REINFORCING

**Responsible tErritories and Institutions eNable and Foster Open
Research and inClusive Innovation for traNsitions Governance**

D.1.2 – ORRI Guidelines

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1 INTRODUCTION

Open Responsible Research and Innovation (ORRI) is a process that considers the broader impacts of research and innovation, marking a paradigm shift in their conduct. Its goal is to ensure that the positive societal and economic benefits of research and innovation are fully realized, while minimizing unintended negative impacts.

However, implementing ORRI often encounters significant challenges and barriers. Achieving the necessary shift in research and innovation systems is difficult, particularly when ORRI goals and principles appear to conflict with objectives deemed of higher value, importance, or urgency. Consequently, numerous resources and tools for ORRI have been developed over the past decade.

Despite this progress, there remains a risk of gaps between ORRI conceptualization, operationalization, and actual implementation and institutionalization. This is perceived as challenging, as ORRI provides limited concrete instruction. The guidelines aim to bridge this gap by disseminating and translating ORRI concepts into easily understandable language, demystifying ORRI and enhancing its applicability. The REINFORCING ORRI guidelines offer innovative guidance to make ORRI initiatives iterative, resilient, adaptive, and aligned with evolving local, European, and global trends and challenges. They consolidate ORRI knowledge, making it easily accessible, up-to-date, and constantly adapted to community needs and advancements.

This deliverable includes key principles for institutional changes and selected examples of 'practice' models based on the wide expertise, experiences and tools developed in a multitude of ORRI projects and initiatives. The REINFORCING ORRI guidelines thus represent the essence of years of research on ORRI but are tailored to the specific needs and settings of ORRI practitioners. To make sure the guidelines meet the needs of the target group, feedback will be solicited from the ORRI community.

The Guidelines are organized as a living document, frequently revised and enriched with further practice examples based on feedback solicited from project grantees, the REINFORCING Advisory Board, the REINFORCING Global Network, and the ORRI community at large to ensure their understandability, user-friendliness, and actionability with needed adaptation to the specific context and setting. This approach aims to achieve REINFORCING's main goal: to provide meaningful support, services, and resources to as many ORRI enablers as possible to enhance ORRI mainstreaming.

2 ORRI PRINCIPLES AT A GLANCE

The set of twelve principles is grounded in the wide array of (O)RRI research and practice to provide well-established ways of 'how' to do ORRI, to suggest 'what' to do, i.e. ORRI content and to illustrate 'why' to do ORRI, i.e. ORRI rationale and motivation. They have been developed into a holistic guide for addressing concrete challenges and needs of ORRI practitioners to support ORRI practices in a variety of settings:

ORRI requires the anticipatory, adaptive, and inclusive governance of research and innovation to steer them towards socially desirable ends.

ORRI ensures that societal goals such as equality, diversity & inclusion, safety & security, social cohesion & sustainability are pursued and practised in R&I organisations and processes.

ORRI recognises the importance of innovation ecosystems and requires a multi-stakeholder commitment by all actors in the quadruple helix (academia, government, business/industry, society) to ensure that all relevant perspectives as well as types and levels of expertise and experience are represented and considered in innovation processes.

ORRI involves the anticipation of future trends, developments and challenges and the strategic adaptation of current activities, thereby fostering reflexivity and mutual responsiveness between society, policy, research, and development.

ORRI aims to overcome market deficits by fostering transformative change required by the SDGs and reflecting the fact that developed and developing countries are unequally benefitting from scientific-technological advancements.

ORRI makes a distinct effort to broaden representation and participation, thus seeking to integrate and address the needs and views of vulnerable or marginalized groups in innovation processes.

ORRI needs indicators and procedures towards transformative change which strengthen individual & organisational agency (the ability to act), legitimacy and accountability to become institutionalized, i.e., integrated in organisational structures.

ORRI takes an experimental approach to innovation based on organizational learning, co-creation, and co-design (e.g., in Living Labs) and to the adaptation of social norms and needs, rules and regulation as well as institutions and infrastructures.

ORRI follows a holistic approach taking into account the interconnected factors influencing the development, use and impact of innovations (including unintended negative effects).

ORRI is based on the values of openness to and mutual responsiveness among all parties involved and, therefore, calls for open science, open innovation, and transparency.

ORRI requires institutional structures for the ethical conduct of all activities, the integrity of all parties involved and adherence to fundamental ethical standards, such as human rights and the precautionary principle.

ORRI relies on an informed, open-minded, and engaged citizenry, which requires quality science education from an early age on and across all social and professional groups, fostering curiosity and science literacy as enablers of public engagement and active science citizenship.

3 ORRI PRINCIPLES AND PRACTICES

Twelve guidelines have been developed to support organizations and territories with their real-life challenges and processes of institutionalizing open, responsible research and innovation. Each guideline consists of a general ORRI principle and shows how practice solutions may take up and deliver on this principle in the context of a specific challenge faced by ORRI practitioners. This is followed by a brief concrete example where and how the practice was applied.

