

Skills 4 eosc

D3.3 Guidelines and best practices for Honest Brokers

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Deliverable Abstract

This document provides guidelines and best practices on the role of Honest Brokers and the advantages of the Open Science practices for this figure. Starting from a landscape analysis based on research in the literature, a use case scenario and interviews, it outlines the challenges Honest Brokers face, such as accessing reliable information, dealing with uncertainties, and how Open Science resources can enhance their effectiveness. The document distinguishes between various roles at the science-policy interface and emphasises the importance of trust, confidentiality, and impartiality. It also discusses the DIKW pyramid model, helpful in transforming data into wisdom. Additionally, it covers ethical conduct, communication skills, legal aspects, and the impact of AI tools. The guide concludes by highlighting the necessity of embracing Open Science practices and addressing the unique challenges Honest Brokers encounter.



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TERMINOLOGY

<https://eosC-portal.eu/glossary>

Terminology/Acronym	Definition
AI	Artificial Intelligence
AISBL	Association Internationale Sans But Lucratif
CAT	Centro Allerta Tsunami
CC	Creative Commons licence
CC BY 4.0	Creative Commons "Attribution 4.0 International" licence
CGR	Commissione Grandi Rischi
ChatGPT	Chat Generative Pre-Trained Transformer
COARA	Coalition for Advancing Research Assessment
COS	Centro Osservazioni Spaziali della Terra
COSMOS	Constorium of Organizations for Strong-Motion Observation Systems
COVID-19	Coronavirus Disease 2019
DIKW	Data, Information, Knowledge and Wisdom
DMP	Data Management Plan
DOAJ	Directory of Open Access Journals
DORA	Declaration on Research Assessment
DPC	Dipartimento della Protezione Civile
DPL	Data Processing Levels
EBDM	Evidence-based decision-making
EFEHR	European Facilities for Earthquake Hazard and Risk
EIDA	European Integrated Data Archive
EIPM	Evidence-Informed Policy Making
EMSO	European Multidisciplinary Seafloor and water column Observatory
EOSC	European Open Science Cloud
EPOS	European Plate Observing System
ERIC	European Research Infrastructure Consortium

ESFRI	European Strategic Forum on Research Infrastructures
EU	European Union
FAIR	Findable, Accessible, Interoperable, and Reusable
FAQ	Frequently Asked Questions
FOSS	Free and open-source software
GAFAM	Google, Apple, Facebook, Amazon e Microsoft
GDPR	General Data Protection Regulation
GEM	Global Earthquake Model
GNU GPL	GNU General Public License
HPC	High Performance Computing
HTC	High Throughput Computing
ICDI	Italian Computing and Data Infrastructure
ICT	Information and Communications Technology
INGV	Istituto Nazionale di Geofisica e Vulcanologia
IPR	Intellectual Property Rights
ISTAT	Istituto Nazionale di Statistica
IT	Information Technology
JRC	Joint Research Centre
MIT	Massachusetts Institute of Technology
MVS	Minimum Viable Skillsets
NC	NonCommercial
NLP	Natural Language Processing
OA	Open Access
OEDataRep	Osservatorio Etneo open Data Repository
ONT	Osservatorio Nazionale Terremoti
ORFEUS	Observatories & Research Facilities for European Seismology
OS	Open Science
RI	Research Infrastructure
RDM	Research Data Management
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SEIS	Shared Environmental Information System
SLR	Systematic Literature Review
SSHAC	Senior Seismic Hazard Analysis Committee

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1. Introduction

Open Science is a movement that advocates for making scientific research and its outputs more accessible, transparent, and collaborative. It has the potential to enhance the quality, efficiency, and impact of science, as well as to foster public trust and engagement. However, Open Science also poses new challenges and opportunities for the interaction between science and policy.

Policy and Decision makers need reliable and relevant scientific evidence to formulate policies and inform their decisions and actions, respectively the so called “Evidence-Informed Policy Making” (EIPM) and the “Evidence-based decision-making” (EBDM). However, there are often difficulties in accessing, understanding, and using the vast amount of scientific information available in the Open Science ecosystem. Researchers, on the other hand, need to communicate their findings in a way that is clear, concise, and actionable for policy audiences. They also need to consider the ethical, legal, and social implications of their research and its dissemination.

This is where the role of the “Honest Broker” becomes crucial. The Honest Broker is an individual or entity that acts as an interface between researchers and policy or decision makers, facilitating the exchange and use of scientific evidence in policy making by mapping all the viable choices. The Honest Broker does not advocate for a specific policy option or agenda, but rather provides impartial, unbiased and objective information and advice based on the best available science, sometimes about complex or controversial issues. The distinctive feature of an Honest Broker, in their ideal role, is in fact that they do not limitate the available options (which is a prerogative of the decision maker's), but on the contrary they “expand (or at least clarify) the scope of choice for decision making in a way that allows for the decision maker to reduce choice based on his or her own preferences and values” [Pielke, 2007].

This document aims to provide a set of guidelines and best practices for Honest Brokers operating within the Open Science ecosystem. To this aim, we relied on different sources as well as on the collaboration among Skills4EOSC and the Joint Research Centre (JRC), the European Commission’s science and knowledge

service. The JRC has been providing scientific support to EU policies for more than 60 years, applying a rigorous and systematic approach to Evidence-Informed Policy Making (EIPM). The document incorporates new insights gained through the Skills4EOSC project, which aims to create a training ecosystem for Open and FAIR science.

The document is designed to serve as a practical guide for current and aspiring Honest Brokers, providing them with the tools and knowledge they need to succeed in their role. It covers topics such as assessing science, understanding policy, engaging with stakeholders, and communicating effectively. It also provides examples and case studies from different domains and contexts, in the hope of strengthening the role of Honest Brokers in promoting the use of research outputs by policy makers and public administration. We also hope that it will inspire more researchers to embrace and support the principles and practices of Open Science.

2. Goals and resources

Honest Brokers face many challenges in their work, such as finding and accessing relevant and reliable sources of information, synthesising and communicating scientific evidence in an understandable and actionable way, and dealing with uncertainty, ambiguity, and conflicts of interest.

Open Science on the other end is a movement that promotes the sharing of scientific knowledge and data in an open and transparent way, with the aim of increasing the quality, reliability, and impact of research. Open Science encompasses various aspects of the research process, such as Open Access to publications, FAIR (Findable, Accessible, Interoperable, Reusable) Open Data, Open Source software, Open Peer Review, Open Collaboration, and Citizen Science. By adopting Open Science practices, researchers can increase the transparency, visibility, reproducibility, and reuse of their work, as well as foster collaboration and innovation across disciplines and sectors within and outside academia.

From our landscape analysis we came to the conclusion that resources made available by embracing the Open Science paradigm can help Honest Brokers to enhance the effectiveness of their job by facilitating their access to scientific knowledge and data, improving their understanding and evaluation of research quality and credibility, and supporting their synthesis and communication of scientific evidence to decision-makers.

In order to identify the most relevant elements to consider, we took advantage of a series of resources made available by other activities conducted in the project, such as the a) Minimum Viable Skillsets (MVS) for various profiles, and a series of b) Key Messages for Civil Servants, Policy Makers and Honest/Knowledge Brokers.

a. Minimum Viable Skillsets of various profiles

The Honest Broker must be aware of the key roles of different profiles involved in the shift to Open Science to facilitate effective communication and collaboration when dealing with a policy maker.

In preparing this document, we took into account the Deliverable “[D2.1 Catalogue of Open Science Career Profiles - Minimum Viable Skillsets](#)” that provides an in-depth description of each career profile, detailing the tasks they perform, the skills and competencies they require, and the qualifications that are typically associated with each profile. In addition to profiling these roles, the document also explores the challenges and opportunities that professionals in these roles may encounter in both current and future contexts. It offers a set of recommendations aimed at enhancing the training and recognition of these professionals, thereby strengthening their capacity to contribute to the Open Science movement. These are the considered profiles and their role in embracing the Open Science paradigm:

- Undergraduate Student. They are the future of research. Awareness of their understanding and adoption of Open Science principles can help shape future scientific practices.
- Masters student. They are often involved in advanced research projects. Their engagement with Open Science can influence the quality and accessibility of research outputs.
- Early Career Researcher. They are at a stage where they are establishing their research methodologies. Their adoption of Open Science can set a precedent for their future work and influence peers.
- Senior Researcher. They often lead research projects and influence decision-making processes. Their commitment to Open Science can drive its implementation within research teams.
- Data Stewards. They manage and preserve data. Their role is crucial in ensuring data is findable, accessible, interoperable, and reusable (FAIR), key principles of Open Science.
- Policy Makers. They create policies that can promote or hinder Open Science. Understanding their perspective can help align scientific practices with policy requirements.
- Knowledge or Honest Broker. They mediate between science and policy making, translating scientific knowledge into actionable information for policy makers. Their understanding of Open Science is key to accurately convey scientific findings.

- Civil Servant. They implement policies and need to understand scientific findings to do so effectively. Their understanding of Open Science can facilitate this process.
- Research Infrastructure Professional. They provide the tools and platforms that support Open Science. Their role is key in enabling collaboration, data sharing, and transparency.
- Legal Expert. They navigate the legal aspects of data sharing, intellectual property, etc. Their expertise ensures that Open Science practices comply with laws and regulations.
- Ethics Advisor. They ensure that research adheres to ethical standards. In the context of Open Science, they help address issues like privacy and consent in data sharing.

b. Key Messages

We, additionally, took into account the Key Messages being worked on by Skills4EOSC Work Package 3 that are targeting Civil Servants, Policy Makers, Honest Brokers as they help better focusing on few key aspects:

- Enhancing their understanding and use of scientific evidence in policy making;
- Fostering trust and dialogue with scientific researchers and other stakeholders;
- Balancing scientific knowledge with other factors, such as values, preferences, and feasibility;
- Acknowledging uncertainty and complexity and being open to learning and adaptation.

3. Definition, responsibilities and challenges

The difference among various professional figures operating at the interface between science and the policy and decision making is important because it can help on various aspects:

- choose the most appropriate role for the specific policy context and issue, narrowing the viable solution to obtain the best possible result;
- avoid confusion or conflict with other actors who may have different roles or agendas;
- more effective and clear communication with the involved parties;
- maintain credibility, legitimacy and integrity as a source of unbiased and objective information and advice;
- avoid being manipulated or co-opted by other actors who may have hidden agendas or interests.

Below we provide a brief definition of similar, but different roles, as well as the key differences between them.

a. Definitions

These are the suggested definitions of similar, yet different profiles mostly based on the book by Pielke (2007) with further integrations based on systematic profile reviews such as the one provided by Neil et al. (2022) and a variety of sources (see [Appendix 2](#)).

Pure Scientist

A Pure Scientist is someone who conducts research for the sake of advancing knowledge and is motivated by curiosity, is only interested in the truth and validity of scientific findings, without any regard for its policy implications or societal impacts, or any practical applications or financial rewards. A Pure Scientist does not usually interact with policymakers or stakeholders, and does not advocate for any particular policy position. A Pure Scientist may or may not be interested in sharing their findings following the Open Science principles, depending on their personal values, beliefs, goals or whether the hosting organisation incentivises this approach. In addition, a Pure Scientist may not fully support the Open Science

paradigm because they are concerned about the diffuse misconception that a potential misuse or misinterpretation of their data or results may occur, or because they fear losing their competitive edge or recognition in their field.

Science Arbiter

The Science Arbiter is someone who provides factual answers to specific questions, especially to policymakers or stakeholders when requested, but does not take a stance on what policy should be adopted or a specific value judgement. A Science Arbiter aims to speak truth to power, and relies on the robustness and credibility of scientific methods and assumes that there is a clear separation between facts and values, and that scientific knowledge is authoritative and sufficient for informing policy decisions. A Science Arbiter does not engage in deliberation or co-production of knowledge with other actors, and does not consider the values or preferences of different groups.

Knowledge Broker

A Knowledge Broker is an intermediary that aims to develop relationships and networks with, among, and between producers and users of knowledge by providing linkages, knowledge sources, and in some cases knowledge itself, such as technical know-how, market insights, or research evidence. A Knowledge broker facilitates the transfer and exchange of knowledge from where it is abundant to where it is needed, thereby supporting co-development and improving the innovative capability of organisations in their network.

Honest Broker

An Honest Broker is an entity (i.e. a person or a group of people) that provides unbiased, neutral and objective information and advice to decision-makers on complex and controversial issues involving science and policy. An Honest Broker does not advocate for a specific policy option, but rather broadens the range of choices, clarifying the possible outcomes and trade-offs of each option, without endorsing any specific one. The Honest Broker should possess relevant, solid expertise and knowledge in the area in which they are mediating, and base their activity on reliable, unbiased data and unprejudiced scientific considerations. They should be able to understand the issues and perspectives of the parties

involved who may have different, potentially conflicting interests, and be able to evaluate the strengths and weaknesses of each party's position. Honest Brokers should be effective communicators and facilitators, using appropriate language and tone; they should be able to listen actively, build a relationship of trust based on credibility, confidentiality and impartiality with different parties, and guide discussions towards constructive and a win-win outcome.

Issue Advocate

An Issue Advocate is a person or a group that advocates for or against a specific policy option on a complex and controversial issue involving science and policy. An Issue Advocate does not provide unbiased or objective scientific information or advice, but rather tries to persuade decision-makers and the public to support their preferred policy option.

Technology Advisor

The increasing importance of Open Science, especially when it involves Big Data and advanced Information and Communications Technology (ICT) solutions, may require the involvement of an ICT specialist also called "Technology Advisor", someone who provides expert advice and guidance on the use and implementation of technology in various domains. A Technology Advisor could help an Honest Broker by assessing their technological needs and challenges, and recommending the best and most advanced technological solutions that would enhance their mediation process. This professional figure ensures that there is a clear understanding of technical aspects within the policy-making process, including the analysing of potential impacts of new technologies and proposing regulatory or policy changes. The support of a Technology Advisor helps communicate complex technical information in a way that is accessible to non-technical decision makers.

Boundary Spanner

Someone who actively facilitates the communication, translation, and integration of knowledge across the boundaries of science, policy, and society. A Boundary Spanner can perform different roles depending on the context, such as a Knowledge Broker, an Honest Broker, an Issue Advocate, or an officer. A Boundary

Spanner recognizes the diversity and complexity of issues, and the need for collaboration and co-creation of knowledge among various actors. Faced issues may be referred to as “wicked” because they “defy efforts to delineate their boundaries and to identify their causes, and thus to expose their problematic nature” [Williams, 2002]. Wicked problems cover a wide range of issues, such as community safety, poverty, social inclusion, health inequalities, teenage pregnancies, urban regeneration, substance misuse, climate change and homelessness, therefore a wide range of competences might be requested by the Policy and Decision Makers to face them. Such a diversity may be linked to a different mandate for the Boundary Spanner, so the role to play might be each time somehow different. It is of fundamental importance that each time the Boundary Spanner precisely defines the mandate conditions, and clarifies the role it plays. A Boundary Spanner also reflects on their own position and expertise, and how they can build trust and legitimacy for themselves and the knowledge they broker.

b. Difference among roles

The differentiation of the professional figures described above can be considered in some ways artificial, fictional and far from the reality for those who practise this kind of activity. In fact, most of the time the mediation activities require a mixture of multiple profiles all at once, boundaries between roles are continuously crossed and maintained in complex and multidirectional interactions, and scientists can arrange knowledge co-production processes in a way that helps to blur the science–policy–society boundaries [Pülzl and Rametsteiner, 2009; Palmer et al. 2019; Pohl 2008; Carmen et al. 2018].

Nevertheless, the distinction of each figure is important (Fig.1), and should help to select, characterise and calibrate various types of approach, based on which one is the most suitable to deal with a specific mediation step or process that the Honest Broker faces.

The figure of the Boundary Spanner can be considered the term defining all other mentioned figures - except the Pure Scientist - anytime there is a need for cross-disciplinary or cross-sectoral collaboration. Depending on the situation, the goals

and the parties involved, the Boundary Spanner may become a Science Arbiter, a Knowledge Broker, an Honest Broker or an Issue Advocate.

The main difference between the Science Arbiter and the Honest Broker is that a Science Arbiter focuses on providing factual information that is relevant to a predefined policy problem, while an Honest Broker focuses on making sense of a complex policy situation that involves multiple problems, options, and perspectives. A Science Arbiter may be more suitable for situations where there is high scientific consensus and low political conflict, while an Honest Broker may be more suitable for situations where there is low scientific consensus and high political conflict.

The main difference between a Knowledge Broker and an Honest Broker is that a Knowledge broker focuses on transferring and exchanging knowledge among different actors, while an Honest Broker focuses on providing information and advice for decision-making. A Knowledge broker may operate in multiple markets and technology domains, while an Honest Broker may operate in a specific policy context. A Knowledge broker may have a stake in the outcome of the knowledge exchange, while an Honest Broker should be impartial and neutral.

Instead, an Issue Advocate has a clear and narrow policy agenda, while both the Knowledge broker and the Honest Broker do not. An Issue Advocate may use selective or distorted evidence, while a Knowledge broker or an Honest Broker should use credible and comprehensive evidence. An Issue Advocate may polarise or simplify the issue, while a Knowledge broker or an Honest Broker should acknowledge the complexity and uncertainty of the issue.

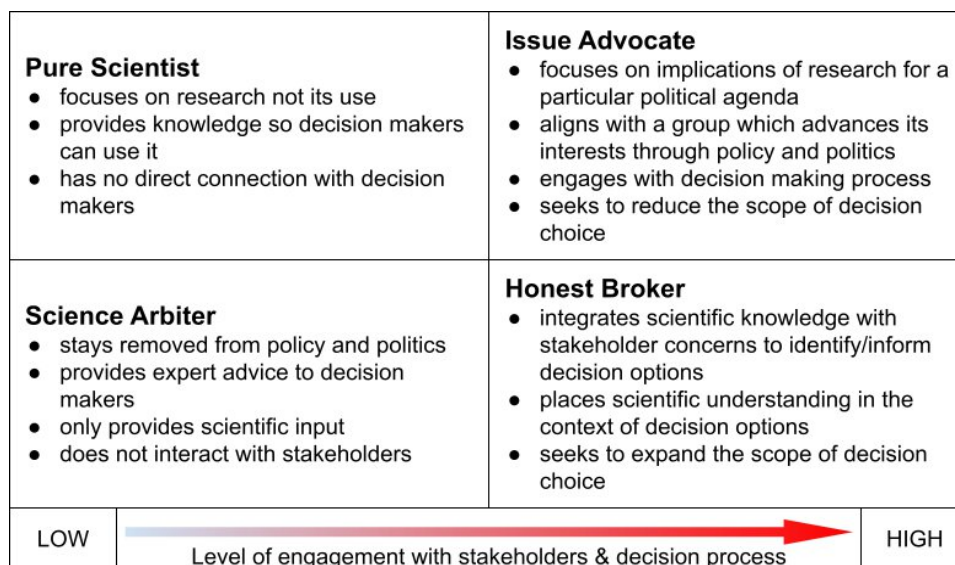


Fig.1. Modes of scientist engagement with stakeholders and decision-making process (Holmes & Cherry Tweed, 2013, Adapted from Pielke, 2007).

c. The DIKW pyramid

The DIKW (Data, Information, Knowledge and Wisdom) pyramid is a useful model for Honest Brokers as it very clearly shows the differences and relations allowing the transformation of raw data into meaningful insights (i.e. information), into knowledge, and into wisdom, a conceptual separation that could facilitate their role as neutral intermediary.

