead to **greater commitments from private partners** since the risk of investment is shared, leading to more innovative and potentially more impactful outcomes.*
- *Nevertheless, it is important to recognise the **tension between breadth and depth** and coverage and impact.*
- *The initiative should manage an **active portfolio** and design it in a way that considers associated risks in the process; portfolio projects should complement and build on each other.*
- ***Flexibility** is needed in the operational processes to create trust and equity among stakeholders. Since a **7-year horizon is a relatively long time in a fast-moving technological R&I space**, it will be important for the partnership to keep an open mind and allow **entry for new actors**, including those from outside the EU to allow learning across the best in class."*

Summarized assessment and conclusion based on a confrontation with the "ROT" dimensions.



European partnership (Proposed IP)	Market uncertainty	Minimal demand/demand risk	Speed of user adoption	Complementarity/Competition (incl. pre-emption)	Crowding in/out	Commercialization risk (incl. regulatory)	Technology uncertainty / unit cost	TRL evolution during program	Product / Service Performance	Scale of the program	Managerial/Budget Flexibility of the program	Diversification versus focus	Synergies and spillovers in the porfolio	Economies of scope	History of succes / Path dependence / Trust	Sunk costs/irreversability (incl. loss of learning effects)	Broader economic and social impact
EDCTP					x					x	x	x			x		
IHI					x			x		x	x	x		x	x		
HPC		x	x			x		x		x		x					
KDT			x			x			x	x			x				
SNS			x			x		x		x	x	x	x				
Metrology			x			x									x		
Europe's Rail			x	x		x		x		x	x	x					
SESAR (Integrated ATM)			x			x		x		x	x	x					x
Clean Aviation			x	x		x	x	x		x	x	x		x			x
Clean Hydrogen			x	x	x	x	x	x	x	x		x	x		x		
Safe and Automated Road Transport		x	x		x	x	x			x	x	x		x			x
Circular Bio Based Europe		x	x	x	x	x	x	x		x	x	x					x
Innovative SMEs			x			x				x	x						

Figure A2-13. Ex-ante impact assessments versus ROT dimensions. Source: Expert Group, 2023

Based on the textual analysis of the ex-ante impact assessments of candidate Institutionalised Partnerships, our analysis brought forward following insights. Important dimensions touched upon in the Impact Assessment are:

- Speed of user adoption (through involvement and co-creation with end users)
- Commercialization risk i.e., regulation and standardisation
- TRL evolution during the program (including coverage)
- Managerial and budget flexibility (including participation)
- Diversification versus focus
- Synergies (internal and external)

Limited but sufficient attention is given towards unit costs of technology and/or crucial resources, as well as broader social and economic impacts. While all partnerships and their impact assessments touch upon these issues, we only considered those where there was a in-depth understanding of both technology and cost issues, as well as the broader economic and social impacts (outlined in a causal way). This can be explained by the different nature of the Institutionalised Partnerships where some are more oriented at solving market failures and/or are oriented at the non-market environment.

Finally, scale seems a difficult dimension to develop (i.e., what is the minimum or optimum scale needed) as there are no convincing answers (expect some fragmented benchmarking e.g., with other global region's initiatives).

However, the assessment largely confirms the dimensions identified out of the various literature analyses.

4. Results from the consultation

4.1. General characterization

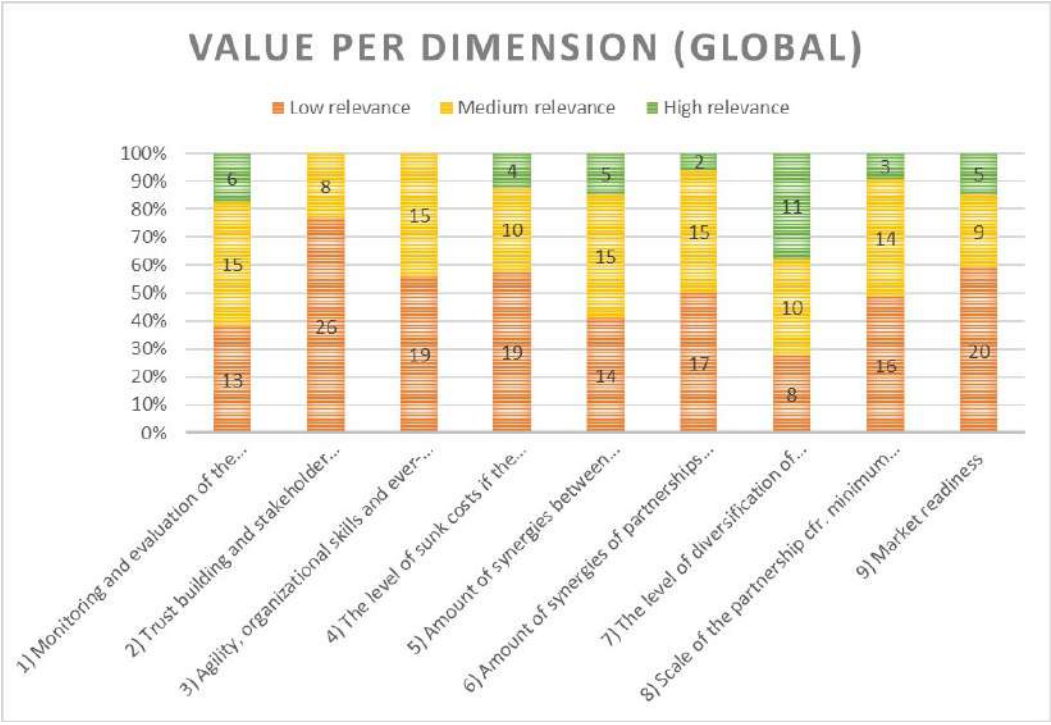


Figure A2-14. Global overview of the relevance of the proposed dimensions. Source: Expert Group (2023)

A first overview of the value per dimension as a global view gives a first insight of the interest of partnerships about the relevance of the proposed items. The interest of the data gathered relies in the fact that various instruments and various trends among the results can be identified.

This first overview allows us to draw an initial balance sheet on the dimensions analysed. This makes it possible to discern the relative importance of various dimensions, for which the medium/high relevance score exceeds 15. Dimensions 1 (Monitoring and evaluation of the partnership), 3 (Agility, organizational skills, and ever-changing business environment), 5 (Number of synergies between partnerships), 6 (Number of synergies of partnerships with other EU programs), 7 (level of diversification of partnerships in the portfolio) and 8 (Scale of the partnership) are thus at the top of the list of concerns for the most relevant criteria.

4.2. Study of categories

The interest of the global analysis appears to be with limited relevance while dealing with the impact of the identified dimensions. Therefore, a more refined point of view is needed. This is

achieved through a refined analysis, taking into account the views per cluster and type of partnership.

4.2.1. Study by dimension and cluster type

In order to refine the analysis of the orders of importance of the different dimensions, with the aim of knowing how precisely to operationalize them, another angle of analysis has been taken. This new analysis by dimension considered, according to the type of partnership and the type of cluster, is useful in order to be able to discern if weak signals leading certain types of partnerships to give priority to certain criteria.

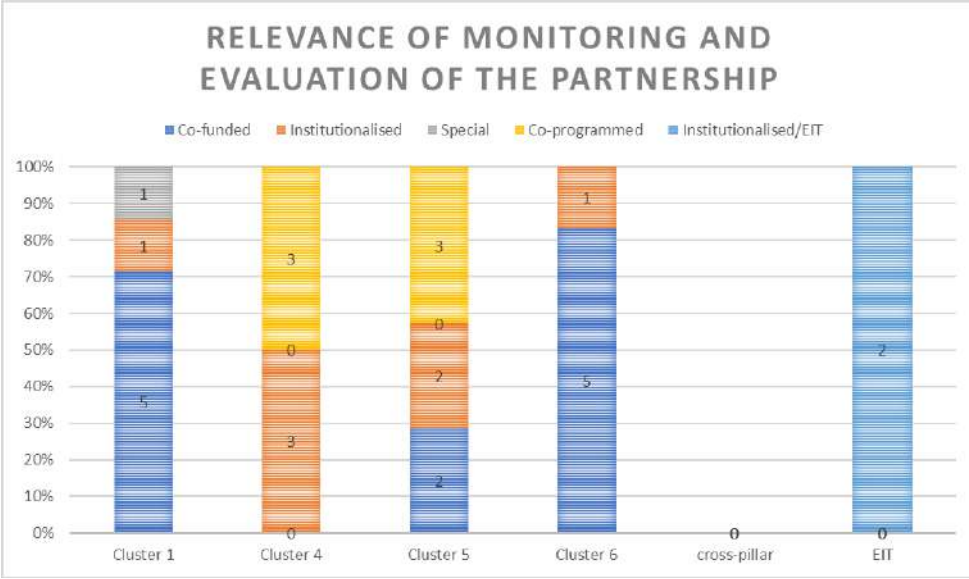


Figure A2-15. Relevance of Dimension 1 (Monitoring and evaluation of the partnership) per Cluster and type of partnership. Source: Expert Group (2023)

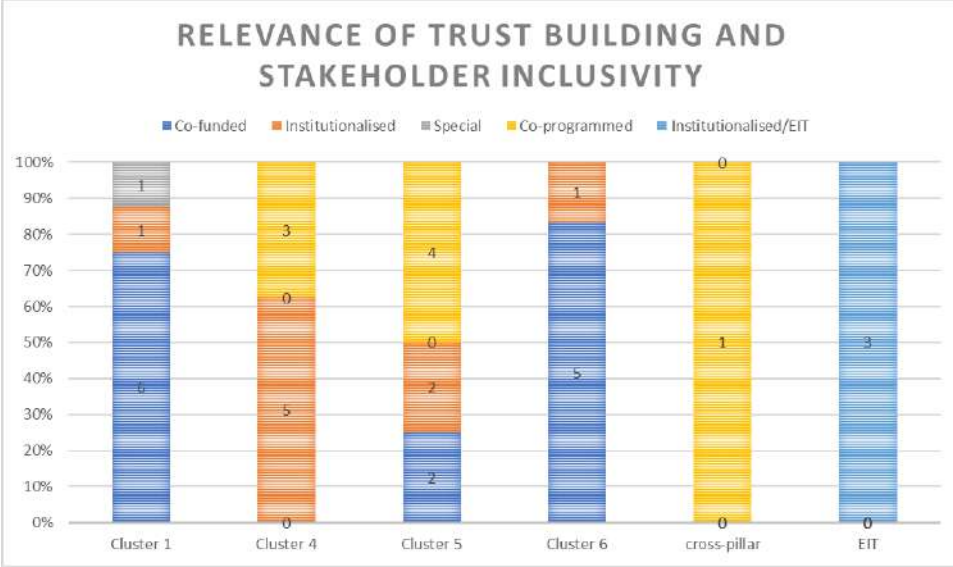


Figure A2-16. Relevance of Dimension 2 (Trust building and stakeholder inclusivity) per Cluster and type of partnership. Source: Expert Group (2023)

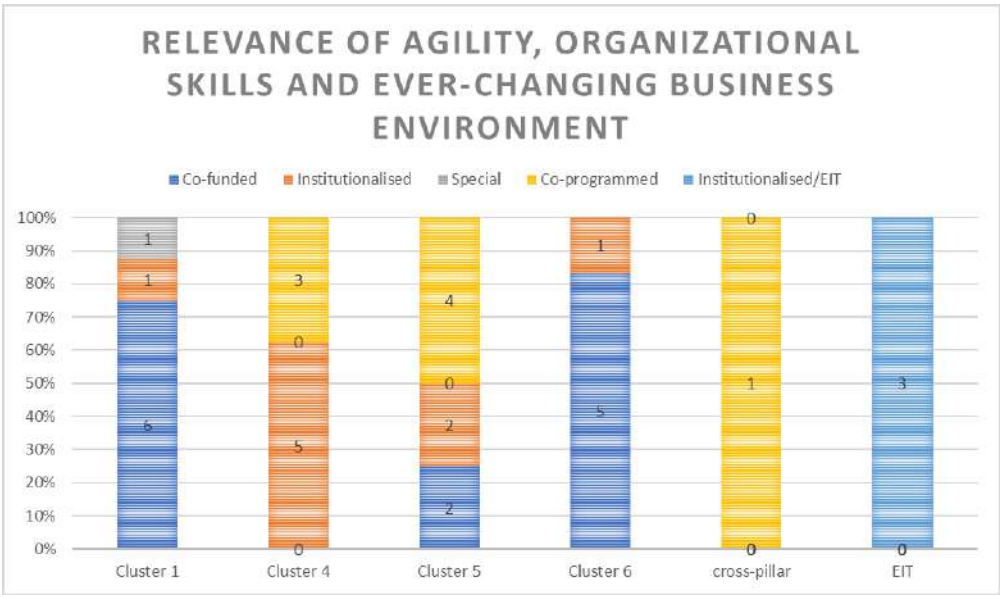


Figure A2-17. Relevance of Dimension 3 (Agility, organizational skills, and ever-changing business environment) per Cluster and type of partnership. Source: Expert Group (2023)

