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SUPER MoRRI – Scientific understanding and provision of an enhanced and robust monitoring system for RRI

A Monitoring Framework for Responsible Research and Innovation

Revised Strategic Development Plan

Deliverable D1.3

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EXECUTIVE SUMMARY

The SUPER MoRRI project (2019-2023) has mainly been guided by three strategic documents: the Strategic Development Plan (D1.2), the Implementation Plan (D2.1) and the Case Study Co-creation Methodology Report (D5.1). A Final Report (D1.4, December 2023) separately summarises the work, outputs, and policy insights of the SUPER MoRRI project.

The Strategic Development Plan made clear the understanding of the task and the principles guiding the development of the SUPER MoRRI project approach. This Revised Strategic Development Plan (RSP, D1.3) supersedes D1.2 and contains three future-oriented lines of thinking regarding the monitoring of open and responsible research and innovation. First, the RSP overviews the point of departure that set the platform for the final output of SUPER MoRRI, the PROMISE portal (www.promise4era.eu)¹. Second, it discusses the main innovations developed by SUPER MoRRI in setting a strategic direction for monitoring *for* open and responsible research and innovation. Third, it highlights lessons learned and key considerations emerging from the experience of the SUPER MoRRI project that may be relevant to future monitoring efforts.

The PROMISE portal hosts a variety of resources relevant to monitoring for ORRI. The PROMISE indicator dashboard contains quantitative outputs that can be compared at country level. Other categorical type indicators are available in modules related to research funding and research performing organisations. Qualitative case studies are provided that consider responsibility in contexts including artificial intelligence, sustainability, and citizen science. These elements are curated from a mix of secondary sources and primary data generated by the SUPER MoRRI project.

The PROMISE portal also provides connections to relevant external resources relevant to monitoring for ORRI. PROMISE endeavours to position itself as a node in a network of data and other types of resources that are relevant to interested stakeholders and citizens. Throughout the SUPER MoRRI project, the number of relevant data and other monitoring resources available online expanded rapidly. Curating a set of thematically organised links to these resources has been done with the objective of increasing awareness and access to relevant resources among interested stakeholders and citizens.

The data and information generated and curated by the SUPER MoRRI project has been summarised periodically in three Monitoring Reports (D2.2, D2.3, D2.5). The Monitoring Reports also contain detailed data fiches specifying the data and calculations used to create indicators and visualisations of different types.

The Annotated Methodological Procedures Report (D2.4) contains details on research study designs and processes. This report would enable any of the research studies conducted in SUPER MoRRI to be reproduced, or conducted with a modified design, in the future.

¹ PROMISE is the acronym for "Platform for the Support of Responsibility and Openness and their Monitoring in Innovation and Science Ecosystems".



The SUPER MoRRI Sustainability Plan (D7.5) outlines a pathway for the maintenance and possible lines of development of the PROMISE portal. The Sustainability Plan was developed in response to suggestions from the European Commission, and the Horizon Europe project REINFORCING (GA no. 101094435) that becomes the initial custodian of the PROMISE portal.

The SUPER MoRRI project was interrupted by the SARS-COV-2 virus outbreak and the COVID-19 pandemic. Years 2020 and 2021 passed without face-to-face interactions and reduced opportunities for exploring engagement with potential stakeholders of the project.

The R&I policy context is an arena of constant experimentation and innovation. At the outset of SUPER MoRRI it was understood that the context of the project was a dynamic one and shifts in the policy context was anticipated. SUPER MoRRI adopted a broad approach to responsibility in R&I with the expectation that this would enable responsiveness to evolving policy or stakeholder needs.

SUPER MoRRI implemented an original research programme of studies that produced new narratives, information and indicators of patterns of RRI activities and of the outcomes that mark pathways toward benefits from RRI. This 'patterns and pathways' approach was designed with the intention of producing outputs that would develop both some 'snapshot' views and some process understandings. This approach remains relevant for thinking about, designing, and developing a monitoring framework for ORRI. Inevitably, there are 'gaps' that can always be identified in the outputs produced by a single project such as SUPER MoRRI, but maintaining a strategic approach that continues this dual approach to patterns and pathways seems to have continued relevance for addressing both existing and emerging needs for further monitoring to support ORRI.