The basic elements on which the Honest Broker should start is a collection of relevant and reliable data, data that should be able to process and interpret respecting the privacy and interests of all parties involved. At the information level, the Honest Broker organises and analyses the data, by applying rules, methods, algorithms, or models to it.

At the knowledge level, the Honest Broker synthesises and evaluates the information, by applying logic, reasoning, experience, or intuition to it. The Honest Broker operates at the wisdom level through the communication of the knowledge to decision-makers considering context, values and perspectives of the parties involved.

Quite some literature is available about the “Data, Information, Knowledge and Wisdom” (DIKW) model [Ackoff, 1989; Rowley, 2007; Baldassarre, 2016; Frické, 2019] which is typically represented as a pyramid placing in a hierarchical relationship four elements: data, information, knowledge and wisdom. Many different representations of the DIKW pyramid exist, each one emphasising particular aspects relevant for a specific topic or context, we provide some examples in Figure 2.

- **Data** represents the lowest layer and it is a collection of raw data in an unorganised form. Raw data could be objective facts, figures, news, signals, numbers etc.
- When the data are combined, processed or are put in a context, they produce **Information**. Information gives data meaning and gains added value, it is differentiated from data because it is meaningful or useful. “The difference between data and information is functional, not structural” (Ackoff, 1989). Information may be presented in various forms, such as reports, charts, graphs, tables, etc.
- The **Knowledge** component of the model is the result of understanding the information and its implications, by adding insight and perspective to it. This is a very complex process that is achieved by adding the opinion of an expert -or a panel of experts- in the field, who has matured the ability and the competencies to provide a valuable help to the policy or decision-making process. Knowledge may be expressed in various forms, such as rules, principles, theories, frameworks, etc.

These three categories refer to the past, they deal with what was known.

- At the top of the pyramid, **Wisdom** is the ability to add value, it is the ability to act. It deals with the future because it reveals the direction. Wisdom implies judgement and it is the capacity to take decisions applying the acquired knowledge and on the basis of principles and experience. The wisdom may be manifested in various forms, such as actions, decisions, recommendations,

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solutions, etc. The wisdom may answer questions such as what is best and what is right.

<p>A pyramid diagram with four levels: DATA at the base, followed by INFORMATION, KNOWLEDGE, and WISDOM at the top. On the left side, arrows point upwards from 'Gathering of Parts' to 'Connection of Parts' to 'Formation of a Whole' to 'Joining of Wholes'. On the right side, arrows point downwards from 'Reflecting' to 'Interacting' to 'Understanding' to 'Doing'. A dashed box on the left indicates a transition from 'Past' to 'Future'.</p> <p>https://www.certguidance.com/explaining-dikw-hierarchy/</p>	<p>A pyramid diagram with four levels: Data, Information, Knowledge, and Wisdom. To the left, a vertical arrow points from 'Low' to 'High' with attributes: Meaning, Applicability, Transferability, Value, Human Input, Structure. To the right, a vertical arrow points from 'High' to 'Low' with attributes: Computer Input, Programmability.</p> <p>By Rowley, 2007</p>
<p>A detailed pyramid diagram with four levels: Data, Information, Knowledge, and Wisdom. Each level has associated activities and descriptions. Data: Signals, Measurements, What we can Observe; Information: Collected Facts and Observation About the Domain; Knowledge: Awareness, Perception, Models of Variables of Interest to the Enterprise; Wisdom: Rules, Experience, Best Answers to Recurring Questions. Activities include: Analytics (Make Sense of it), Control (Act of it), Simulation (Make Sense of it), Modeling (Make it Relevant), Fusion (Make it Relevant), and Data Science/Simulation Science.</p> <p>By Dinesh Barupal https://twitter.com/dk_barupal/status/1293935485463801856/photo/2</p>	<p>A pyramid diagram with four levels: DATA, INFORMATION, KNOWLEDGE, and WISDOM. Above WISDOM is a box for 'SHARED UNDERSTANDING'. Processes are shown as arrows: Processing (Data to Info), Cognition (Info to Knowledge), and Judgment (Knowledge to Wisdom). Management focuses are: Information Management (Collect, Process, Disseminate, Store, Display, Protect) and Knowledge Management (Create, Organize, Apply, Transfer). A 'Decision Risk' color scale is on the right, ranging from red (low risk) to green (high risk).</p> <p>By Dinesh Barupal https://twitter.com/dk_barupal/status/1293935485463801856/photo/1</p>
<p>An upward-pointing arrow labeled 'Analytics' is on the left. A pyramid of five levels is shown: DATA (Signals, know-nothing), INFORMATION (Useful, organized, structured), KNOWLEDGE (Contextual, synthesized), WISDOM (Understanding, integrated, actionable), and DECISIONS (Change, movement). Transitions are: 'Given context, becomes' (Data to Info), 'Given meaning, becomes' (Info to Knowledge), 'Given insight, becomes' (Knowledge to Wisdom), and 'Given purpose, becomes' (Wisdom to Decisions). On the right, questions are mapped to levels: 'WHAT? Reveals relationships' (Data), 'PAST WHY? Reveals patterns' (Information), 'WHAT IS BEST? Reveals principles' (Wisdom), and 'FUTURE WHAT ACTION?' (Decisions).</p> <p>https://electronics360.globalspec.com/article/4890/optimal-analysis-algorithms-are-iiot-s-big-opportunity</p>	

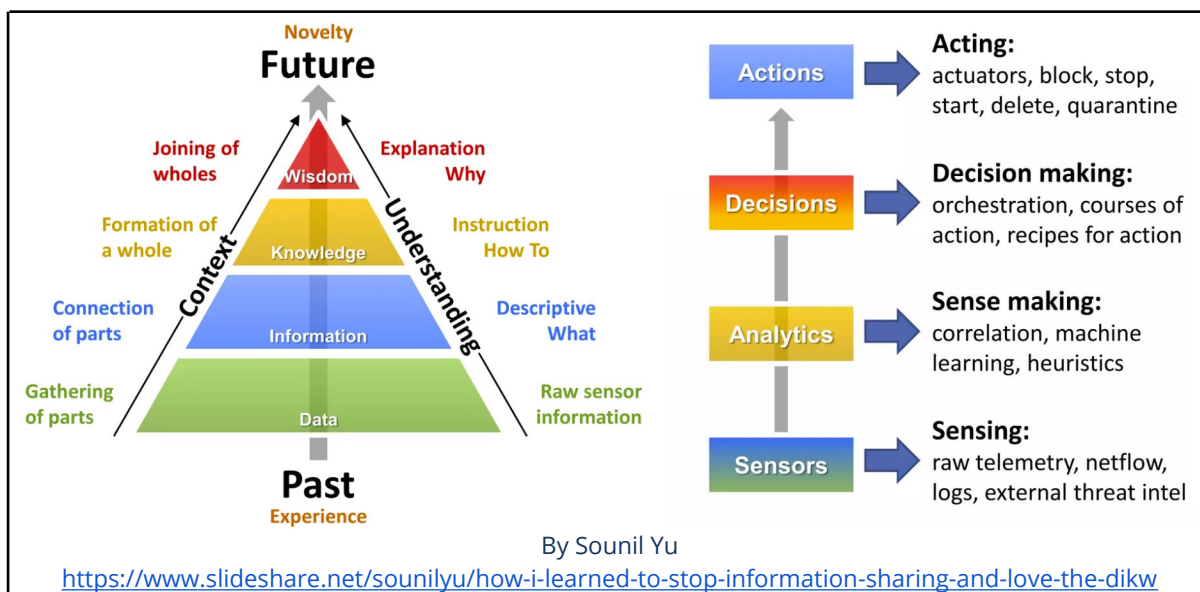


Fig.2 - Examples of various DIKW pyramid interpretations from the literature.

d. Challenges faced by Honest Brokers

The role of the Honest Broker requires a very difficult to achieve and sustained relation of trust with all involved parties, a condition required to make any suggestion credible to the eyes of each party. The trust is closely linked to confidentiality, impartiality and transparency, and must avoid the risk of being influenced or biased by personal judgments or because of the inability to discern scientific from political aspects. In addition, the impartiality may be difficult to sustain during the entire mediation process because of the inability to cope and mitigate the pressure generated by one of the parties involved that may have more negotiating power than others. A loss of trust or credibility may create tension, conflict, or resentment among the parties, undermining the legitimacy and effectiveness of the Honest Broker. Ultimately, the loss of trust may damage the overall Honest Broker reputation and potentially compromise its entire career.

Depending on the complexity and sensitivity of the field in which the Honest Broker operates, a break in the confidentiality of the communications among the parties required by the mediation process may lead to unplanned and unwanted

potential misinterpretation of any of the aspects of the activities (i.e. intentions, considered data, interpretations, possible solutions). For example, the data considered may contain sensitive or personal information that cannot be disclosed or anonymized without compromising the validity or usefulness of the data, a typical case with medical records, biometric data or social media data. Another scenario requiring a high level of confidentiality is when data is restricted because it is protected by Intellectual Property Rights (IPR) such as patents or copyrights, the typical case when data is generated by private investments. Finally, there could be a scenario where data cannot be disclosed because, especially in the case of raw, unprocessed data, it may be incomplete, inaccurate, or unreliable and requires further validation, verification, or quality control before being made available for reuse, and at the same time, decisions based on such data may generate a serious impact on society. This is the typical case of the raw data recorded by an environmental monitoring network, and preliminary considerations made upon it. As a consequence, the required confidentiality level may seriously impact the degree of openness that can be achieved by the Honest Broker, and putting the Open Science principle “as open as possible, as closed as necessary” to the test.

An Honest Broker also needs to be able to handle criticism, controversy, and scrutiny that may arise from their role, and to respond appropriately and professionally to any feedback or complaints. Solving these conflicting situations may suddenly lead to changing circumstances and expectations, and the Honest Broker must cope with it and adjust their strategies and actions accordingly. A failure to manage complexity and uncertainty may lead to confusion, misunderstanding, or miscommunication among the parties, and may affect the quality and feasibility of any potentially viable solutions.

4. Landscape analysis

In the complex scenario in which the Honest Broker operates, the resources provided by the adoption of the Open Science paradigm may provide sound and reliable scientific cornerstones around which an open debate can be conducted. As trust among the parties must always be robust during the entire mediating process, clearly communicated scientific evidence may help corroborating an honest discussion and may help removing possibly biased arguments. Therefore, performing a landscape analysis of key resources and aspects based on the Open Science paradigm is key for an Honest Broker. This chapter tries to emphasise on the most relevant ones with the aim of identifying which elements should be absolutely included in the ToT material.

Given the extremely vast amount of resources available in terms of scientific publications and data, we included among the unmissable elements tools based on Artificial Intelligence (AI). These tools are essential to enhance the capabilities of the Honest Broker to identify what is relevant on a specific scientific topic in a timely manner.

We also included Research Infrastructures among these unmissable elements as the Honest Brokers must know their existence and know how to exploit them because we strongly believe that they can efficiently help identify the current state, strengths, gaps, in their respective fields and scientific domains because they represent the selected result of the consensus of entire communities and they interact with multiple stakeholders outside their inner scientific circles.

We tried to identify additional elements by analysing a specific use case based on the activities and competences of the Italian National Institute of Geophysics and Volcanology (in Italian “Istituto Nazionale di Geofisica e Vulcanologia”, INGV) that was selected because of being active in embracing the Open Science paradigm and because interfaces with the national policy in the domain of the civil protection against natural hazards.

Finally, we designed interviews with real-world Honest Brokers and other actors concerned with evidence-based decision making as they can provide some

valuable qualitative information, i.e. insights and feedback from the perspective of those who facilitate the access and use of research data and information for various purposes.

a. Use case analysis

The analysis of the activities and practices performed at the Italian “Istituto Nazionale di Geofisica e Vulcanologia” (INGV) research institute is potentially relevant for an Honest Broker because:

- The INGV is a leading research institute that bases its activities on the collection, analysis and interpretation of multidisciplinary scientific data for Earth Sciences, especially in the fields of geophysics, volcanology, which are related to complex and controversial issues involving science and policy, such as natural hazards, climate change, energy, and environment.
- The INGV is committed to the principles of Open Science, such as making its research outputs and data accessible, transparent, and collaborative for all levels of society, and contributing to the advancement of scientific knowledge and its societal impact. It is among the first Italian public research institutions to have adopted formalised data sharing policies (Data Policies) and practices to provide access and interoperability (Access Rules, Data & Metadata Registry) and to have a Data Management Office. Thanks to this, INGV is now a cutting-edge reality in the research landscape in Italy for the adoption and implementation of such policies and procedures.
- It is a research institution that carries out activities for the surveillance of the national territory for the Civil Protection and other public and private stakeholders. Surveillance is carried out by analysing the same data that are shared and used for research. INGV uses all of its resources and services to obtain scientifically sound, credible and comprehensive evidence for their information and advice.

- Even though INGV is one institute only, it has main branches based in 8 different cities, and 24 additional smaller branches spread all around the Italian peninsula. Such a geographically distributed structure, forced the Institute to develop interesting networking solutions both from a technological and a management organisation point of view.
- The INGV operates several research infrastructures that provide resources and services for the scientific community and the society, such as seismic and volcanic monitoring, data management, modelling, and forecasting. In particular, it has made international commitments to data sharing both by hosting two international Research Infrastructures (EPOS, EMSO) and by actively participating in international projects and initiatives.
- INGV is a member of the EOSC AISBL association.

For the above purposes, on November 15, we organised an internal discussion at INGV in Rome, where the most relevant top level Directors in both the scientific and the management sectors were gathered, to discuss how the Open Science paradigm is being tackled in the data production and management perspective. As the goal of the discussion was to collect inside information on how to manage potentially controversial topics, such as how to manage the flow of data and communications during serious seismic or volcanic emergencies, we opted for a closed door session to allow anybody to express their views on very sensitive topics.

The initiative was a success and many useful tips were collected on many aspects of the Research Data Management, either coming from single Researchers, and from working groups running various types of Research Data Infrastructures. Many aspects of this Deliverable reflect these contributions.

A detailed description of the initiative, its structure of the event, and the main outcomes are detailed in [Appendix 1](#).

b. Interviews

Interviews to Honest Brokers and closely related figures is of fundamental importance to get a glance to real-world scenarios, help to understand from their experiences, challenges, and best practices in providing unbiased and objective information and advice to researchers and decision-makers on complex and controversial issues involving science and policy. In addition, we wanted to know directly from the Honest Brokers and related figures how we can help identify and suggest ways to improve their skills, competencies, and performance in their role by taking advantage of Open Science based resources. The three interviews can be found in [Appendix 3](#).

Alongside the Honest Brokers themselves, we also interviewed two different kinds of decision makers: a parliamentarian and a high-level civil servant working in a funding agency. The idea behind these interviews was to get a first-hand account of what a decision maker would expect or even require from the relation with an Honest Broker and more generally what challenges, opportunities and open issues in relation to the interface between science and policy would emerge from their experience.

i. Description of the respondents

The Honest Broker mediating with Decision Makers. The first respondent is a former member of the national commission for the prevision and prevention of the major risks which is established and regulated by a dedicated national law in the framework of the Italian Civil Protection System. The interviewee has also experience in playing the role of the Honest Broker in multiple other occasions, both with public and private organisations.

The Policy Makers dealing with Decision Makers. The second respondent is a Senator in the Italian Parliament, member of a political party that stressed a lot on the transparency of political agenda that was particularly active during the COVID-19 pandemic. The interview helps to get more insights for an “Evidence-Informed Policy Making” (EIPM) process.

The Decision Maker. The third respondent is a programme leader in Open NL, the Netherlands' funding agency for Open Science. The interview helps to get more insights for an "Evidence-based decision-making" (EBDM) process.

ii. Questions

These are the selected questions posed to the interviewed Honest Brokers, meant first to clarify the level of awareness of Open Science practices and resources, then to get more insights into which specific aspects of the Open Science turn out to be potentially useful:

- Why do you identify as an Honest/Knowledge broker?
- How much are you familiar with Open Science practices?
- Can you describe the workflow of your knowledge translation work?
- Which are the aspects of OS you have found useful in your role as Honest/Knowledge Broker?
- Which are the most challenging aspects of your job?
- Which aspects would you like to see enhanced and why?

These are the selected questions posed to interviewed policy and decision makers, that are meant to get more insight into their activities, then to investigate the interactions with the Honest Brokers, and finally to sense the relevance of Open Science practices:

- In your experience as a decision maker, have you ever been in the position of taking a decision (also) based on scientific evidence?
- Did you use the expertise of one or more persons or groups that acted as an interface between the science and the policy level?
- According to the definitions you have been provided with, how would you define such an interface (Honest/Knowledge Broker, Issue Advocate - not sure how familiar you are with these concepts, but we normally provide definitions and some context before we commence the interview)?
- How would you define your experience in dealing with this person(s)/group(s)?
- Can you describe the flow of information in this interaction? (E.g. what you asked of the broker, what would you get, what supporting information would be included in the exchange etc)

- In your experience, which are the factors that hamper evidence-based policy and decision making?
- Which are the aspects of Open Science that you would identify as helpful to reach an evidence-based decision? Would the availability of open and verifiable data (irrespective of the data being actually verified by you or someone in your staff) be a requirement for you to trust the expert? Which other factors would you identify as helpful to form an opinion re. The options available and /or make a decision?
- Which aspects would you like to see enhanced and why?

Findings

The interview allowed us to retrieve quite a few points that definitively helped in the shaping of the present document, and for most of them we found a corresponding in the literature.

From the first interview to the Honest Broker emerged that:

- An Honest Broker can be a panel of experts, acting as an entity governed by specific rules.
- Mediation activities involve a mixture of multiple roles at once, it is not always easy to discern one's role.
- Sometimes the participating rules characterising the mediation process are not quite formalised, and even the roles are not clearly defined; unwritten rules do exist, and are quite obscure for a newcomer.
- Legal implications may seriously impact the efficiency and productivity of the job of the Honest Broker as he/she may have to respond to problems as an individual, a personal insurance may be required depending on the topic.
- The advent of Open Science in the last few years changed quite a lot for the better the mediation activities in many ways, for example making it easier to access scientific results.
- Sharing not just research outputs but also information regarding the adopted tools and methodologies is a welcome practice, as it provides a more

comprehensive base to prove the level of replicability and reliability of the scientific results.

- Sometimes Policy and Decision Makers just want answers to very specific questions, but they are not always willing to provide complete context information that is of fundamental importance for providing the most relevant answers.
- The Policy and Decision Makers do not have time to investigate the reliability and sources of the provided answers, they trust the Honest Broker that does the job for them. It is important to keep the trust relationship, as the entire mediation activity gets into trouble when the level of trust is low.
- Correctly preserving and communicating appropriately uncertainties associated with scientific results is of fundamental importance (also in order to maintain trust).
- The Honest Broker should strive to be as objective as possible,, even when professional and personal experience, beliefs and values may provide some bias.
- Scientific data may come from the Policy and Decision Makers, not just from the scientific community.
- Unsupervised use of modern tools based on Artificial Intelligence by humans may endanger the reliability and transparency of the scientific evidence provided by the Honest Broker, as AI tools can be seen as a black box where there is a lack of transparency in the methodology to achieve the results, therefore delegating decisions to these tools alone should be avoided.
- Open Science practices may greatly improve the job of the Honest Broker: the more open the scientific results are, the easier the task of providing a complete mapping of the most relevant, reliable and viable scientific solutions.
- As a consequence of the previous point, the Honest Broker is inclined to encourage the scientific community in practising Open Science.

