Monitoring the Evolution and Benefits of Responsible Research and Innovation (MoRRI)

Progress Report D5.1

Update of the literature review (Sub-task 6.1) & Visioning exercise (Sub-task 6.2)

This report is part of a series of documents produced as part of the European Commission's service contract RTD-B6-PP-00964-2013, "Monitoring the evolution and benefits of responsible research and innovation" (MoRRI).
The following deliverables have been produced so far:

- Citizen engagement and participation of societal actors in research and innovation, Task 2, Analytical report, Deliverable D2.1, April 2015
- Science literary and scientific education, Task 2, Analytical report, Deliverable D2.2, April 2015
- Gender equality, Task 2, Analytical report, Deliverable D2.3, April 2015
- Open access, Task 2, Analytical report, Deliverable D2.4, April 2015
- Ethics, Task 2, Analytical report, Deliverable D2.4.1, April 2015
- Governance, Task 2, Analytical report, Deliverable D2.4.2, April 2015
- Synthesis report on existing indicators across RRI dimensions, Task 3, Progress report, Deliverable D3.1, May 2015
- Metrics and indicators of Responsible Research and Innovation, Task 3, Progress report, Deliverable D3.2 September 2015

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Table of Contents

1. Introduction

Task 6 of the MoRRI project has the objective to analyse the benefits of RRI. In this Progress Report, the findings of the update on the state of the knowledge related to RRI (Sub-task 6.1) and the identification of possible benefits in specific scientific disciplines and industrial sectors (Sub-task 6.2 – visioning exercise) are collated. The overall aim of these two sub-tasks is to support the development of a sound understanding of benefits to be expected when RRI is broadly recognised and becomes an institutionalised ambition amongst research and innovation actors. Together with the findings of the in-depth case studies (sub-task 6.4) and the other activities to be completed in Task 6, the findings on RRI benefits are intended to support the development of appropriate metrics and indicators in Task 7.

Sub-task 6.1 is based on the research conducted in Task 1 (literature review). In order to ensure a focused and systematic review of existing knowledge relevant for MoRRI, the expertise of the project's dimension leaders was tapped. For each dimension, the dimension leaders – as experts in their respective fields – were asked to provide a list of 10-15 key publications which should be included in the review. For the systematic review of the selected publications, a review template was developed with the aim to provide each member of the review team with a common framework and reference point to conduct the reviews and, once the reviews are completed, to facilitate a systematic and structured analysis of the literature.

The review results fed into the six analytical reports of Task 2 (D2.1, D2.2, D2.3, D2.4, D.2.4_1, D.2.4_2), contributing to an improved understanding of the relevant, definitions, the existing knowledge and related debates, and the availability of qualitative and quantitative data.

For the update of the literature (sub-task 6.1), the dimension leaders were asked again to make suggestions for newly published work in their respective areas of expertise. However, with the exception of public engagement, the dimension leaders responded that between the first round of literature review (sub-task 1.1) and the update (sub-task 6.1) no noteworthy publications were identified as relevant for the project. And the newly published literature in the field of public engagement was of rather general interest but did not provide any additional measures of benefits.

In consultation with the project coordinator, it was decided to better exploit the rich findings of the literature review by revisiting the selected publications and focusing specifically on potential impacts – particularly the benefits – of the RRI key dimensions being discussed in the publications. However, it should be noted that the few benefits identified in the literature tend to be rather abstract and very general. In addition, the claims made by many publications about the benefits of each dimension are not always systematically based on firm empirical findings or expressed by indicators. Against this background, more often than not it was not possible to clearly spell out benefits of the RRI key dimensions within the six sub-sections of chapter 2 of the literature review.

As this potential shortcoming of the current literature and knowledge base was anticipated when the project design was developed, a different methodological approach to the objective of improving our understanding of RRI benefits was included to Task 6: a visioning exercise (sub-task 6.2). With the help of this exercise, a valid and instructive choice of potential future benefits across different scientific disciplines and industrial sectors was obtained. With about 20 R&I stakeholders from diverse backgrounds, an image of a European R&I system where the most ambitious aspirations are realised for all RRI dimensions (vision) was sketched. In a next step, participants specified the benefits, forming the basis for the definition of indicators for each benefit within sector/discipline. The visioning process was structured by a

cutting-edge foresight methodology, enabling the project team to harness the diversity of values, knowledge and perspectives of the group and mobilise collective anticipatory intelligence for a better understanding of potential RRI benefits.

2. Potential benefits of Responsible Research and Innovation (RRI) discussed in the relevant literature

In the following, the impacts related to the key dimensions, as derived from the secondary literature review, will be summarised. However, as stated in the introduction, the identified literature rarely discusses impacts or even potential benefits explicitly. Thus, the following overviews of the relevant literature cannot be limited to a narrow understanding of impacts, but reflect to a large extent the genealogies, main lines of reasoning and rationales of the key dimensions. The literature reviews, on which the summary is based, are made available in the Annex.

In Task 1 (Literature review) of the MoRRI project, the consortium conducted a systematic review of selected key publications in the RRI key dimensions:

- Citizen engagement
- Science literacy and science education
- Gender equality
- Open access
- RRI governance
- Ethics[1]

The results of the focused review of the benefits of the key RRI dimensions are structured accordingly.

2.1 Benefits of Citizen Engagement and Participation of Societal Actors

Citizen engagement and the participation of societal actors is one of the key components in redefining the means of science, public and democracy in modern societies to facilitate effective participation practices.[2] Furthermore, Smith (2005) claims that democratic innovation (i.e. RRI) decreases and deepens citizen participation in the political decision-making process. Later on Kenneth & Geissel (2012) highlighted the importance of public involvement in the political process. They argue that in the face of increasing political disenchantment, many Western governments have experimented — by using different aspects of RRI — to enhance the efficiency and quality of democracy as well as increasing citizens' political awareness and understanding of political matters increase citizen involvement in the political process".

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[1] Please note that for the purpose of the literature review and the development of a clear operational understanding of the RRI dimensions, it was decided to deal with the dimension "governance" and "ethics" separately.

[2] For the purpose of this report, the terms "public engagement" and "citizen engagement" and similar variants will be used interchangeably to denote "citizen engagement and the participation of societal actors".

Public engagement is also highly important in science. Stirling (2008) argues that even though there is a growing recognition of social agency in technology development and choice, higher appreciation is required to facilitate the opening up of governance on science and technology to the public. This is in line with earlier work by Wilsdon & Willis (2004) who claim that public engagement (i.e. RRI) can change the scientific community's approach to the risks, uncertainties and wider social implications of new and emerging technologies (i.e. nanotechnology back in 2004). Furthermore, Vargiu (2014) recently added that RRI and public engagement enable universities to increase their direct and indirect contribution to society (sometimes referred to as the "third mission").