Through the project review process, the consortium received advice that the policy climate had shifted somewhat toward a heightened emphasis on the value of Open Science and Citizen Science as drivers of responsible practices and cultures in R&I. Recognition of these shifting priorities has been translated into the understanding of monitoring to support ORRI practices and culture presented at PROMISE.

Monitoring to support ORRI requires attention to the contextual value and relevance of information and data. The generation of relevant and useful information to support ORRI in specific contexts exists in a tension with the interest of some stakeholders in comparative information with a broad scope. The concept of 'credible contextualisation' was developed within SUPER MoRRI and is used to support informed and appropriate interpretations of data and information provided at PROMISE. This concept reflects an understanding that some monitoring information and data that are generated in specific contexts does not translate well to more generalised contexts of presentation or comparison. Such monitoring information has a value that is limited to supporting actors and processes in specific contexts in which ORRI is being promoted or supported.

Methodological approaches to monitoring for ORRI are shaped by the level of analysis at which data and information are created, and the purposes foreseen for monitoring activities. In the SUPER MoRRI project, a great deal of variety occurred with regard to the levels and objects of monitoring experimentation. A continuous working group (SwafS Ecosystem) was established that met monthly to discuss challenges associated with monitoring the implementation of ORRI in regional development and other types of collaborative projects. This group shared learning, experiments and methods used for monitoring in these contexts.

A Country Correspondent Network (CCN) was set up with members in all Member States and associated countries that were actively employed in research projects at the organisational level in all



these countries. Studies designed to produce monitoring elements to support ORRI in research performing and funding organisations were conducted by in collaboration with the CCN, ensuring analyses of policies, practices and cultures of ORRI could be approached in local languages and with appropriate levels of understanding of national and regional R&I system contexts.

SUPER MoRRI engaged in a process of international benchmarking using a network of International Satellite Partners, who conducted adapted research in eight countries where conceptualisations of ORRI practices and cultures are differently understood and enacted.

All of these methodological innovations (Ecosystem, CCN, ISP) can be considered to have strengths and weaknesses from a strategic perspective. Strengths revolve around the capacity to engage with and produce context sensitive information and data about heterogeneous efforts to implement ORRI. The main challenge of such approaches is that they are labour and time intensive, meaning reproduction of such elements requires a considerable investment of resources.

In a contemporary context in which there appears to be a rising fascination and emphasis on quantitative data collection techniques and processes utilising machine learning and artificial intelligence, it is important to reaffirm the importance of monitoring initiatives that have the capacity to produce and engage with 'sticky' context dependent information needs. A pragmatic philosophy of reflexive attention to the stickiness of information – for whom is monitoring data relevant and what are the limits of translating this information to other contexts or levels of analysis? – has a continuing and potentially increasing importance in relation to the 'easy option' of yet more web-scraping and quantitative text-mining.

SUPER MoRRI developed a responsible quantification approach called credible contextualisation. There are no universal context-free indicators or other data quantifications of RRI or related concepts. Rather, data used in indicators are gathered in a specific context. The degree to which any quantification can be utilised as a comparator or as a benchmark, for example, depends on the degree of de-contextualisation this quantification can credibly stand. Quantifications at PROMISE are accompanied by resources that support users to understand the contours of appropriate use of those data and indicators provided. All metrics and measures underpinning indicators are detailed in an indicator fiche. All measures used as proxies for a concept or category are thus known and their validity can be independently assessed by users.

Existing and emerging 'indicators in the wild' are important resources for future monitoring to support open and responsible research and innovation. For example, increased engagement and interaction with the many international and other organisations promoting Open Science appears a potentially valuable avenue for the continued development of PROMISE.