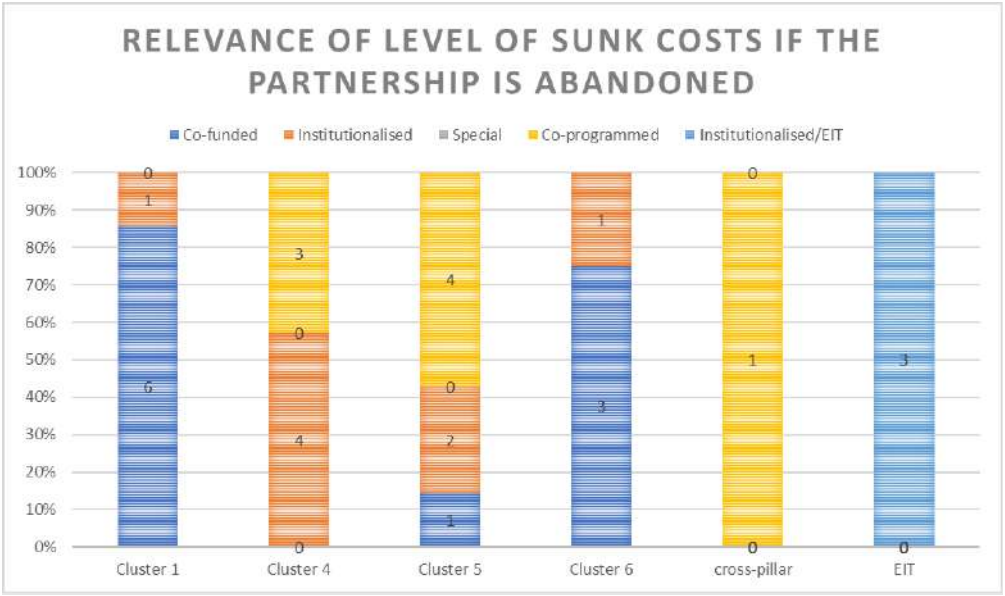


Figure A2-18. Relevance of Dimension 4 (level of sunk costs if the partnership is abandoned) per Cluster and type of partnership. Source: Expert Group (2023)

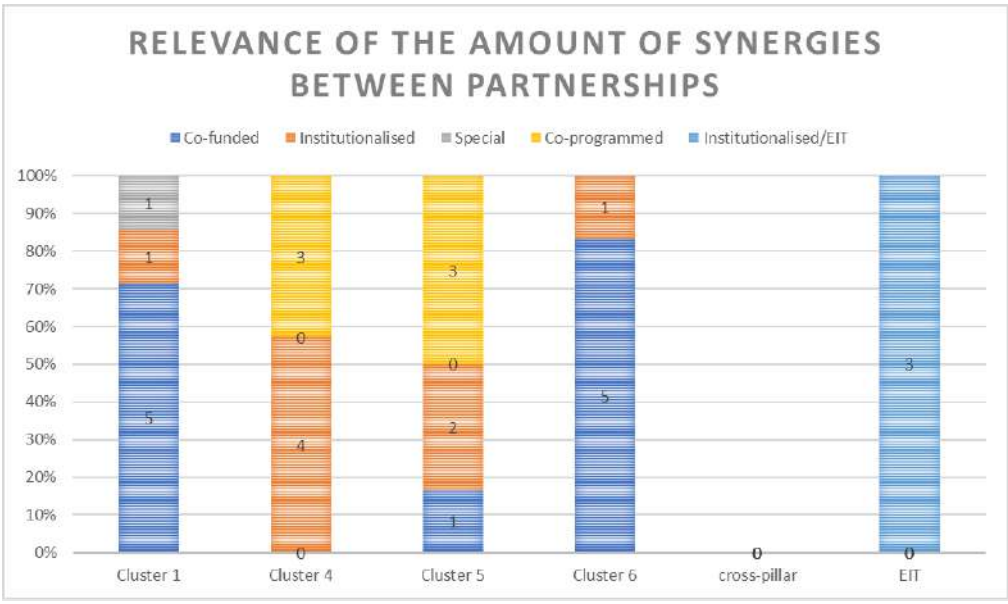


Figure A2-19. Relevance of Dimension 5 (Number of synergies between partnerships). Source: Expert Group (2023)

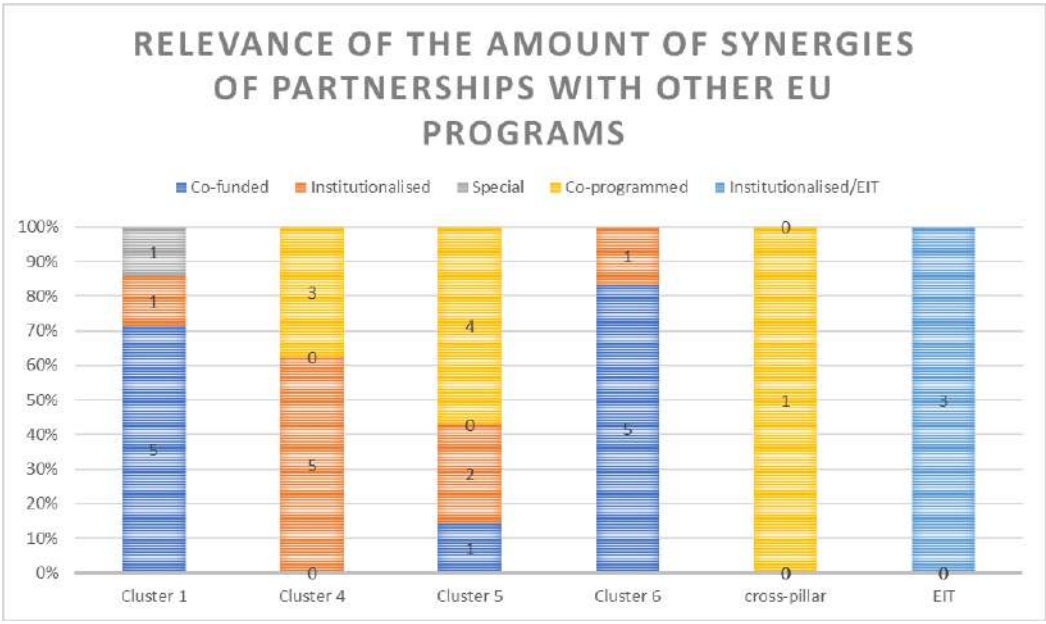


Figure A2-20. Relevance of Dimension 6 (Number of synergies of partnerships with other EU programs) per Cluster and type of partnership. Source: Expert Group (2023)

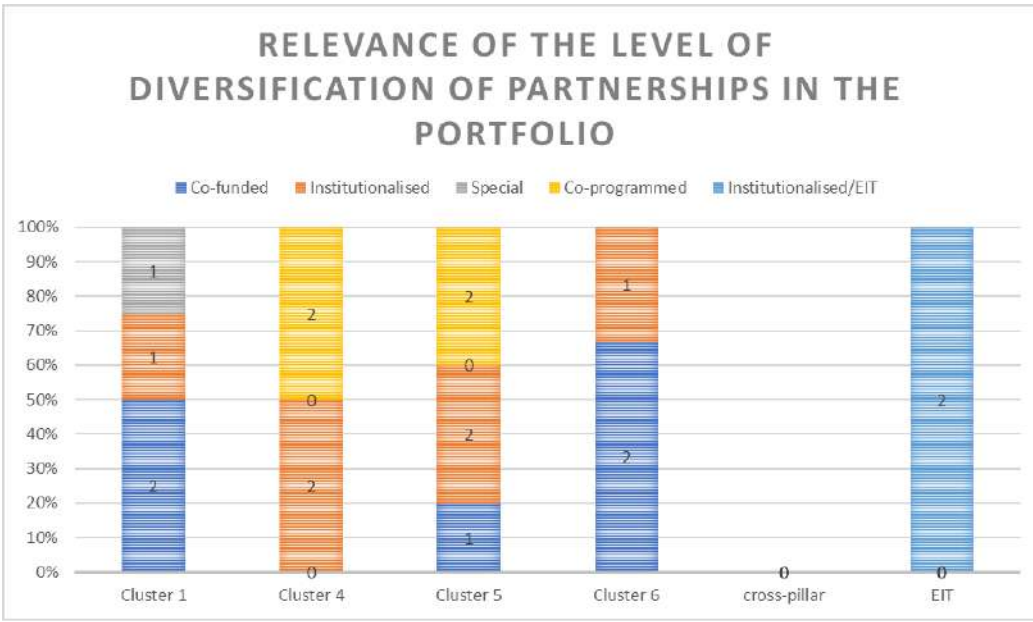


Figure A2-21. Relevance of Dimension 7 (Level of diversification of partnerships in the portfolio) per Cluster and type of partnership. Source: Expert Group (2023)

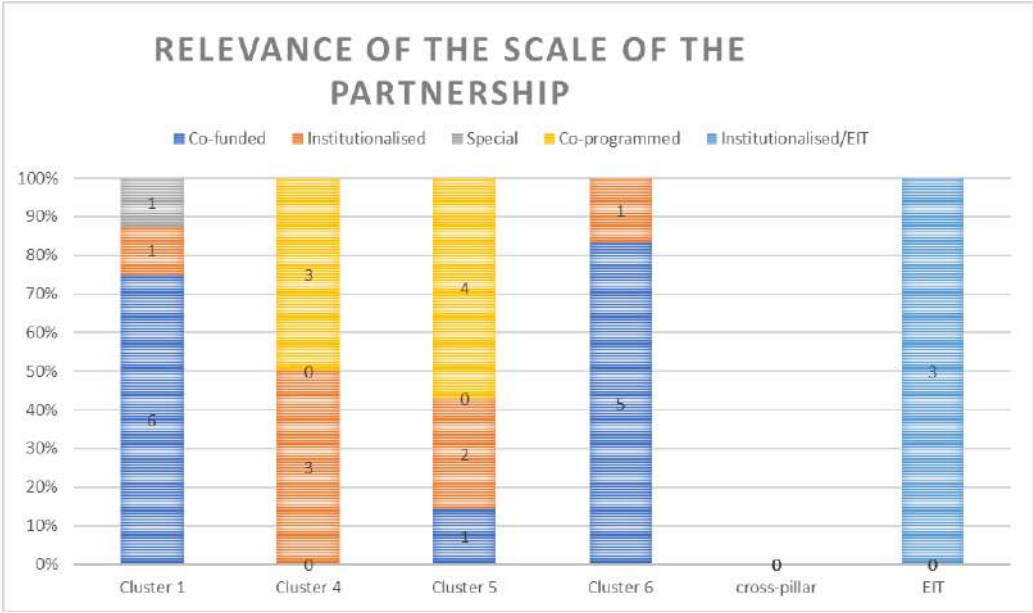


Figure A2-22. Relevance of Dimension 8 (Scale of the partnership) per Cluster and type of partnership. Source: Expert Group (2023)