1. **ORRI requires the anticipatory, adaptive and inclusive governance of research and innovation to steer them towards socially desirable ends (e.g., equality, diversity, inclusivity, safety, security, social cohesion, sustainability) including territorial and organizational perspectives.**

Open and Responsible Research and Innovation emphasizes proactive, inclusive decision-making on strategies and actions across various levels to steer research and innovation toward socially beneficial outcomes. ORRI thus acts on current and anticipates future challenges and embraces equality, diversity, inclusion, social cohesion, safety, security, and sustainability as core values. By incorporating territorial and organizational viewpoints, it ensures holistic decision-making, fostering an environment where diverse voices contribute to shaping research and innovation agendas. This approach seeks to align technological advancements with societal needs, promoting ethical, inclusive, and sustainable change.

Challenge

Society demands new governance instruments and approaches to research and innovation that can help steer them towards societal needs and concerns. But governance of research and innovation can be an arduous and complicated process as there are a plethora of stakeholders who can have different interests, visions and priorities around research and innovation.

Solution

Emphasizing values such as transparency, participation, accountability and inclusivity in the governance of research and innovation policies can help improve governance mechanisms and develop specific instruments for organizational and territorial contexts.

Practice example

Within the EU-funded [TRANSFORM](#) project, the [Lombardy Region](#) adopted a more inclusive, transparent and participatory research and innovation agenda setting for the design and the operational implementation of its regional Smart Specialization Strategy and connected strategic R&I regional plans. Through a structured and multi-phase participatory journey, which also included a deliberative [Citizens Jury](#), to the Regional Government ensured that citizens' voices were not only heard but also considered in key regional R&I policies. The initiative carried out in the context of TRANSFORM is aligned with a wider commitment in the region and explicit mentioning of Open Innovation and RRI in their key R&I laws and strategic R&I policies. The Lombardy case showcased the region's commitment to leveraging citizen engagement and creating a compelling model for participatory decision-making in complex societal issues. Lombardy prioritized inclusivity by involving diverse stakeholders—industry representatives, researchers, policymakers, and citizens in an approach combining surveys, deliberative workshops and processes. Efforts were made to ensure that marginalized groups had meaningful participation,

promoting a more representative and equitable process. Transparent decision-making processes upheld accountability and trust, reinforcing the democratic legitimacy of outcomes. This comprehensive approach enabled the Lombardy region to adopt citizen engagement to transcend the complexities of regional policy, demonstrating the transformative potential of inclusive and participatory decision-making.

2. ORRI ensures that societal goals such as equality, diversity & inclusion, safety & security, social cohesion and sustainability are pursued and practised in research and innovation organisations and processes.

Open and responsible research and innovation commits to integrating societal values like equality, diversity, inclusion, safety, security, social cohesion, and sustainability into research and innovation. This entails not only pursuing these goals but actively incorporating them within organizational cultures and processes. Thereby, ORRI promotes equitable access to opportunities, fosters diverse perspectives, prioritizes safety and security measures, enhances social cohesion, and champions sustainable practices. By embedding these values in private and public research and innovation policies, these efforts align with broader societal aspirations, ultimately leading to more impactful and beneficial outcomes for all stakeholders.

Challenge

Diversity, equity, and inclusion (DEI) practices are essential for ensuring that research and innovation agendas, methodologies, and outcomes align with diverse stakeholder needs and perspectives. By this way it enhances the societal relevance of research, empowers participating people, and increases the acceptance and desirability of the results of research and innovation. Despite these benefits, integrating DEI practices faces challenges such as 1) restricted participation of various communities leading to undermining innovation validity; 2) implicit biases influencing e.g. data collection, analysis, and interpretation; 3) narrowing down the available talent and competencies; 4) intersecting forms of discrimination based on race, gender, etc. marginalizing certain voices and limiting collaboration opportunities.

Solution

Systematic and practical approaches to DEI awareness-raising and investing in training and capacity-building, and implementation of strategies and policies to mitigate biases throughout the process, and interventions that recognize and address the intersecting needs and realities of diverse individuals and communities.

Practice Example

The GenderSTI project analyzed the integration of the gender dimension in research and innovation (R&I). With its "Inclusiveness in Research" manual organizations can e.g. find novel approaches to understand discrimination, gender, intersectionality and their relevance to research and innovation; identify solutions and use as guidance to DEI challenges like e.g. inclusive leadership and recruitment; reflect DEI in different fields such as AI, smart mobility and cities and health technologies; and use tools for researchers' self-evaluation and inclusiveness for research proposals and projects.

Based on the project's recommendations the following actions were taken in VTT ltd, Technical Research Centre of Finland to integrate DEI approaches into existing practices and processes:

- Tailor-made workshops for research staff on implementing a gender-sensitive and inclusive approach to R&I processes and content

- An online introductory course on inclusiveness in R&I
- Internal exploratory surveys on perspectives and competencies on inclusiveness in different departments
- Development of an inclusive and measurable Gender Equality Plan
- Provision of contact points for further support in topics related to gender, inclusiveness and R&I work

The Gender Equality in Academia and Research (GEAR) tool provides universities and research organizations with practical advice and tools through all stages of institutional change, from setting up a gender equality plan to evaluating its real impact.