Stilgoe et al., (2014) argue at the same time that public engagement would seem to be a necessary but insufficient part of opening up science and its governance; those involved in advocating for public engagement practice could be accused of overpromising. They add that public engagement has the potential to open up productive and surprising discussions about the politics and purposes of science. However, one must keep in mind that in the past un-reflexive public engagement has also taken place, used to close down vital debates in contentious areas (Stilgoe et al., 2014, p.11).

2.2 Benefits of Science Literacy and Scientific Education

Science literacy and scientific education (SLSE) have been well researched and a topic of academic and public discussion for a long time. The importance of SLSE has also been emphasised by high-level policy makers, according to Commissioner Vassiliou: "A basic understanding of science is considered a necessary skill for every European citizen." (Eurydice, 2011, p. 3).[3]

According to Miller (1983), science literacy is composed of different aspects, including awareness of the impact of science and technology on society – that is closely related to main principles of RRI. Miller's expectation, stated in the early 1980s, that the number of science-related issues on the policy agenda will dramatically increase in the future, by and large proved to be true and stills holds today. Therefore, RRI needs to be successfully employed in order for citizens to participate in these policy debates and they need to understand basic scientific concepts and methods (civic scientific literacy) (Miller, 1998, p. 218/19). Scientific literacy should go beyond fact and content knowledge; rather, it includes the relationship between science and society (p. 4), an understanding of the processes of science (p. 13) and diverse competencies/skills at the interface of knowledge, values and action/everyday life (p. 14) (Gräber, 2002).

Furthermore, according to Gräber (2002), the current situation in schools is unsatisfactory: a) knowledge and skills are not learned as intended, b) initial interests get lost through school education, and c) knowledge attained in scientific education is hardly applicable in everyday life (Gräber, 2002, p. 6). Especially important is the gender equality in this aspect, meaning that girls and women need additional support in order to encourage them to choose science fields/careers (Eurydice, 2011).

Finally, Bauer et al. (2007) add that the range of data used to monitor and analyse public understanding of science should be broadened. To get more meaningful results comparative collections of science reportage in mass media is required (Bauer et al., p. 90). Also with a focus on the methodology of measuring and analysing science literacy, Miller (1998) proposes that the inclusion and replication of the measure of

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3 In the following, the terms "science literacy" and "scientific education" (SLSE) are not discussed separately as the selected literature tends to use the concepts interchangeably, thereby also reflecting the strong interrelationship between the two perspectives.

science literacy in a wider range of studies of the public understanding of and attitudes toward science and technology are necessary.

2.3   Benefits of Gender Equality

The benefits of gender equality are obvious: they contribute to excellent research by the diversity it brings to research teams and through the analysis of research content by gender (Lipinsky, 2014). Also, the increased representation and the advancement of academic women in chemistry and engineering develops a more diverse science and engineering workforce (Gilmer et al., 2014, p. 34).

It is important to identify gender bias and understand how it operates in science and technology. But analysis cannot stop there. RRI-based "gendered innovations" offer sophisticated methods of sex and gender analysis to scientists and engineers. Integrating these methods into basic and applied research produces excellence in science, health & medicine, and engineering research, policy, and practice (European Commission, 2013). Gendered innovation adds value to research and engineering by ensuring excellence and quality in outcomes and enhancing sustainability, and adds value to society by making research more responsive to social needs and to business by developing new ideas, patents, and technology (European Commission, 2013).

Gendered innovations also seek to create gender excellence: that is to say, to build inclusive scientific communities where men and women share equally at all levels in decision making, policy, and defining and carrying out research. Gendered innovations seek: 1) to create gender equality; 2) to enhance creativity; 3) to stimulate economic and technological development (or business innovation); 4) to make research more responsive to society (Schiebinger & Schraudner, 2011). To improve gender balance, it is necessary to broaden the spectrum of activities and achievements to be included in the definition of scientific excellence (European Commission, 2004). It is important to include other dimensions of scholarly practice, such as education, participation in committees, external consultancy, and contribution to public debates (European Commission, 2004). In other words, it is important to emphasize not only production, but also relevance and the different users of scientific knowledge (European Commission, 2004).

Besides science, a recent study shows the following results in private sector: firms with the highest representation of women on their top management teams experienced better financial performance than firms with the lowest women's representation (Catalyst, 2014; McKinsey&Company, 2007). Gender diversity improves corporate financial performance - in companies that focus on diversity & developing and leveraging women's talent - the relationship to the bottom line is remarkable (Catalyst, 2014).

According to recent studies - although recognised as a fundamental value, the status and profile of gender equality currently shows signs of decreased importance in Europe (EIGE, 2014). Therefore, there is a clear need for more EU-wide coordination of gender equality policies through the regular exchange of experiences, and progress reporting against equality indicators (Lipinsky, 2014).

2.4   Benefits of Open Access

A number of limitations and barriers in the adoption of data sharing are still in place (Costas et al., 2013). In particular, there is a general concern regarding the limited uptake of open access in Europe (Davies, 2013) due to a lack of policy coordination and/or framework conditions which impede the free movement of research activities and knowledge, hindering access to publicly funded research results and knowledge transfer (Cragin et al., 2010). Davies (2013) argues that the uptake of open data

would enable to establish a latent value, to stimulate innovation and to increase transparency.

Costas (2013) has added that data sharing and open access offers important benefits for scientific progress and advancement/diffusion of knowledge. Dallmeier-Tiessen et al., (2011) report that in the SOAP online survey, about 40,000 active scientists around the world in different scientific disciplines gave their assessments on open access. According to the survey, the main benefit of open access publishing lies in the rapid sharing of research results (36%). In addition, the respondents see financial benefits and benefits for the public good associated with open access (20% each). Increased visibility and recognition as an author and scientist was placed at fourth place, with 10% (Dallmeier-Tiessen et al., 2011, p. 5).

2.5   Benefits of Governance

As stated in the MoRRI analytical report D4.1.2 on the governance dimension, "[t]he relationship between governance, research and innovation is far from simple, and far from linear." (MoRRI, 2015, p. 8). In many ways, the governance dimension of RRI cuts across the other key dimensions,; put differently, RRI governance influences and shapes the dynamics, directions and concrete manifestations of public engagement, open access, gender, ethics, and SLSE. In this sense, the benefits associated with RRI-governance are mostly not direct, but might be termed as "meta-benefits". Drawing on the selected governance literature of this review, the main "meta-benefit" of RRI governance lies in its potential to clarify the purpose, form and scope of the other key dimensions of RRI. In the following review, direct benefits are not identified, but the potential of RRI-oriented governance to open up the governance of research and innovation for new perspectives, interests and directions is demonstrated (cf. Stirling 2008).