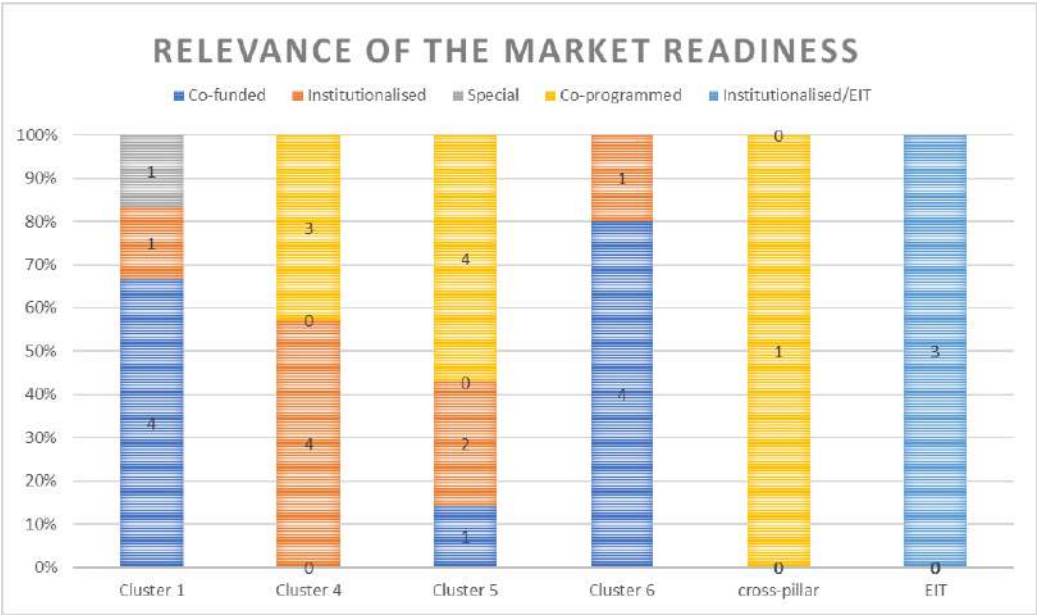


Figure A2-23. Relevance of Dimension 9 Market readiness per Cluster and type of partnership. Source: Expert Group (2023)

4.2.2. Study by dimension and type of partnership

A second line of analysis could be considered by focusing on the type of instrument in relation to the level of relevance of each dimension.

Generally speaking, the dimensions identified do not seem to be, a priori, at the heart of the concerns of the different types of partnership. However, different trends can be defined and the large number of responses to the relevance medium criterion confirms the overall interest of these dimensions studied.

In order to establish these trends, the methodology followed compared low relevance results with medium and high relevance results, in order to identify the most relevant but also the promising dimensions that can lead to different awareness-raising.

Co-funded partnerships show a particular interest in market readiness. They also have a particular emphasis on dimension n°7 (level of diversification of partnerships in the portfolio).

The results of the dimensions concerning internal and external synergies also show an interest that can potentially grow in these areas. The dimension concerning agility is also an indicator in the making.

The dimension n°1, relating to evaluation, seems relatively well integrated as well.

Co-funded partnerships also highlight the importance of dimensions 5 and 6 (internal and external synergies) and agility as a particular focus of interest.

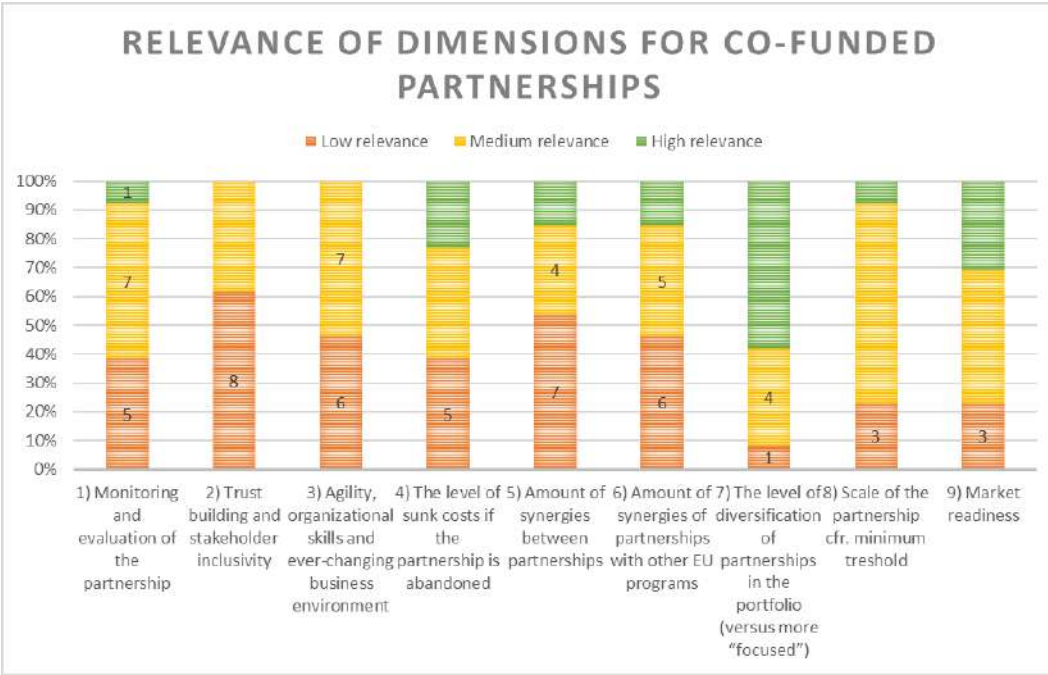


Figure A2-24. Relevance of dimensions for co-funded partnerships. Source: Expert Group (2023)

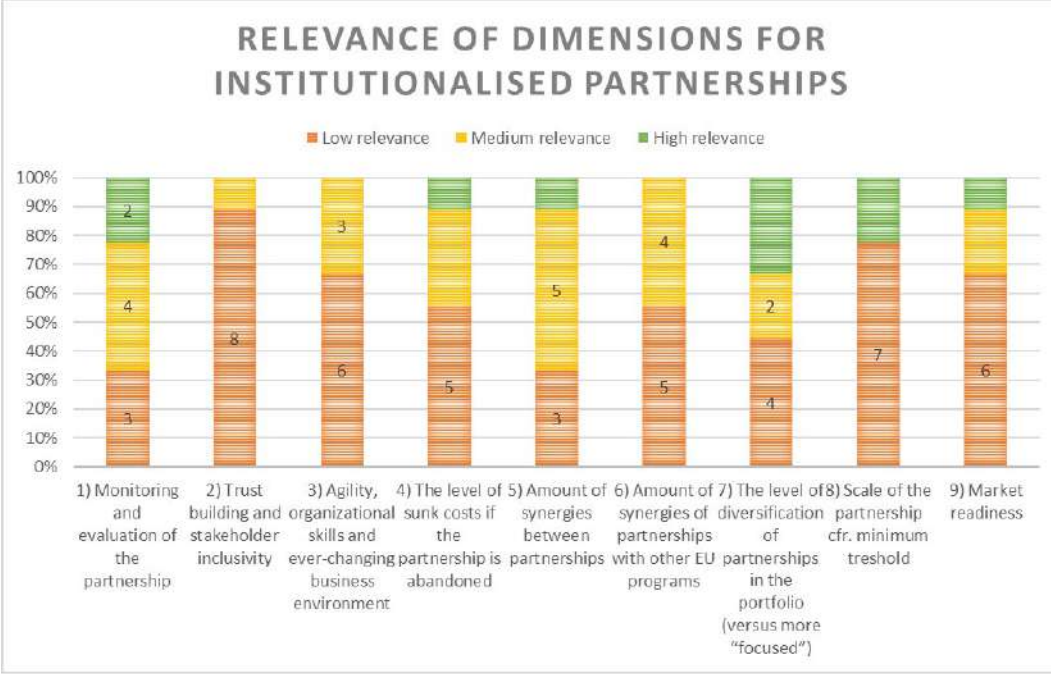


Figure A2-25. Relevance of dimensions for institutionalised Partnerships. Source: Expert Group (2023)

The institutionalised partnerships highlight few priorities in relation to the proposed dimensions.

While for this type of partnership, the monitoring/evaluation aspect is partly important, as well as internal synergies and the dimension relating to the level of diversification of the partnership in the

portfolio, different aspects seem to be less significant. The dimensions of trust building, agility, leadership and market readiness can be mentioned in this context. The sunk costs are not clearly identified in the priority dimensions either.

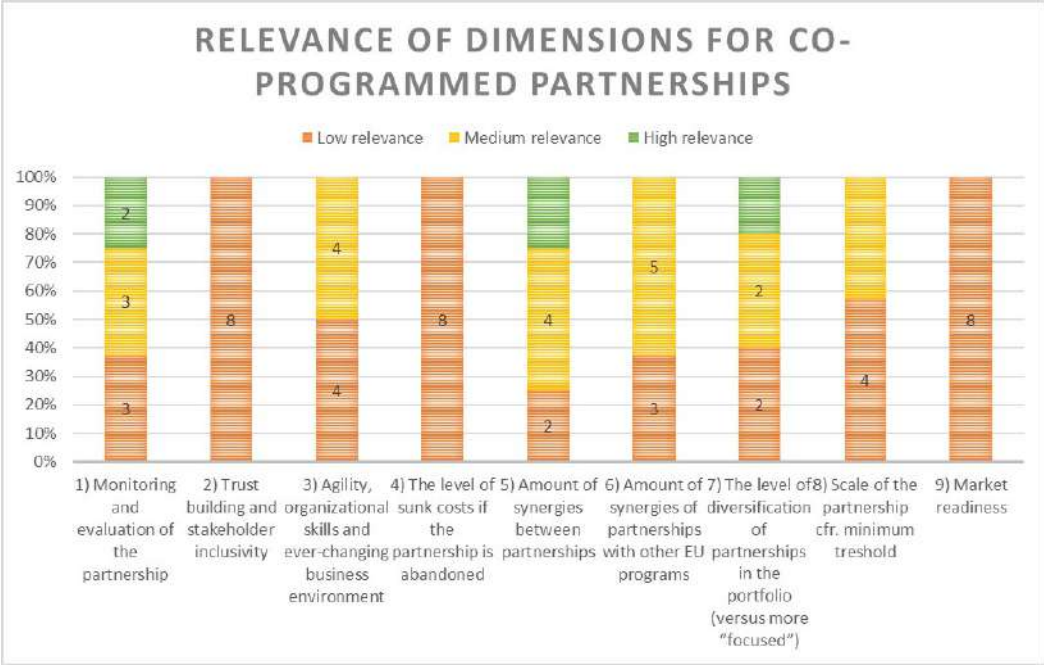


Figure A2-26. Relevance of dimensions for programmed /EIT Partnerships. Source: Expert Group (2023)

The co-programmed partnerships also offer a slightly different view of their priorities. While trust building; sunk costs; and market readiness clearly do not seem to be part of the priority dimensions of their strategy, internal and external synergies as well as agility notions show a medium to high interest for many of them.

The notion of monitoring also seems to be well integrated in the partnership's roll-out.

For this type of partnership, the picture of the priority dimensions is also slightly different. Even if the small number of respondents has to be considered to put it into perspective, all dimensions are of potential interest.

The monitoring/evaluation aspect is again more popular than the other dimensions.