3. ORRI recognises the importance of innovation ecosystems and requires a multi-stakeholder commitment by all actors in the quadruple helix (academia, government, business/industry and society) to ensure that all relevant perspectives as well as types and levels of expertise and experience are represented and considered in innovation processes.

The quadruple helix model involves four key stakeholders:

Academia: Universities and research institutions generate knowledge, conduct research, and train the next generation of innovators. They contribute expertise, conduct fundamental research, and often serve as hubs for collaboration and knowledge exchange.
Government: Governments provide funding, set policies, and create regulatory frameworks that shape the research and innovation landscape. They also support initiatives aimed at addressing societal challenges and fostering economic growth through innovation.
Business/Industry: Corporations and businesses drive innovation by developing and commercializing new products, services, and technologies. They invest in research and development, bring innovations to market, and create economic value through entrepreneurship and industry partnerships.
Society: Civil society organizations, communities, and citizens represent the broader societal context within which innovation occurs. They articulate needs and preferences, provide feedback, and advocate for ethical and socially responsible innovation. Their engagement ensures that innovations are aligned with societal values and address real-world challenges.

ORRI recognizes the interconnectedness and interdependence of these actors within innovation ecosystems and ensures that innovation processes are more inclusive, responsive to societal needs, and better positioned to generate positive impacts for both individuals and communities.

Challenge

Public and private stakeholders increasingly recognize the need to engage citizens and other stakeholders in different projects and initiatives. Recognizing the value of involving a diverse set of actors can contribute to more inclusive and socially accepted R&I outputs, as these can be legitimized through societal engagement processes. This is particularly relevant in contexts such as infrastructure development (e.g., new energy or mobility systems) and/or with the introduction, diffusion, and adoption of novel technologies. However, different interests of diverse stakeholders, as well as resistance by different groups can rise during these participatory processes.

Solution

Establishing a multi-stakeholder engagement process in particular R&I contexts can help align different interests and create a sense of purpose and community for working together

to address societal needs, which can lead to more inclusive and comprehensive R&I outputs. Intermediary organizations can play a vital role in orchestrating multiple stakeholder perspectives in shaping a sustainable regional innovation ecosystem.

Practice example

Stakeholders in the [Karlsruhe Technology Region](#) (KTR) aimed to develop sophisticated dialogue strategies within local innovation and development projects and to create opportunities and infrastructure for exchanging practical experience and insights from seasoned practitioners in the [tetRRIS](#) project.

Despite the recognized value of participation, the KTR lacked dedicated structures for dialogue and exchange among practitioners. During initial investigations ("mapping") of the region's innovation ecosystem and the role of ORRI, this gap became evident. Scoping workshops with KTR regional stakeholders in Spring and Summer 2021 reinforced the need for a "safe space" to discuss experiences, successes, challenges, and failures.

To address this gap, the TetRRIS team in Karlsruhe initiated the development of a "[Practitioner Network for Public and Stakeholder Engagement](#)." This network facilitates meaningful exchanges, fostering learning between peers and providing feedback among them. The Practitioners' Network is a platform that brings together European Development Cooperation organizations. Its primary goal is to give these organizations a collective voice and facilitate meaningful exchanges.

The perspectives and knowledge generated by the Practitioner Network have made numerous actors and stakeholders in the region more aware of the value and possibilities of public engagement, participation and ORRI in general. They are thus better placed to integrate these into their own future work. It can thus be expected that public engagement and participation will receive increased attention in the KTR and thus play a larger role in its regional innovation and development strategy.

4. **ORRI involves the anticipation of future trends, developments and challenges and the strategic adaptation of current activities, thereby fostering the reflexivity and mutual responsiveness between society, policy, research and development.**

Foresight and anticipation involve the systematic exploration and analysis of potential future developments, trends, and scenarios to inform decision-making and planning. Methods such as horizon scanning, roadmapping, scenario analysis, panels or workshops are used to anticipate emerging opportunities and challenges. This allows for the proactive consideration of potential societal impacts, ethical dilemmas, and emerging risks associated with new technologies and innovations and enables individuals, organizations, and policymakers to prepare and adapt effectively. Foresight methods can provide valuable insights and help build resilience by enhancing anticipation, adaptation, and innovation capabilities in the face of uncertainty and change.

Challenge

Anticipatory governance faces the challenge of navigating uncertainty and complexity in an increasingly dynamic world. Traditional governance structures often struggle to address emerging issues before they become crises, leading to reactive rather than proactive decision-making. Additionally, the rapid pace of technological advancements and socio-

economic changes further complicates the ability of governance systems to anticipate and respond effectively to future challenges.

Solution

To address these challenges, anticipatory governance employs foresight methodologies and participatory approaches to anticipate and prepare for future developments. By engaging diverse stakeholders, including policymakers, experts, citizens, and industry representatives, anticipatory governance seeks to foster collective intelligence and develop robust strategies to address emerging issues. This proactive approach enables decision-makers to anticipate potential risks and opportunities, adapt policies accordingly, and promote resilience in the face of uncertainty.