Over the course of the last years since the inception of SUPER MORRI, the project was able to learn a number of lessons that seem particularly relevant for future monitoring efforts related to ORRI and the sustainable provision of monitoring insights:

- While the sustainability of the technical infrastructure of the PROMISE portal will be secured by the REINFORCING project, the rich monitoring data generated by the different streams of the SUPER MoRRI project cannot be fully exploited by the end of the project. Yet, it is the project's ambition to organize the handover of the raw data in such a way that it allows for and is conducive to further analytical explorations and visual representations.



- The rapid development of digital applications proved to be a significant challenge for SUPER MoRRI, making necessary unforeseen and unaccounted for revisions and redesigns of the initial plans for the online presence. The consortium is confident that the technical architecture chosen for the PROMISE portal lives up to current expectations regarding usability and visualization.
- The role of RRI as a policy goal changed significantly with the transition from Horizon 2020 to the current framework programme Horizon Europe. Apart from the weakening of a community of practice based on dedicated RRI projects, it remains to be seen if sufficient commitment for the resource-intensive monitoring of ORRI will be mobilized in the future. In view of this uncertainty, the SUPER MoRRI partners' approach was to develop a monitoring framework that remains relevant regardless of the policy context of the day. Clearly, the current policy emphasis on directionality and mission-oriented approaches, entailing far-reaching interventions in daily lives, point to the persistent need for responsible R&I practices and their responsible monitoring.
- The SUPER MoRRI project's conviction that monitoring of R&I needs to follow the principles of RRI was operationalized by our reflexive and critical approach to monitoring, responsible use of metrics and the support of appropriate interpretations of data. In view of new analytical possibilities driven by big data, machine learning and AI, pursuing such a balanced and diverse approach to monitoring seems more important than ever.



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1. INTRODUCTION

The aim of this revised Strategic Plan is to document the state of play in the development of a monitoring framework for open and responsible research and innovation in Europe. The Strategic Plan specifies the monitoring elements developed for the PROMISE online portal (www.promise4era.eu). It proposes some basic principles for the continuation of PROMISE in the medium-term future. It also provides a summary of the status of key resources that might be considered for updating and further development.

The remainder of this Introduction section briefly reviews the original Strategic Plan developed by the SUPER MoRRI. It is followed in Section 2 by summary of the starting point of the original monitoring framework in terms of concepts and approach. Section 3 and Section 4 summarise the role of secondary and primary data elements respectively in the monitoring framework. Section 5 deals with lessons learned and future directions.

The SUPER MoRRI Strategic Plan

The SUPER MoRRI Horizon 2020 Research and Innovation Action (RIA) ran from January 2019 to December 2023. SUPER MoRRI was a successor to the MoRRI project that provided the legacy set of ‘MoRRI indicators’ of RRI (Peter et al. 2018). The major output of the SUPER MoRRI project is the PROMISE online portal that anchors a public facing monitoring framework for the advance and support of open and responsible research and innovation.

The SUPER MoRRI Strategic Plan (D1.2) set out the project’s broad principles and main areas of activity. It’s companion pieces, the Implementation Plan 2020-24 (D2.1) and the Case Research Methodological Plan 2020-24 (D5.1), set out the project’s data harvesting and generating strategy and case study programme respectively. These three strategic documents together specified the conceptual orientation and empirical research programme of the project (cf. Figure 1).

All elements of these plans have been successfully implemented. A summary of the results of the project can be found in the SUPER MoRRI Final Report (D1.10). This revised Strategic Plan and the SUPER MoRRI Sustainability Plan (D7.5) are forward-looking documents, that provide guidance and suggestions about the future direction of monitoring *for* open and responsible research and innovation (ORRI) and about the maintenance and development of the PROMISE portal (www.promise4era.eu).



Figure 1: SUPER MoRRI project structure



The first version of the SUPER MoRRI Strategic Plan was built on a review of existing approaches and tools for monitoring RRI, a stakeholder workshop, expert consultations, engagement with then current SwafS projects, and the circulation of a call for comments on a prior Briefing Paper. In the sphere of academic research, the Plan built on key conceptual and empirical contributions in developing its approach to RRI (section 2).