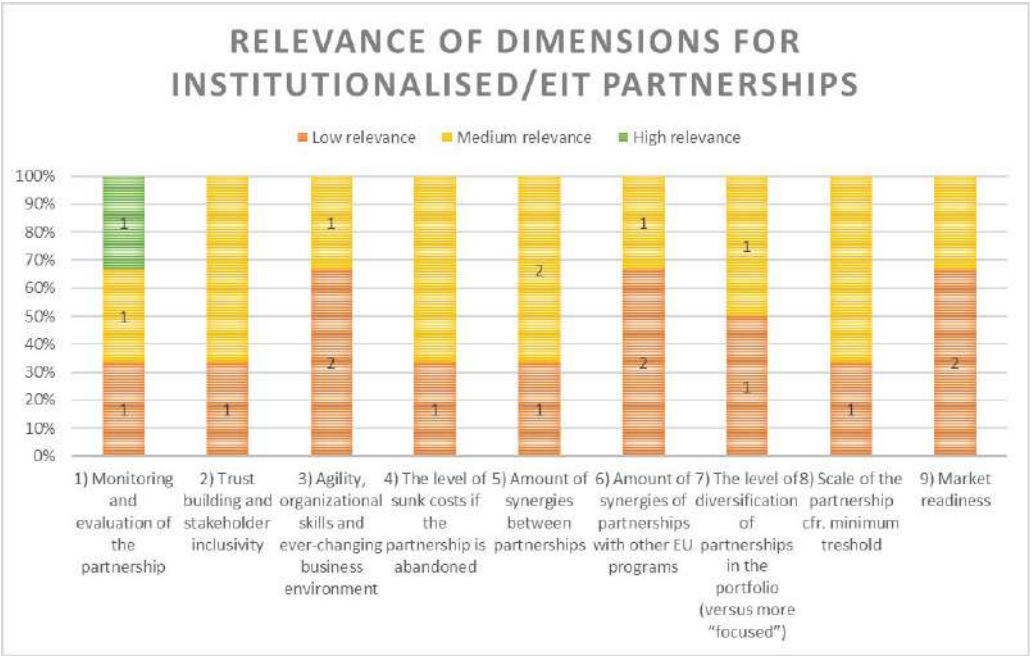


Figure A2-27. Relevance of dimensions for institutionalised/EIT Partnerships. Source: Expert Group (2023)

4.3. Conclusions

The analysis carried out by cluster shows an overall homogeneity in the positioning of priorities. Even if, in a first overview, the study of the different dimensions did not seem to receive extraordinary support, but a detailed analysis nevertheless shows interesting perspectives.

First of all, the type of dimension seems to be of little importance in its implementation within clusters: the results of the detailed analyses for each dimension according to the cluster seem to be very homogeneous overall and do not allow for any particular trend to emerge: the distribution by taking the axis of analysis of the composition of relevance within each cluster is also rather homogeneous. The diagrams reproduced are globally identical with a few adjustments concerning cluster 6 in particular.

This translates into a good alignment of the partnerships within their ecosystem in relation to these different dimensions. Regarding the study by dimension and type of partnership, more feedbacks can be obtained.

Dimension N°1, which takes into account monitoring and evaluation, seems to be well integrated overall. In particular, this reflects a certain maturity of the partnerships and a real acculturation to the policy of continuous improvement through these monitoring and evaluation elements carried out on a regular basis.

Dimensions N°5 (Amount of synergies between partnerships) and N°6 (Amount of synergies of partnerships with other EU programs) (sometimes in a more limited way for the dimension 6) and to a lesser extent dimension N°3 (Agility, organizational skills and ever-changing business environment) are also taken into account with a certain interest in the implementation of partnerships.

Dimension N°7 gathered in total (high + medium) 21 points confirming the value of a diversified set of partnerships at the level of the entire partnership programme.

5. Summary of criteria to be considered and their operationalization.

Based on the previous sections, a number of criteria stand out as of common interest to assess European Partnerships from an internal portfolio perspective. While we consider these criteria, based on the various analyses performed in previous sections, all as **relevant** to assess (either in quantitative and/or qualitative ways) the portfolio of partnerships, in order to perform the actual portfolio analysis the **implementation feasibility** (i.e. are there specific quantitative indicators or sufficiently developed qualitative methodologies available to assess the partnerships on these dimensions) also plays an important role towards operationalization. Table 4 below summarizes these criteria and their priority in terms of potential short term operationalization for portfolio assessment purposes, based on an initial assessment of both the difficulty as well as availability of data to make a harmonised assessment possible. Some important criteria, such as the 'sunk cost' (or irreversibility assessment) need significant additional research and analysis to suggest harmonized quantitative and qualitative approaches to allow for proper assessment and seems, while considered very relevant in decision-making, difficult to implement in the short term as there has not been an accepted and validated method developed yet. Further discussions are also needed to assess the criteria or dimensions against the types of partnerships (cf. the sub-portfolios) as depending on the sub-portfolio division, criteria may be more or less relevant (or even weighted). Below a high-level summarizing table shows the list of criteria and their operationalisation priority depending on both acceptance and feasibility. A more detailed table, containing ideas and comments related to the short-term operationalization of the criteria with a focus on implementation feasibility in a harmonized way, to develop the (sub-)portfolios can be found in Annex 2.

Below two tables are provided:

- A high-level summarizing table, showing the list of criteria and their operationalization priority depending on both acceptance and feasibility.
- A more detailed table containing ideas and comments related to operationalization of the criteria in a harmonized to develop the (sub-)portfolios.

Table A2-1. Prioritisation of dimensions/criteria for internal portfolio analysis/management. Source: Expert Group (2023)

Dimension / criterion	Priority
Agility and flexibility	High
Synergies (internal)	High
Synergies (external)	High
Market Readiness	High
TRL evolution	High
IP generation	High
Sunk costs / irreversibility	Medium
Trust and stakeholder flexibility	Medium
Scale	Medium
Diversified portfolio management	Low
Monitoring and evaluation	Low

Table A2-2. Dimensions/criteria for internal portfolio analysis/management and their operationalisation (issues). Source: Expert Group (2023)

Dimension / criterion	Operationalisation	Priority
Agility and flexibility	Need for unbundling in different elements: (1) Change in project portfolio or program orientation due to economic, technological, or societal changes. (2) Change in partnership composition (participation of stakeholders) due to economic, technological, or societal changes. Ex-ante: assessment of governance mechanisms, processes, and rules to determine partnership strategy and composition. Interim: proven and (speed of) modifications based on changes in the external environment (note: need to have solid and formalized monitoring of external tendencies) Final: idem but over the lifetime Note: to be discussed whether flexibility is needed in all forms of partnerships – e.g., for Institutionalised Partnerships, different viewpoints are presented as regards their potential for or contribution to strategic flexibility	High
Scale	Difficult to define "minimum" scale in a harmonized way given different ecosystems per technology, per industry, per societal challenge; however, could be operationalized through global benchmarking (North America, China, Japan).	Medium
Synergies (internal)	Synergies within the partnership portfolio, see Technopolis and other assessments (expert analysis K. Erbe). Ex-ante: based on expert analysis of SRIA and other documents, determination of a score (note: to be harmonized based on "horizontal" or "vertical" nature of P's – cfr Technopolis) / setting of baselines of synergies and shared resources (cfr. examples BMR) as well as expected impacts. Baseline performance may depend heavily on the type of partnership or the subportfolio considered (e.g., "vertical" partnerships may have lower baselines in terms of expected synergy creation). Interim: Measurement of realized synergies and impacts against KPIs Ex-post: Measurement of realized synergies and impacts against KPIs. Note: for impacts, challenges of causality if impacts need to be quantified, probably better based on case studies.	High
Synergies (external)	Synergies outside the partnership portfolio: • Other EU funding mechanisms: CEF, Regional Development,… • Other European agencies/initiatives: ESA,… • Other global and regional initiatives: CERN, NATO, NASA,… Ex-ante: based on expert analysis of SRIA and other documents, determination of a score (note: to be harmonized based on "horizontal" or "vertical" nature of P's – cf. Technopolis) / setting of baselines of synergies and shared resources (cfr. examples BMR, in euro) as well as expected impacts Interim: Measurement of realized synergies and impacts against KPIs	High

	Ex-post: Measurement of realized synergies and impacts against KPIs. Note: for impacts, challenges of causality if impacts need to be quantified, probably better based on case studies.	
Sunk costs	Quantification of winding down costs (cf. Technopolis impact assessment) could provide indications – but does not cover the full sunk cost/irreversibility assessment. Further need to assess, which resources (networks of knowledge, social capital, infrastructures/labs, …) will be irreversibly abandoned, and need to quantify (a more qualitative/strategic approach needed). Recommendation to task experts to develop a methodology to quantify the sunk costs (or alternatively valuing the 'exit' option)	Medium
Trust and stakeholder flexibility	Governance indicator: partly captured by agility and flexibility, or presence of particular governance mechanisms (board composition, etc.). Presence of structures and processes for better stakeholder inclusion does not mean "quality" inclusion per se. Hence: could be further operationalized if a harmonized survey instrument is developed towards P's stakeholders	Medium
Diversified portfolio management	Governance indicator (checkbox approach) – difficult to quantify	Low
Market Readiness	Could be a composite indicator consisting of: (1) Uptake of innovation (compared to baselines from either predecessors or jointly defined against the "zero" or second-best solution) (2) Private sector crowding-in Existence of a significant harmonization challenge: e.g. partnerships dealing with societal/non-market challenges will have different definitions to crowd in societal actors as well as uptake of the solutions.	High
Monitoring and evaluation	Governance indicator (assessment of the quality and relevance of monitoring systems and governance processes associated) – strong link with flexibility and agility as monitoring when done in a foresight looking way will lead to flexible decision-making. Difficult to operationalize: how to measure the quality of a measurement system and the associated decision-making process?	Low
TRL evolution	TRL improvement levels: amount and speed of TRL improvement (e.g. number of years for programmed projects to reach TRL8) Next to TRL improvement, broadness of scope in terms of TRL coverage to be successful may be an additional measure (suppose there is a need of having both low and high TRL in a balanced way)	High
IP generation	Traditional measurements of IP generation (number of patents, …) , potentially benchmarked against global competition	High

6. Conclusion and way forward

Developing a portfolio analysis method to support decision-making from the vantage point of the European Commission in the context of the development of European Partnerships proves particularly challenging due to important divergences in terms of underlying rationales as well as different types of instruments (in contract to traditional R&D portfolio analysis frameworks or portfolio management in general).

Therefore, several aspects may need to be further developed based on this initial, exploratory approach:

(1) Developing the appropriate sets and dimensions to be used to define relevant sub-portfolios: in this analysis, all relevant dimensions to subdivide the full set have been inventoried and could provide a solid basis for further discussion, leading to an accepted set of meaningful sub-portfolios.
(2) Linking the relevant dimensions to the diverse sub-portfolios: as we highlighted, not all dimensions (and associated indicators to operationalize the approach) may prove to have the same relevance (or weight) depending on the sub-portfolio considered.
(3) Based on the dimensions for difference sub-portfolios put forward, select the appropriate combinations of dimensions to provide insights into partnership performance from a portfolio perspective.
(4) Develop harmonized approaches to measure performance on the portfolio dimensions in order to position partnerships against each other within the portfolio.
(5) Develop policy recommendations based on obtained results from the sub-portfolio analysis, i.e., develop the linkages between positions in the (sub)portfolio and the policy recommendations that are resulting from a position.

Notwithstanding the fact that a full-fledged portfolio analysis methodology and its operationalisation, given the resources available, lies beyond the work performed in this initial, explorative analysis, the analysis provides ground to more prominently assess the following elements when decision-making processes around new of existing partnerships take place:

- The degree of (strategic) flexibility and agility, both at the level of resource allocation decisions within the partnership as well as composition of the partnership;
- Internal (i.e. within the portfolio) and external synergies (i.e. other EU programs as well as national and global programs);
- Market readiness as defined by uptake of innovation and private sector crowding in (note that for some partnerships this is less relevant)
- TRL evolution over the lifecycle
- Amount of IP generation

Finally, while only considered as medium priority, our analysis points to the dimension of sunk costs / irreversibility as an important element for which appropriate methodologies, both qualitative and quantitative, have to be developed in terms of resource allocations. This also resonates from the increased call, both from public and private perspectives, to integrate real options reasoning into decision-making under uncertainty in volatile environments. In sum, the value of exit, or delayed investment into a partnership, should be better understood and defined.

7. Bibliography and additional graphs

7.1. Bibliography

Adam B. Masters, Cultural Influences on Public-Private Partnerships in Global Governance, 2019, Palgrave Macmillan Cham, DOI https://doi.org/10.1007/978-3-319-96782-0

Anand, J., Oriani, R., & Vassolo, R. S. (2007). Managing a portfolio of real options. In *Real Options Theory* (Vol. 24, pp. 275-303). Emerald Group Publishing Limited.