Practice Example

Practical solutions in anticipatory governance include scenario planning, horizon scanning, and impact assessments, which help identify potential future trends, drivers of change, and their implications. Collaborative platforms, such as the European Policy and Strategy Analysis System, and deliberative processes facilitate stakeholder engagement and co-design of strategies to address anticipated challenges. Additionally, capacity-building initiatives and knowledge-sharing networks support policymakers and stakeholders in developing foresight capabilities and implementing anticipatory governance practices effectively.

One concrete example of anticipatory governance in action is the European Commission's Strategic Foresight Report. This report, published annually, identifies key trends and challenges shaping the future of Europe and provides insights to support evidence-based policymaking. Through consultations with experts and stakeholders across various sectors, the report informs EU policies and initiatives, such as the European Green Deal and the Digital Agenda, by anticipating emerging issues and opportunities. By integrating foresight into policymaking processes, the European Commission aims to enhance the resilience and sustainability of the European Union in an ever-changing global landscape.

5. **ORRI aims to overcome market deficits by fostering transformative changes required by the SDGs and reflecting the fact that developed and developing countries are unequally benefiting from scientific-technological advancements.**

Open and Responsible Research and Innovation addresses market deficits by enabling transformative changes through responsible governance of innovations which are required to achieve the Sustainable Development Goals (SDGs). Market deficits often result in the under-provision of socially desirable goods, innovations and services critical for sustainable development, such as in the areas of healthcare, education, and environmental conservation. This is, on the one hand, created by an erosion of the knowledge commons by a commodification of science and privatized access to knowledge and data and, on the other hand, by a lack of commercial interest of industrial actors in investing in transformational research and innovations and issues of the common good.

Challenge

Responsible governance requires governmental bodies to become proactive in the innovation process to ensure more inclusive and socially desirable outcomes of innovation processes. This governance includes international coordination and governance, for example as practiced by the WHO during the COVID pandemic by supporting open science

practices and the reallocation of resources to developing countries. ORRI requires a broader governance of research and innovation as international markets will not deliver 'automatically' on SDGs, especially considering that the current trends of weakening international governance point in the opposite direction. At the same time, the international property rights regime impedes innovations in the areas of transformational change.

Solution

A reduction in disparities in the provision of services in healthcare, mobility, education, and other sectors is needed between privileged and underserved populations. Approaches to overcoming these disparities include:

- Ensuring affordability and accessibility to democratize access to innovative solutions not addressed by market logic, thereby promoting equity
- Developing integrated and networked infrastructure to support sustained innovation and collaboration
- Adopting a people-oriented approach to ensure high acceptance and improve the quality of services
- Establishing strategically located hubs and decentralized models for the provision of products and services to enhance efficiency and accessibility
- Committing to long-term benefits, emphasizing dedication to sustainable and impactful solutions

Practice example

A vivid example of overcoming market-deficits for equitable healthcare in countries of the Global South is the company Immuneel in India. Immuneel aims to democratize access to cancer therapies with globally compliant, cost-effective cell manufacturing processes that are affordable and widespread in India. Immuneel offers personalized treatments minimizing side effects, using patients' own cells thus providing better quality of life to patients and empowering them to use their own immune cells as personalized "drug factories". Immuneel addresses disparities by bridging the gap between technological advancements and patients' access to affordable healthcare, thus contributing to a more equitable healthcare system in India and beyond.

6. ORRI makes a distinct effort to broaden representation and to increase participation, thus seeking to integrate and address the needs and views of vulnerable or marginalized groups in innovation processes.

Open and Responsible Innovation seeks to broaden representation and increase participation to address the biases and unbalanced benefits present in research and innovation processes, often characterized by a focus on WEIRD (Western, Educated, Industrialized, Rich, Democratic) societies. This bias marginalizes perspectives and expertise from non-WEIRD regions and communities, hindering the development of inclusive and globally relevant innovations. By actively engaging diverse stakeholders from different geographical, cultural, and socioeconomic backgrounds, Open and Responsible Innovation aims to overcome this bias. It recognizes the value of incorporating diverse viewpoints and knowledge systems in research and innovation, leading to more contextually appropriate solutions that better serve the needs of diverse populations worldwide. By fostering inclusivity and collaboration across borders, Open and Responsible Innovation promotes a more equitable and representative innovation ecosystem to provide positive impacts for all stakeholders, regardless of their geographic or socioeconomic context.

Challenge

Frugal innovations play a crucial role in driving open innovation by democratizing the innovation process, fostering inclusive solutions, and addressing pressing social and environmental challenges on a global scale. The challenge often is that, firstly, grassroots frugal solutions lack the needed quality and scale to have a real impact. Secondly, innovators may lack the needed diversity of perspectives to come up with radically new concepts. Thirdly, citizen participation in innovation processes is limited, and many companies do not have the knowledge on how to integrate diverse actors into their research and development processes.