In the field of governance, it is increasingly acknowledged that new and emerging technologies – such as nanotechnology, biotechnology, cognitive technology – have the potential to disrupt established social and technological systems (Fisher et al., 2006). Additionally, there are growing public concerns about the social and environmental implications of these developments (Fisher et al., 2006, p. 485). In the literature on governance, public "upstream engagement" and other RRI approaches to the social control of technology are currently receiving attention in policy discourses around emerging technologies (i.e. nanotechnology) (Fisher et al., 2006). These approaches hold implications for research and development (R&D) activities for scientists, meaning that they would have to change the way how R&D is conducted (Fisher et al., 2006). Fisher and colleagues (2006) also argue for a need for more reflexive participation by scientists and engineers in the internal governance of technology development. The same authors also introduce the concept of midstream modulation (example of RRI), through which scientists and engineers, ideally in concert with others, bring societal considerations to bear on their work.

These issues have also been highlighted in earlier work by Kuhlmann (2007). Kuhlmann argues that there is a need for STI studies to improve our understanding of the governance of science, technology and innovation. More specifically, RRI and governance should deal with an interrelationship between science, technology and innovation in practice, and to take RRI into consideration when analysing the role of public policy and in STI studies (understood as "theory in action") (Kuhlmann, 2007).

The role of RRI-related issues in governance has also been analysed in the context of earlier innovation studies (Smits & Kuhlmann, 2004). Smits & Kuhlmann claim that with regard to innovation policy, "systemic instruments" (SI) are gaining in importance. SI have the potential to fulfil 5 functions: (Smits & Kuhlmann, 2004, p. 5)

- Management of interfaces
- (de-)constructing and organising (innovation) systems
- Providing a platform for learning and experimenting
- Providing an infrastructure for strategic intelligence
- Stimulating demand articulation, strategy and vision development

2.6   Benefits of Ethics

One of the major areas where principles of (global) ethics are being discussed is in science, technology and innovation policy (Brom et al., 2015). Thus, it is important to analyse and understand how ethical debates can be institutionalised in science, technology and innovation policy (Brom et al., 2015). The same authors also argue for the importance of participatory practices in ethical deliberation especially in the European context (Brom et al., 2015).

Within science and technology, specific areas have been highlighted where RRI plays an especially important role in ethical issues. For example, Felt et al. (2009) focused on genomics in this context. Their work explores the difficulties of addressing ethical questions of genome research in a public engagement setting where laypeople and scientists met. Within this interaction, Felt and colleagues identified a number of difficulties that constrained an open discussion on ethical issues and where the principles or RRI could be successfully implemented (Felt et al., 2009, p.358).

Later on, Hedlund (2010) adds that government advisory organisations should also be democratic and consider RRI regarding ethical issues around genomics. "Genetic technology concerns all society and therefore it is important that expert bodies advising political decision-making about regulation of gene technology are democratically legitimate" (Hedlund, 2010, p. 234). In this regard, as a positive example of RRI, Sakkas (2014) mentions National Ethics Committees (NECs) as dedicated bodies to the specific goal to inform decision making in the area of bioethics (or the ethics of biomedicine and biotechnologies).

In the same line of thinking, ethics advisory bodies (EABs) are discussed as an instrument to promote RRI by Mali et al., (2012). According to the authors, EABs are expert bodies whose remit is to issue recommendations regarding ethical aspects of new and emerging science and technology. EABs are described as a promising mechanism for furthering RRI if they incorporate participatory elements. One basic problem is that the majority of EABs are not participatory enough. Most of them "still function mainly as expert bodies rather than as hybrid forums. There are many deficiencies with regard to public participation in the work of EABs" (Mali et al., 2012, p. 181).

In his recent work, Grunwald (2014) has highlighted the importance and benefit of RRI also on Technology Assessment (TA). He argues that Responsible Innovation adds explicit novel ethical reflection to TA and merges both into approaches of shaping technology and innovation. The field of ethics of responsibility and its many applications to the scientific and technological advance is the second major root of Responsible Innovation. Furthermore, Grunwald goes beyond them by an effort to "shape innovation", taking "a closer look on societal contexts of new technology and science", a "clear indication for intervention into the development and innovation process", and trying "'to make a difference' (…) in the 'real world'" (p. 25). In this sense "Responsible Innovation can be regarded as a radicalization of the well-known post-normal science (…) being even closer to social practice, being prepared for intervention and for taking responsibility for this intervention" (p. 25). Finally, Grunwald states that "Responsible development and innovation might be a new

umbrella term with new accentuations which may be characterised by (i) Involving ethical and social issues more directly in the innovation process by integrative approaches to development and innovation, (ii) Bridging the gap between innovation practice, engineering ethics, technology assessment, governance research and social sciences (STS), (iii) Giving new shape to innovation processes and to technology governance according to reflections in all of its three dimensions mentioned above, (iv) In particular making the distribution of responsibility among the involved actors as transparent as possible, (v) Supporting 'constructive' paths of the co-evolution of technology and the regulative frameworks of society." (p. 29). Lastly, Kiran (2015) has argued that RRI enables introduction of ethical Technology Assessment (eTA) that includes also ethical implications in addition to 'quantifiable risks' regarding safety, health and environment.

References (Section 2.)

Bauer; Allum; Miller, 2007. What can we learn from 25 Years of PUS survey research? Liberating and expanding the agenda. Public Understanding of Science 16, p. 79-95.

Brom, F. W.A.; Chaturved, S.; Ladikas, M.; Zhang, W., 2015. Institutionalizing Ethical Debates in Science, Technology, and Innovation Policy: A Comparison of Europe, India and China. In: M. Ladicas et al. (eds.) Science and Technology Governance and Ethics.

Catalyst, 2004. The bottom line: Connecting Corporate Performance and Gender Diversity.Catalyst Publication.

Costas, R.; Meijer, I.; Zahedi, Z.; Wouters, P., 2013. Metrics for datasets from a cultural and technical point of view. A Knowledge Exchange Report. Copenhagen.

Cragin, M. H.; Palmer, C. L.; Carlson, J. R.; Witt, M., 2010. Data sharing, small science and institutional repositories. Philosophical transactions. Series A, Mathematical, physical, and engineering sciences, 368(1926), p. 4023–38.

Dallmeier-Tiessen, S. et al., 2011. Highlights from the SOAP Project Survey. What Scientists Think About Open Access Publishing.