Avrane-Chopard, J., Muhlmann, D., How to develop soft skills? 2019, Available at https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/the-organization-blog/how-to-develop-soft-skills

Bednyagin, D., & Gnansounou, E. (2011). Real options valuation of fusion energy R&D programme. *Energy Policy*, *39*(1), 116-130.

Belz, A., Eckhause, J., Terrile, R., & Zapatero, F. (2021). Applying Stakeholder Theory in a Real Options Model of the NASA SBIR R&D Portfolio. *Boston University Questrom School of Business Research Paper*, (3907466).

Boer, F. P. (2000). Valuation of technology using "real options". *Research-Technology Management*, *43*(4), 26-30.

Choi, H. Y., Kwak, S. J., & Yoo, S. H. (2016). Using real options pricing to value public R&D investment in the deep seabed manganese nodule project. *Asian Journal of Innovation and Policy*, *5*(2), 197-207.

Grant, R. M., & Jordan, J. J. (2010). *Foundations of strategy*. John Wiley & Sons.

Gunther McGrath, R., & Nerkar, A. (2004). Real options reasoning and a new look at the R&D investment strategies of pharmaceutical firms. *Strategic Management Journal*, *25*(1), 1-21.

Hayes, C., 4 Essential Partnership Soft Skills, 04/2022, available at https://www.resonanceglobal.com/blog/partnership-soft-skills

Hsu, Y. G., Tzeng, G. H., & Shyu, J. Z. (2003). Fuzzy multiple criteria selection of government-sponsored frontier technology R&D projects. *R&D Management*, *33*(5), 539-551.

Huchzermeier, A., & Loch, C. H. (2001). Project management under risk: Using the real options approach to evaluate flexibility in R&D. *Management Science*, *47*(1), 85-101.

Ilinitch, A. Y., & Schaltegger, S. C. (1995). Developing a green business portfolio. *Long Range Planning*, *28*(2), 29-38.

Johnson, W. H. (2007). Managing uncertainty in innovation: the applicability of both real options and path dependency theory. *Creativity and Innovation Management*, *16*(3), 274-281.

Karamitsos, D. (2009). Real options in Strategy of R&D Portfolio. *ETH Zurich and Industrial Partner*.

Linquiti, P. D. (2012). *Application of Finance Theory and Real Option Techniques to Public Sector Investments Made Under Uncertainty: Research & Development and Climate Change*(Doctoral dissertation, The George Washington University).

Lint, O. (2002). *Retrospective insights from real options in R&D*. Leuven, Belgium: Vlerick Leuven Gent Management School.

Mankins, M., & Gottfredson, M. (2022). Strategy-Making in Turbulent Times A dynamic new model. *Harvard Business Review*, *100*(9-10), 60-69.

Martín-Barrera, G., Zamora-Ramírez, C., & González-González, J. M. (2016). Application of real options valuation for analysing the impact of public R&D financing on renewable energy projects: A company' s perspective. *Renewable and Sustainable Energy Reviews*, *63*, 292-301.

Martín-Barrera, G., Zamora-Ramírez, C., & González-González, J. M. (2017). Impact of flexibility in public R&D funding: How real options could avoid the crowding-out effect. *Renewable and Sustainable Energy Reviews*, *76*, 813-823.

Meirovich, G. (2012), "Cultural Similarities and Differences: Impacts on Performance in Strategic Partnerships", Cooper, C.L. and Finkelstein, S. (Ed.) *Advances in Mergers and Acquisitions* (*Advances in Mergers and Acquisitions, Vol. 10*), Emerald Group Publishing

Limited, Bingley, pp. 55-74. https://doi.org/10.1108/S1479-361X(2012)0000010007

Newton, D. P., Paxson, D. A., & Widdicks, M. (2004). Real R&D options. *International Journal of Management Reviews*, *5*(2), 113-130.

OECD – Successful Partnerships, a guide. 36279186.pdf (oecd.org)

Oriani, R., & Sobrero, M. (2008). Uncertainty and the market valuation of R&D within a real options logic. *Strategic Management Journal*, *29*(4), 343-361.

Özdemir, M. N., & van den Ende, J. (2021). Innovators' gains from incumbents' exit options in R&D alliances: A reconciliation of real options and transaction costs logics. *Strategic Entrepreneurship Journal*, *15*(1), 144-166.

Park, R., The importance of adaptability in an increasingly complex world, EY, available at https://www.ey.com/en_us/innovation/the-importance-of-adaptability-in-an-increasingly-complex-world

Perlitz, M., Peske, T., & Schrank, R. (1999). Real options valuation: the new frontier in R&D project evaluation?. *R&d Management*, *29*(3), 255-270.

Reeves, M., Moose, S., & Venema, T. (2014). The growth share matrix. *BCG–The Boston Consulting Group*.

Schneider, M., Tejeda, M., Dondi, G., Herzog, F., Keel, S., & Geering, H. (2008). Making real options work for practitioners: a generic model for valuing R&D projects. *R&d Management*, *38*(1), 85-106.

Shishko, R., Ebbeler, D. H., & Fox, G. (2004). NASA technology assessment using real options valuation. *Systems Engineering*, *7*(1), 1-13.

Trigeorgis, L., & Reuer, J. J. (2017). Real options theory in strategic management. *Strategic management journal*, *38*(1), 42-63.

Tsui, M. (2005). *Valuing innovative technology R&D as a real option: Application to fuel cell vehicles* (Doctoral dissertation, Massachusetts Institute of Technology).

Van Bekkum, S., Pennings, E., & Smit, H. (2009). A real options perspective on R&D portfolio diversification. *Research Policy*, *38*(7), 1150-1158.

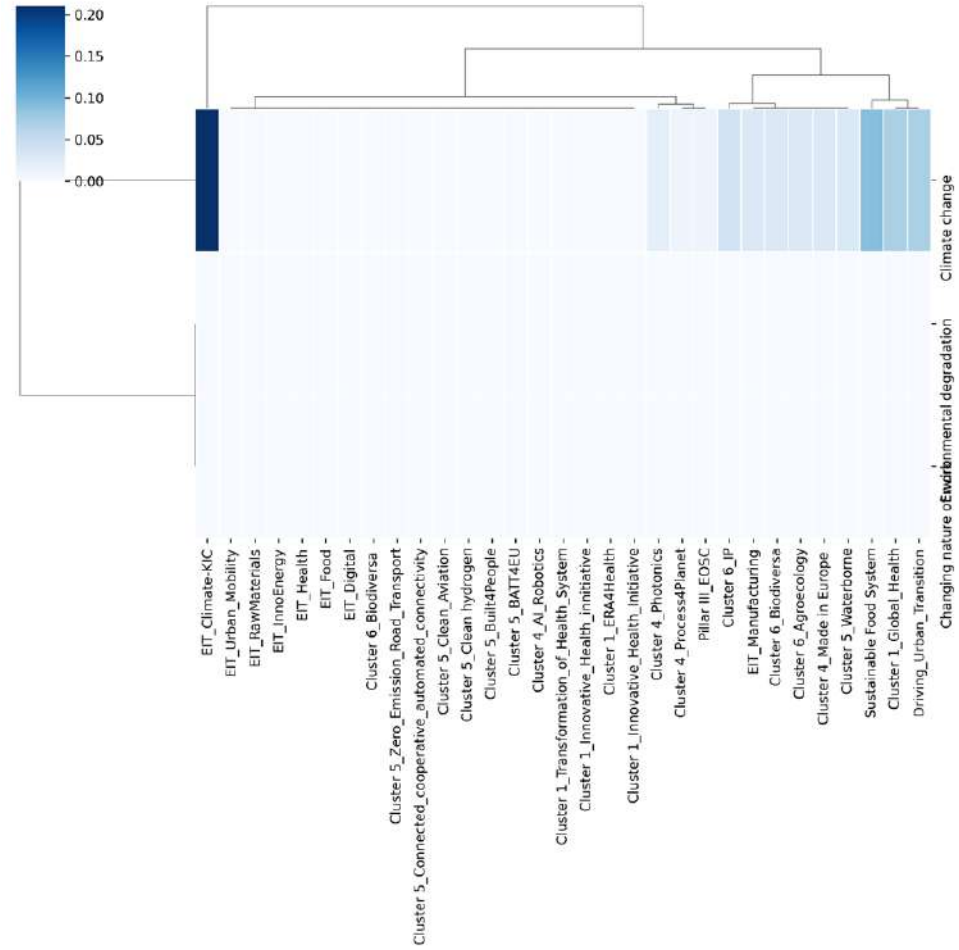
Van Zee, R. D., & Spinler, S. (2014). Real option valuation of public sector R&D investments with a down-and-out barrier option. *Technovation*, *34*(8), 477-484.

Varadarajan, R. (2018), "Innovation, Innovation Strategy, and Strategic Innovation", *Innovation and Strategy* (*Review of Marketing Research, Vol. 15*), Emerald Publishing Limited, Bingley, pp. 143-166. https://doi.org/10.1108/S1548-643520180000015007

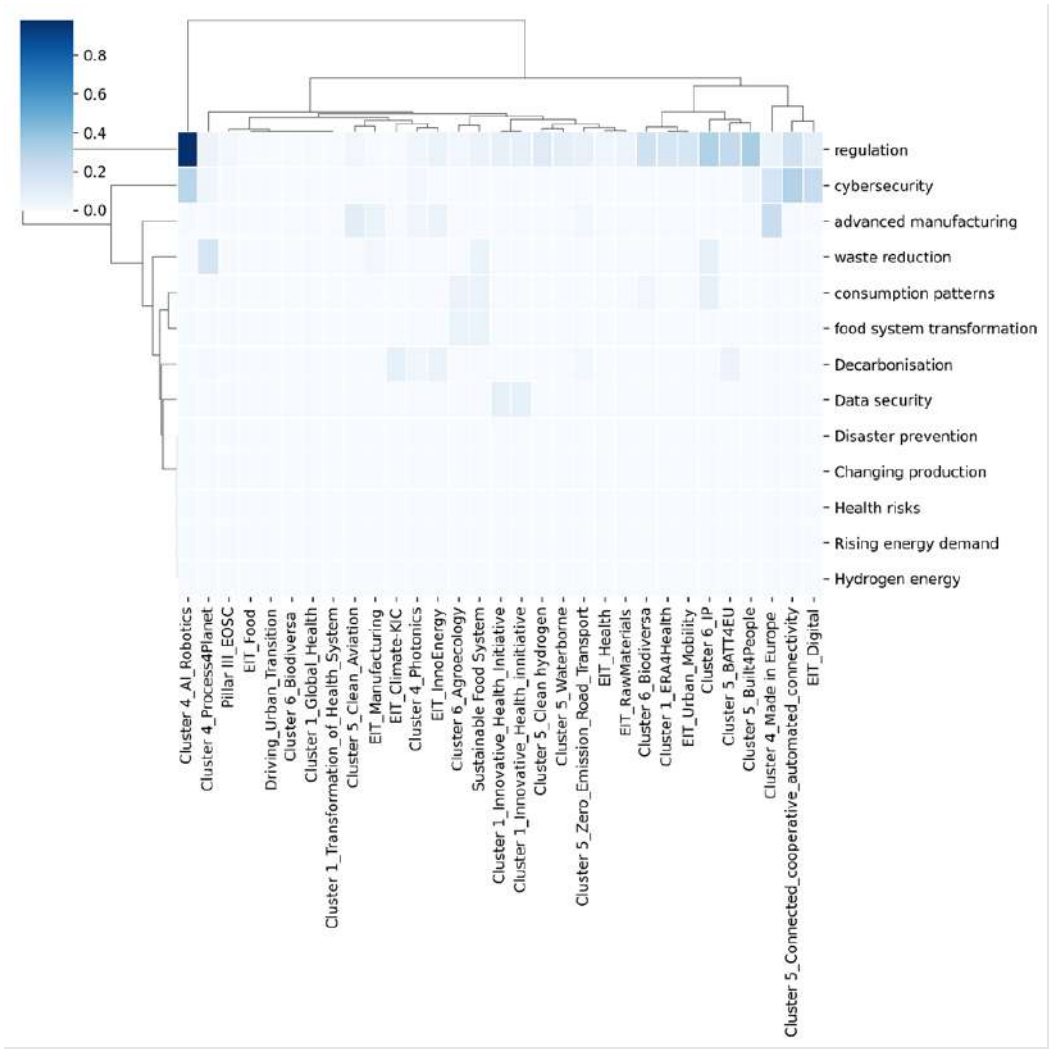
Vonortas, N. S., & Lackey, M. (2003). Real options for evaluating public sector R&D investments. In *Learning from Science and Technology Policy Evaluation* (pp. 339-351). Edward Elgar Publishing.