Solution

Supporting frugal innovation solutions that are cost-effective, resource-efficient, and often simpler in design, aiming to address challenges faced by underserved communities or resource-constrained environments. They target affordability, making essential products and services accessible to a wider population, especially in developing regions where financial resources are limited. Due to their simplified and cost-effective nature, frugal innovations have the potential for rapid scalability, allowing them to reach large numbers of people in a relatively short amount of time. Frugal innovations tend to be resource-efficient, requiring fewer materials and energy inputs. This not only reduces environmental impact but also promotes sustainability by encouraging responsible consumption and production practices. By focusing on meeting the needs of underserved communities, frugal innovations promote inclusivity and equity, addressing gaps in access to essential goods and services. Frugal innovations often emerge from diverse and collaborative processes, harnessing local knowledge and creativity. This agility enables quick adaptation to evolving challenges and local contexts.

Practice Example

The European project "FRANCIS - Frugal innovation by citizens for citizens" aims at the development of frugal innovations in open innovation challenges that bring together corporate entities and citizens. The project calls for citizen innovations that arise from the real, everyday challenges that people encounter, and provides grass-roots innovators with a chance of mentoring from industry coaches and scientists. The best citizen innovations might become commercially distributed by the industrial partners, thus reaching more people and creating greater impact.

One of the practical outcomes of FRANCIS is an RRI & SDG impact assessment tool for citizen science and frugal projects. This tool is to be launched at the end of the project on the project website. It will provide a structured framework for assessing the impacts of citizen-led frugal innovations.

7. ORRI needs quantitative as well as qualitative indicators and procedures towards transformative change which strengthen (individual and organisational) agency (the ability to act), legitimacy and accountability to become institutionalised and thus part and parcel of organisational structures.

By combining quantitative indicators (such as participation metrics, diversity metrics, impact assessment or multi-criteria analysis/decision-making) with qualitative assessments (such as stakeholder feedback, case studies and process evaluation) and participatory procedures (including co-creation workshops, multi-stakeholder dialogues or ethical review boards), stakeholders can direct transformative change in research and innovation towards socially desirable outcomes, thereby strengthening individual and organizational agency, legitimacy, and accountability. The institutionalization of these approaches involves integrating them into organizational policies, procedures, and practices, embedding principles of openness, responsibility, and inclusivity into the fabric of research and innovation institutions. This includes establishing mechanisms and structures ensuring continuous monitoring, evaluation, and promotion of open and responsible research and innovation, as well as fostering a culture of continuous improvement and accountability.

Challenge

Monitoring, indicator development and indicator use to assess the impact of research and innovation are challenging tasks in every field, becoming even more complex with inter- and transdisciplinary research involving a broad range of different actor types - an essential quality of ORRI. Typical methodological problems include data availability, causality claims, impact trajectories and the time lag between intervention and impact. In addition to methodological challenges, indicators and metrics often carry the risk of creating unintended, sometimes even perverse effects, are prone to unsound interpretations, and can thus entail problematic policy implications.

Solution

Monitoring and indicators for ORRI should first and foremost be aligned with the principles of responsible metrics. First, on a general level, attention should be drawn to monitoring the qualities of processes in order to counterbalance an overemphasis on final outputs or products. Second, monitoring activities should be primarily designed to support desired ORRI practices. And third, the perspective should be broadened beyond "key areas" such as gender equality or public engagement to also include critical challenges such as sustainability.

These broad principles have been translated into the following requirements:

- The primary purpose of monitoring should be to advance learning about transformation processes to inform ongoing policy designs and practical responses.
- Monitoring should utilize a variety of quantitative and qualitative data sources and methods to generate data and information to open up diverse perspectives on ORRI.
- Monitoring should assist in appropriate interpretations of what quantifications actually 'indicate'.
- Monitoring should engage in a continuous fashion the community of practice.

Practice example

The [SUPER MoRRI project](#) ("Scientific understanding and provision of an enhanced and robust monitoring system for RRI") was conceived to develop a monitoring and evaluation framework with the aim of supporting the broad uptake of Responsible Research and Innovation. As an integral part of this objective, SUPER MoRRI had the ambition to monitor

and evaluate in a responsible way. It was the understanding of SUPER MoRRI that the measurement of ORRI needs to be seen in complex contexts. To better understand how possible impacts and benefits of ORRI and ORRI-like activities could be described in the presence of complexity, SUPER MoRRI built on two core principles with the aim of making the project's own practice responsible:

- <u>Credible contextualisation</u>: There are no universal context-free indicators; indicators should be developed in ways relevant and meaningful to specific use contexts and should pass through a co-creation phase with potential users.
- <u>Responsible quantification</u>**:** Data and information provided to users as a resource is prepared, presented, and made interpretable in appropriate ways.

To accommodate diversity and difference, translational work was essential in engagements with diverse stakeholders also in processes of developing indicators and monitoring approaches. Cognizant of the potential unintended consequences of metrics and indicators, the project developed the PROMISE portal (www.promise4era.eu) with key project outputs.

8. ORRI takes an experimental approach to innovation based on organizational learning, co-creation and co-design (e.g. in Living Labs) and to the adaptation of social norms and needs, rules and regulation as well as institutions and infrastructures.