In the sphere of policy research, the Plan built on previous work conducted by the Expert Group on Policy Indicators for Responsible Research and Innovation (Strand et al. 2015), the Expert Group on Altmetrics (Wilsdon et al. 2017), the Open Science Policy Platform (Hormia-Poutanen et al. 2017), the MoRRI project (Mejlgaard et al. 2018; Peter et al. 2018), She Figures (2019) and the Expert Group on Indicators for Researchers' Engagement with Open Science (Wouters et al. 2019). As was foreseen in the Strategic Plan, shifts in the policy landscape were expected to occur during the active lifespan of the SUPER MoRRI project. This indeed proved to be the case, with initiatives such as the Coalition for the Advancement of Research Assessment (CoARA), the launch of the new European Research Area (ERA) (EC 2020b; EUCO 2021), and the heightened prominence of both Open Science (EC 2019) and Citizen Science in policies and processes designed to promote and support institutional change in R&I.

A monitoring framework was seen as one element to support and influence transformations of R&I in the interests of placing a higher value on responsibility. The Strategic Plan therefore set out to support RRI by identifying relevant levels of analysis for gathering data and coupling this with a clear understanding of appropriate forms and degrees of de-contextualisation for interpretations of these data. The overall goal of supporting RRI was not to be hindered or negatively affected by inappropriate quantification innovations. In this sense the monitoring framework for RRI took a responsible approach to the design and use of indicators and other quantification tools as a paramount value (Hicks et al. 2015; Wilsdon et al. 2015).



Conceptual and policy debate about the focus of desirable institutional changes in research and innovation has continued to be lively, and the terrain has shifted somewhat during the lifespan of SUPER MoRRI. However, the fundamental point remains, as Fisher (2018: 53) describes, that “deep structural ambivalence to science and expertise mean that responsible innovation as a necessary aspiration is here to stay”. Our basic motivations to develop a monitoring framework followed from this recognition. First, more responsible knowledge production and innovation regimes are both desirable and necessary, and second, a reflexive process of information gathering, sharing, and learning can support and contribute to this aspiration.



2. MONITORING FRAMEWORK

The SUPER MoRRI project designed a monitoring framework in which a variety of different forms of information were gathered. Different types of data were generated at varying levels of analysis. These data and information resources are assembled at the PROMISE portal (promise4era.eu) with the aim of supporting transformation in R&I toward enhanced openness, citizen participation, and more responsible practices and cultures. Attention was paid to the policies and actions of different types of organisations and the practices and motivations of researchers toward transforming R&I for the benefit of society.

2.1 Conceptual and policy basis for the monitoring framework

The basis for the development of the PROMISE portal was conceptual thinking regarding responsible research and innovation (RRI). The SUPER MoRRI project embraced a variety of approaches to thinking about RRI, which had developed in parallel rather than through a process of consolidation (European Commission 2014, 2017; Owen et al. 2012; Stilgoe et al. 2013; Von Schomberg 2013, 2014). A review of the underlying ontological and axiological assumptions of the main conceptualisations of responsible innovation (Timmermans and Blok 2018) argued that differences among these visions are in part tied to the policymaking and scholarly contexts from where they emerged. SUPER MoRRI adopted an open understanding of responsibility in research and innovation, viewing this as a strength in terms of potential versatility of operationalisations that could be developed.

The European Commission (EC) conception of RRI emerged from its science with and for society (SwafS) policies and R&D work programmes. The EC describes RRI as diverse sets of societal actors (researchers, citizens, policymakers, business, third sector organisations, etc.) that “work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society”.² The major mechanism for bringing actors together is public engagement, one of the EC’s six RRI ‘keys’ along with ethics, gender equality, governance, open science and science education. Implementing interventions focused on each of these keys thus describes the broad pathway toward better alignment between science, innovation and society. The abstract framing of the EC definition around ‘alignment’ is to some extent counterbalanced by the six keys as categories that can be more straightforwardly operationalised.