Wang, J., Wang, C. Y., & Wu, C. Y. (2015). A real options framework for R&D planning in technology-based firms. *Journal of Engineering and Technology Management*, *35*, 93-114.

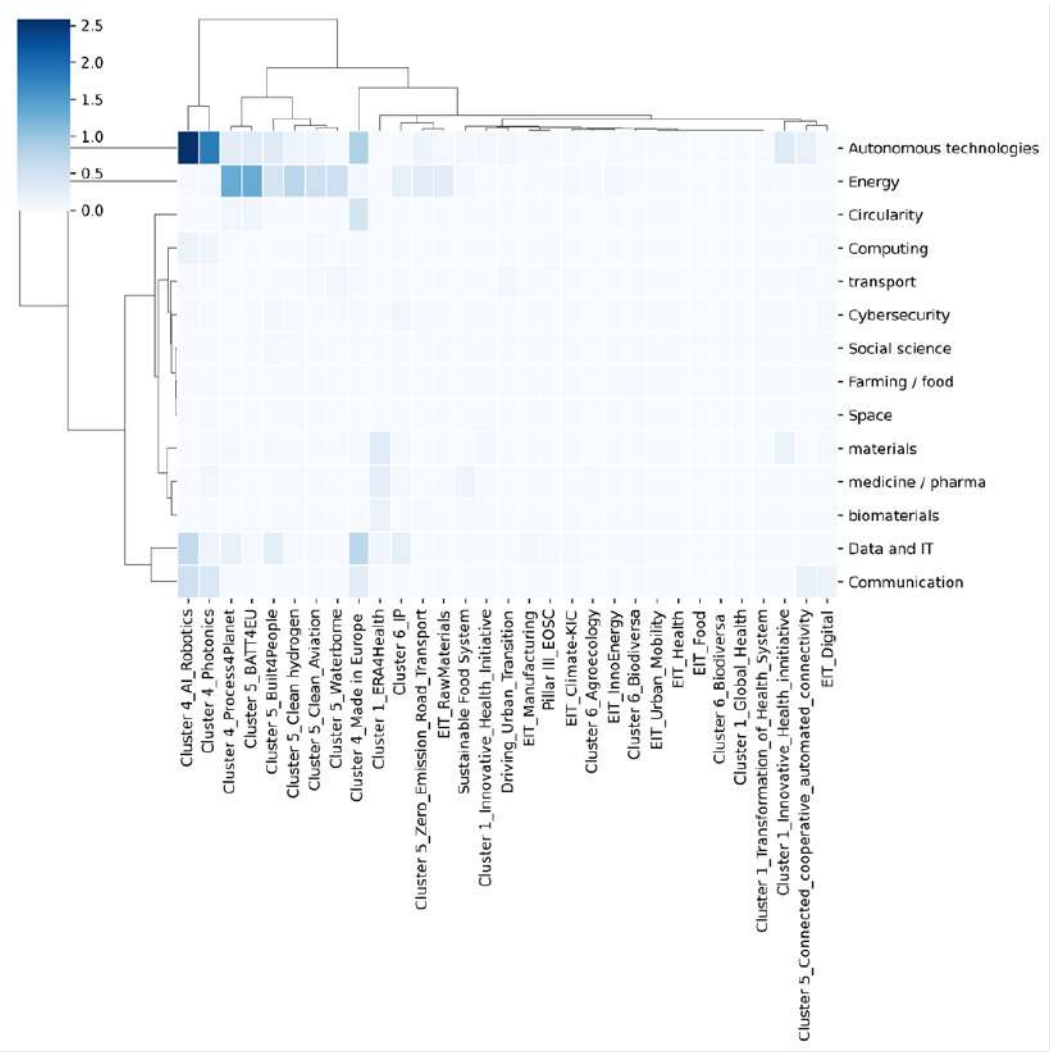
7.2. Cluster maps / dimensions studied.