Open and Responsible Research and Innovation encourages iterative experimentation and feedback loops, allowing stakeholders to collectively explore and adapt to evolving social norms, needs, regulations, and infrastructures. By embracing experimentation and flexibility, ORRI promotes the emergence of innovative solutions that are responsive to diverse societal values and contexts. Through continuous organizational learning and adaptation in co-design and co-creation processes, for example, facilitated in Living Labs, ORRI seeks to address complex societal challenges while remaining attentive to the dynamic interplay between technology, society, and governance.

Challenge

Finding effective solutions to compelling, complex, and rapidly evolving "glocal" challenges can be achieved through multi-sector and cross-societal collaboration. New models of innovation pathways are needed, in which various actors join forces to handle collective matters in order to share and use all available expertise, skills, knowledge and experience towards adaptive, responsive and forward-looking answers.

Solution

The experimentation of collaborative forms of innovation, for example co-creation, is key in order to ensure an actual shift towards demand-driven innovation. Developing new replicable ways of doing innovation that match the supply of new products and services with the real needs of civic society and the public sector, can contribute on the one side to design and create socially desirable solutions that would have not been possible without the multi-stakeholder collaboration, and on the other side to inspiring transformative changes within all groups involved in the process.

Practice Example

The EU H2020 funded project MOSAIC explored how solutions to pressing global challenges, such as leading cities towards climate-neutrality can be made possible and reinforced by engaging all concerned actors through sound participatory methodologies. Its main aim was to study, develop and test the effectiveness of co-creation, i.e., an open

and participatory approach to innovation in which actors from the quadruple helix work together to co-produce tangible outcomes, such as new products or services. The MOSAIC methodology emphasized inclusivity and fairness aspects of the process by trying to involve civil society as much as possible. The approach was developed to be functional to the local context and tested in two pilot cities that are part of the EU Mission Climate-Neutral and Smart Cities to achieve climate neutrality by 2030. The co-creation pathway developed and successfully experimented by MOSAIC built on three main phases:

- Challenge definition and stakeholder recruitment: The first step is about choosing which challenge the entire process should focus on. The chosen challenge needs to be connected to locally identified priorities (such as the "Climate City Contracts") and defined by the initiators of the process (i.e., city representatives). Participants should be recruited through the launch of an open call. In order to engage stakeholders beyond the "usual suspects", an extensive mapping of potential participants and active recruiting should be conducted.
- Gathering: All selected and recruited quadruple helix stakeholders gather for the first time in a face-to-face workshop aimed at launching the process and involving the participants around the selected challenge. Multi-stakeholder teams are formed at the end of the event, each working on a specific solution for the challenge.
- Co-creation: Participants will co-create online or in-person to agree on core aspects of a shared idea (ideation stage). Then all of them contribute with their expertise to imagining how it could take shape and to the concrete generation of the solutions.

In the specific pilots of MOSAIC, the co-created solutions were delivered to the municipalities (Gothenburg and Milan), which provided official feedback to participants about their implementation and support for further development. The two municipalities are also planning to replicate the co-creation process on other key topics for the cities.

9. ORRI follows a holistic approach taking into account the interconnected factors influencing the development, use and impact of innovations (including unintended negative effects).

Open and Responsible Research and Innovation (ORRI) employs various strategies and tools to anticipate, monitor, and evaluate the impacts, including unintended negative effects, of innovation, thus promoting proactive anticipation, vigilant monitoring, and robust evaluation of impacts:

- *Stakeholder engagement: Actively involve diverse stakeholders throughout the innovation process to anticipate potential impacts, gather insights, and identify concerns. This can include engaging with end-users, community groups, policymakers, and experts from different sectors.*
- *Foresight and scenario planning: Conduct foresight exercises and scenario analyses to anticipate future developments and potential impacts of innovation. By exploring different plausible scenarios, stakeholders can identify risks, opportunities, and uncertainties and develop strategies to mitigate negative effects.*
- *Impact assessment: Systematically evaluate the social, economic, environmental, and ethical impacts of innovation using appropriate indicators and methodologies. This can involve conducting ex-ante assessments to anticipate potential impacts before implementation and ex-post evaluations to assess actual outcomes.*
- *Surveillance and monitoring systems: Implement surveillance and monitoring systems to track the deployment and use of innovative technologies and interventions. This can help detect and address emerging risks or unintended consequences in real-time.*

- *Feedback mechanisms:* Establish feedback mechanisms to solicit input from stakeholders and affected communities about their experiences and perceptions of innovation. This can include surveys, focus groups, and participatory monitoring approaches to capture diverse perspectives and identify issues early on.
- *Adaptive governance:* Adopt adaptive governance approaches that allow for flexibility and responsiveness to changing circumstances and feedback. This can involve iteratively adjusting policies, regulations, and practices based on monitoring and evaluating findings to address unintended negative effects and improve outcomes.