EIGE (European Institute for Gender Equality), 2014, Effectiveness of Institutional Mechanisms for the Advancement of Gender Equality – Review of the implementation of the Beijing Platform for Action (BPfA) in the EU MS, 2014, Luxembourg: publications Office of the European Union

European Commission, 2004. Gender and Excellence in the Making, 2004, European Commission, Luxembourg: Office for Official Publications of the European Communities

European Commission, 2006. Women in science and technology- the business perspective, 2006, European Commission, Luxembourg: Office for Official Publications of the European Communities

European Union, 2013. Report of the Expert Group "Innovation through Gender", Chairperson: Londa Schiebinger Rapporteur: Ineke Klinge, 2013

Eurydice, 2011. Science Education in Europe: National Policies, Practices and Research. Brussels: EACEA.

Felt, U.; Fochler, M.; Müller, A.; Strassnig, M., 2009. Unruly ethics: on the difficulties of a bottom-up approach to ethics in the field of genomics. Public Understanding of Science 18 (3), p. 354-371.

Fisher, E.; Mahajan, R; Mitchum, C. (2006): Midstream Modulation of Technology: Governance From Within Bulletin of Science, Technology and Society 26(6), p. 485-496.

Gilmer, P J.; Tansel, B; Hughes M, M. (eds.) Alliances for Advancing Academic Women. Guidelines for Collaborating in STEM Fields 2014 Rotterdam/Boston/Taipei: Sense Publishers.

Gräber, W., 2002. „Scientific Literacy" - Naturwissenschaftliche Bildung in der Diskussion. In: Döbrich, Peter (Hrsg.): Qualitätsentwicklung im naturwissenschaftlichen Unterricht. Fachtagung am 15. Dezember 1999. Frankfurt am Main: GFPF/DIPF, p. 1-28.

Grunwald, A. 2014. Technology Assessment for Responsible Innovation. In: van den Hoven et al. (eds.) Responsible Innovation I: Innovative solutions for Global Issues, Dordrecht, Springer Science * business Media, p. 15-29.

Hedlund, M. 2010. Democratic Expert Influence Through Bioethical Advisory Committees? The Case of PGD Legislation in Sweden. Kristofferseon, U.; Schmidkte, J.; Cassiman, J.-J. Quality Issues in Clinical Genetic Services. Springer.

Kiran, A. H., 2015. Beyond checklists: toward an ethical-constructive technology assessment. Journal of Responsible Innovation 2015, p. 1-15.

Kuhlmann, S., 2007. Governance of Innovation: practice, policy and theory as dancing partners. Inaugural Lecture, University of Twente.

Lipinsky, A., 2014. Gender Equality Policies in Public Research, European Commission, Luxembourg: Publications Office of the European Union.

Mali, F.; Pustovrh, T.; Groboljsek, B; Coenen, C., 2012. National Ethics Advisory Bodies in the Emerging Landscape of Responsible Research and Innovation. Nanotechnologies 6, p. 167-184.

McKinsey&Company , 2007. Women Matter - Gender diversity, a corporate performance driver.

Miller, J. D. 1983. Scientific Literacy: A Conceptual and Empirical Review, Daedalus, 112:2, p. 29-48.

Miller, J. D. 1998. The Measurement of Civic Scientific Literacy. Public Understanding of Science, 7, p. 1-21.

MoRRI (2015): Analytical report on the dimension of Research and Innovation Governance. Deliverable D2.4.1 of the Project Monitoring the Evolution and Benefits ofResponsible Research and Innovation (MoRRI), Brussels.

Müller, J., et al. 2011. Policy towards Gender Equality in Science and Research, Brussels Economic Review, 54 (2/3), p. 295- 316.

Newton, K.; Geissel, B., 2012. Evaluating Democratic Innovations: Curing the Democratic Malaise? New York: Routledge.

Rowe, G.; Frewer, L., J., 2000. Public Participation Methods: A Framework for Evaluation.

Sakkas, S., 2014. Ethical Expertise facing the public regulation of reproductive biomedical issues. Results from a comparative study between the National Ethics Committee in France and Belgium, PhD Thesis, Universite Catholoque de Louvain.

Schiebinger; Schraudner, 2011. Interdisciplinary Approaches to Achieving Gendered Innovations in Science, Medicine, and Engineering, INTERDISCIPLINARY SCIENCE REVIEWS, Vol. 36 No. 2, June, 2011, 154–67, Published by Maney on behalf of the Institute (Institute of Materials, Minerals and Mining)

Smith, G., 2005. Beyond the ballot. 57 Democratic Innovations from Around the World. The POWER Inquiry.

Smits, R. and Kuhlmann, S., 2004. "The rise of systemic instruments in innovation policy", in: International Journal of Foresight and Innovation Policy 1 (1/2), p. 4-32.

Stilgoe, J; Lock, Simon J.; Wilson, James 2014: Why should we promote public engagement with science? In: Public Understanding of Science, 23, 1, p. 4-15.

Stirling, A. 2008. "Opening Up" and "Closing Down". Power, Participation, and Pluralism in the Social Appraisal of Technology. Science, Technology, & Human Values. Volume 33 Number 2, p. 262-294.

Davies, T., 2013. Open Data – Barometer, 3013 Global Report, World Wide Web Foundation and Open Data Institute, 35 p.

Vargiu, A., 2014. Indicators for the Evaluation of Public Engagement of Higher Education Institutions. In: Journal of Knowledge Economy, 5, 3, p. 562-584.

Wilsdon, J.; Willis, R., 2004. See-through Science Why public engagement needs to move upstream, Demos, London.

3. Visioning workshop

3.1 Approach

The rationale of the visioning exercise was to lay the foundation for a collection of possible future benefits of RRI implementation by sketching an "ideal" future RRI landscape. For this purpose the MORRI visioning workshop gathered a group of 19 R&I actors from 15 European countries from the different core R&I actor groups academia, RTOs, policy and industry and 5 colleagues from different units of the European Commission. The vision was developed through a visioning process starting from individual visions of the participants which were then synthesised in ever larger group compositions until finally an agreement was reached in the plenary. This vision, which contained five key elements, then formed the basis for the generation of benefits for the different actor groups and of possible indicators for measuring these benefits.
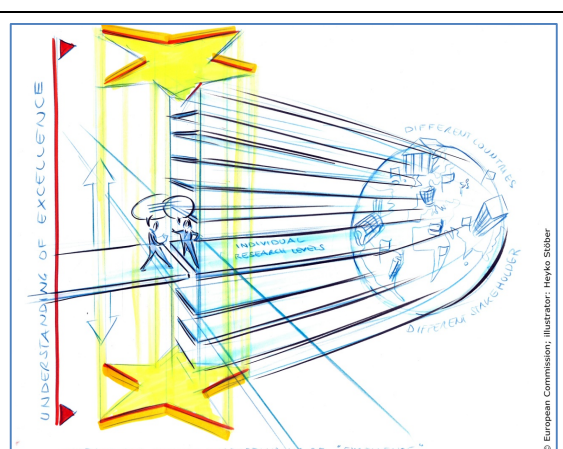
3.2 The Vision