The second interview to the Policy Maker helped us to identify the following points:

- A high awareness of the Open Science implications greatly benefit the interaction with the Honest Broker.
- As the Open Software movement is well established and has a longer history and a viable business model, the Open Access and Open Data movement can learn from it.
- During the pandemic there was a shared commitment of working on policies and decisions based on published scientific data (i.e. evidence) for a greater level of transparency. After the pandemic, these aspects consolidated in the political environment in all covered domains, not just related to Public Health, pushing even further on the adoption of Open Science practices.
- It is common practice in politics to involve one or more boards of experts and hold hearings; these individuals and groups are entities that fully comply with the Honest Broker definition.
- Because of their limited power in drafting policies, parliamentarians can only gain limited advantages from the support provided by the Honest Broker. On the contrary, these figures are of fundamental importance for the Italian Cabinet that has the power to design and enforce laws.
- Issue Advocates quite often lobby for the adoption of specific solutions, and can take advantage of decision makers who are pressed for time. The Italian political system is rather ill-equipped to deal with lobbies, there is no clear nor modern laws regulating it in detail.
- Forming an opinion or deciding based on evidence can be difficult when there is not enough data, or the data is present but there is no scientific consensus, or there is a high level of uncertainty to be managed. When data is scarce, the political system can enforce actions to collect it.
- Limited time is a fundamental factor that must always be taken into account when it comes to policy and decision making.
- The most important factor that a policy or decision maker normally relies on is consensus, not only among scientists but also among other societal actors.
- 'Too much' data is never a problem because the decision-maker always relies on experts to interpret it, but when there are conflicting opinions, it is necessary to investigate whether this is due to ideological issues or just lack of maturity in the knowledge of the problem.

- Politics reflects the level of awareness of scientific evidence-based decision-making in society, meaning that the higher the society is aware of the need for scientific evidence, the higher the chance of politicians may rely on Honest Brokers. Conversely, politicians have a role in supporting education to EBDM in society, and this may lead to a virtuous circle where the public asks for EBDM and politicians adopt it.
- It is impossible to make policies and decisions based on data alone, multiple factors and values come into play.

The third interview to the Decision Maker allowed us to identify these points:

- Funders in the field of scientific research play an active role in providing feedback for the update of policies, and they heavily interact with the community to do that, also by means of figures acting as Honest Brokers.
- Funders play an active role in driving the scientific community shifting to Open Science practices.
- Funding decisions need evidence, and when the evidence is lacking, they simply fund research on the topic that would be able to provide the required evidence.
- Relying on Honest Brokers is useful when you need to investigate all the possible implications of a decision, as it allows to identify which are the adverse effects of certain policy actions that supposedly have a positive impact, investigations that the funder does not always have the time or competence to perform by itself.
- Trust in the Honest Broker is of fundamental importance during the mediation process. Everyone may have some bias due to personal factors, even if an Honest Broker should be impartial, therefore it is important to declare these potential biases from the beginning.
- The Honest Broker should identify which are the system of values of each of the involved parties in the mediation activity, as to better choose the tone and language to adopt to more effectively communicate the available knowledge.
- Even if it may lead to frustration and it is an exhausting process, dealing with Issue Advocates may help identify critical points that a funder may miss out.

- Dealing with Honest Brokers is commonly a very positive experience because all the involved parties become more knowledgeable, as they provide the required insights to envision the practical outcomes of a decision within a specific community.
- The main problem while dealing with Honest Brokers is that getting the broad spectrum of ideas or viable solutions -also conflicting ones-, make it more difficult to consolidate them in order to end up with a decision (especially in sectors where not enough evidence is available).
- A problem may occur when the Honest Broker does not provide evidence for certain statements, most of the time simply due to insufficient research into those specific aspects. Lack of evidence leads to mistrust, potentially compromising the entire mediation process.
- Providing a reproducible analysis process helps to identify the provided outcomes as trustworthy. Again, providing underlying basic data whenever possible helps in this regard, because one can understand the limitations of the data, as well as the methodology to draw conclusions based on that.
- Outcomes based on inaccessible research outputs may lead to frustration in all parties involved, Open Science practices such as better indexing and more openly available results are always welcomed.

c. Scientific literature

An extensive literature is available about the role of the Honest Broker, especially focusing on case studies in the medical field. The complete list of relevant publications considered while working at this Deliverable is listed in [Appendix 2](#).

These publications offer a comprehensive exploration of the challenges and opportunities for the Honest Brokers, some of them involving the Open Science paradigm in the discussions. The vast amount of articles and books span various aspects of science communication, policy influence and ethical considerations, collectively addressing the multifaceted role of Honest Brokers and the evolving landscape of scientific research.

The following is an attempt to summarise the main outcomes of the Literature considered.

Challenges for Honest Brokers

- **Navigating Conflicts of Interest.** Honest Brokers face the challenge of managing diverse conflicts of interest, extending beyond financial to include intellectual and ideological biases. Baveye (2023) and Rantala et al. (2017) emphasise the need for Honest Brokers to maintain objectivity and neutrality, particularly in politically charged or commercially sensitive research areas.
- **Communicating Uncertainty and Complexity.** The task of conveying complex scientific information and inherent uncertainties to non-expert audiences, including policymakers, is a significant challenge. This is highlighted in works by Lamberts (2023), Curtis et al. (2023), and Duncan et al. (2020), who stress the importance of clear, transparent communication that acknowledges uncertainties without undermining confidence in scientific findings.
- **Building Trust.** Establishing and maintaining trust in scientific advice is crucial yet challenging, as discussed by Curtis et al. (2023) and Rantala et al. (2017). Honest Brokers must navigate scepticism towards scientific authority and expertise, often exacerbated by conflicting information and misinformation.
- **Balancing Advocacy and Neutrality.** Striking the right balance between being a passive conveyor of information and an advocate for specific outcomes is a nuanced challenge for Honest Brokers. This balance is essential for maintaining credibility and effectiveness in policy influence, as discussed in the works of Pielke Jr (2007) and Sarkki et al. (2020).

Opportunities for Honest Brokers

- **Enhancing Policy Influence.** Honest Brokers have the opportunity to significantly influence policy by effectively translating scientific knowledge into actionable insights. This role is elaborated by Cairney and Oliver (2017), who discuss the potential of evidence-based policymaking, and by Montana and Wilsdon (2022), who explore the interplay between scientific advice and policy decisions.

- **Promoting Collaborative Science.** The role of Honest Brokers in fostering collaboration among scientists, policymakers, and other stakeholders is a significant opportunity. This is highlighted in works like Turnhout et al. (2013) and Gluckman et al. (2021), emphasising the value of interdisciplinary and cross-sector collaboration in enriching scientific understanding and policy development.
- **Facilitating Open Access and Data Sharing.** Honest Brokers can advocate for and facilitate open access to scientific data and publications, thereby enhancing transparency, reproducibility, and public engagement in science. The European Commission’s directives on Open Data (2019; 2022) and the work of De Filippo and Sastrón-Toledo (2023) underscore the importance of open science practices in this context.

Relevance and Impact of the Open Science Paradigm

- **Promoting Transparency and Accessibility.** Open Science practices, such as open data, open access publishing, and open peer review, address key challenges faced by Honest Brokers by enhancing the transparency and accessibility of scientific research. Armeni et al. (2021) and Burgelman et al. (2019) discuss the role of open science in democratising access to scientific knowledge and fostering public trust.
- **Support a rapid knowledge dissemination.** Open Science supports the use of modern communication technologies for a more efficient sharing of scientific results, thus fostering collaboration and innovation on a worldwide scale, and build upon each other’s work without a delay. This approach greatly facilitated solutions for facing the COVID-19 pandemic, for example by the open and timely sharing of the genome sequence of the SARS-CoV-2 virus, by supporting an informed adoption of public health measures, and by combating misinformation.
- **Use of scientific evidence.** The Open Science paradigm fosters the use of scientific evidence in policy making by enhancing the accessibility and comprehension of research findings for policymakers. Papers by Cairney and Oliver (2017) and Oliver et al. (2014) highlight the importance of accessible

and transparent scientific information in informed policy decisions. Reichmann and Wieser (2022) emphasise that the potential of open science at the interface between science and politics can be greater if participatory practices are at the beginning of the knowledge-making process.

- **Addressing the Commercialization of Research.** The Open Science movement also confronts the challenge of the commercialization of research. Fernández Pinto (2020) raises concerns about how open science practices might inadvertently prioritise private interests, suggesting the need for a balanced approach that considers the public good. To advance the public discussion on how the Open Science approach could evolve it is worth mentioning the [“Manifesto on Science as Global Public Good: Noncommercial Open Access”](#) (2023), a declaration of principles and a call to action for achieving non-commercial open access to scientific knowledge, as a way to promote science as a global public good. Among the envisioned actions and recommendations there is a strong support for the Diamond Open Access, a fee-free solution for both reading and publishing.

In summary, the cited papers collectively underscore the multifaceted challenges and opportunities for Honest Brokers in the context of the Open Science paradigm. They emphasise the need for managing conflicts of interest, communicating uncertainty, building trust, and balancing advocacy with neutrality. The Open Science paradigm emerges as a critical framework for enhancing transparency, speeding up access to information, facilitating evidence-based policymaking, and addressing the commercialization of research, thereby shaping the evolving role of Honest Brokers at the intersection of science, policy, and society.

5. Guidelines and best practices

While interacting with both researchers and policy and decision makers, the Honest Broker benefits greatly from a free, easy and efficient availability of scientific results, in other words from the Open Science practices. In fact, the mediation process conducted by the Honest Broker is easier whenever it is based on open, reproducible scientific results based on transparent procedures. Therefore, the Honest Broker should encourage researchers in pursuing the Open Science paradigm and goals. In addition, the Honest Broker should help scientists to perform their social responsibility in rendering their knowledge accessible and understandable [Gluckman, 2014]. This section provides a set of guidelines and recommended practices for Honest Brokers to effectively conduct their mediation tasks, leveraging the benefits derived from the Open Science paradigm.

a. Ethical conduct

Honest Brokers are integral to the Open Science ecosystem, as they should impartially facilitate the policy or decision makers to grasp on the variety of viable scientific solutions to adopt, so they should have an irreproachable behaviour while mediating otherwise their actions may potentially impact the integrity and trustworthiness of the research environment. This section outlines specific guidelines and best practices for Honest Brokers to maintain ethical conduct in their role.

Promote Honesty and Integrity

- **Accurate Information.** Always provide accurate, truthful, and unbiased information. Avoid exaggeration, sensationalism, or misrepresentation of research findings.
- **Cite Sources.** When sharing research or scientific information, provide proper citations and references to acknowledge the original source. Avoid presenting others' work as your own.
- **Data Integrity.** Respect the integrity of research data. Do not manipulate or distort data to fit a particular narrative or agenda.

- **Balanced Representation.** Present a balanced view of scientific research, acknowledging both strengths and limitations. Avoid cherry-picking data to support a specific viewpoint.
- **Transparent Reporting.** When conveying scientific findings, clearly disclose any potential conflicts of interest and the sources of funding. This transparency builds trust among your audience.
- **Reproducibility initiatives.** Supporting initiatives that encourage and facilitate replication studies helps to verify the robustness of research findings. This reproducibility can further strengthen trust in the research and the Honest Broker's role in evaluating it, so the Honest Broker may interact with Researchers to provide a reproducibility framework of their outcomes to show how robust their scientific outcome is.

Avoid Conflicts of Interest

- **Disclosure.** Be transparent about any financial, personal, or professional interests that could influence your work. This includes affiliations with organisations, funding sources, or relationships with researchers.
- **Independence.** Strive to remain independent and objective in your role as an Honest Broker. Avoid recommending or promoting research due to personal gain or bias.
- **Ethical Decision-Making.** When confronted with conflicting interests, prioritise the best interests of the research community, the public, and the pursuit of knowledge over personal or financial gain.
- **Avoiding Commercial Bias.** If your Knowledge Brokerage involves commercial partnerships or endorsements, clearly distinguish between your commercial activities and your role.

As the Honest Brokers play a critical role in upholding the integrity and ethical conduct of the research ecosystem, we must ensure accountability in their actions by following these actions.

Self-Assessment

- **Continuous Reflection.** Engage in regular self-assessment to evaluate your actions and adherence to Open Science principles. Reflect on your ethical conduct, transparency efforts, and collaboration initiatives.
- **Personal Code of Conduct.** Develop a personal code of conduct that outlines your commitment to ethical Knowledge Brokering and Open Science principles. Use it as a reference for your actions.
- **Feedback Mechanisms.** Be open to feedback from peers, researchers, and the public. Act on constructive feedback to improve your Knowledge Brokering practices.
- **Professional Development.** Invest in ongoing professional development, including staying updated on the latest Open Science developments and ethical considerations.

Reporting Concerns

- **Identifying Ethical Violations.** Be vigilant in identifying and reporting ethical violations, such as data manipulation, plagiarism, or conflicts of interest.
- **Whistleblower Protection.** Understand the importance of whistleblower protection and encourage those who report ethical concerns to do so without fear of retaliation.
- **Reporting Mechanisms.** Familiarise yourself with reporting mechanisms and channels for ethical concerns within your institution or community. Ensure these channels are easily accessible to others.
- **Engaging Authorities.** If necessary, engage appropriate authorities, institutions, or organisations to address ethical violations in a fair and transparent manner.

b. Communication skills

Advanced communication skills are of fundamental importance for any type of broker, but especially for an Honest Broker. Since the beginning of their intermediation activity, these skills enable a much more effective way to explain their role and function to the parties involved, using clear, concise, and appropriate language. Typically, knowledge brokerage requires interacting with a number of stakeholders and in most real-life cases it takes the form of a two-

ways communication or even co-creation more than just a translation: for this reason, it is important that the Honest Broker's communication skills also include advanced facilitation techniques and negotiation skills.

Good communication skills, combined with a strong commitment to the principles and values of Open Science, such as transparency, accessibility, reproducibility, collaboration, and public engagement, may help support the Open Science paradigm even with the most reluctant subjects, and in the most adverse conditions, pushing the limits of the principle "as Open as possible, as closed as necessary".

Being a skilled communicator helps promote the trust and cooperation among the parties, by using effective and respectful communication strategies, such as active listening, empathy, feedback, and persuasion.

In addition, having good communication skills may facilitate the resolution of conflicts, by using efficient and creative communication methods, such as brainstorming, problem-solving, negotiation, and mediation. For example, an Honest Broker could effectively depict all scenarios, help evaluate each viable option, negotiate and agree on terms, and mediate and resolve disputes.

An Honest Broker may improve these communication skills by:

- **Seeking feedback and guidance** from experts and peers on their communication performance and outcomes, and by reflecting on their strengths and weaknesses.
- **Learning from best practices and examples** of successful communication by other Honest Brokers, organisations, or initiatives, and by adapting them to their own context and goals.
- **Updating and expanding their knowledge** and awareness of the latest developments and trends in the field or domain that they are involved in, and by staying informed of the opportunities and challenges that may arise.
- **Practising and experimenting with different communication formats**, styles, and channels, and by evaluating their effectiveness and impact on the intended audience and purpose. A list of possible formats that the Honest Broker should be familiar with is the following: Infographics, Data

Dashboards, Heat Maps, Graphs and Charts, Sankey Diagrams, Scenario Visualisations, Probability Distribution Plots, Story Maps, Decision Trees, Flowcharts, 3D Models and Simulations, Interactive Simulations.

c. Legal context

The Honest Broker should be aware of the legal context in which they operate. As the Honest Broker is most of the time coming from a research environment, and may underestimate the legal implications of his or her actions, they should seek professional advice whenever necessary. The Honest Broker must comply with the relevant laws and regulations that govern the management of each research result, starting from the data collection, storage, analysis, and dissemination. They should also respect the rights and interests of the data subjects and the data owners, and seek their consent or approval when necessary. Getting acquainted with the legal context should be a habit for the Honest Broker, taking into account that the legislator may suddenly change the legal environment affecting the brokerage activity, by enacting new laws, court decisions, or regulatory actions.

Among other things, it is important that the Honest Broker be aware of the most common IPR and licensing aspects that could be associated with each type of scientific products, their distribution, reuse and modification.

Publications. From its start in the 1990s, the Open Access movement has made great strides forward and is now widely known by the scientific community. Publishing on Open Access journals is becoming more popular, while the number of Open Access journals have constantly increased in the last two decades, today the Directory of Open Access Journals (DOAJ) lists more than 20,000 journals. However, the situation is still extremely fragmented, with large differences between disciplines and organisations and the implementation of transformative agreements that tends to exacerbate inequalities, while the vast majority of publishers continue with their traditional copyright system, requiring the transfer of certain rights (typically to copy and distribute the work) from the author to the publisher by signing a copyright agreement. Each publisher or journal may present different policies and terms of use, and also when publishing in Open

Access, different models (e.g. Diamond, Gold, Green...) can be applied. In their [conclusions published in May 2023, the Council of the European Union published in May 2023](#) highlighted the importance of an open, equitable (i.e. not-for-profit) and sustainable scholarly publishing system, encouraging Member States to financially support these systems, in other words clearly supporting the Diamond Open Access model.

The situation is even more complicated for books, although also in this case a steady increase can be observed in the number of peer-reviewed academic books, with more than 75,000 entries currently listed in the Directory of Open Access Books (DOAB).

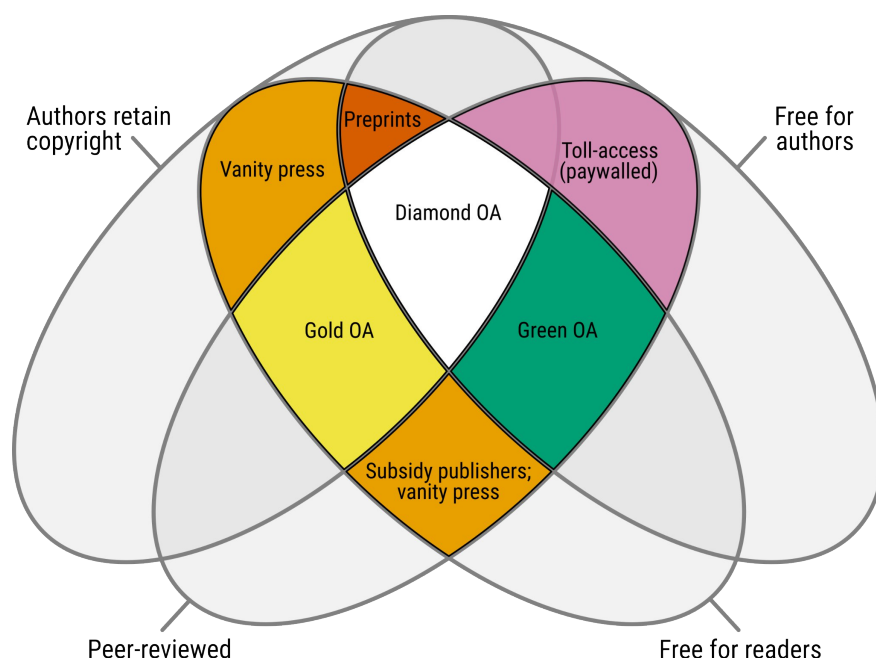


Fig.3 - Farquharson J. (2022). Diamond open access venn diagram. Figshare. <https://doi.org/10.6084/m9.figshare.21598179.v1>

The licensing aspects for Open Access publications are well defined and well established; but some individual exceptions that may pose some restrictions (for instance NC, the non-commercial condition) to the terms of use, OA publications are licensed under the Creative Common “Attribution 4.0 International” licence, or CC BY 4.0 in brief, in all cases the copyright is not transferred and remains with

the author. This licence enables reusers to distribute, remix, adapt, and build upon the material in any medium or format, also for commercial use, as long as proper attribution is credited to the author.