Challenge

Cities are laboratories for democratic and sustainable innovation where decision-making power is coupled with infrastructure and close connection to citizens. As urban societal challenges and the potential of data technologies intensify, responsible and effective use of (open) data can speed up and optimize urban responses to societal and economic crises — from inequality to climate change to crime. Yet data governance and the ethical use of AI are major challenges that cities face. In the realm of urban planning, the integration of deep learning technologies has emerged as a solution promising to transform the way cities are designed and managed and create public value.

Cities have only begun to tap into the potential of urban data. Although they make some of the data they collect available as open data to the public, most urban data is controlled by private companies that operate in the urban space and are reluctant to share this data.

Solution

If place-based data should better serve society, the question of democratic control over the data ('data commons') arises in terms of:

- Shifting the paradigm of urban data sharing: make access as broad as possible. Introducing data sharing rights and obligations (such as the EU AI Act) is a way forward.
- Giving legal certainty: address protection laws while balancing data confidentiality and public interest for accessibility
- Systematizing solutions for urban data sharing: reduce sharing efforts
- Institutionalizing urban data sharing: build a public data intermediary
- Experimentation is essential and challenging

Practice Example

Based on insights gained from experiments on urban data sharing for public interest in the City of Hamburg, the New Hanse blueprint contains recommendations for cities and communities:

- Stakeholder engagement and feedback mechanisms can be implemented by urban challenges, a prize competition that aims to address an identified social, environmental, economic, or technological need of a city and is open to the broader public resp. the targeted innovation ecosystem. Challenges can be paired with the values of transparency, openness, and partnership.
- Monitoring and impact assessment framework should determine outcomes (e.g. public value to be achieved) with use case repositories as a key tool. Measuring, registering and publishing key indicators enables policy-makers to understand the public value generated.

10. ORRI is based on the values of openness to and mutual responsiveness among all parties involved and, therefore, calls for Open Science, Open Innovation, and Transparency.

Open Science, Open Innovation, and Transparency are essential principles that foster collaboration and maximize the societal benefits of research and innovation.

- *Open Science takes an integrated inter- and transdisciplinary approach to the co-creation of knowledge and promotes the unrestricted sharing of knowledge, data, and research outputs to enable greater transparency, reproducibility, and collaboration. By removing barriers to access and sharing, Open Science enhances the quality, societal relevance and reliability of research outcomes.*
- *Open Innovation encourages sharing and collaboration across organizational boundaries to harness collective intelligence and accelerate innovation. By opening up the innovation process to external inputs, expertise, and resources, including those of end-users, Open Innovation enables organizations to tap into a broader range of ideas, technologies, and perspectives, leading to more creative and impactful solutions to complex challenges.*
- *Transparency is fundamental to both Open Science and Open Innovation, ensuring accountability, trustworthiness, and ethical conduct. By providing visibility into the research and innovation process, transparency enhances public trust, fosters collaboration, and enables stakeholders to assess the validity and reliability of findings and outcomes.*

Challenge

One significant challenge is managing the balance between open collaboration and the need to protect intellectual property. Open collaboration in some sectors could potentially limit the commercial incentives for innovation and the protection of proprietary technology. This presents a challenge in aligning the interests of public and private stakeholders within research collaborations, especially in competitive sectors.

Solution

Non-for-profit organizations such as the [Structural Genomics Consortium](#) (SGC) address this challenge by designing and implementing robust policy frameworks that encourage transparency and unrestricted sharing while ensuring that all outputs are placed in the public domain. This includes:

- Clear policy guidelines: The policy mandates that all research outputs are to be made publicly available without restriction, reinforcing the commitment to Open Science and Open Innovation.
- Conflict resolution mechanisms: It includes provisions for handling conflicts, where scientists must declare any potential conflicts with the policy. These conflicts are then reviewed by a Board or its delegated sub-committee, ensuring that deviations from the policy are managed transparently and appropriately.
- Public disclosure and accessibility: Following the public disclosure of project outputs, the entity ensures that data remains freely available, and materials are accessible to the research community at a reasonable cost. This practice supports ongoing collaboration and utilization of the research outputs by wider communities.

Practice example

Through the implementation of this strategic policy, the SGC has forged a public-private partnership with 8 industries. Their societal impact is remarkable: Since its inception in

2004, the SGC has facilitated over 25 ongoing clinical trials, notably expediting the timeline for bringing molecules to clinical trials and targeting diseases big pharmaceutical companies do not care about.

11. ORRI requires institutional structures for the ethical conduct of all activities, the integrity of all parties involved and adherence to fundamental ethical standards, such as human rights and the precautionary principle.

Institutional structures such as research ethics committees, institutional review boards, and research integrity offices play crucial roles in ensuring the ethical conduct of research and innovation. Such organizational bodies provide oversight, review research protocols, and assess the ethical implications of proposed studies to ensure that they adhere to ethical principles and regulatory standards. Additionally, universities and research institutions often have codes of conduct and ethical guidelines in place to govern the behavior of researchers and ensure integrity in research practices. These institutional structures serve to safeguard the rights and welfare of research participants, promote integrity and transparency in research conduct, and uphold public trust in the scientific and innovation enterprise.