The final RRI vision embraced five key elements:

1. RRI is in your "DNA" – embedded in daily activities across all actors.
2. There are multiple and diverse understandings of excellence in research and innovation.
3. There is a merits and incentive structure to support RRI at all levels.
4. RRI is a creative activity or opportunity instead of a burden.
5. In all steps of the research process – agenda setting, evaluation, implementation – society is actively involved.
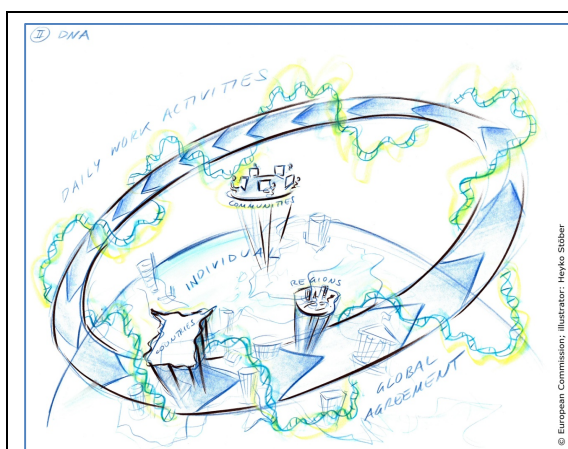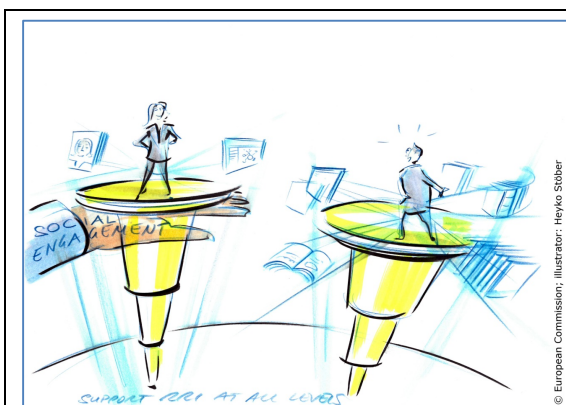

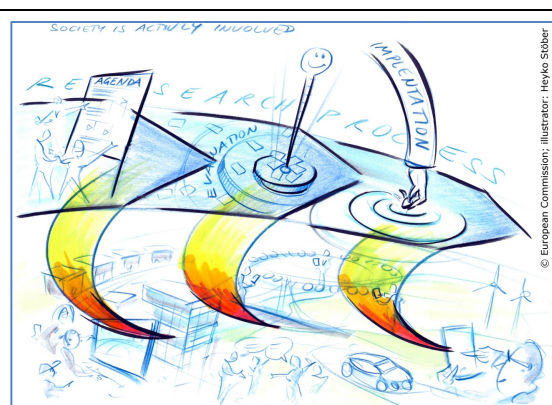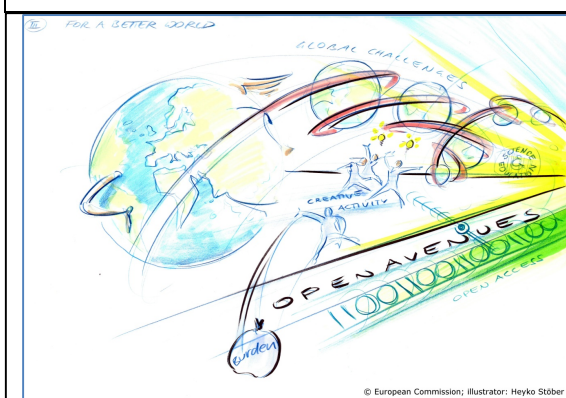|	
RRI in the DNA of all actors	Multiple and diverse understanding of excellence

Support to RRI on all levels

Society is actively involved in all phases

RRI as creative activity and no burden

3.3 Results and benefits of RRI

In the following sections the findings of the workshop on RRI benefits and indicators are reported. These results mainly stem from the workshop's world café session on benefits and indicators, but insights from other elements, such as the development of fictive newspapers from the future, are integrated. The few aspects with a low agreement of participants (marked by question marks) are not taken up here.

3.3.1 Benefits of RRI for policy and funding

One set of benefits revolves around improvements in the policy process. With RRI embedded in the DNA of all system actors and society involved in all steps it is reckoned that the collaborative problem solving capacity for policy will be substantially enhanced. A framework for societal actors to engage in R&I both in the activities and agenda setting will be firmly in place. This enables decentralisation and fair priority setting of R&I activities. The collaborative mode of operation will provide policy makers with a better knowledge of the R&I system and better access to gatekeepers of societal developments. These improved framework conditions would enable more creative and responsive policy making with less top-down steering and maybe even less legislation.

The better process will allow for better outcomes and impacts. The new RRI-based tools will enable better identification of emerging issues as well as tackling of societal challenges and enhance in particular achievement of environmental targets. The social

added value of RRI spending would be substantially enhanced resulting in more effective and efficient spending of public investment.

This situation would also impact on the way R&I policy is perceived by society. The RRI framework will substantially increase legitimacy and acceptance of policy measures and in particular funding decisions.

All these developments will also boost the happiness and quality of life of policy makers and civil servants.

3.3.2 Benefits of RRI for research

Implementation of the fully-fledged RRI vision will greatly improve the framework conditions of research. Most notably the R&I system will be able to harness the full range of human potential for research and innovation by mobilizing different types of competences and creativity in particular both female and male talent. Moreover, the funding situation may be improved e.g. by providing a more diverse and distributed range of funding possibilities.

Secondly, the installation of the RRI framework will heavily impact on the research process. Through the continuous interaction across disciplines a common language will emerge and mutual understanding increase. At the same time the research system will become more transparent. Both developments will underpin an ever increasing level of sharing and collaboration. One notable benefit of this will be the saving of resources due to the increasing sharing of research infrastructure.

It seems obvious that these developments will have major impacts on the way research is assessed. While, the notion of "indicator-free science" was not shared by all participants, the overwhelming agreement to the visionary statement that in an ideal RRI landscape "There is a multiple and diverse understanding of excellence in research and innovation" points to a substantial diversification and contextualisation of indicators. Also, it seems reasonable to expect that increased trust in the system will reduce the need for monitoring.

The improved process will also impact the outcomes. Science will generate better quality and more meaningful results. The number of redundancies and duplications will decrease.

Both the process and outcomes will boost the intrinsic motivation of research actors.

3.3.3 Benefits of RRI for society

Firstly, society will substantially benefit from the stronger orientation of research and innovation content towards social needs and the higher allocation of resources to societal challenges. Research and innovation will better fit society's requirements which will reduce the conflicts around new technologies and innovation.