Data. There is still some debate on the most viable licensing scheme that should be adopted while sharing data. In recent years, the most common licensing scheme adopted in the scientific community, and the one officially supported by European Commission for the “high value datasets” (EC regulation 2023/138), as well as in the most recent version of the Open Science obligations for Horizon Europe projects, is the one provided by the Creative Commons, either their “Public Domain” licence, shortened as CC0, or their “Attribution 4.0 International”, shortened as “CC BY 4.0”.

EPOS ERIC and data providers in the field of Earth Sciences have adopted since 2018 an interesting data taxonomy based on their Data Processing Levels (DPL), a classification that is now adopted by the entire Environmental Research Infrastructures (ENVI) community to differentiate the level of intellectual contribution:

- Level 0: raw data, or basic data. Data generated by instruments that measure environmental physical properties or phenomena.
- Level 1: data products coming from nearly automated procedures applied to raw data at level 0.
- Level 2: data products resulting from scientists’ investigations. This data requires the intervention of scientists that interpret and add values to Level 0 or Level 1 data.
- Level 3: integrated data products coming from complex analyses or community shared products, which require collaborative processes over a considerable time span.

It is important for a Knowledge Broker to be aware of the implications of mixing data from a variety of sources, which could use different licences. The compatibility between different licensing schemes must be always checked as it may become a serious problem when sharing the combined data or derivative

works (Fig. 4). As long as CC licences are concerned, this occurrence is already foreseen, and combining different data (or any other licenced dataproduct for that matter) is always possible provided that attribution is given and compliance with possible non-commercial restrictions of part of the data sources is ensured (see table below); in the framework of CC, also adapter's licences are foreseen based on differently licenced sources. However things can become more complicated in case licences other than CC are applied.

	PUBLIC DOMAIN	PUBLIC DOMAIN	BY	BY SA	BY NC	BY ND	BY NC SA	BY NC ND
PUBLIC DOMAIN	✓	✓	✓	✓	✓	✗	✓	✗
PUBLIC DOMAIN	✓	✓	✓	✓	✓	✗	✓	✗
BY	✓	✓	✓	✓	✓	✗	✓	✗
BY SA	✓	✓	✓	✓	✗	✗	✗	✗
BY NC	✓	✓	✓	✗	✓	✗	✓	✗
BY ND	✗	✗	✗	✗	✗	✗	✗	✗
BY NC SA	✓	✓	✓	✗	✓	✗	✓	✗
BY NC ND	✗	✗	✗	✗	✗	✗	✗	✗

Fig. 4 - Combining objects under different licence types is a possibility contemplated by design in the CC framework, as shown in this licences compatibility chart from the CC FAQ website, licensed under CC BY 4.0

- **Software.** In the scientific domain, there is an extensive use of Open Source software, therefore the Honest Broker should be aware of the most common licences that specifies how the software code can be used, modified, or distributed by others. These licences grant certain rights and permissions to the users of the software, such as the freedom to study, change, share, or improve the software. There are different types of open source licences, each

with its own terms and conditions, the most common ones are the Apache License, GNU General Public License (GPL) or the MIT License.

By properly considering the legal context, the Honest Broker can avoid or minimise the legal risks and enhance his or her credibility, trustworthiness, and professionalism.

d. Open Publications

This refers to the free and unrestricted online availability of scientific publications, such as journal articles, books, and reports. Open Publications, often referred to as simply “Open Access”, allows anyone to read, download, copy, distribute, and reuse the scientific literature, without legal, financial, or technical barriers. Open access to data and data products underlying the policy alternatives offered by the Honest Brokers and substantiating their claimed implications may support the level of trust of an Honest Broker, by enhancing transparency and by clearing the field from any suspicions of incompleteness, biases and possible conflicts of interest. Enhancing the visibility, dissemination, and impact of scientific outputs facilitates the creation of a strong link between scientific evidence and the options presented; by making them challengeable and replicable by the scientific community, it also enables the verifiability and validation of their claims and of the arguments they submit to the parties.

For this reason, the authors believe that it is in the best interest of the brokerage practice that Honest Brokers should actively support the adoption of Open Access practices under the condition of respecting the neutrality during the mediation with the involved parties. In particular:

- **Promote Open Access to publications.** Promote the principles of open access to scholarly publications. Encourage authors and institutions to make their research outputs freely accessible to the public, especially in those areas relevant for policy and decision makers.
- **Support Open Access Journals.** Promote and collaborate with open access journals that follow rigorous peer review and publishing standards, contributing to the dissemination of high-quality research. Honest brokers

involved in relevant decision-making processes should present open-access scientific publishing, as a key element that needs to be sustained, emphasising their role in fortifying research integrity, upholding high quality and transparency, and fostering societal trust through open access, rigorous and open peer review, ethical publishing practices, and collaborative knowledge dissemination.

- **Open Licensing.** Encourage the use of open licences (e.g., Creative Commons) to allow for the reuse, adaptation, and redistribution of research materials, ensuring maximum accessibility.
- **Raise Awareness.** Educate researchers and institutions about the benefits of open access, including increased visibility, greater impact, and the potential for broader societal engagement.

e. Open Data

This refers to the sharing and publication of the data and metadata that underlie the scientific research, such as experiments, observations, surveys, and simulations. In order to be Open, data should be FAIR (Findable, Accessible, Interoperable, Reusable), i.e. they should be easy to find, they must be described with rich metadata, be associated with the relevant documentation to avoid data misinterpretation or misuse, and it should be clear who, how and when can access the data. The curation effort required to comply with each of the four FAIR principles may vary (Fig.5), in general, the more efficient and convenient the data reusability is, the higher the effort may be required, especially when complex data include ontologies for providing a semantic interoperability. Open data allows anyone to access, analyse, reuse, and repurpose the scientific data, without restrictions or limitations. Open data may support the level of trust of an Honest Broker by increasing the transparency, accountability, and quality of their scientific evidence, as well as by enabling the replication and reproduction of their results and findings.

- **Champion Data Sharing:** Promote and facilitate the sharing of FAIR research data, methods, and protocols. Encourage researchers to make their data openly available for scrutiny and reuse.

- **Respect Data Privacy and Security:** Emphasise the importance of data privacy and security. Ensure that researchers adhere to ethical and legal standards when sharing sensitive or personally identifiable information.
- **Data Management Planning:** Encourage researchers to create comprehensive data management plans, including data organisation, documentation, and long-term preservation strategies.
- **FAIR Data Principles:** Advocate for the adoption of FAIR (Findable, Accessible, Interoperable, Reusable) data principles to enhance the accessibility and utility of research data.

In addition to the more generic FAIR data principles, also the less known **SEIS principles** should be mentioned because of the long tradition in the worldwide exchange of environmental data, these principles are general enough to be relevant in other contexts. The SEIS principles are a set of guidelines for organising the collection, exchange and use of environmental data and information in Europe. SEIS stands for Shared Environmental Information System, which is a virtual environment that provides access to data, services and resources for researchers, policy makers and the public. Following the SEIS principles, environmental data should be:

- **Managed as close as possible to its source.** This means that data and information should be collected, processed and stored by the authorities or organisations that are responsible for them, and that they should be updated and maintained regularly.
- **Collected once, and shared with others for many purposes.** This means that data and information should be reused and exchanged among different users and applications, and that duplication and inconsistencies should be avoided.
- **Readily available to public authorities and enable them to easily fulfil their legal reporting obligations.** This means that data and information should be accessible and interoperable, and that reporting processes should be simplified and harmonised.

- **Easily accessible to all users.** This means that data and information should be provided in user-friendly formats and languages, and that users should be able to find and access them through common entry points and platforms.
- **Accessible to enable comparisons at the appropriate geographical scale and the participation of citizens.** This means that data and information should be compatible and comparable across different spatial and temporal scales, and that citizens should be able to contribute and benefit from them.
- **Fully available to the general public and at national level in the relevant national language(s).** This means that data and information should be transparent and open, and that they should respect the linguistic and cultural diversity of the European Union.

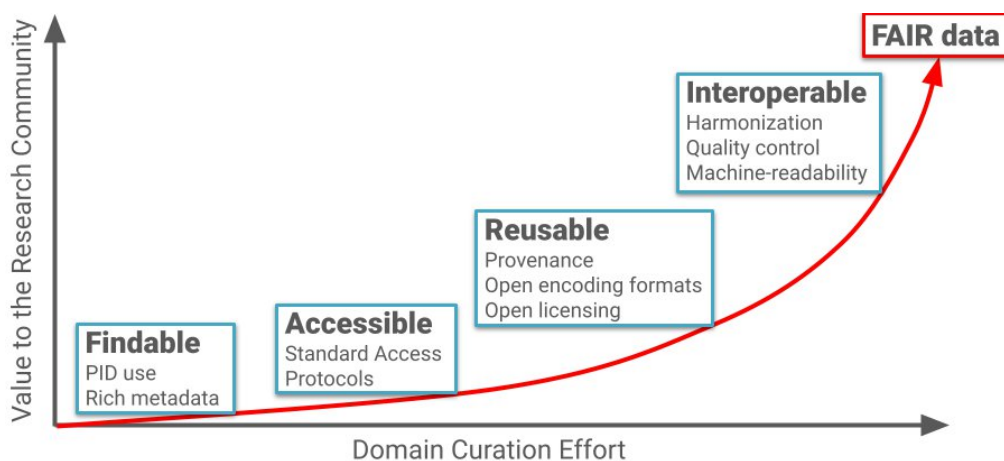


Fig.5 - Curation effort required to make the data FAIR (adapted from Soenen K., 2021).

f. Open Software

This refers to the development and distribution of the software used or produced in scientific research, such as codes, algorithms, models, tools, and devices. Open source allows anyone to inspect, modify, improve, and contribute to the scientific software and hardware, under the terms of a specific licence. Open source may support the level of trust of an Honest Broker by improving the reliability, efficiency, and usability of their scientific methods and techniques, as well as by fostering the innovation and creativity of their solutions and products. The FOSS

(Free and open-source software) movement establishes the four essential freedoms of Free Software:

- The **freedom to run** the program as you wish, for any purpose.
- The **freedom to study how the program works, and change it** so it does your computing as you wish. Access to the source code is a precondition for this.
- The **freedom to redistribute** copies so you can help others.
- The **freedom to distribute copies of your modified versions** to others. By doing this you can give the whole community a chance to benefit from your changes. Access to the source code is a precondition for this.

g. Open peer review and quality assurance

Honest Brokers in Open Science play a key role in maintaining the quality and integrity of research and information. The Open peer review is a process that helps keep a high quality standard, and refers to the evaluation and assessment of scientific research by other experts in the field, such as peers, reviewers, editors, and referees. Open peer review allows anyone to see the identity, comments, and ratings of the evaluators, as well as the responses and revisions of the authors. Open peer review may support the level of trust of an Honest Broker by enhancing the fairness, rigour, and quality of their scientific review process, as well as by encouraging constructive and respectful feedback and dialogue among the evaluators and authors.

The open peer review process has more or less direct advantages:

- **Promote Rigorous Peer Review.** Advocate for the importance of robust peer review processes in ensuring the quality and reliability of scientific research.
- **Transparent Review.** Encourage transparent peer review, where the identities of reviewers and authors are disclosed, fostering accountability and openness.
- **Ethical Conduct in Peer Review.** Ensure that peer reviewers act ethically by maintaining confidentiality, avoiding conflicts of interest, and providing constructive, unbiased feedback, reducing misconduct.

- **Addressing Bias.** Raise awareness of potential biases in peer review and support efforts to reduce them, such as through double-blind or diverse peer review.
- **Quality Control.** Implement quality control measures to ensure that only high-quality and methodologically sound research is promoted.
- **Promote Ethical Citation Practices:** Advocate for ethical citation practices that give proper credit to original sources and authors. Discourage self-citation and citation manipulation.
- **Avoid Unfair Self-Promotion:** Encourage researchers to cite their own work only when relevant and appropriate, and not for self-promotion.
- **Plagiarism Prevention:** Educate researchers and the public about the importance of avoiding plagiarism, and support the use of plagiarism detection tools.
- **Promote Fair Attribution:** Emphasise the importance of attributing ideas and findings to their rightful authors, and discourage the misattribution of work.
- **Open Metrics.** Support the use of open citation metrics and altmetrics to enhance the transparency and accuracy of research impact assessment.
- **Reward of peer review contribution.** The openness in peer review allows to reward Reviewers' contributions.

h. Open Collaboration

Honest Brokers in Open Science are instrumental in fostering collaboration among researchers, institutions, and stakeholders. These are the key actions and related advantages in supporting Open Collaborations:

- **Identify Common Interests.** Actively seek out researchers, institutions, and organisations with common research interests, and connect them to foster collaboration.
- **Interdisciplinary Engagement.** Encourage and facilitate interdisciplinary collaborations to address complex scientific challenges and promote a holistic approach to research.

- **Collaboration Platforms.** Promote the use of online collaboration platforms, such as open science networks and research collaboration tools, to connect researchers and streamline collaborative efforts.
- **Research Partnerships.** Support the establishment of research partnerships, including joint projects, to facilitate the exchange of knowledge and resources.
- **Public engagement and outreach.** Engaging the public in the research process through open communication and outreach activities can demystify science and promote understanding of the research process. This engagement can build trust in the research community and the Honest Broker's role in translating scientific findings.

Facilitate Networking

- **Professional Networking:** Encourage researchers and Knowledge Brokers to build and maintain professional networks through conferences, workshops, and online forums.
- **Community Building:** Assist in the formation and nurturing of Open Science communities that share common objectives and values. These communities can offer peer support and facilitate knowledge exchange.
- **Networking Events:** Promote and facilitate networking events and gatherings that bring together researchers, policymakers, and other stakeholders to foster collaboration and information sharing.
- **Engage Stakeholders:** Encourage the active involvement of policymakers, industry representatives, and the public in networking events, as their input can enrich the scientific discourse.

i. Access restricted research outputs

As mentioned among the challenges that the Honest Broker may face, there is a variable level of confidentiality that must be maintained during the mediation process among the parties.

As the Honest Broker should advocate for the highest level of openness of any aspects of their work, even restricted material may be disclosed at the end of the job, following the principle “as Open as possible, as closed as necessary”.

While dealing with restricted personal data, the Honest Broker may overcome the restrictions by applying anonymization or aggregating algorithms to the raw data, if such a procedure will not make such data completely useless or even misleading.

Another viable solution may be to apply a limited embargo period to all scientific products considered, and try to convince the parties that sharing scientific results may help the work of others, or even may help identifying flaws in solutions adopted as the outcome of the mediation process thanks to observations that may arise from to a broader scientific community.

Adopting an embargo period however may lead to various issues that must be taken into account:

- The embargo may be a source of conflict or resentment between the parties, by creating a sense of isolation or hostility.
- The embargo may be a barrier to communication or collaboration between the parties, by reducing the opportunities for dialogue or exchange.
- The embargo may be a hindrance to innovation or development, by restricting the availability or diversity of data or products.

j. Scientific uncertainties

Scientific uncertainties are inevitable in any complex and dynamic system. They arise from incomplete data, measurement errors, model limitations, or inherent randomness. Scientific uncertainties can be expressed in different ways, such as probabilities, confidence intervals, scenarios, or qualitative statements. However, not all forms of expression are equally appropriate or useful for different audiences or contexts.

Being able to correctly manage scientific uncertainties is essential for Honest Brokers to fulfil their role as trusted intermediaries and impartial facilitators. This ability allows them to accurately represent scientific information, identify and address potential biases, and communicate complex concepts in a clear and concise way, clearly telling the counterpart what we don't know and not trying to hide it by any means. The Honest Broker should be aware that effectively

communicating uncertainties without exaggerating or downplaying the level of confidence or the range of possible outcome does not undermine trustworthiness, on the contrary, by transparently managing scientific uncertainties the Honest Brokers help to promote informed decision or policy making.

In practice, an Honest Broker need to be able to:

- **Explain complex scientific concepts in a clear and concise way, without oversimplifying or misrepresenting the information.** This is especially important when dealing with scientific uncertainties, as these can be difficult to understand and interpret.
- **Distinguish between legitimate scientific uncertainties and those that have been created or exaggerated for political or ideological purposes.** This can be a challenge, as uncertainties can be used to support a wide range of views. Honest Brokers need to be able to evaluate the evidence objectively and to identify potential biases or misinterpretations.
- **Communicate scientific uncertainties to their stakeholders in a way that is accurate, transparent, and respectful.** This means that they need to be able to explain the limitations of the evidence, the range of possible interpretations, and the potential consequences of different courses of action. By using inappropriate language or framing, or because of different cognitive biases, cultural values, political agenda, or prior beliefs there is a high risk of inducing false or unwarranted certainty, or inducing excessive doubt or scepticism.

k. Open research infrastructures

Open research Infrastructures provide resources and services for research communities to conduct research and foster innovation. They can be used beyond research, such as for education or public services, and they may be single-sited, distributed or virtual. They include major scientific equipment or sets of instruments, collections, archives of scientific data, computing systems and

networks, and any other research and innovation infrastructure of a unique nature that is open to external users.

A landscape analysis of the existing Research Infrastructures in a specific scientific domain may efficiently provide the Honest Broker a quick overview of that specific field of research. In addition, the Honest Broker may provide back to each Research Infrastructures some useful feedback about a strategic vision for their future development and improvement, as well as a more focused alignment with the Open Science paradigm.

In Europe a relevant role is played by ESFRI (European Strategic Forum on Research Infrastructures), which promotes and coordinates pan-European Research Infrastructures (RIs) that cover very different scientific domains. ESFRI RIs are very often coordinated by the European Research Infrastructure Consortia (ERICs), but all are governed by a legal body in charge of the sustainable operation of the infrastructure and its research data management. ESFRI RIs also engage the scientific communities of specific disciplinary fields to collect, quality-control, curate and share data and metadata, thus playing a crucial role for fostering FAIR data management. Furthermore, RIs and ERICs promote the adoption of viable solutions for connecting with the recognised panel of experts in a specific scientific field. The design, implementation and operation of RIs and ERICs are carried out by the European Commission following the European Research Area Policy Agenda, and it is supported by the work of ESFRI.

EOSC, the European Open Science Cloud, has a much wider scope of an ERIC, as it aims at providing an open collaborative way that will push multidisciplinary research to the extreme. Unlike what happens in the ERIC context, data that can be reached via EOSC is not related to a specific scientific community, it is an aggregation of multiple data sources governed by a variety of entities, therefore it might be more difficult for an Honest Broker to sense the good and weak point characterising a specific domain. As a consequence, an Honest Broker may take advantage of a higher level of technical and semantic interoperability of data in the ERIC, as well as its legal framework and governance structure, which can help to ensure a more coherent compliance with ethical, legal, and social standards.

Some of the key factors that characterise Research Infrastructures are:

- They are open, as they allow access and use of their resources and services by researchers and other stakeholders from different fields, domains, countries, and sectors.
- They collaborate, as they establish networks and partnerships with other Research Infrastructures, as well as with academic, industrial, public, and civil society actors, to share knowledge, data, and best practices.
- They are diverse, as they reflect the diversity of scientific disciplines, methods, approaches, cultures, and languages, and they promote inclusiveness and gender equality among their users and staff.
- They are adaptable, as they respond to the changing needs and demands of the scientific community and society, and they embrace new technologies and innovations.
- They support the principles of Open Science, as they make their resources and services accessible, transparent, and collaborative for all levels of society, and they contribute to the advancement of scientific knowledge and its societal impact.