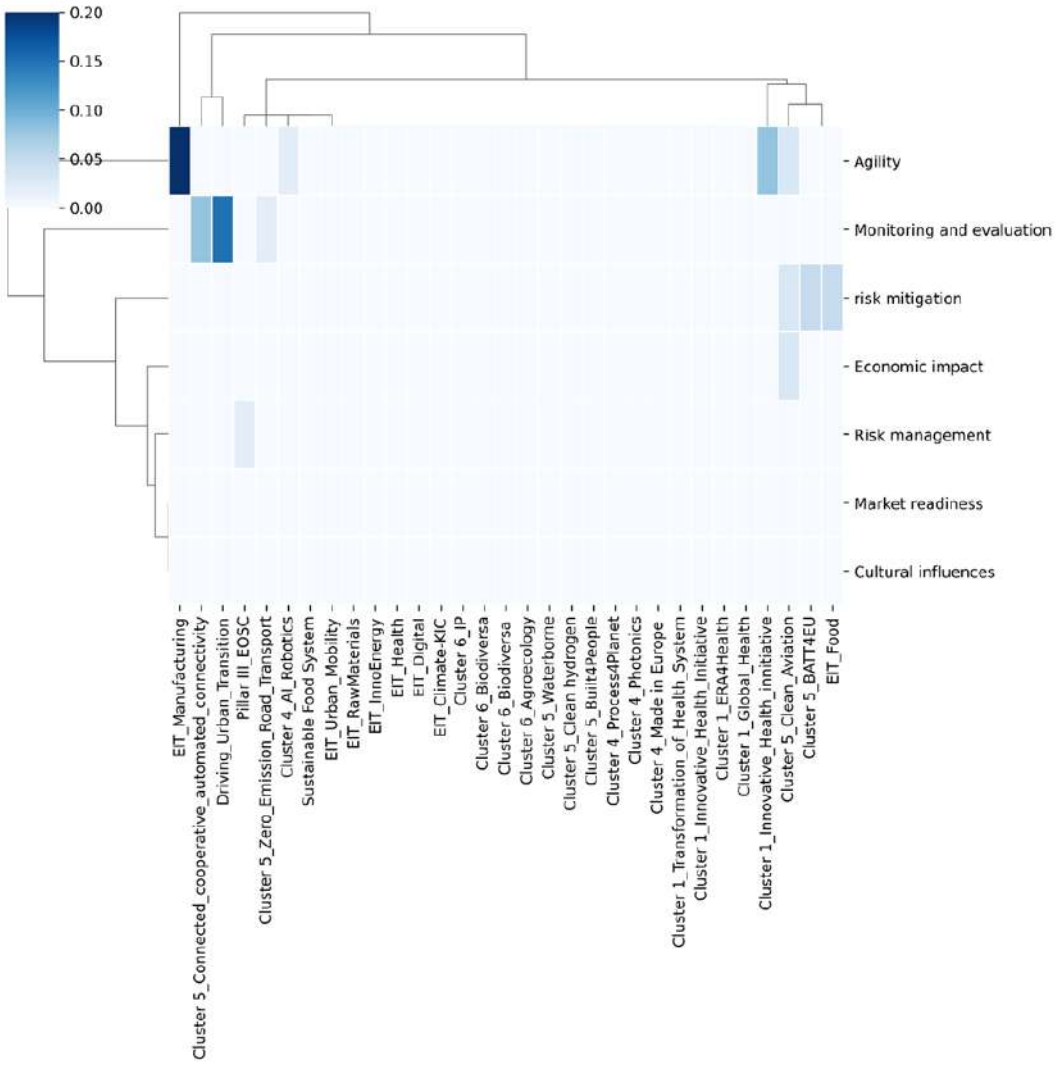
Cluster map Megatrends



Cluster map Forward looking issues



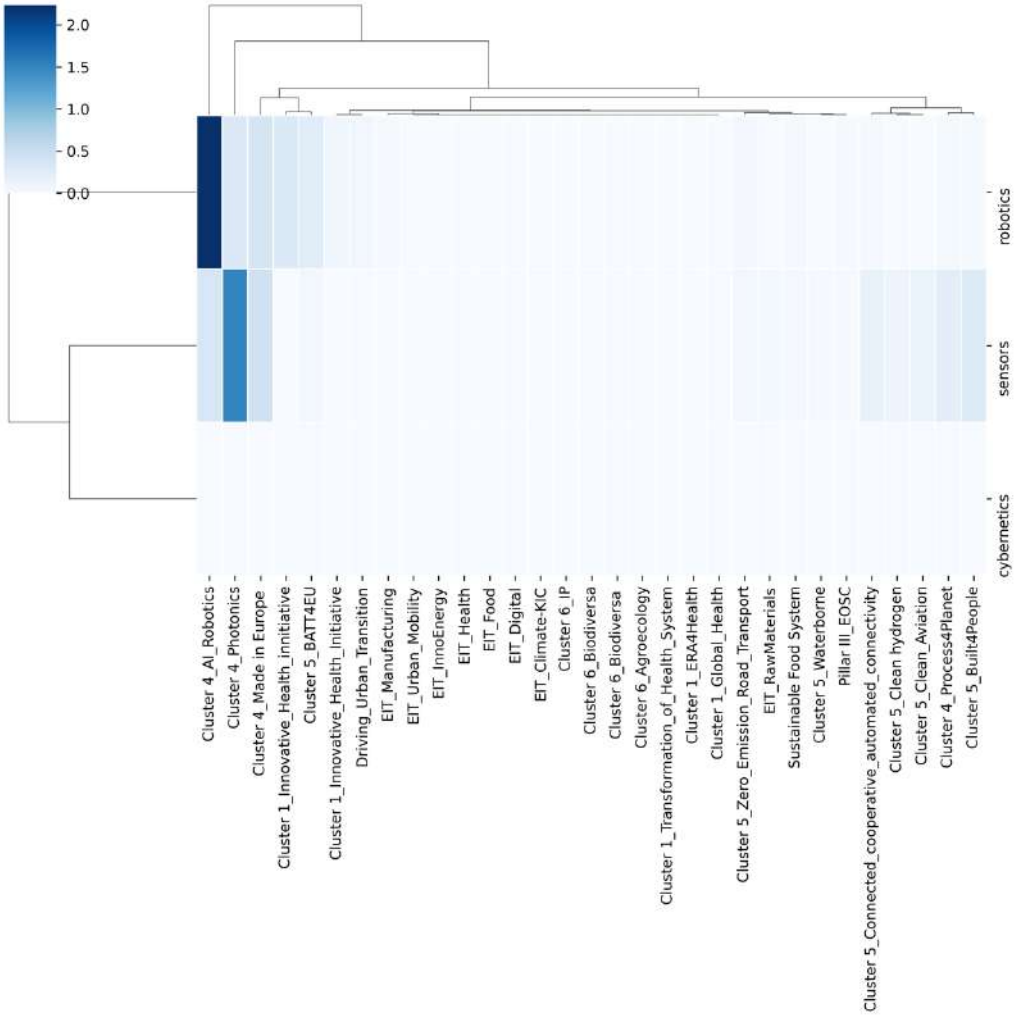
Cluster map Technologies



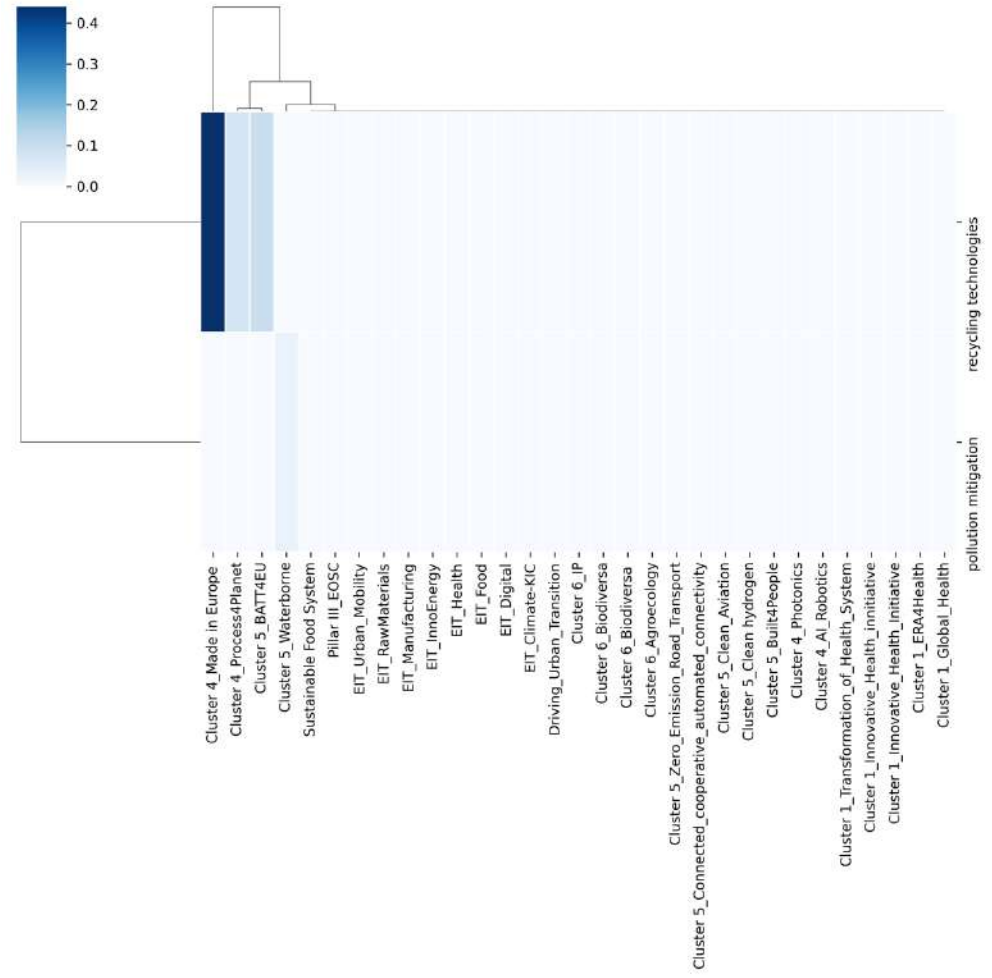
Cluster map Portfolio Dimensions

7.3. Detailed technologies impact in SRIA's

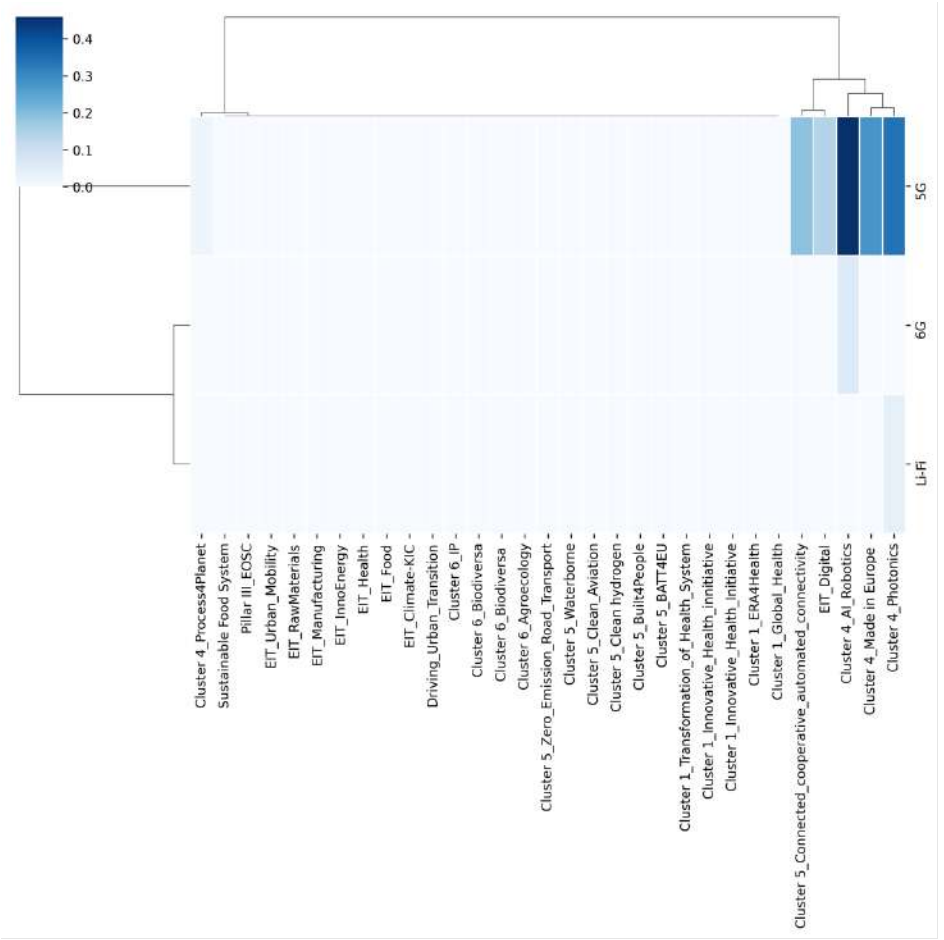
This part presents a detailed view on the sub-categories populating the promising technologies studied.