Human rights and the precautionary principle are essential in research and innovation to protect individuals' dignity, autonomy, and well-being, ensuring that advancements benefit society without causing harm or violating fundamental rights. By upholding human rights, research and innovation efforts are guided by ethical principles that prioritize the interests and welfare of all stakeholders, including vulnerable populations. Similarly, the precautionary principle emphasizes the need to anticipate and mitigate potential risks and harms associated with new technologies or interventions, promoting responsible and sustainable innovation that minimizes negative impacts on society and the environment.

Challenge

New and emerging technologies, including neurotechnology, digital extended reality, and climate engineering, have the potential to profoundly impact society. However, research on these technologies raises a broad set of ethical concerns – ranging from questions on autonomy, misuse, and mental and physical health to privacy, equity, and ecosystems. These ethical concerns are often associated with the long-term societal and environmental impacts of these technologies, thus necessitating a reshaping of the research governance system supporting ethical research practices. Research ethics committees (RECs) play a vital role in furthering ethical research. However, the scope, structure, expertise, and principles of RECs, designed with a primary focus on reviewing biomedical research, are often ill-suited to conduct comprehensive ethics assessments of research related to new and emerging technologies.

Solution

One approach to address the challenge is ethics by design, or the incorporation of ethical principles into the development process of technologies. Ethics by design brings ethical and societal values into the design and development of new and emerging technologies from the very beginning of the process.

Practice example

The project TechEthos produced operational ethics guidelines for three technologies for users such as researchers, research ethics committees, and policymakers. Suggestions for

actors in the research governance system (policymakers, funders, research institutions, conference organisers, publishers, ethics organisations, and learned societies) include:

- Determining which projects are high risk and conducting reviews proportionate to risk levels, e.g. complement ex-ante review with further ethical reflection mechanisms.
- Developing REC-specific guidance documents for ethics review and assess ethics-by-design roadmaps.
- Ensuring REC composition and the expertise of members are aligned with their purview.
- Promoting exchange amongst RECs and between RECs and requiring ethical reflection for researchers in publications and conferences.
- Improving transparency in decision-making processes.
- Ensuring REC access to adequate resources.
- Incentivizing private-sector actors to engage in ethics review processes.

12. ORRI relies on an informed, open-minded and engaged citizenry, which requires quality science education from an early age on and across all social and professional groups, fostering curiosity and science literacy as enablers of public engagement and active science citizenship.

While promoting science education from an early age is essential for fostering a culture of engagement and critical thinking, it is crucial to recognize that access to quality education is unequal across communities, which can exacerbate disparities in participation and citizenship. Additionally, while science literacy is valuable, it is not sufficient on its own to ensure meaningful public engagement in science. Structural barriers (such as lack of access to education, the digital divide or institutionalized discrimination), unequal access to resources, and power imbalances must also be addressed to truly democratize science and innovation processes. Thus, while Open and Responsible Research and Innovation may rely on an informed and engaged citizenry, achieving this goal necessitates addressing systemic inequities in education and fostering inclusive, participatory approaches to science and innovation governance.

Challenge

ORRI faces the critical challenge of ensuring equal access to public science engagement. Effectively engaging a diverse range of actor groups, particularly those often overlooked such as civil society organizations and unorganized publics, remains a significant difficulty. Understanding the purposes of societal engagement is crucial, as motivations can vary from normative to instrumental. Additionally, the framing of science and technology within engagement processes must address relevant issues comprehensively, avoiding overly restrictive perspectives. The timing of public involvement is also critical; engaging the public too late can render the process ineffective, while engaging too early can prevent meaningful input. Diverse engagement and science communication formats are necessary. These formats range from public outreach initiatives to active participation in research projects. The democratization of science further requires accountable governance structures, and without thorough implementation, can become paradoxical, underscoring the need for innovative forms of participation.

Solution

Effective science communication and informal science education methods are needed to set the stage for the introduction of robust public engagement activities. A successful approach is to invite stakeholders and citizens to question and to experiment with science.

Experimental approaches invite the public to deal with emerging concepts and practices. Specially designed formats for activities and workshops that combine interactive elements to engage participants in idea sharing and debates. Tools that can help achieve this goal are e.g. Reverse Science Cafés and Science Espressos. Reverse Science Cafes invert the usual format by having experts ask the public questions, gathering inputs relevant to their work. Science Espressos are brief 10-minute talks by an expert on a current topic followed by informal discussions with the public.

Practice example

The SPARKS project tackled the challenge of engaging the public in science and raising awareness of ORRI principles with interactive activities and workshops. Local organizers established partnerships, facilitating events that focused on health, DIY science, and RRI processes. Besides Science Cafes and Science Espressos, a very successful tool to engage the public was the "Beyond the Lab: The DIY Science Revolution" exhibition created with local partnerships, which showcased citizen-driven scientific discoveries. It uniquely combined personal science success stories with artistic visions of future technology impacts. SPARKS activities generated new research inputs from the public, led to new strategies and collaborations, and provided insights into public engagement with science.