An Honest Broker who wants to take advantage of the Open Science paradigm can benefit from using Research Infrastructure by:

- Accessing and using the resources and services of Research Infrastructures to obtain credible and comprehensive evidence for their information and advice. Policy-makers seek information that is timely, relevant, credible and available, and these infrastructures may provide an efficient way to find relevant research outputs (e.g. publications, data, software).
- Engaging and communicating with the researchers and other stakeholders who are involved in or affected by the Research Infrastructures to foster trust and dialogue on complex and controversial issues. Infrastructure comes with a research already cooperating community, therefore making it easier to establish a direct contact with key people that may provide a better insight into specific scientific domains.

- Learning from the experiences, challenges, and best practices of other Honest Brokers who work with or within Research Infrastructures to improve their skills, competencies, and performance.
- Promoting the values and benefits of Open Science to the decision-makers and the public who rely on their information and advice to support informed and responsible choices.

I. Information overload

Information overload may be an issue for the Honest Broker, as well as for other actors involved in the policy process. Information overload refers to the situation where the amount of information available exceeds the capacity of an individual or a group to process and use it effectively. Information overload can lead to cognitive difficulties, such as confusion, distraction, stress, reduced attention span, and poor decision making, in other words, may seriously compromise the entire mediation process.

The Honest Broker, as a scientist who expands the scope of policy alternatives and clarifies the possible outcomes and trade-offs of each option, may face information overload from various sources, such as:

- The complexity and uncertainty of the policy problem and its context, which may require a multidisciplinary and multi-stakeholder approach to understand and address.
- The diversity and volume of scientific data and evidence, which may be incomplete, inconsistent, or conflicting, and may require quality assessment, synthesis, and interpretation.
- The plurality and variability of values and interests of different policy actors, which may influence their preferences, expectations, and perceptions of the policy options and outcomes.

To cope with information overload, the Honest Broker may need to adopt some strategies, such as:

- Prioritising and filtering the relevant and reliable information, based on the needs and goals of the policy process.
- Organising and presenting the information in a clear and concise way, using visual aids, summaries, and scenarios.
- Engaging and collaborating with other Knowledge Brokers, such as news media, think tanks, or advocacy groups, who can help disseminate and communicate the information to the target audiences.
- Facilitating and supporting the deliberation and co-production of knowledge among the policy actors, who can help identify and evaluate the policy options and outcomes

m. Tools based on the AI

Modern tools based on Artificial intelligence (AI) are able to support the Honest Broker in taking advantage of a multitude of resources based on the Open Science paradigm, resources that are able to enhance their efficiency, effectiveness, and credibility in their role. AI tools can handle repetitive tasks, freeing up time for the Honest Brokers to focus on more strategic tasks, therefore the Honest Broker should be aware of them and, possibly, master them properly in order to reduce potential risks [FINRA, 2020].

For example, these tools can help the Honest Broker:

- Reducing the impact of an information overload, as they help to find, access, and analyse Open Data and publications from a big variety of sources and disciplines, using techniques such as natural language processing, machine learning, and semantic web. There are multiple machine learning techniques to perform the so-called Systematic Literature Review (SLR), some of them are more suitable than others in specific tasks or domains.
- Extrapolating meaningful trends or the most relevant data in the world of Big Data. Thanks to Natural Language Processing (NLP) based tools, the analysis of big data becomes feasible in a timely manner.
- Generating and presenting different options and scenarios for decision-making, using techniques such as simulation, optimization, and visualisation.

- Communicating and collaborating with other researchers and stakeholders, using tools for providing a visualisations of concepts or ideas, such as tools able to generate images starting from a detailed description, or are able to make slide in a presentation much more effective and professional-looking, all easy-to-use tools that support the creation of more effective communication with policy makers, social media analysis, and recommender systems. It is expected that video creation tools will also be available in the near future. At the moment most solutions are still heavily under development, therefore they are not able to provide a completely satisfying solution yet.
- Monitoring and evaluating the impact and outcomes of the decisions made, using techniques such as sentiment analysis, impact assessment, and feedback mechanisms.

Few downsides and potential risks are associated with tools based on the AI:

- **Risk Management.** AI models, especially machine learning (ML) models, pose unique challenges such as model explainability, data integrity, and privacy. These models require rigorous validation processes to ensure they are free from bias, errors, and that they respect risk thresholds, and some AI solutions may not guarantee all these conditions.
- **Ethical Risks.** The adoption of AI must require an updated ethical model. It is crucial to ensure AI is used responsibly, prioritising accuracy, safety, honesty, empowerment, and sustainability. Ethical considerations include the use of appropriate data, human oversight, and continuous testing and feedback.
- **Explainability.** AI models, particularly deep learning models, are often seen as “black boxes” because their decision-making processes are not easily understood by humans. This lack of transparency can be problematic for an Honest Broker who needs to explain decisions to the parties involved in the mediation process.

- **Repeatability.** AI systems can produce different outcomes even with the same input data due to their stochastic nature, especially in models that include random elements or are sensitive to initial conditions. This variability can challenge the repeatability and consistency expected by an honest broker.
- **Data Integrity.** AI tools rely heavily on data quality and consistency. If the data is flawed, biased, or manipulated, it can lead to incorrect or unethical outcomes. Ensuring data integrity is crucial for an honest broker to maintain trust and accuracy in AI-driven decisions.
- **Bias and fairness concerns.** AI solutions are often influenced by the data, algorithms, or objectives that they are trained on. This may introduce bias or unfairness in the AI outputs, such as discrimination, stereotyping, or favouritism. For example, an AI solution may generate or recommend outcomes that are skewed or unequal for certain groups, individuals, or interests, based on factors such as gender, race, age, or location. This could undermine the impartiality, neutrality, or justice of the Honest Broker and the mediation process.
- **Performance and reliability issues.** AI solutions are not infallible or perfect. They may have errors, flaws, or limitations that could affect their performance or reliability. For example, an AI solution may produce or suggest outcomes that are inaccurate, inconsistent, or irrational, based on faulty data, algorithms, or assumptions. This could compromise the validity, quality, or trustworthiness of the Honest Broker and the mediation process
- **Limited customization and control.** AI solutions are usually designed to cater to a wide range of businesses with varying needs. However, this may also mean that they are not fully tailored or optimised for the specific context, objectives, or preferences of the Honest Broker and the parties. For example, an AI solution may not be able to handle complex or novel scenarios, adapt to changing circumstances, or incorporate feedback from the users. This could limit the flexibility, creativity, or quality of the mediation process and its outcomes.

- **Vendor lock-in and dependence.** AI solutions are often provided by third-party vendors or platforms that may have their own terms, conditions, or policies. This may create a dependency or a lock-in effect for the Honest Broker and the parties, who may have to rely on the vendor for maintenance, updates, or support. This could also reduce the transparency, accountability, or autonomy of the Honest Broker and the parties, who may not have full access or control over the data, algorithms, or outputs of the AI solution.

Concluding, the use of any AI based solution should be intended as a tool or a supplement, not a substitute, for the human judgement, expertise, and experience of the Honest Broker and the parties. Extensive verification, explanations, and justification of the AI outputs must be a condition before any acceptance, nothing should be taken for granted.

6. Conclusions

The very complex role of the Honest Broker is to act as an impartial and trustworthy intermediary between parties in a negotiation, transaction, or dispute, without favouring any side or having any personal interest in the outcome.

Based on extensive research in the literature, interviews, and analysis of a case study, we have provided some guidelines and best practices, always trying to stress on the importance of adopting the Open Science paradigm in all considered aspects and actions, encouraging the Honest Broker to promote it whenever possible while carrying out the mediation among the parties. We have also discussed some of the challenges and opportunities that an Honest Broker may face, providing some of the viable solutions taking advantage of resources based on the Open Science approach.

Appendix 1: Use case analysis

Background

Open Science is a well-recognized current target for scientists and research organisations. Within the Open Science (OS) paradigm, Open Access (OA) to publications and scientific data is the major endeavour, whose implementation requires addressing legal (policies and rules), financial, technological and governance challenges. In this framework, OA to scientific data and products is a major objective in Europe, as corroborated by the European Open Science Cloud (EOSC) initiative. OA to scientific data relies on FAIR Research Data Management (RDM), which involves scientists, producing, curating, and managing data and scientific products, and research organisations called to govern and support RDM. RDM is a process that requires governance, dedicated resources, skills, and sustainable solutions. This places emphasis on the role of **research organisations**, particularly on public research organisations.

Research data have a well-known lifecycle and RDM concerns the whole lifecycle. The RDM process requires the engagement and the direct involvement of the research communities (data providers in charge of collection, quality-control, curation) as well as the adoption of technological solutions to ensure access, interoperability, and use. This is nowadays represented by the FAIR (Findable, Accessible, Interoperable, Reusable) data management paradigm. RDM also requires the governance of the whole process and suitable approaches to tackle the sustainability challenge. In Europe, **Research Infrastructures** coordinated by ESFRI (European Strategic Forum on Research Infrastructures) have tackled these challenges and are collaborating to share solutions to address the sustainable FAIR data management. Research Infrastructures (RIs) engage scientists, research organisations and national authorities (ministries and funding agencies) committed to support their mission dedicated to providing access to data and facilities, therefore fostering the generation of scientific products, services, and open science.

Referring to data in OS and RDM requires the adoption of a clearly defined, and hopefully shared, taxonomy. The term Research Data includes different types of scientific data. Here we follow the **data taxonomy** proposed and adopted by EPOS (European Plate Observing System, www.epos-eu.org), an ESFRI RI governed by EPOS ERIC (European Research Infrastructure Consortium). The EPOS data taxonomy consists of distinguishing the term data in the following categories:

- Level 0, Raw data coming from observing systems and instruments
- Level 1, Data products generated by (nearly)-automated procedures
- Level 2, Data products generated and published by scientists through their research activity
- Level 3, Data products coming from complex analyses and community-shared initiatives
- Level 4, Software, services, and IT tools.

This distinction is essential to effectively address the governance and legal issues, with particular attention to the ethical aspects associated with OS and RDM.

In this report, we focus on the role of public research organisations in the governance of the RDM process through the adoption of sustainable practices and solutions as well as on their awareness to support OS and OA to scientific data. It is worthy to note that any professional profile identified to operate OS and RDM (data stewards, data curators, data managers) will perform her/his activities within the working environment and the governance established and maintained (i.e., operated) by the research organisations. In the framework of the Skills4EOSC project, it is useful to emphasise that the so-called “Honest Brokers” and “Knowledge Brokers” will operate within the legal framework and existing procedures (and protocols) adopted by the research organisations to undertake their actions toward decision- and policy- makers.

Introduction

According to the European and global landscape described above, research organisations play a key role for the sustainable operation of RDM and OA to research data. To further investigate this role and responsibilities we have proposed a case study in Skills4EOSC identifying the Istituto Nazionale di Geofisica

e Vulcanologia (INGV) as a research organisation committed to govern and support OS, OA and RDM. INGV has been identified as a representative case study for several reasons:

- INGV is a public research organisation committed to collect, analyse, interpret, and use scientific data and products for fostering scientific progress and innovation.
- INGV adopted quite advanced policies to support OS and RDM (data policy, access rules, licensing scheme, Data Management Office, ...).
- INGV signed the relevant documents facilitating the adoption of the Open Science, such as the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (2012), National Position Statement on the Open Access to scientific results (2013), San Francisco Declaration on Research Assessment - DORA (2018), Coalition for Advancing Research Assessment - COARA (2023).
- INGV hosts two ESFRI RIs, namely EPOS and EMSO, being the legal seat and the host institution for the two ERICs governing the RIs.
- INGV participates in international initiatives to share scientific data, not limited to the two ESFRI RIs (EPOS and EMSO).
- INGV is a member of EOSC AISBL.
- INGV uses the collected and available data to provide expert opinions for decision-making as well as to the surveillance of the national territory from earthquakes, volcano eruptions and tsunamis.
- INGV is part of the Italian Civil Protection System, therefore has a long-lasting experience of relationships between science and decision making.

For all these reasons, we believe that INGV is a suitable and representative case study.

There is another peculiar feature that characterises INGV. Scientific data are provided by research infrastructures and observing systems, which might differ and be characterised by a different complexity. There are large infrastructures committed to monitor natural processes (such as national seismological and geodetic networks) and local multidisciplinary observatories (such as a volcano observatory and a near-fault observatory). These national and regional (local)

observing systems require research data management to work properly because the monitoring activity is associated with the surveillance of the territory; that is, the use of these data is part of the observing system. Moreover, there are also complex observing systems (such as satellite observations) in which raw data provided by different providers (i.e., private companies, national and continent-wise space agencies) are elaborated to produce original scientific products (i.e., deformation maps, elevation changes) in accordance to rules enforced by strict contracts. There is also data provided by small facilities and laboratories (i.e., an experimental laboratory) as well as scientific computing (HPC - High Performance Computing, HTC - High Throughput Computing). This heterogeneity of the data generation landscape implies different levels of complexity in undertaking RDM and FAIR data management.

The analysis of the proposed case study is designed as an internal workshop aimed at discussing with INGV researchers, technicians, and decision makers the awareness on the sustainable operation of research infrastructures, including the commitments taken with pan-European ESFRI RIs, as well as the awareness of the resources to be dedicated for supporting RDM as a key contribution to OA and OS, together with the services provided to society.

The structure of the event

The INGV workshop was held on November 15th, 2023, at the INGV headquarter in Rome with attendance in presence and online. The workshop was organised as a think tank initiative more than a real workshop. After a short introduction with two presentations for introducing the initiative, the goals, and the institutional setting at INGV concerning RDM, the agenda consisted of two panel discussions with a short introduction by panellists and open discussions with the attendees. The agenda of the workshop is provided at the end of this text.

The first panel discussion was dedicated to discussing data management and data sharing at INGV. The topic was introduced by the Coordinator of the INGV Data Management Office (M. Locati) and by several panellists including the INGV Departments' Directors (having a role of decision-maker at institutional level), the

Coordinator of the Data Policy Working Group (G. Puglisi) and by a Researcher (R. Basili) acting as a Data Manager and being a member of the Scientific Committee of the Joint Research Unit coordinating the Italian participation in the EPOS RI.

The second panel discussion was dedicated to data sharing and data management (RDM) in the international and European landscape. The topic was introduced by the former EPOS ERIC Executive Director (M. Cocco) and by several panellists representing some of the major RIs in which INGV is heavily involved: EPOS (D. Bailo), EMSO (L. Beranzoli), the ORFEUS seismological RI (L. Luzi), the INGV Representative in EOSC AISBL (F. Quareni), a representative for the Tsunami Alert Centre (S. Lorito), a representative of the Space Earth Observation Centre (V. Romano), and an expert involved in managing and sharing research data for marine science (S. Simoncelli).

The goal of the first session was to discuss with INGV researchers, data managers, RIs managers, decision makers in charge of supporting OS and RDM at INGV about the current landscape and the future perspectives of RDM and OA to scientific data at INGV. The ambition was to understand and assess the awareness and governing aspects of the INGV role in contributing to data management and data sharing to accomplish its mission of fostering innovation in science (scientific research) and a science for society (surveillance, hazard assessment and decision-making).

The goal of the second session was to discuss the INGV role within the international landscape of ESFRI RIs, EOSC, international RIs and OS. This panel session aimed at discussing the INGV's commitments in international initiatives supporting OS and RDM, the impact for INGV from its participation in these initiatives, as well as awareness about the sustainability of OS, OA and RDM in the international and European landscape.

The afternoon was dedicated to presenting practical showcases and discussing further specific issues such as computational Earth Science, metadata curation and management, role of data stewards and data managers, open access at INGV. It was also a further opportunity to promote an open exchange of ideas on the topics and criticalities discussed in the morning.

Agenda of the event.

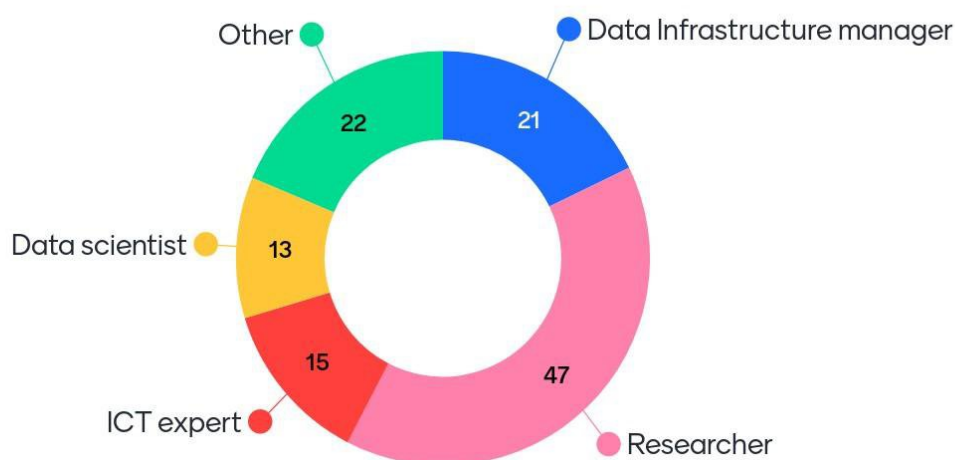
<i>Time</i>	<i>Partner/Activity</i>
09:30-10:00	<p>Welcome and introduction</p> <p>Institutional greetings, INGV President</p> <p>Introduction, objectives and national and international context, Massimo Cocco</p> <p>Data management at INGV, Mario Locati, Data Management Office</p>
10:00-11:30	<p>Session I - Data management and sharing at INGV</p> <p>Topics addressed: data archives, valorization, sustainability, relationship with infrastructures, dynamic data sharing in emergency phases.</p> <p>Discussion animated by the following panel:</p> <ul style="list-style-type: none"> ● Mario Locati, moderator ● Claudio Chiarabba, Director of the Earthquake Department and INGV-DPC Joint Commission ● Francesca Bianco, Director of the Volcanoes Department and INGV-DPC Joint Commission ● Massimo Chiappini, Director of the Environment Department ● Roberto Basili, contact person of the INGV component in the Joint Research Unit of EPOS Italia ● Giuseppe Puglisi, coordinator of the group that drafted the current Data Policy
11:45-13:30	<p>Session II - Data Sharing in the European and International Context</p> <p>Topics addressed: data sharing and management in the international and European context, commitments and role of INGV in the European context, impact of participation in European and international initiatives, sustainability of INGV's participation in European and international initiatives.</p> <p>Discussion animated by the following panel:</p> <ul style="list-style-type: none"> ● Massimo Cocco, moderator ● Daniele Bailo, contact person for EPOS ERIC ● Laura Beranzoli, contact person for EMSO ERIC ● Lucia Luzi, contact person for ORFEUS/EIDA ● Francesca Quareni, contact person for INGV's participation in EOSC AISBL ● Stefano Lorito, contact person for the CAT, the Tsunami Warning Center ● Vincenzo Romano, contact person for COS, the Space Observation Centre ● Simona Simoncelli, contact person for shallow marine monitoring
11:45-13:30	<p>Session III - Research Data Management in practice</p> <p>Topics addressed: policies and processes reflected in the work of groups and projects. Presentations and discussions:</p> <ul style="list-style-type: none"> ● Simona Simoncelli, moderator ● Alfonso Mandiello, Data Management Plan at ONT ● Fabrizio Pistagna and Mario Torrisi, OEDataRep ● Rossana Paciello, Data Sharing: Practical Aspects ● T. Esposti Ongaro, The Role of Computational Geosciences in Data Science <p>Further discussion at the end of the presentations.</p>

Interaction with the audience

As a part of the event, a set of questions were designed to engage the audience in the discussion and get their opinion and sentiment on some key RDM-related issues concerning their home institution. These questions were proposed to the audience through the Mentimeter interactive presentation tool and were commented on and elaborated in the course of the event. The event totalled around 250 participants between onsite and online and the participation to the mentimeter survey was good, with one third of the participants actively answering the mentimeter questions.