Rene Von Schomberg’s well-known conception of RRI describes “a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society” (Von Schomberg 2014: 63). The need for collective responsibility and ‘mutual responsiveness’ is driven by a series of global deficits in research and innovation (Von Schomberg 2019). In particular, the reproducibility and (over)production crises in science, innovation governance focused on macro-economic impact, regulation concerned exclusively with risks, and markets

² [https://wayback.archive-it.org/12090/20220124160515/https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation_\(retrieved June 10, 2023\)](https://wayback.archive-it.org/12090/20220124160515/https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation_(retrieved%20June%2010,%202023))



obsessed with technological potential, form a self-reinforcing system that is underdetermined in its orientation toward broadly shared public values and expectations. The normative turn towards responsibility is thus a consequence of the “directionality failure” of innovation systems and innovation policy (Lindner et al. 2016). Von Schomberg (2019) argues strongly that the “right impacts” from R&I are already obvious, linked to strategies for addressing ‘grand societal challenges’ and embedded in multi-party agreements such as the Lund Declaration 2009. Overcoming the multidimensional failure of research and innovation requires a collective response that is transparent about where scientific and societal certainty is lacking and prepared to ‘open up’ innovation pathways to multiple alternative outcomes and solutions (Stirling 2008), understanding individual or sectoral interests as nevertheless mutually constituted and interdependent.

The third prominent conceptualisation of RRI, described by Jack Stilgoe, Richard Owen and Phil Macnaghten, defines RRI as “taking care of the future through collective stewardship of science and innovation in the present” (Stilgoe et al. 2013: 1530). The authors operationalise collective stewardship through the four ‘dimensions’ anticipation, reflection, inclusion and responsiveness. Individual and collective practices that institutionalise these dimensions can be expected to reflexively shape the purposes, processes and products of scientific research and technological innovation. Collective stewardship should also seek to include, within the innovation process, a range of knowledges that are wider than engineering and technical knowledge, such as indigenous, ethical and social science knowledge. Whereas the European Commission and Von Schomberg both anticipate benefits from interactions among diverse actors throughout the R&I process, Stilgoe and colleagues consciously reject a “consequentialist framing for responsibility” (Stilgoe et al. 2013: 1569) in favour of an ethics focused on the qualities of processes (care, custodianship).

Despite their differences, the three most prominent conceptualisations of RRI share a number of core precepts:

- the inclusion of both scientific research and technological innovation within the framing of what needs to be transformed;
- a fundamental reliance on the integration of diverse scientific, innovation and societal actors as the transformative (social) mechanism;
- the imperative to always look beyond scientific and technological challenges, problems and opportunities to concurrently consider societal uncertainties;
- the value of diverse domains and types of knowledge; and
- a requirement that research and innovation practices and processes be more transparent, accessible, and inclusive.

The EC Expert Group on Policy Indicators for Responsible Research and Innovation (Strand et al. 2015) recommended the addition of thematic keys for ‘social justice/inclusion’ and ‘sustainability’ in the conceptual framing of RRI. Potential indicators of three types, process, outcome and perception indicators were described. The framing of the Expert Group’s policy indicators placed a strong emphasis on taking a responsible and constructive approach to indicator design and use, providing insights which are of direct relevance to SUPER MoRRI. SUPER MoRRI responded to the prompting of the Expert Group report by invested research efforts in developing new indicators of sustainable innovation (see section 4.7 below).



2.2 Purposes and functions of monitoring

Processes of continuous observation of social phenomena, including highly complex entities such as research and innovation, are multi-faceted.

Monitoring alone can have multiple purposes, including:

- learning about transformation processes and informing ongoing policy design and response;
- building and reinforcing collaboration and trust among policymakers, stakeholders and citizens;
- accountability of policymakers, programme and project managers (Kleibrink et al. 2016);
- making appropriate comparisons, including bench-marking; and
- reflexively engaging with our own assumptions.

Monitoring has three main functions:

- gathering valid information that can be considered by decision-makers at all levels;
- making clear the aims and functioning of policy and development strategies for all stakeholders and the public; and
- ensuring transparency that supports the involvement and participation of stakeholders (Kleibrink et al. 2016).