In an RRI context innovation is free from pure capital interests on return on investment. Accordingly, there is a better chance that issues with no direct economic interest are addressed. Therefore research and innovation will contribute to global challenges ranging from new aid and services for vulnerable people, e.g. immigrants via personalized medicine and healthcare to space exploration. Even on a global level shrinking inequality in income distribution may strengthen social justice worldwide.

At the same time, society will profit from the more collaborative R&I process. In the envisioned RRI framework society is empowered to do research: The infrastructure for engagement of society in research is in place and society has the right channels to influence innovative processes. Gender balance in research and innovation activities is accomplished, non-academic knowledge is acknowledged and there is easy access to

global and local data, e.g. on issues of nature, culture and health. Citizens are scientifically literate and trust in science. This empowerment of citizens strengthens democracy also in other areas. Social cohesion may be strengthened as people feel more involved. Last but not least, science is fun and a highly entertaining attractive leisure activity.

3.3.3 Benefits of RRI for industry

Industry benefits from the realisation of the RRI vision with respect to human resources, costs, processes, relations with users/consumers and products.

Human Resources
Companies will have better chances to attract and retain new talents and thus build a highly qualified labour force. This is partly due to better recruitment tools such as crowd sourcing exercises as screening devices. Most prominently however due to better education and gender balanced participation in R&I more and better qualified staff will be available.

Costs
The early involvement of societal stakeholders emphasized in the vision will lead to a better return on research investments with less sunk costs and fewer stranded investments. Also the better knowledge of user requirement will allow companies to reduce spending on market research. The decrease in environmental impact will improves long term cost management. Finally the environmentally friendly processes will lead to tax savings.

Process
The vision entails a much closer interaction of consumers and producers. Next to the reduction of costs (see above) this yields other benefits for industry. Time to market which is increasingly critical in increasingly dynamic environments will be reduced. In addition, the better acceptability of the collaboratively developed products will shorten market penetration time. The closer knowledge of the market will reduce risks thereby increasing stability, remaining risks will be easier to assess and monitor due to the shared responsibility with societal actors.

The collaborative mode of R&I will generate a wide range of new successful business models such as crowd sourcing and open innovation. This will open up for a wealth of new ideas and input from outside and ultimately boost entrepreneurship.

Finally, the open access/ open data infrastructure will allow companies easier use of research results data for new innovative products and processes and thereby increase business opportunities.

Consumers, Products
The RRI vision leads to products with lower environmental footprint, high quality ethics standards that are produced in fair production processes. This will enhance the credibility of CSR schemes so companies will gain in reputation and increase their market share. Also the responsible research processes e.g. in the pharmaceutical industry will meet better acceptance from society. The fact that products are developed in close interaction with users and society will lead to better products that are responding to consumers needs and are at the same time socially desirable such as e.g. longer product life and improved safety and security. At the same time the improved interaction will allow for generating a wider range of products tailored to each user's needs (longer tails). Brand perception and thereby loyalty will be enhanced.

3.4 Findings on indicators for benefits

Whereas MORRI task 3 generated indicators of RRI implementation the challenge of MORRI task 6 and 7 is to generate indicators for the benefits of this implementation. In the visioning workshop suggestions for both types where made.
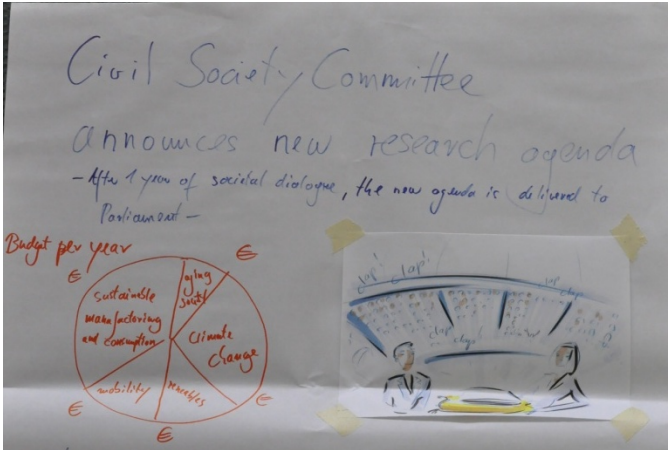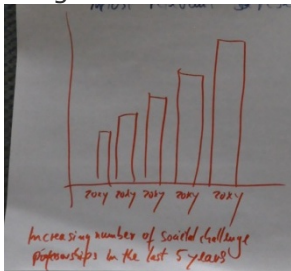
3.4.1 Indicators for RRI implementation

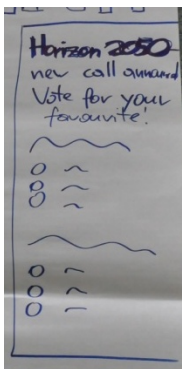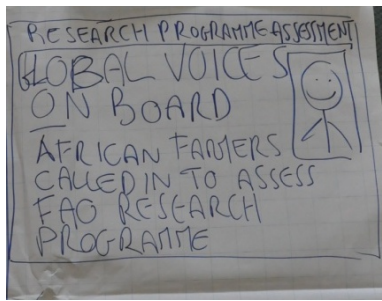| RRI aspect	Indicator
Open Access	Quality of open data provision mechanisms (how much is provided to whom how well)
Governance	- Diversity of funding sources - Share of money attributed to societal challenges vs. other topics (image) Figure 1: New research agenda announced - Rising number of societal challenge professorships Figure 2: Rising number of societal challenge professorships
Transdisciplinarity	Share of trans-disciplinary research process + publications

	Figure 3: Ivory tower becomes museum exhibit
Overall concept	Collection of narratives of "successful" implementation of RRI
Engagement	- People participating in public discourse formats - Number of interactions society – research - Indicators of Stakeholder engagement (e.g. number of stakeholder processes in R&I policy e.g. contributions of societal actors to H2050) - Figure 4: Voting procedure for H2050 calls Number of research programming processes integrating global stakeholders - Figure 5: Integration of global stakeholders - Degree of companies' engagement & investment in crowd-sourcing activities - Number of collaborative research projects

Figure 6: Collaborative Project Citizen Powered Mars Expedition

- Number of discoveries by school labs

Figure 7: School lab discovers novel biodegradable packaging solution

RRI Incentive Structure	- Number of PhD thesis defended in public events (e.g. science slams) - Number of scientific awards awarded by CSOs - Number of science awards provided for most relevant research for society