The first question was designed to provide a segmentation of the audience by asking their role in the organisation. The question was designed with the possibility of identifying with more than one role and interestingly enough, 30% of the respondents provided more than one role and 8% identified with three different roles.

Q1: role in the organisation



As it is apparent from the chart, about half of the participants identified as a researcher, with a good presence of professionals working in the research data management and/or in data analysis, and ICT experts. The “other” category

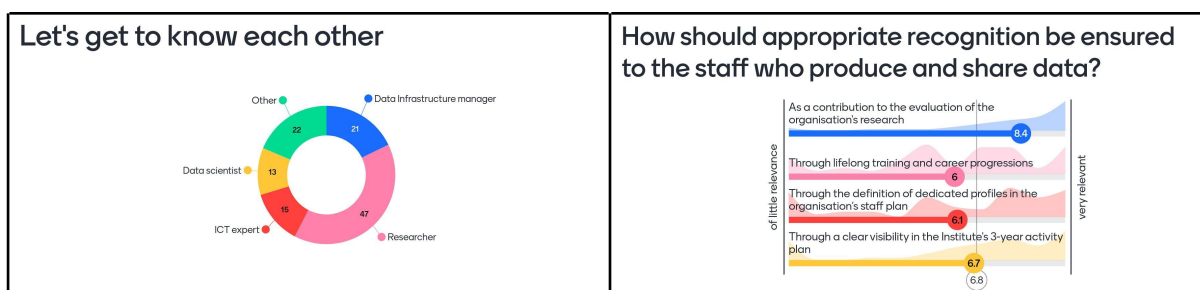
includes managerial profiles, as well as others more related to communication and exploitation.

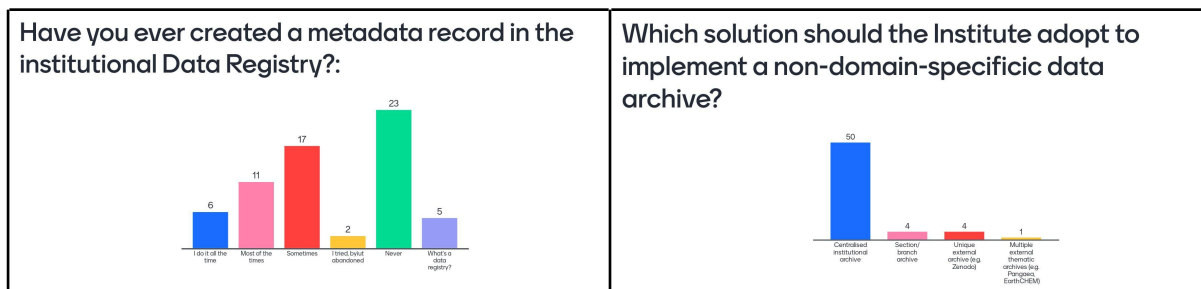
The key points touched in the other questions mirrored the discussion in the two morning panels, focussing on the recognition of the work done in data sharing and RDM, on sustainability and on the development of the RDM services within the Institute, and the openness of the research data underlying the expert (first panel), on the role and relevance of international collaborations to support the RDM activities (second panel).

Results

The initiative was a success. The participation was highly representative of all profiles involved with RDM with more than 75 people attending in presence and 166 attendees connected online. The discussions were highly participated, and first reactions were extremely positive.

Immediate feedback was collected during the workshop using a Menti.com survey (Mentimeter). The outcomes of the survey were extremely interesting to understand the expertise of the respondents, mainly scientists with a reasonable participation of data managers, RI managers and ICT experts for a total of 128 respondents. One of the most important outcomes was the acknowledgment of the relevance to establish and operate a Data Management Office and to have a centralised metadata catalogue for the whole INGV, called “Data Registry”. Most scientists never created a metadata record in the INGV Data Registry, proving the importance of improving training and communication inside the research organisation.





One of the most relevant questions for the study of the Honest Broker role is the one related to the availability of open data underlying the formulation of expert advice, an aspect that is especially relevant in INGV considering its role at the interface between science and practical decisions regarding civil protection and other critical aspects that are affected by natural phenomena like volcanism and earthquakes. The topic is sensitive, because there always is, in the geological community, the concern that making these data available can prompt on one hand their misinterpretation or fraudulent misuse, and on the other could cause irrational and scientifically unsubstantiated behaviours in the population (e.g. causing panic for a situation that can be managed without risks for the citizens); on the other hand, as it is also discussed elsewhere in this document, the availability of data supporting a statement is considered by many decision makers an important factor supporting the trust in a scientific expert/group of experts. As shown in the chart, a large majority of respondents emphasised the importance of openness over the valid ethical concerns; a part of them however is the opinion that an expert filter should be put on the data before they are disclosed. Only one individual however chose to answer this question negatively.

In your opinion, should the data collected for the formulation of expert opinions (e.g. by the Major Risks Commission) be made openly available?



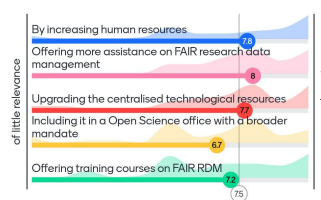
While this result depends on the existing protocols signed with decision-makers, it also suggests that researchers are aware of the importance of making data available through OA and RDM. This open approach, however, strives against the limited awareness of the resources needed to operate RDM as well as with the modest experiences of publishing data and metadata on institutional repositories.

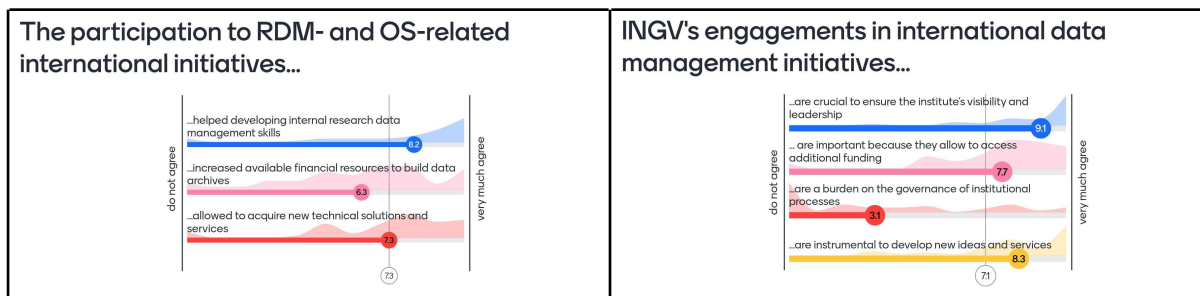
Further indications emerged for the improvement of the Data Management Office at INGV, both in terms of the allocation of human resources, skills and technological infrastructures. It clearly emerged that in order to foster and operate RDM within the research organisation, training and support is needed to help researchers to manage and share data and metadata. This certainly assigns a key role to the RDM Center, but also increases the impact of sustainability for operating RDM and OS.

How important do you consider these aspects for the sustainability of research data management?



How can the INGV Data Management Office be further developed?





Points to bring home

The interpretation of the discussions and the exchange of ideas during this initiative at INGV, allows us to highlight the following points to be exported and exploited to a larger European context.

1. The initiative confirmed the centrality of a public research organisation (or more generally, a research institution) to govern RDM and contribute to OS. The data management process (RDM) requires governance, resources, and an organisation in which the various professional figures (data providers, data stewards or managers) can play their role.
2. The initiative also confirmed the complexity of the RDM process that determines the ability to support OA and contribute to OS. This complexity manifests itself at multiple levels: from the typology of data generation (large observation systems, small laboratories, observatories, and local networks) to the taxonomy of data and scientific products, as well as the organisational structure for managing scientific data. This complexity, that research infrastructures like EPOS deal with every day, must be considered when talking about Training Plans and Learning Paths.
3. The initiative also highlighted both the role of a national research organisation in the pan-European landscape of research infrastructures, but also the difficulties of harmonising and coordinating the expected contributions at different levels: European (i.e., ERICs, EOSC), National (ICDI Competence Center, Research Evaluation from Ministry), Institutional (Civil Protection,

Departments) and scientific (National and international research projects). This proliferation of initiatives and Data Hubs makes it difficult to support the centrality of an organisation (point 1) and manage the complexity of data management (point 2).

4. The initiative also highlighted that the governance of the RDM process requires decisions on the role and capacity of a Centralised Data Management Office which must be able to interface with the different components of data generation and management both externally and internally to the institution.
5. The discussion on making available and sharing data and scientific products used for the implementation of expert opinions for decision-making and the provision of scientific information to society has not been fully explored. On one hand, there is the awareness of sharing data, even those used for surveillance, and of communicating scientific information to society. On the other hand, the discussion is conditioned both by existing agreements with decision-makers, often regulated by formal protocols, and by the increased awareness of the legal exposure and the ethical framework that raise concerns among the top roles.
6. Finally, the initiative highlighted the insufficient awareness of who should play the role of decision-maker in the organisation. In other words, there is an insufficient awareness of the importance of including computational science and data management among the key strategic objectives of the long-term planning of the research organisation. This represents a serious limitation on the ability to take suitable measures for RDM and AO to scientific data. This last consideration also determines the fact that it is not possible to seize the opportunities provided by large institutional projects. This tells us that the problem is not funding, but rather awareness and the will to govern these processes. This corroborates that the challenge is not solely identifying professional profiles, rather to insert them in a governed and structured institutional approach to RMD and OS.

Conclusive Remarks

The workshop provided interesting indications for further discussions, before being exported and exploited by other contexts and research environments. Without overinterpreting these results, we believe that the INGV case study corroborated that RDM is a process which needs to be governed at institutional level (i.e., at the level of the research organisation) to adopt a sustainable approach to RDM, and in particular to FAIR data management. It also pointed out the need for training personnel to build the professional profiles necessary to operate RDM, OS and OA. However, these efforts must be associated with the effective knowledge of the institutional context and with the awareness of the role played by the research organisation in governing and maintaining the RDM process.

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Appendix 3: Interviews

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Interview 1: Former member of a commission for the Civil Protection

The following is an interview with a former member of the Italian “*Commissione Grandi Rischi*”, the national commission for the prevision and prevention of the major risks which is established and regulated by a dedicated national law.

The commission is an organ of technical and scientific advice for the Department of Civil Protection, which is the central authority of the national civil protection service in Italy. The commission supports the department in eight sectors of risk: seismic, volcanic, tsunami, hydraulic, hydrogeological, meteorological and climatic, forest fires and water deficit, nuclear and radiological, chemical, technological, industrial and transport, environmental and health.

The commission's main tasks are to provide scientific opinions and recommendations on the assessment, monitoring, and mitigation of major risks, to contribute to the development and updating of the national and regional civil protection plans, to promote the dissemination and communication of scientific knowledge and information on major risks, and to collaborate with the centres of competence and other relevant research organisations.

The commission is independent from the Department of Civil Protection, and operates according to the principles of transparency, impartiality, and accountability.

Interviewer 1: Thank you for accepting this interview. Have you had the opportunity to read the descriptions of the profiles I sent you, those relating to the figure of the Honest Broker, the Knowledge Broker, and the Issue Advocate? In particular, do you see yourself in the profile of the Honest Broker?

Interviewee: Yes, in the past on more than one occasion, not only with *“Commissione Grandi Rischi”* (national commission for the prevision and prevention of the major risks, from now on simply CGR), but in many other situations. I played the role of the Honest Broker, that is, having to act as an intermediary between scientific knowledge and the people who had to use it so that they could make decisions in a logical and sensible way, with all the information possible.

Interviewer 1: The field in which we operate for the construction of training modules is focused on the paradigm of Open Science combined with the role of the Honest Broker. I guess the term Open Science is clear to you afterwards also thanks to the definitions we have given you; I wanted to understand what specific aspects of Open Science you have personally addressed in carrying out your activities as an Honest Broker.

Interviewee: No, not much, but certainly the preponderant part is related to my publications, especially when it comes to conventional scientific journals. We can consider my participation in the activities of the Global Earthquake Model (GEM) because they were clearly Open Science-compliant actions for that sector, especially with regard to the activities in which I was involved in the Scientific Committee. I gave my time to support them in the development of some aspects of this model, a model that would then have to become totally public. This was one of my few participation in Open Science activities.

Interviewer 1: Open Science does not only cover the field of scientific publications in Open Access journals. In fact, Open Science encompasses all aspects of a scientific process, similar to what you have just told us in the context of GEM, so also activities concerning the opening of the data generated, the software that is created, every aspect of the process is open, so it is an extremely broad spectrum of activities and practices. Changes in the way evaluation of the research results is conducted is also part of this novel approach.

Interviewee: Yes, it's clear to me, even when we write articles with my students, we take care, for example, to always make the data we have used available, so that the processes are as reproducible as possible. We have no problem sharing the data analysis and processing scripts we have built. So I would say yes, we have in fact adopted the Open Science paradigm.

Interviewer 1: Excellent. I suppose that some guidelines on this matter are provided by the University where you work in Italy, guidelines that encourage this approach in sharing all research outputs and processes.

Interviewee: Yes, there are guidelines, even if the University is not adequately structured in an optimal way. However, yes, there are guidelines even if they are not particularly effective.

Interviewer 1: Let's focus on the activity you carried out in the CGR for the past ten years, an activity that we consider interesting because it could make us better understand the mechanisms related to the activity of an Honest Broker. For example, it would be interesting to understand more specifically

what activities are being conducted, activities that may have required interaction with people who have generated data and information that you have considered. In other words, our goal is to understand how important this data and information has been in carrying out the work of providing opinions or in any case, how you facilitated the creation of scientific opinions. We are interested in understanding the mechanisms that facilitate the connection between the scientific world and the world of Policy Makers or Decision Makers. It is important to understand how significant access to this kind of research results, processes and products has been and how it has been possible to exploit these results that had been freely available by the scientific community.

Interviewee: Yes, the intent is clear. The environment in which the CGR operates, as you all know, is a rather peculiar one and the exchanges between the parties are formal. The answers that can be given are very constrained, there are many qualms about the possibility of freely expressing one's opinions because of lack of legal assistance by the department of civil protection, at least at that time. There were requests to provide a very direct opinion and since I was for a long period the only one in the group who dealt specifically with seismic risk, I had limited ways of confronting myself. There were other people in the expert group, but they were dealing with other issues such as seismic hazard or other aspects of the complex chain. In my answers, I based myself on data, which I knew I have on risk in Italy, data that I had developed with models made by me and my students and other collaborators of mine. I have never had any problem giving my clear opinion as it is always based on facts. I wasn't always asked where the data used to support my answers came from. Let's say that after reading the definition provided of Honest Broker, I feel that I have done just what is expected of an Honest Broker.

Interviewer 1: Why wasn't the data made explicit about the origin of the data? For example, did you use data that can be classified as personal communications, therefore not publicly available?

Interviewee: For example, I was asked if the models used by the Civil Protection Department for the calculation of seismic risk in Italy were state-of-the-art, if they were robust and defensible. On this I provided an opinion based on what I knew also thanks to several other works carried out both in the academic and non-academic fields, thanks to the knowledge of other risk models in Italy, models in which the vulnerability of buildings and seismic hazard were calculated in a fairly sophisticated way, models that were not public. So my opinions were also based on data and models that I was aware of because I had worked on them myself, but models tied to contracts with such confidentiality constraints that they did not allow me to share them even with the CGR.

Interviewer 1: What is the level of formalisation that characterises these questions and answers? Are these formal steps related to these exchanges? Are they recorded?

Interviewee: Yes, it's all recorded, both the questions and the answers, of course.

Interviewer 1: In the literature we have found the term "entity" to define an Honest Broker in order to clarify that it is often not a single person but a structure often composed of several people. The functioning that you describe of the CGR seems to us to be in line with what we have read in the literature. We would like to understand to what extent the processes are formalised, to what extent the mechanisms follow some manual or guidelines that the parties involved must follow, for example for communications.

Interviewee: No, in my experience there wasn't a real manual that explains the procedures to follow.

Interviewer 1: So we are not at the levels of formalisation that characterise bodies such as the Senior Seismic Hazard Analysis Committee (SSHAC) in the USA for activities dealing with nuclear power plants. These aspects are useful to us because in the Skills4EOSC project we want to illustrate examples of how these bodies work in order to better build suitable training modules. Unfortunately, in the literature that analyses Honest Broker scenarios also related to Open Science practices, we have not found cases in the field of Earth Sciences, and this one that you illustrate is certainly very useful.

Interviewer 2: Yes, it could be that the CGR does not have an extremely precise operating regulation, a detailed code of conduct for each of its members. However, it should be made clear to the participants of the project who are extraneous to the field of seismic hazard of which interviewee spoke, that the CGR has its own instituting regulations and has procedures to some extent formalised by the Civil Protection. I ask the interviewee for confirmation of this, especially in light of the fact that for the Civil Protection, the CGR is similar to a technical consulting table made up of experts who have been carefully chosen to formulate a collective opinion. That is, we must clarify that although there are no formal and rigid procedures for the individual members of the CGR, it is sufficient that in carrying out their role they must abide by their own deontological, ethical and moral code.

Interviewee: Thank you for the clarification. In fact, it might even be the case that the CGR has some kind of manual, however when I entered it was not indicated to me. I wasn't told to read a behaviour guide that I would have to stick to for subsequent meetings. I was called to be part of the CGR by the Civil Protection because they considered me an expert in the field, I was simply asked to participate in the meetings and say what I knew about very specific issues.

Interviewer 2: I would like to return to this specific topic at the end of the interview and sorry if I interrupted, but it was necessary to clarify that the structure and functioning of the CGR is formalised by a law of the Italian state, it has its own manager, it has a quorum, it has a whole series of formal regulations with legal value. However, it is likely that those who are called upon to participate in the activities of the CGR will not be put in a position to know exactly what the complete and detailed procedure of the individual activities is.

Interviewee: Going back to the CGR issue, I learned that its operation has changed slightly. For example, when I was a member there was no legal coverage, so I bought an insurance policy to protect myself, a policy paid for privately and independently. After the issues related to the L'Aquila earthquake of 2009 we were told clearly and peremptorily to be extremely cautious in our statements during the sessions of the CGR. This warning had generated concerns in all the members of the CGR that may have limited the openness of their statements, they all just made thoughtful statements knowing that they would then be written in a report with legal value. I have discussed this approach on several occasions with the person in charge, because on the one hand the Civil Protection asked for the opinion of experts who were not paid and they were not put in the ideal conditions to speak freely. I had the impression that the experts who came from all over Italy to participate found themselves in an unclear situation. Fortunately things seem to have improved, now I am told that, for example, there is legal protection for members.