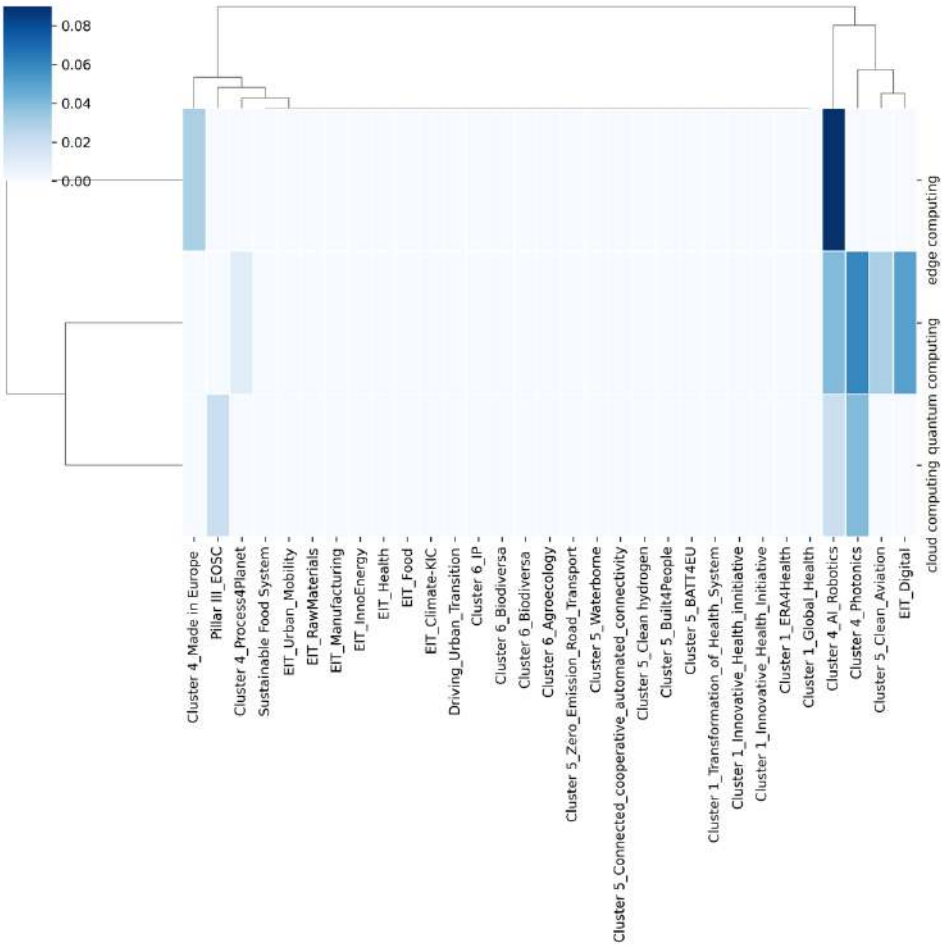
Cluster map Autonomous Technologies



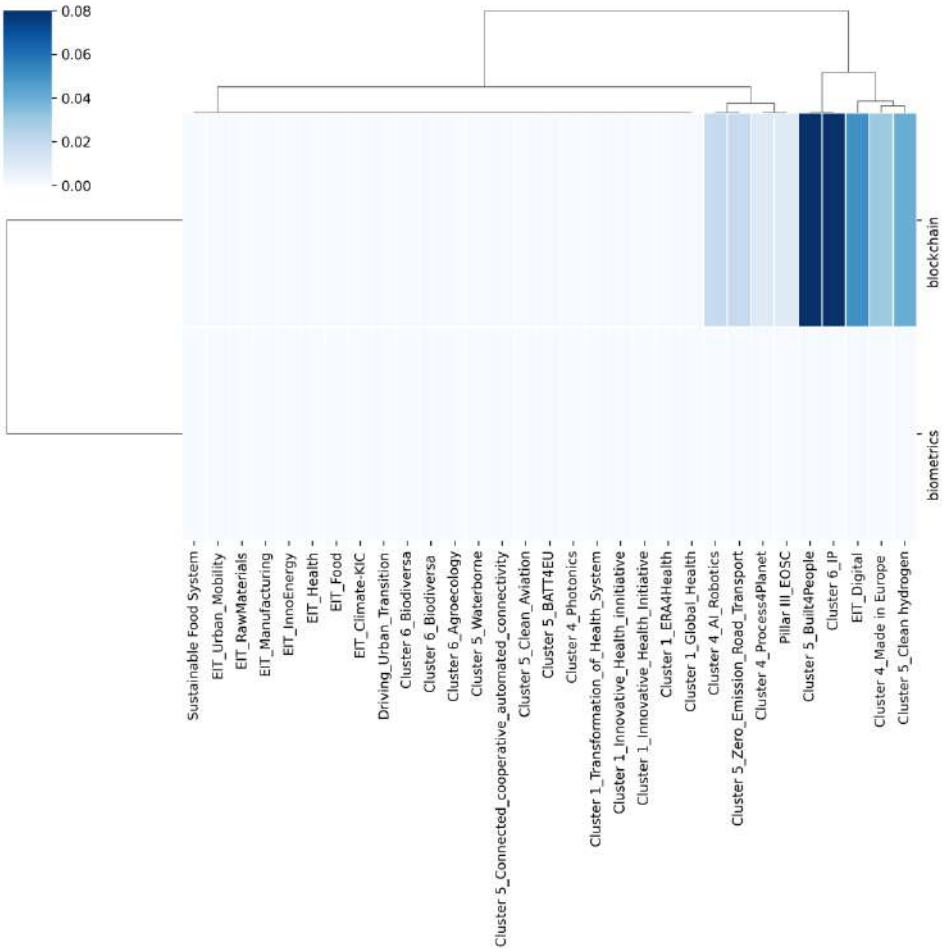
Cluster map Circularity



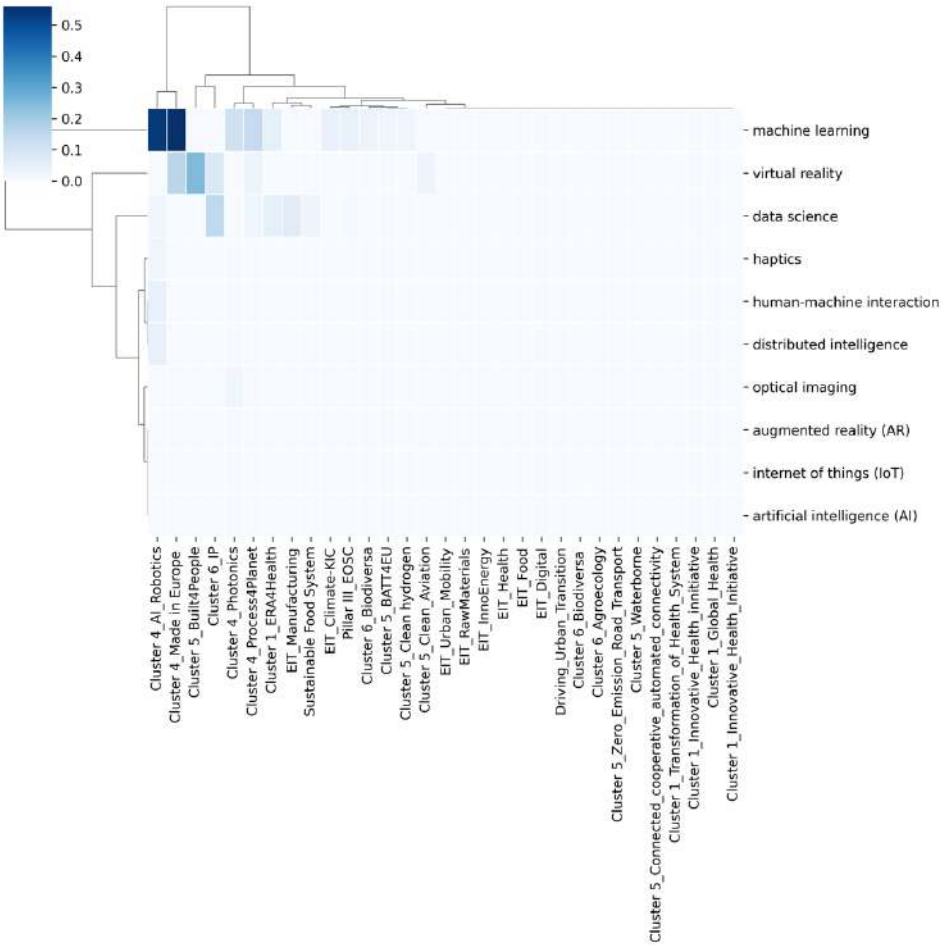
Cluster map Communication



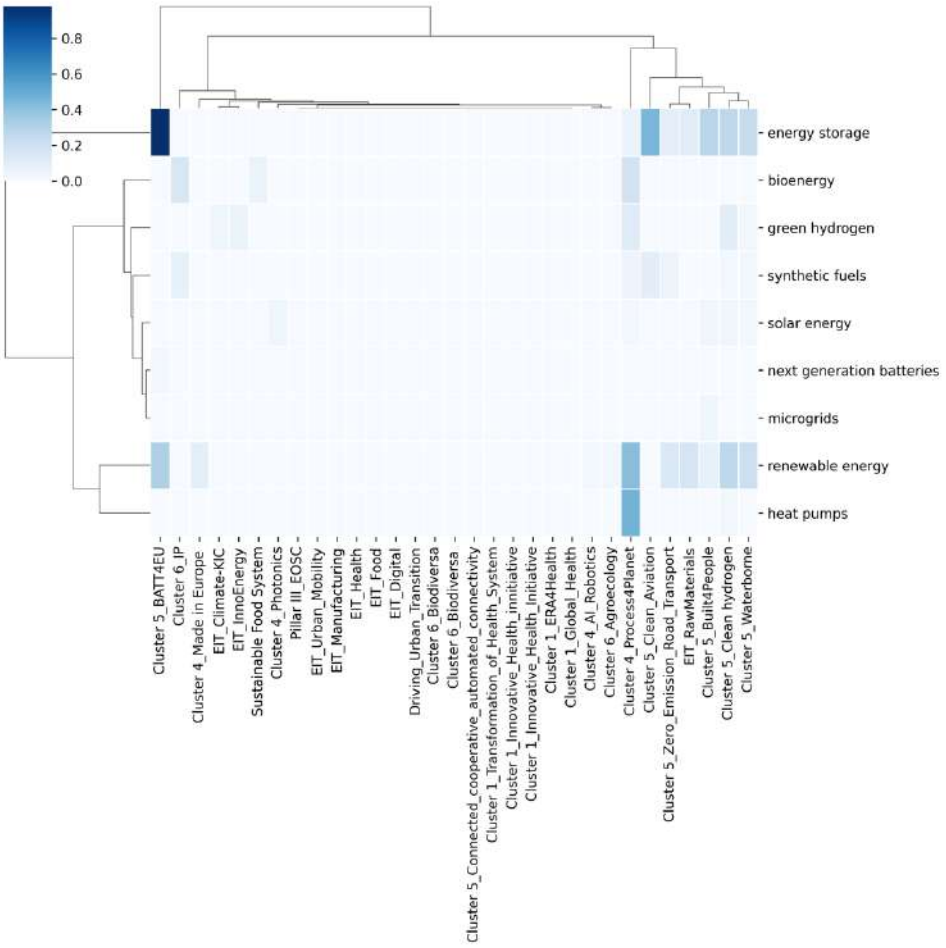
Cluster map Computing



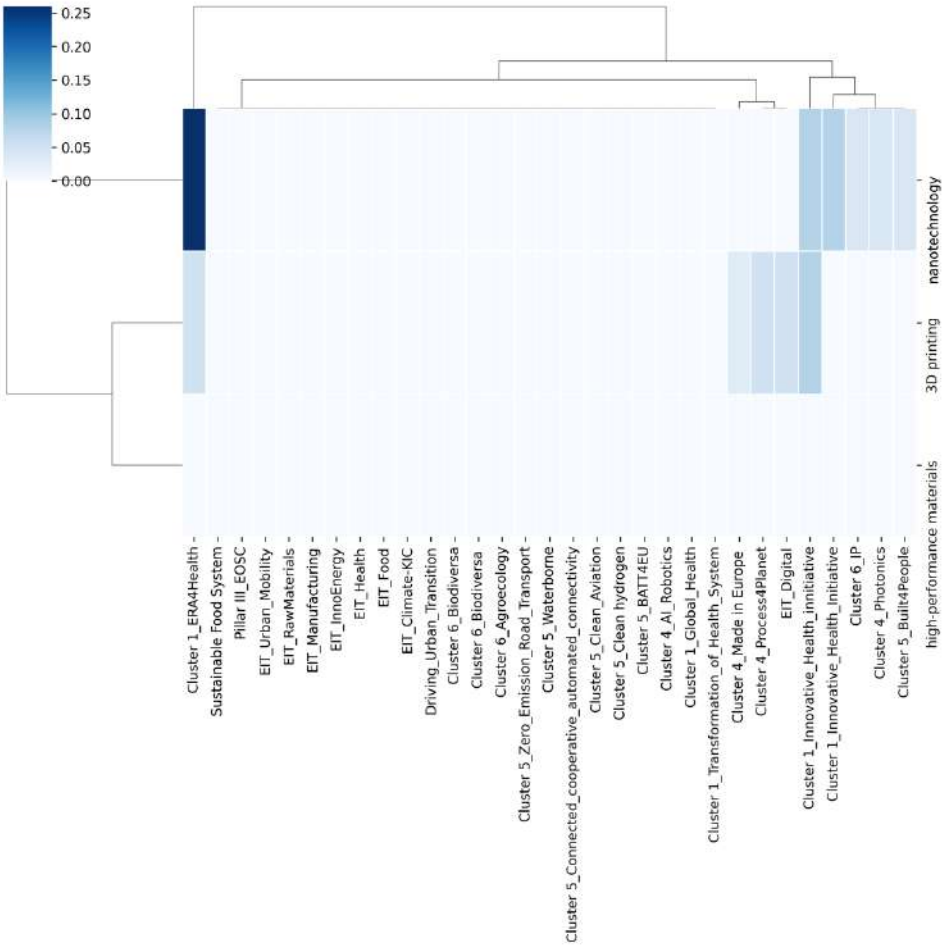
Cluster map Cybersecurity



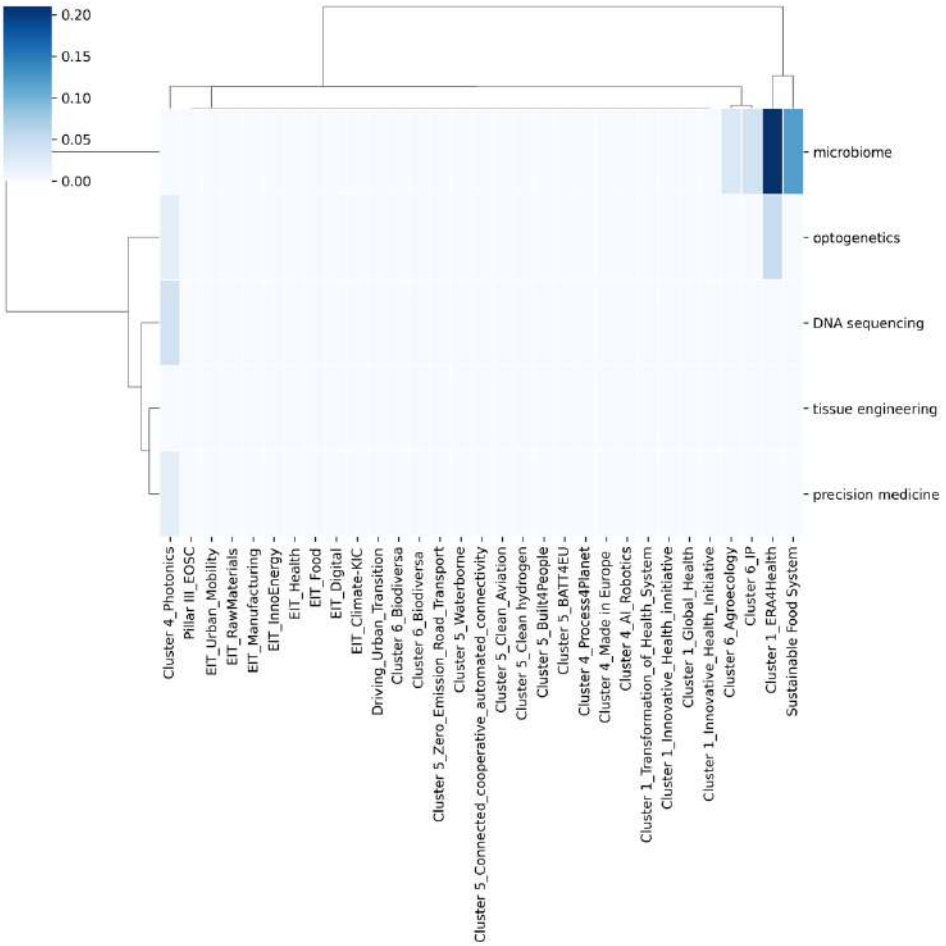
Cluster map Data and IT



Cluster map Energy



Cluster map Materials



Cluster map Medicine

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct centres. You can find the address of the centre nearest you online (european-union.europa.eu/contact-eu/meet-us_en).

On the phone or in writing

Europe Direct is a service that answers your questions about the European Union.
You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696,
- via the following form: european-union.europa.eu/contact-eu/write-us_en.

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website (european-union.europa.eu).

EU publications

You can view or order EU publications at op.europa.eu/en/publications. Multiple copies of free publications can be obtained by contacting Europe Direct or your local documentation centre (european-union.europa.eu/contact-eu/meet-us_en).

EU law and related documents

For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

EU open data

The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

This report describes the development of a methodology for assessing the relevance of European Partnerships as instruments to address current and future European policy priorities. The use of the developed approach is illustrated by positioning the existing European Partnerships and Missions into the landscape of policy priorities framed by relevant Megatrends, Forward-Looking Issues, and Technologies, as well as by reviewing the existing institutionalised partnerships against legal framework and identified relevant internal portfolio analysis dimensions.

Research and Innovation policy

Publications Office
of the European Union