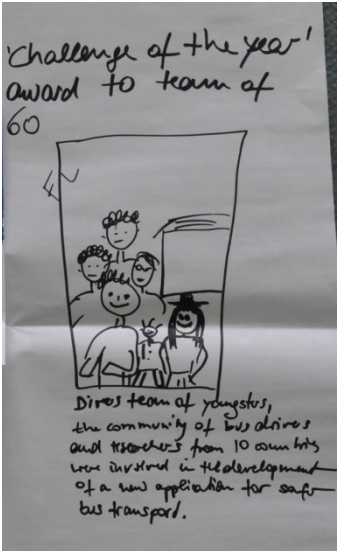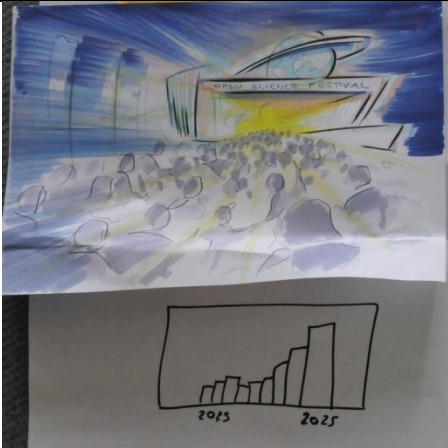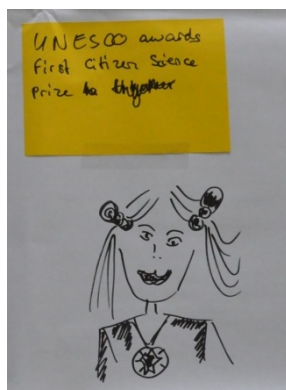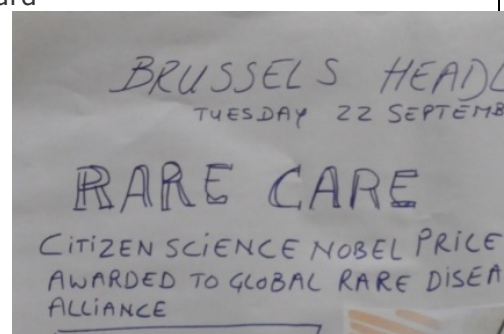|	
	• Number of scientific awards given to citizen science projects Figure 8: Citizen Science Award Figure 9: Citizens Science Nobel Price
Gender in content	Share of gender aspects in R&I content
Ethics	Number of companies that have CSR-policies
Gender equality	Cross-indicator of gender balance/gender representation in R&I Share of female CEOs in companies
Diversity	• Indicators of diversity at work • Higher diversity of company managers (or staff in general) in terms of age, … • Horizontal mobility • Share of people with disabilities employed in industry

3.4.1 Indicators for RRI benefits

Expected Benefit[4]	Indicator
Increase in contribution of R&I to societal progress	Indicators for social impact of research/funded research projects (time-bound, culture-bound, dynamic) • Number of solved problems through stakeholder engagement/ crowd sourcing (fictive examples c.f. figures below) Figure 10: RRI is connecting the world to fight dementia Figure 11: Controlling the uncontrollable - Citizen science for managing migration in Europe

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4 The benefits marked in bold came up in several groups/working sessions and may therefore be considered as particularly relevant.

Figure 12: Collaborative research project - team of youngsters, bus drivers and researchers from 10 countries developed application for safer bus transport

Reduction of inequality	Income distribution
Research contribution to environmental benefit	Research projects' environmental impact Figure 13: View from drone in 2030 on green mobility innovation - Autoroute du soleil turned green
Reduction in research	Number of cases of research misconduct

misconduct	
Increased job satisfaction/motivation (policy makers, innovators, researchers both in academia and industry)	Job satisfaction/motivation measure e.g. Happiness level of civil servants Qualys – quality adjusted life years
Work-life-balance (policy makers, innovators, researchers both in academia and industry)	Work-life-balance indicators • Share of remote-work
Increasing number of productive interactions in R&I policy making (productive interaction framework)	Number of productive interactions (productive interaction framework)
Increase of trust of society in policy making	Trust level of society in policy making
Increase of interest in/ attractiveness of policies	Interest in/ attractiveness of policies
Better effectiveness of public investment in R&I	Money spent per R&I project impact
Reduction of R&I related conflicts; increase of trust in science and innovation	Level of trust in science and innovation (Euro-Barometer on trust in science, public perception of science in the UK) Number of R&I related conflicts (e.g. judicial cases)
Increasing interest in science	Attendance of citizens to science festivals

Figure 14: Attendance to citizen science festivals

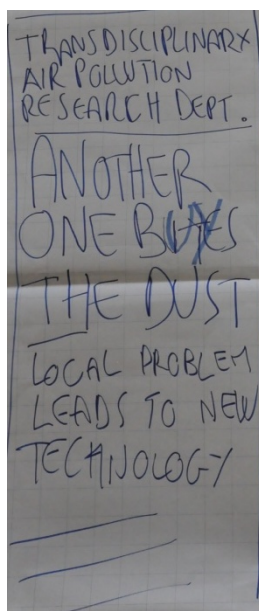| Enhanced qualification levels	Formal degrees in labour-force
More innovation	Innovation in business models / production systems (CIS European manufacturing surveys) • share of these innovations resulting from stakeholder involvement (RRI)

Figure 15: Transdisciplinary local collaborative air pollution research project leads to new technology

Higher salaries for women in R&I	Income of women in R&I (compared to male colleagues)
More life-long learning	Standardized statistics on life-long learning
Higher mobility of workforce	Mobility of workforce
More companies (e.g. in Europe) receiving rewards for responsible conduct (e.g. environment, social, ethical)	Number of awards granted to (e.g. European) companies
more start-ups in high-tech sectors	Number of start-ups in high-tech sectors
Higher revenue (due to better qualified and motivated employees)	Revenue/employee; Employee productivity
More high-tech	Share of high-tech innovation

innovation (provides competitive advantages)	
More ethical business models / fair production chains	Share of ethical business models / fair production chains Figure 16: Fair Production Business Model - Global Production Network with Bangladesh Family Start-Up
More long term investment	Proportion of financial sector investment focused on long-term value

3.4.2 Domains where the benefits occur

Participants were asked to name domains such as sectors or disciplines where the benefits of the vision implementation would be most prevalent.

For the case of **research** it was stressed that the dissolution of strict boundaries between domains and the emergence of a common language across sectors are a vital part of the RRI vision so the benefit would occur equally across domains.