Interviewer 1: Yes, I can imagine that these activities were also very impactful on a personal level, especially being aware that they did not have legal coverage. Moreover, I can imagine that sometimes being forced to base one's answers, which were then recorded, on data that might not be publicly available, was a gamble. Wasn't it possible to imagine in this context publishing this data so that your answer would be based on open and verifiable data?

Interviewee: I had never been asked to publish the non-public data that I had available and then in reality most of the data that was used by the activities in the CGR on which most of the decisions that were made when there was some seismic swarm in progress were based on data that INGV provided to the CGR officially. These data were very interesting and supported our opinions. However, I believe that not all of these data and elaborations were publicly available, I do not believe that they were open data, or rather, I have never seen them published anywhere, not even on the INGV website, but maybe I am wrong, this was not a topic of discussion in the CGR.

Interviewer 2: On this I can try to clarify the situation myself. The data provided by INGV are for the most part basic data, raw data on which technical reports drawn up expressly for the CGR were based. The master data is open, these are hypocentral locations, the strong motion data and peak values, and so on. The elaboration and opinions that are prepared by the INGV colleagues called to participate in the CGR cannot be disclosed by express order of the Civil Protection itself, these are communications addressed exclusively to the Civil Protection, I personally agree that these communications must not be opened. Open Science doesn't mean that everything has to be open.

Interviewer 1: Of course, I confirm, one of the axioms of Open Science is "open as possible and as closed as necessary".

Interviewer 2: I'll give you an example to clarify the conditions in which INGV operates. Immediately after the earthquake in central Italy on August 24, 2016, the President was changing at INGV and the senior managers decided to hold a press conference in which we presented all the data we had collected on the ongoing seismic event. The Civil Protection has decided to no longer authorise the organisation of press conferences of this kind at INGV in the future.

Interviewee: Yes, the context in which we operate is absolutely clear, I will also add a few examples that help to clarify the situation. It has happened to me that I have been asked questions at the CGR. Before providing an answer, I asked them to contextualise it and clarify what the purpose of the question was so that I could provide a more relevant answer. For example, I was asked if the model used by the Civil Protection Department to assess damage and risks in Italy could be improved or was it okay. Obviously, the answer was related to the purpose for which this model was used, but this question of mine was not answered. The context of use is fundamental to give an answer, a model for example can be more or less suitable for the rough assessment of damage after an earthquake and it may be sufficient to rely on input data such as those relating to rupture, strong motion data, shakemaps, etc., and for these purposes a certain type of model can be suitable. If, on the other hand, the aim is to understand if, for example, hospitals in Italy can suffer damage that alters their functionality, then the level of detail required requires other types of models. In those occasions the absence of a completely open discussion did not put me in a position to operate at my best.

Interviewer 1: Let's say that the absence of contextual information can therefore be a condition in which the Honest Broker may find himself operating, even if such information is necessary to provide an adequate scientific answer.

Interviewee: Yes, it may happen that subjects such as the Civil Protection formulate a precise question and demand an equally precise answer, at the same time without providing any contextual explanation on how this answer will then be used. Failure to provide background information undermines a relationship of trust between the parties and prevents me from giving an informed response, which is free of charge. It is implicit in the relationship of trust that should be established that I am bound by confidentiality and that the contextual information that should be provided to me confidentially should undertake not to disclose it.

Interviewer 1: So you confirm that confidentiality is the basis of the relationship of trust that is established between Honest Broker and Decision or Policy Maker. Changing the subject, we would like your opinion on an issue that we have found traces of in the literature, namely the availability of data and information in a timely manner, because often the process of transferring knowledge from the scientific world is required with often extremely tight timelines. However, we found many case studies in healthcare and virtually nothing in the field of Earth Sciences. Your case could help us to focus the processes of reshaping information in this area to be correctly received by the Decision or Policy Maker. We speak of remodulation because often the terminologies adopted by the various disciplines could be misinterpreted by external parties, a remodulation that must not distort the original information and that must be carried out quickly because there is no time to develop ad hoc tools. It is therefore necessary for the Honest Broker to be in a position to take advantage of existing tools, what do you think these tools are? Could Research Infrastructures be suitable for this purpose? To clarify, when we talk about Research Infrastructure we think for example of the one managed by EPOS ERIC, I assume you have had the opportunity to know it.

Interviewee: In the field of seismic risk that I deal with, it is very difficult to be able to use data that have not been processed in a uniform way and it would be desirable that this data be accessible from a common and open platform such as the one run by EPOS ERIC. Let me give you a practical example to clarify what I am referring to. After an earthquake, inspections are carried out to ascertain damage to buildings. Unfortunately, however, these data are not collected in a uniform way, or they do not cover a homogeneous area and moreover either they are not available at all or they are made available in pieces with various embargo periods, sometimes we are talking about several months. In some cases, the first data were published a year and a half later. If infrastructures such as EPOS were to take charge of creating archives that host data of this type, which could then be processed in a homogeneous way and made available to everyone, the scientific community would benefit enormously. As anywhere else, in Italy having the data provides a power to its holder.

Interviewer 1: Are you referring to the building usability sheets compiled by various subjects on behalf of the Civil Protection or rather to the macroseismic investigations conducted at INGV? I know that the usability sheets, for example, are all collected in an archive managed by the Civil Protection inside, an archive that, however, is not open access. Are you referring to the usability sheets?

Interviewee: Yes, but the problem is not only related to the fact that the archive run by the Civil Protection platform is not publicly accessible, often the same researchers involved in the investigations jealously store this data for a long time before depositing it into the archive. Fortunately, I see that in recent years this approach of researchers is less relevant, even if it persists in Italy. Until a few years ago, it was really difficult, for example, to obtain the accelerations recorded by seismic stations close to an earthquake. There were people who kept these recordings locked in a drawer until articles were published. Recently, things have improved, although there is still plenty of room to improve the level of openness. The Civil Protection Department could certainly help and make data available in an open way or at least more open than it is now.

Interviewer 1: We must not forget that the availability of data such as those related to the usability of individual buildings, especially for those for private use, are linked to the privacy protection rules dictated by the European-wide GDPR laws.

Interviewee: Yes, of course, the issue of personal data privacy is important, but it is sufficient to give the data in a slightly aggregated and not punctual way. Of course, you need a level of aggregation that is not too exaggerated, otherwise the data becomes useless for certain purposes.

Interviewer 1: Thank you for this discussion, I see an emerging aspect that I had not personally encountered yet in the literature, namely that some useful information for the role of the Honest Broker can come not only from the scientific world, but can also come from the Decision or Policy Maker.

Interviewee: Of course, yes. For example, the Italian National Institute of Statistics (ISTAT) holds data on the exposure of buildings with a very high level of granularity, but these data are not distributed. These data are essential for people who deal with seismic risk assessments, but they have to make do with what ISTAT makes publicly available, i.e. data aggregated at levels that are of limited usefulness. Of course, Google also has data on the footprints of all buildings around the planet, obviously the ones you see. If a researcher just extracts a few of this information from Google's platforms, nothing happens, but if you extract large amounts of it then Google identifies you and sues you, a cause from which the individual researcher cannot get out alive. So yes, there's still a ton of potentially useful data that could be made available but isn't.

Interviewer 1: I wonder if in the role, that in some ways could be considered privileged, of the Honest Broker operating under the aegis of the CGR, he can exploit this position to claim access to confidential data potentially useful to adequately carry out his role.

Interviewee: If, for example, in my work at the CGR I had been asked to develop or refine an existing model relating to seismic risk, I could certainly have asked for access to confidential data. For example, the data held by ISTAT on buildings would have been essential, which include not only their distribution, but also a classification of buildings based on building materials, height, construction periods, all at very high granularities. So yes, I could have requested them, and I guess they would have been given to me. However, this request of mine would certainly not have made these data available to the entire scientific community, and all of my work would have remained confidential and confined within the CGR.

Interviewer 1: What are your hopes for the future? Set aside data covered by the GDPR, what are the aspects related to Open Science practices that could further improve the activity of the Honest Broker?

Interviewee: In the future, I hope that organisations such as EPOS ERIC or EFEHR will be able to obtain a lot of structured data in freely accessible databases, hopefully supported by adequate funding in the medium to long term to ensure their sustainability. With the availability of these databases open to all, scientific research would make great strides even faster. I say this because this is what happened in the United States when models began to be made available, data on buildings, so that different researchers could use them freely without having to start from scratch. Certainly, this data would be an excellent vehicle to improve research. This process is unfortunately not always easy to achieve. Even in the United States, if one wants to get the accelerograms, they will not be provided. Some accelerograms are not publicly available even on the COSMOS platform, an archive with all the accelerograms of which, however, the managers of the archive are not the owners, the owners are the various bodies that take care of the stations that generated those accelerograms and that do not give permission to make them publicly available all at once. A researcher can download data in the order of perhaps 200 accelerograms, but there are 40,000 in the whole database, but not all of them can be downloaded. All these problems mean that research is moving forward less quickly than it could.

Interviewer 1: So far, I haven't heard you mention the word "artificial intelligence". There are even those who fear scenarios in which tools such as chatGPT will be able to replace the figure of the Honest Broker. How do you see artificial intelligence applied in this area? What are the AI-based and machine learning-based tools that could make the Honest Broker's work easier?

Interviewee: Let me start by saying that I am not an expert in artificial intelligence. Of course, I have used it sporadically in some fields of research, mostly out of interest for some students themselves. I believe that Artificial Intelligence can be useful to get you out of a complicated problem easily. It's true that Artificial Intelligence can find connections that we can't see. However, I fear the use of artificial intelligence to get results because we don't realise exactly how these results are obtained, it's a bit like a black box that obscures the most important parts of the process. I haven't used as many tools like ChatGPT so I can't say how useful it might be, however I have students who use it profitably to do literature searches, in the sense that it helps to find scientific articles that you were not aware of. I am not against the use of artificial intelligence a priori, if used well it can certainly be useful. I'm concerned because I've seen a lot of work based on the use of artificial intelligence that shows results generated by phenomena and processes that the authors themselves can't fully understand. These are results that may be useful but do not help us progress, do not use artificial intelligence in the hope that it will solve our problems, you need to have control over what you are doing.

Interviewer 1: I confirm the same impression, it seems to me that the answers that are provided by Artificial Intelligence go in the opposite direction to the philosophy underlying Open Science practices, because the answers that are provided are not reconstructable, it is not always possible to understand the process that, starting from a series of input data, that specific result was obtained. Yes, I agree with the use of the term "black box" for certain answers provided by Artificial Intelligence.

Interviewee: Yes, as a researcher you could provide access to the neural network that generated a given response, but it is difficult to fully understand what was the precise mechanism that led to the generation of a given response.

Interviewer 2: I would like to pose two questions to the interviewee. The first question starts from the assumption that in EPOS ERIC we try to separate and classify data with a specific taxonomy, identifying them starting from the raw data that come directly from the observation systems, moving on to the scientific products that come from automated procedures, then to the scientific products that come from the work of individual researchers and finally to the consensus scientific products generated by research groups and communities. Do you share the idea that an Honest or Knowledge Broker acting in the field of Open Science must adopt a similar distinction of data by linking different ways of interacting with a Decision or Policy maker to this classification? We believe that these data classes should be differentiated when communicated to the stakeholders, as the most elaborated data may enter the ethical dimension of an Honest or Knowledge Broker himself. What do you think?

Interviewee: Surely the distinction you made is very useful. In the various working environments in which I have found myself operating in the role of Honest Broker, both with public and private entities such as those in the insurance sector, the counterparty is not interested in having all the data and information, they are only interested in having enough data and information to make a decision. So yes, the distinction that you have made that you have made is useful, for example, to distinguish what can be made available to everyone publicly and what does not necessarily have to be public.

Interviewer 2: Exactly. It is of great interest for EPOS ERIC to contribute to the sharing of data and information from the scientific community. The issue is that as the taxonomy level increases, the problems increase both in the ethical and legal spheres, because, for example, we risk interfering at the European level with any agreements and decision-making processes taking place at the local level. For example, I am convinced that when a European platform such as EPOS ERIC will provide a model of seismic hazard or risk on a European scale generated as part of a European project, the individual Civil Protections on a national scale will not object to this operation. However, any differences between the European model and the local model could lead to problems. The second question is related to the definitions of the Honest Broker and Knowledge Broker profiles that we have provided you. Do you agree with these distinctions and definitions? Do you recognize yourself and can you distinguish when you play the role of the Honest Broker instead of the Knowledge Broker?

Interviewee: I have to admit that this is the first time I've discovered these definitions, I don't completely agree with these subdivisions. To better explain myself I'm trying to think back to all the occasions in which I found myself passing scientific knowledge to other subjects to put them in a position to be able to make informed decisions. In my opinion, in some cases it was a middle ground between the figure of the Knowledge Broker and the Honest Broker. Sure, in specific cases, such as when I worked for the CGR, I certainly recognize myself in the role of the Honest Broker. However, there have been many cases in the past where the distinction was not so clear-cut. Out of curiosity, who wrote these definitions?

Interviewer 1: There is literature on this topic. In fact, we found an impressive amount of publications, especially in the medical field.

Interviewer 2: I am very critical of these definitions and I sense at least two issues. First, I agree in saying that there is not a clear distinction between the figure of the Honest Broker and the Knowledge Broker, and sometimes there is a margin of overlap even with the Decision Maker. The second issue is the impossibility for a figure of this kind not to influence, even involuntarily or imperceptibly, the communication of information, consequently influencing the Decision or Policy Maker. I would like to remind you that there is a distinction between data, information and knowledge, each one has a specific context. The data comes from a rigorous scientific process, the information is the description of the scientific process, and finally the knowledge is linked to the profile of the recipient. Each of the three contexts presents an increasing level of potential influence, up to the communication of knowledge in which an ethical and personal level of elaboration also enters. It is very dangerous to use these three terms without knowing the scientific contexts in which they operate. The last critical aspect I find is very much related to the last one, because in the absence of a specific scientific context, one cannot theorise the best practices, because each context is linked to very specific procedure, dissemination and decision-making practices.

Interviewee: Yes, I agree with what you say, it's very clear to me. For example, in cases where I was an Honest Broker, I had to provide data or information to decision-makers. If you don't also clearly communicate the degree of uncertainty of the data, information, and even opinions you provide, you're certainly proceeding to influence the other party. The issue of uncertainty communication is a fundamental aspect that I teach my students. I always explain to them that it is necessary to be clear about what you know and what you don't know, and what you don't know is potentially influenceable and therefore leads to potentially "replacing" the role of the Decision Maker, thus leading to wrong behaviour.

Interviewer 1: Thank you, we will certainly highlight this aspect of the communication of uncertainty in the context of the project.

Interviewer 2: Thank you, what you say confirms to me the impossibility of making the distinction between these profiles without a context. Whatever the stakeholder is, who receives the information or scientific knowledge must be sufficiently prepared to receive it. Therefore, Open Science cannot disregard the ability of its user to deal with the information or knowledge that is made available, otherwise it is an unworkable principle.

Interviewee: I agree, there is a great characterising factor for each scientific field. If, for example, in the medical field the communication of uncertainty and probability is a practice often accepted, indeed encouraged, in the field of seismic risk it is still a taboo. In Italy today, you can't talk clearly about the fact that if you live in a certain type of house, in a certain area of Italy, you have a lower probability of dying in the event of an earthquake that could happen in the next 50 years than in other areas of Italy, where the probability of dying is 10, sometimes 100 times, higher. This is a taboo, it is clear that it cannot yet be said explicitly. In Italy, on the other hand, we continue to talk about anti-seismic rules or prescriptions, conveying the idea that if you adopt a project for an anti-seismic building then absolutely nothing will happen to you. I am disconcerted by the fact that in Italy we are not able to talk about these issues in an open, normal, and even minded way.

Interviewer 1: Do you think that the underlying causes of the impossibility of talking openly about these issues are political, religious or otherwise?

Interviewee: It's about politics, it's absolutely not a scientific problem. For example, if a politician speaks to the media during an earthquake and says that he will support the affected population, he will be rewarded. If, on the other hand, a politician before an earthquake incentivizes or, worse, forces the population to spend money to strengthen their homes or buying insurance, then that politician will be penalised because he will be assimilated to someone who imposes a new tax. This occurs despite the fact that the total of money spent in prevention would be much lower than the money that needs to be spent to support the population with destroyed houses because they were poorly built.

Interviewer 1: I would like to conclude the interview by asking you for advice on the training modules for the figure of the Honest Broker that we are going to build during the project. What do you think are the elements of Open Science that we absolutely must communicate to the Honest Broker?

Interviewee: Certainly, the aspects related to the ethical issue are fundamental, because as I have had the opportunity to say, it is a matter of avoiding, or at least reducing, the influence that is imposed on the Decision or Policy Maker. It is important to make it clear that it is very easy to influence the Decision Maker by passing on partial information. It is extremely difficult to completely refrain from influencing the communication process because everyone has an opinion on the issues on which they have particular expertise. Avoiding including these opinions in what you say and do is not easy, but you have to force yourself to do it, it is not trivial at all.

Interviewer 1 and 2: Thank you very much for this interview.

Interviewee: Thank you very much for contacting me.

Interview 2: Politician with experience with Honest Brokers

The interviewee has an academic background in information technology and was a senator of the republic in the last legislature, in the ranks of “Movimento 5 Stelle” in Italy. She has worked on various issues including Open Data. Among other activities, she has promoted this series of events on the topic of the importance of data for decision-makers.

Interviewer: Are you familiar with Open Science practices?

Interviewee: Yes, although it seems to me that there is still a lot to be done both for open access to publications, which I think is still a minority phenomenon compared to publishing with the big publishers, and for open data both in science and from other sectors, despite the commitment from so many sides (political, scientific, civil society...). Open software fared better, I think because in this case there was a clear business model, which worked because companies bet on the fact that the production of Open Source software gave better results than proprietary software.

At least as far as basic software is concerned, the way I see it, Open Source has won, it is probably the open practice that works best, precisely because these investments that have been made have in some way triggered a virtuous circle that has allowed it to develop.

Interviewer: In your political experience, have you ever found yourself in the position of making a decision (also) based on scientific evidence?

Interviewee: I would like to preface this by saying that in our legal system, a parliamentarian is not in a position to make a decision - something that is more related to the prerogatives of the executive and the various ministries - but he or she may or may not support it, and may direct the decision by offering a stimulus or a suggestion.

As far as decisions based on scientific evidence are concerned, I can give two examples:

1) at the time of the pandemic there was a strong commitment - including my own - that decisions should be made based on data and that the data on which these decisions were based should in turn be published in an open manner, so as to ensure the transparency of decision-making processes. This orientation resulted in a lot of work, both to organise the collection of data and to publish them daily in a repository with a 'dashboard' showing them to the public. What I can say about this experience is that the biggest issue was that it proved impossible to make decisions based on data alone.

2) As far as the National Resilience and Recovery Plan is concerned, there was a push for openness requirements for projects to be included in the regulations, aimed at documenting how the funding was used. By now, we can say that there is a growing awareness among politicians that the availability of open, accessible, transparent and verifiable data is the basis for appropriate, proportionate, effective and timely policy decisions. In my experience as a parliamentarian, I realised that bills were often based on an assessment (also) of the scientific aspects at the drafting stage; furthermore, very often bills were drafted with even very specific parts devoted to the regulation of data collection. An example I can give is that of the fight against gender violence, for which the Femicide Commission had already been introduced in the previous legislation: here, already in the establishment of the

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commission, the specifics of how the data for monitoring and decision making were to be collected were also addressed. Outside the scientific context, also in the fiscal and taxation sphere everything is done on data.

In my experience, when decisions are not made on the basis of data there is always a desire to follow other value systems, interests and considerations: in the decision-making phase, data is taken into consideration at the same time as other requirements, in particular the objectives to be achieved. Sometimes data is used as leverage to substantiate objectives.

Interviewer: In your political practice, have you made use of the expertise of one or more persons or groups who have acted as an interface between the scientific and political levels (e.g. by providing expert opinions, or information on possible scenarios and the consequences of certain decisions based on scientific evidence)?

Interviewee: It is a common practice to call in experts, and even to have, on various issues of a certain seriousness and importance, steering cabins that include experts and scientists of national or even international relevance.

It is common practice of parliament and chambers to hold hearings as part of the legislative process of every bill, and also of every decree-law proposed by the government.

Interviewer: Could you briefly describe the information flow of this interaction? (E.g. what was expected from the expert, what was requested and what was actually delivered, what supporting information was included in the exchange, etc.).

Interviewee: In rounds of hearings, experts, such as lawyers or scientists, but also other stakeholders, such as citizens' associations pursuing 'citizen science' issues and initiatives, are called upon.

In particular, open data (not only scientific) is dealt with in various parliamentary initiatives and decree-laws.

Often already at the drafting stage of the bill there is an intervention of these experts: in fact, the bill is proposed by an individual parliamentarian, but he/she has usually also received solicitations from the scientific community (e.g. by 'Issue Advocates') or civil society.

When it arrives in parliament for discussion, the bill is assigned to a committee, in which all political groups are represented, who may or may not be aware of the contents of the bill at the time it is assigned: they have to come to a consensus on the bill under discussion, which is typically done by calling in their own experts, to see if the proposal is reasonable, is in line with their own political agenda, and what the implications are.

In most cases, these are experts who are already accredited, who have a prominent figure or are representatives of a certain institution, and are normally called indifferently by the political party asking the question because they are considered reliable and super-partes. (Editor's note: this description is very close to that of the Honest Broker found in the literature)

Despite the intervention of these experts, however, in my experience it is very difficult to make decisions on the basis of data alone: even in the best-case scenario when there is, that is, abundant

and good-quality data and a scientific consensus on their interpretation, there are still other factors that come into play in the policy decision and have to be weighed against pure evidence.

Interviewer: How would you generally define your experience in dealing with these people/groups?

Interviewee: Consulting what you call an Honest Broker, or even an expert to write an opinion on a specific question, as I said, is common practice in parliament. The impact of Issue Advocates (or stealth Issue Advocates), on the other hand, is quite limited for a parliamentarian: these kinds of figures come to talk to you, but they are not so incisive because the parliamentarian does not have executive power. The issue of lobbying and the need for authoritative and unbiased opinions are instead two critical aspects at the level of ministries and even more so at the level of government. If a good lobbyist manages to have direct interaction, for example with a minister (but also an undersecretary), he can succeed in achieving his goal, whatever it may be. In particular, ministries in our country are rather ill-equipped to deal with lobbies, in the sense that they are often looking for a solution to a pressing problem and can become prey to those who manage to get through to them by proposing an (at least seemingly) acceptable solution. An example I saw first-hand was the government's policy for the management of distance learning during the pandemic, where GAFAMs ticked off conditions extremely favourable to them due to the pressure on the ministry to come up with a workable and quick solution.

Interviewer: In your experience, what factors hinder the practice of making policy decisions based (also) on evidence?

Interviewee: It depends very much on the field, but in a number of cases (e.g. in the epidemiological field, but also in the psychosocial field) there is often a lack of data and action must first be taken to ensure that it is collected.

Other cases where it is particularly difficult to decide on the basis of the evidence are those where the data is present but there is no scientific consensus or where there is a level of uncertainty to be managed.

'Too much' data is never a problem because the decision-maker always relies on experts to interpret it, but when there are conflicting opinions, it is necessary to investigate whether this is due to ideological issues or the phenomenon one wants to understand and make a decision should simply be studied in greater depth.

Interviewer: What aspects of Open Science do you consider useful in reaching an evidence-based decision? For example, would the availability of open and verifiable data to support an opinion (regardless of whether the data is actually verified by someone you trust) be a requirement for trusting the expert? What other factors would you consider useful?

Interviewee: Limited time is a fundamental factor that must always be taken into account when it comes to policy decisions: the availability of open and verifiable data (and possibly in quantity to limit the effects that some less reliable datasets might have) that can be questioned by other experts is crucial, but the decision maker never has the time to go and look at the data, even if he or she had the expertise, and therefore relies on the availability of expert interpretations. This is why the most important factor that one normally relies on is consensus.

Interviewer: Is there any aspect that you think could be improved and why?

Interviewee: There is a lack of widespread education on evidence-based decision-making, not so much or not only to the policy-maker but above all to the public. More training and dissemination to the population would therefore be essential to support evidence-based decision-making mechanisms at all levels, but also to strengthen those at the political level, because if you raise the level of the population, the decision-maker must also adapt to the level of society, he must therefore take into account the requirement that comes from society to have answers based also on the scientific method and on evidence. Schools can do a lot in this sense, but of course it also takes political will to promote this kind of change in society, a change that a politician should in any case have as a priority.

Interview 3: High-Level civil servant implementing the practice of evidence-based decision making

The interviewee is Programme Leader on FAIR Data at Open Science NL. She is a researcher by training and has an academic background, but also as a decision maker, having been the director of a research data service, also in the context of open science. In both previous and current roles, she acted and acts as a decision maker and states that she strives to base her decisions on evidence.

Interviewer: In your experience as a decision maker, have you ever been in the position of taking a decision (also) based on scientific evidence?

Interviewee: Definitely, and that's what we strive for. Both in my previous roles and now in my current role as a funder, we always strive to try and make policy decisions - or, looking at my previous role, develop new services - based on evidence.. So for example when we were looking into our DMP policies at TU Delft, we were quite inspired by several papers about actionable data management plans, where people were describing their own use cases and experiences about how beneficial this might be, and this stood out that something that we should definitely try out in our own context.

Another example comes from my current role as a funder. One of my tasks in my new job is to look at our policies for data management that apply to researchers receiving funding from our agency and review them to see whether they need updating or improving. To this end I'm designing a process to get feedback from the community, including experts in the field, researchers who need to adhere to this policy, but also data stewards and various heads of departments who provide support for data management. Before that however I actually looked for existing evidence regarding the usefulness, for example, of data management plans, in this area, and how other funders go around data management policies. Then I realised there's actually not so much evidence available [for how DMPs lead to better data management practices]. So that was one of my struggles: to find evidence for such policies, which to some extent I did by reaching out to various people and mailing lists asking whether they could refer me to some documentation: and where data was lacking, people kind of crowdsourced and shared some more evidence.

But what we as a funder also want - and I think it's quite important - is to use part of the budget allocated to support the transition to open science to fund new research into open science practices, thus getting the evidence we lack for example on funding instruments or policy changes we can introduce that really would help us to achieve the culture change in open science.

So long story to say it is indeed very important and we really strive to take decisions based on evidence, but sometimes it's a bit difficult to find the evidence that you would want to have. When this happens, I think you have to fund the research first in order to be able to get the evidence you are looking for.

However, when we do this, because we intentionally keep the research question(s) open, we miss the opportunity to ask a direct question¹. On one end, this could be useful (especially in the long term)

¹ These observations refer in particular to the future call for proposals Open-NL is intending to launch (described on page 24 here: https://www.openscience.nl/sites/open_science/files/media-

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because you might be exploring new aspects - but on the other end it's up to the researcher to define the question, and with such a broad scope it might or might not be helpful to us.

Another thing to mention is that funding calls within the Dutch Research Council are regularly evaluated, and that happens through multiple mechanisms. In a few calls that I've heard about there was an external assignment to evaluate the call: a group of people not receiving the funding - so not biased either way - who were tasked to conduct interviews with both researchers who were receiving funding and with those who didn't get funded regarding the entire process (and the content). In another case there was a big call related to open science that funded replication studies focussing on reapplying a given methodology. For this call, there also was an external committee that was evaluating the studies and the impact of those through interviews and paper research, and then making recommendations for the future.

Periodically large quantitative studies² are also carried out here. For example, there was a study with regards to Open Science uptake. The survey was about researchers' attitudes towards Open Science, and about their practices. Most of the time, these studies are carried out by hired contractors, both in order to assure they've the right expertise and professionalism and to avoid any biases that could get into the picture if we were to conduct the study ourselves.

Interviewer: And in that case, how do you organise? When you hire someone who carries out the study, what kind of information do you provide them or what kind of request?

Interviewee: I could not be able to tell you that myself because I was not yet in that position [only started a few months ago]. I've only received their reports, the evaluation of the programs, but if I can ask my colleagues.

Interviewer: Did you use the expertise of one or more persons or groups that acted as an interface between the science and the policy level? And according to the definitions you have been provided with, how would you define such an interface (honest/knowledge broker, issue advocate, expert)?

Interviewee: At the moment we are reviewing our data policy and we're doing it in several steps: the first phase mostly included a desk research based on literature, while the second is based on a co-creation process that involves experts in the community such as data stewards and people who act as an interface between the researchers and policy makers - I guess "honest brokers" would be a good name for those people - about their perspective on what works, what does not work, or works better - that was somehow an informal consultation with these experts. In the next phase we want to draw some conclusions re. What we learned from this informal consultation and call for open feedback from the broader community.

Interviewer: How would you define your experience in dealing with this person(s)/group(s)?

Interviewee: I think all three play a role, and you can see it for example in Open Science: you need lobbyists first, people who can make an issue a point in the policy agenda and act as frontrunners for

[files/Work%20programme%202024-2025%20v18_W3_WIM.pdf](#))

² See <https://www.nwo.nl/en/only-way-forward>

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others to be able to hear it, but you also need honest brokers because you want to understand, what are the implications and the adverse effects of certain policy actions that supposedly have a positive impact, but if you only look on one side you might be missing another important point or and not envisioning consequences for other groups. And of course there are moments, as we discussed earlier, when you have a very specific question to be addressed, and you might not have the expertise or the time to do it yourself and you need somebody you trust to look into the problem.

However I think it's crucial to be clear about which role you're playing: are you an issue advocate or a knowledge broker? Who are you representing? What are your interests? And you need to be aware when you perform a certain role in a given moment: clarity about which hat you have on is key.

Interviewer: Yes, this is consistent with our desk research: one thing that was clearly stated in the literature is that every role is fine as long as you clearly state where you are and what your role is, otherwise, you will be perceived as an impostor or someone who shouldn't be trusted and at that point you'd probably lose the trust of the decision maker.

Interviewee: Mm- Yeah, indeed if you are an issue advocate, but you pretend to be a knowledge broker or if you pretend to be indeed a consultant with no bias, that I think is tricky. But this is also true if you are the one making decisions. I knew a professor in research Integrity who, when introducing himself in a meeting, started from declaring his own "intellectual conflict of interest". What he meant was that because of his own expertise and beliefs, he valued certain schools of thoughts, had certain beliefs or valued certain approaches to science and integrity. I found this quite important. I've realised myself and probably every decision maker has got some of their own biases - from the ways we work, from the people we encounter, from what we consider to be true or valuable. And I think that's also quite important for I think anyone in the decision making process should acknowledge and declare their intellectual conflicts of interests (or other types of interest).

Interviewer: Yes, I can see your point. And I think it also is a reminder that we should consider this also for other people, when we enter a complex context and the interface between science and politics is one of those and for sure we should consider our own biases, and priorities and values - and the ones of the other parties involved because. For instance, sometimes scientists have this bad habit of believing that if their ideas are not heard is because laypeople don't understand

Interviewee: Oh yes, I've heard this so many times.

Interviewer: but the point is: is your idea not heard or understood because people are not intelligent or forward thinking enough? Or they don't understand because you're using a different language and a different system of values?

Interviewee: Indeed, I think you're right, especially I think that as a decision maker you have lots of responsibilities to always introspect yourself and think about the others, who are they and why are they at the table? What are your own issues and values that you carry, what the others', how your decision will impact other groups, and how it will be perceived.

Interviewer: Okay, very good. Next question: how would you define your experience in dealing with these people or groups (here I'm referring to honest brokers, independent experts and issue advocates)? Did it work? What worked and what did not, and why in your opinion? And subjectively, was it satisfactory? Was it frustrating?

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Interviewee: just to be completely honest, sometimes the experience with issue advocates can be quite exhausting - and can be quite frustrating as well. When somebody really wants something that you cannot give for one or the other reason, then it is really exhausting. I guess for both parties at some point that can lead to frustration.

But sometimes it's also important if you hear something persistently, that something matters for certain communities. And perhaps it can lead you to have a critical look on whether perhaps you're missing an important point. Thus [issue advocates] can play an important role as well and I've experienced both situations: where that actually was really important, and that helped us realise important issues that we risked overlooking if we have not been reminded by those activists; and in the other direction, where you would have a constant lobby and at some point, you were like that's just not going to work.

For Honest Brokers I only had positive experiences so far. I think that has always been informative and I guess you can always draw a positive experience of that: I mean that you always become more knowledgeable, always get a better understanding and you gain insight into how your decisions impact the community, what it really means in practice - and perhaps get some suggestions for what doesn't work. But also exactly as you said [introducing the different definitions] sometimes you would get opinions on all spectrum of ideas and also conflicting advice, and it might be difficult to consolidate them and to make a decision which in the end is useful across the broad stakeholder community that you are to serve, so that's perhaps the challenge of that.

With regards to that scientific consultants I did not have direct experience of that so I cannot comment. But I will ask colleagues of mine to give their feedback into the process. For my job I only have been the recipient of consultant reports, so while I look at the final product I wasn't there when that whole consultation has been arranged. What I can say is that I found these reports very helpful because you have the exact information about the methodology and the steps that have been taken to reach a conclusion and that saves in the end a lot of time no matter if you have complete recommendations or whether indeed you have different choices present. I've seen some reports which were not a complete recommendation, but more a possibility of different choices and the decision maker can decide which way to take but then at least somebody has done that research for you and that helps a lot. So again as I mentioned I think the experience can be the most frustrating with the first, the issue advocates and is the most straightforward with [scientific consultants], but again, you have the entire spectrum of information that it's sometimes useful or even essential for you at certain moments of your decision making.

Interviewer: Okay, and in your experience, which are the factors that hamper evidence-based decision making: where are the pitfalls?

Interviewee: Indeed the issue of trust is an important one and especially comes into play where you have a feeling, or realise as a matter of fact that someone who let's say, positions themselves as a unbiased consultant is in fact and an issue advocate, and that leads to some kind of mistrust. Of course also if you have invested a lot of effort in a certain consultancy, or perhaps your consultancy wasn't specific enough, it can lead to a lot of frustration.

Maybe also one other thing that comes to mind is the lack of supporting evidence for certain statements. I mentioned this already before, my search for evidence into the usefulness of data management plans, and there was just basically not enough research done into some specific

questions. Furthermore, it also happened to me on several occasions, even as a scientist, reading an article, which claims more than what your evidence base would grant for, but actually you don't have the access to the whole data set - and perhaps that's my own tendency [to wish to see the supporting data] because I'm a trained researcher. So I like to see the data, look into the numbers, look at the spreadsheets, and if I don't see that or if I don't have access to that, then I start to have doubts. There's this very clear example I've been looking at recently. There are now various monitoring dashboards for all kinds of statistics with regards to open science. I was looking at one of these dashboards and at the number of datasets per certain publishers and whether they mentioned or not funders affiliation - and you get the end number, let's say 150, but what does this number mean? Does it mean that the other datasets don't mention a funder? Or maybe that the funder's name has been misspelt? But as I haven't access to the full dataset, I cannot really understand what the limitations of the study are, nor where does this number come from. And I think that's a big problem nowadays not just for funders but for all stakeholders.

So sometimes, instead of the actual data you are presented with some pretty colourful dashboard, where you can click through and see different things. Dashboards are great, interactive and very visual but often if you wish to see actually where a number comes from, you'd be in trouble and you'd lose the trust in the actual advice and the conclusions that you can draw based on the data. So, personally speaking - and maybe I'm a little bit biased because I'm a researcher by training - I only trust the outcomes when I can see the real data and understand the methodology that allows to draw a certain conclusion from these data, or a certain analysis to be carried out. So for me personally, it's very important and my trust increases where I can transparently see reported both the datasets and the process, as well as any limitations or any caveats that have been made to the data.

Maybe just one example of that is the work done by some of my colleagues on yearly reports on the compliance with the open access policy³. I was actually really impressed by it. This year in particular colleagues were really striving to make everything transparent and they have only used openly available databases to make their measurements. As a policy maker, I would really trust such a work because anyone can reproduce the steps that have been taken and retrieve the data themselves and repeat the analysis. So I think that gives you a lot of accountability and transparency to the process...

Interviewer: ...in principle someone else could challenge the methodology.

Interviewee: I think it's quite a nice example of something I would consider trustworthy.

Interviewer: And so we come to the next question which are the aspects of open science that you would identify as helpful to reach an evidence-based decision. Although in fact you already partly replied to that already... Which other factors would you identify yourself to form an opinion?

Interviewee: As I mentioned before, data is one thing, but also the methodology that has been used, for instance, if you conducted a survey, how did you identify your respondents? How did you approach them? What was the response rate? How did you ensure the diversity in your group? These are examples of all kinds of things that I would definitely look at. In case of other data types, how did you process the data? What is your methodology for example, excluding outliers or taking into account or interpreting certain events? So I like when the process is as clear as possible so that you can understand the limitations of the data. So being honest about your own knowledge and

³<https://www.nwo.nl/en/news/nwo-and-zonmw-to-use-open-data-for-monitoring-open-access>

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understanding what might be the potential issues. I always trust an author who is factual and does not overstate their findings.

Findability, of course, is another important point. Sometimes I've been trying to access publications about open science or open access, only to discover they were behind a paywall - Come on!

In general, I've personally struggled with finding sometimes the right sources, sometimes narrowing down the results can be challenging, and - even finding the right resources - it can be tricky when you look for data sets, which are scattered in different places. Oftentimes I have missed sources which were maybe in an Institutional repository, but actually very valuable for specific questions that I had in mind, so I think that better indexing and finding the right information are still a challenge.

Interviewer Yeah, I see your point: I think this is actually one of the biggest challenges in the famous or in-famous data Deluge, because you have so many information but this not ensures per se that you find it, an often we tend to redo things just because we cannot find the results of others..

Interviewee: Yeah,, that's actually very frustrating

Interviewer: which other aspects would you like to see enhanced? What's missing in the picture?

Interviewee: I think we spoke already of them. I think the discoverability and findability is a challenge. The quality of information I think also could be improved, but as we mentioned that It's not only that information is available openly, but also that you have the description of the methodology, the context of the study, and its limitations - that's super important. So I think that can definitely get better. I think maybe the other, overall reflection is that we have to always remember about that self-reflection: who we are while we are here, and what are our conflicts of interest in a given situation. I think that being honest about that can be sometimes easier said than done, especially in some political contexts. But I think that kind of honesty about what you are trying to achieve, and what is the role that you play would really add to transparency. And maybe the last thing that I can mention is that we should spend more resources both in terms of time and funding into getting evidence for our decisions and for our policies in particular. I think that's very important as funders, but also in general, to allow yourself to have enough resources and time to ask questions, and try to get the evidence for what you're deciding on. Plus, it is also important to have the time to do it because indeed, sometimes evidence-based decision making can be more time consuming in the short term, although hopefully more beneficial in the long term.