Figure 17: Transgressing boundaries in research

For **industry** it was expected that sectors with complex division of labour such as high value added manufacturing would in particular benefit from the availability of better qualified human resources. In addition companies using complex systems and diverse consortia large industries launching open system development will benefit from the availability of the open collaborative platforms for problem-solving. Possibly industrial mediators will play a more important role. Also start-ups are expected to flourish due to increasing flow of ideas from the multitude of high quality innovation initiatives. The energy sector will benefit from the availability of sustainable locally produced energy. ICT and health may benefit in particular from the open access implementation.
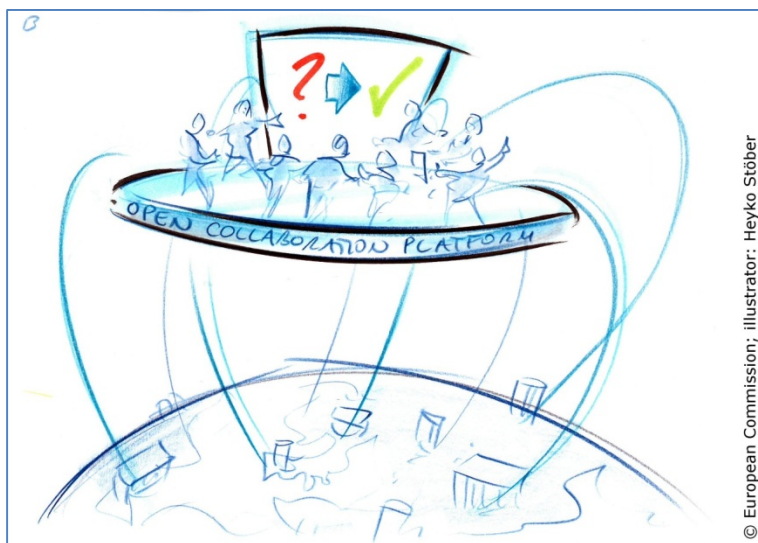

Figure 18: Open collaborative platforms

3.5 Conclusions for MoRRI

The visioning exercise generated a wealth of diverse suggestions for RRI benefits and indicators and possible cases to study. Across the different individual contributions a few issues emerge that seem of particular relevance for MoRRI (and wider RRI policies).

In general, it becomes clear across domains that RRI is expected to substantially enhance the research and innovation **process** which then leads to enhanced

outcomes. It is important to note, however, that the process advancement is not just a means to the end of better and more innovation but in itself yields benefits for society. The enhanced collaboration competence implies a better problem-solving capacity and thereby a boost in society's innovation capacity and resilience. Also, other key aspects of societal development such as the level of trust, gender equality, cohesion, empowerment of citizens, democracy, transparency, happiness and quality of life and work are expected to receive positive momentum through RRI.

While these wider aspects are difficult to capture for the MoRRI analysis, some very concrete areas of RRI benefits are emerging that may well lend themselves to indicator development and monitoring.

An RRI landscape is characterised by a **close and trusting interaction** of society, research, industry and policy in all phases of the R&I process. From this seamless "quadruple helix" collaboration a number of benefits to all parties are expected:

- Higher effectiveness and efficiency of resource spending (both public and private), e.g. saving of resources in research due to the increasing sharing of research infrastructure, in policy due to better prioritisation, in industry due to less sunk investment in conflict prone innovations,

- More enjoyable and meaningful working lives, more productive interactions, increased intrinsic motivation for staff in research, industry and policy,

- Easier access to information and people across the R&I system (no more gatekeepers),

- Ability to harness the full range of human potential for by mobilizing different types of competences and creativity in particular both female and male talent.

The RRI process will generate better and more innovations due to the better interaction and resources. In particular innovations will be

- better tailored to users' and consumers' needs,

- addressing societal needs such as achievement of environmental targets, health, energy and mobility solutions,

- meeting higher ethical standards.

With RRI embedded in all actors' DNA and society involved in all steps it is reckoned that the society's collaborative problem solving capacity will be substantially enhanced. The visioning workshop has revealed a rich spectrum of fictive examples of highly beneficial collaborative research projects pointing towards different types of collaborative projects that would populate a future RRI landscape:

- Developing solutions for complex societal challenges such as migration and dementia,

- Embarking into highly daring societal endeavours such as space exploration,

- Developing local solutions for problems with a potential for up-scaling such as air pollution, clean energy, mobility solutions (safe bus transport), sustainable materials (biodegradable materials),

- R&I projects with a particularly high personalization need such as healthcare solutions (specifically rare diseases),

- Highly distributed tasks (bird-watching, databases).

It seems reasonable for MoRRI to identify and analyse collaborative R&I projects that are already implemented today and to assess their social impacts as a model for futures benefit.

The three suggested domains of RRI benefits could serve as a starting point for development of RRI benefit indicators. The indicators suggested in the visioning workshop could be used to monitor each benefit domain through several lenses as outlined in the table below.

Participants discussing society expected benefits in the following domains: Security and safety, education, social care, health, Food production and agriculture, environment, free time.

Further domains for collaborative projects with high benefit for society were specified in the newspaper session:

- Solutions for complex societal challenges such as migration and dementia,

- Highly daring societal endeavours such as space exploration,

- Local problems with a potential for up-scaling/mutual learning such as air pollution, clean energy, mobility solutions (safe bus transport), sustainable materials,

- R&I projects with a particularly high personalization need such as healthcare solutions (specifically rare diseases),

- Highly distributed tasks (bird-watching, databases).

Participants were asked to name specific cases of outstanding RRI implementation that may be investigated by MORRI in more depth. The following cases were mentioned:

- Joint innovation projects. Research organisations working together / developing innovation together with: companies, users, etc.

    o For example, health R&I projects with producers of these products and hospitals

- User committees in the health care sector as they are in place in the Netherlands and Norway

- Patient Organisations

- Crowd-sourcing in ICT

Benefit Domain	Possible Indicators
Interaction Quality	Level of trust in science and innovation (Euro-Barometer on trust in science, public perception of science in the UK)
	Number of R&I-related conflicts (e.g. judicial cases)
	Number of cases of research misconduct
	Job satisfaction/motivation measure e.g. Happiness level of civil servants
	Qualys – quality adjusted life years
	Work-life-balance indicators
	Number of productive interactions (productive interaction framework)
	Trust level of society in policy making

	Interest in/attractiveness of policies
	Money spent per R&I project impact (efficiency) (public and private sector)
	Income of women in R&I (compared to male colleagues)
	Number of start-ups in high-tech sectors
	Employee productivity
Innovation Quality	Indicators for social impact of research/funded research projects (time-bound, culture-bound, dynamic)
	Research projects' environmental impact
	Share of high value-added innovation
	Number of awards granted to (e.g. European) companies
	Number of fair global value adding networks
Collaborative Problem Solving Capacity	Number of solved problems through stakeholder engagement/ crowd sourcing
	Innovation in business models/production systems resulting from stakeholder involvement (RRI)
Wider societal benefits	Income distribution, social cohesion, democratic participation, transparency in policy processes