SUPER MoRRI was designed as a monitoring framework that could be useful for various purposes and fulfilled different functions. A monitoring framework allows for *bricolage*, experimentation, discrete perspectives and admits potentially high degrees of context dependence. This offers greater strategic potential than a system of indicators at a single level of analysis, such as national scoreboards, that drive toward indicator standardisation and context independent comparisons. Whilst new national level indicators may also support some monitoring purposes and functions, the SUPER MoRRI approach aimed to first diversify what could be seen as possible and useful in monitoring institutional change in R&I. Future iterations of the SUPER MoRRI framework should aim to be responsive to new demands driven by factors such as urgent policy changes, emerging fields of research and technology development, or shifting dimensions of societal and environmental challenges, for example.

SUPER MoRRI gathered monitoring data and information at different geo-spatial and institutional levels. For example, within the research system it gathered data and information at research performing and funding organisation, scientific field, and individual researcher levels. It also gathered information regarding a number of emerging topical issues. The PROMISE portal thus contains heterogeneous information that support transformation in R&I from a variety of perspectives, providing resources that foster understanding and learning. As the needs of users will vary over time, PROMISE endeavours to provide a digital footprint for a monitoring framework that can continue to evolve and respond to these emerging needs into the future.



2.3 Users

Monitoring only has value in use. Different users of the framework will likely have varying principal or secondary purposes for monitoring. The same data and information elements will therefore have different value and meaning depending on users' purposes.

A number of key users of PROMISE have been anticipated, although these should not be considered an exhaustive set.

- Science, research and innovation policymakers - including national and regional agencies
- Higher education policymakers - including national and regional agencies
- Research managers, directors and planners at research performing organisations (RPOs) - including universities and national and regional research institutes
- RRI practitioners - including academia and regional development
- Research funding organisations - including public agencies and private foundations
- Science with and for Society actors - including citizen science organisations
- Companies - including R&D performing firms and technology and social innovation focused SMEs (particularly with regard to the Self-Assessment Tool (SAT)).
- Third sector organisations working in knowledge-intensive fields or deploying scientific or technological know-how
- Researcher development related organisations - including professional associations, professional development agencies and firms, accreditation agencies, research evaluators, or human resource units in RPOs.

Some aspects of the data and information presented in the monitoring framework has been trialled in collaboration with users. It is envisaged that the range of indicators, visualisations or other vehicles for communicating monitoring that are prepared using the data available at PROMISE will be considerably expanded following the completion of the SUPER MoRRI project. This work could conceivably include efforts to co-create useful resources based on extended collaboration with stakeholders and users.

2.4 Responsible Quantification

SUPER MoRRI developed some simple tools to assist users in interpreting the quantifications presented, including indicators. Support for the capacity to make well-informed interpretations of data and information reflects a commitment to responsible quantification. A variety of quantification and visualisation techniques provide users with monitoring outputs within the framework. Primary data underpinning tools and resources provided at PROMISE are available to prospective users under FAIR (findable, accessible, interoperable, reusable) principles.

SUPER MoRRI developed the concept of [credible contextualisation](#) as part of a general approach to responsible quantification. The main tenet of credible contextualisation is to support users of indicators and other data-driven elements, by providing specific tools to support the appropriate and credible interpretation of the information provided. Credible contextualisation extends from a



recognition that there are no universal context-free metrics, indicators, or other quantifications. Rather, data used in indicators are gathered in a specific context.

The degree to which any quantification can be credibly utilised as a comparator or as a benchmark, for example, depends on the degree of de-contextualisation appropriate for this quantification. Generally, the further you move away in time and space from a specific action or intervention of interest that you wish to monitor, the more likely it becomes that the complex dynamics of broader societal factors will influence or 'over-determine' the outcomes or impacts that you might be seeking to attribute to that action or intervention. Second, credible contextualisation recognises that indicators should be developed in ways that are relevant and meaningful in specific use contexts.



3. DEVELOPING MONITORING ELEMENTS BASED ON SECONDARY DATA

Indicators are quantification tools which 'indicate' in the sense of providing information about an entity which is not directly measurable and 'signal' in the sense that they must be interpreted to have meaning (Lehtonen 2017). What separates indicators from other data or information is that they are the product of a conceptual framework or model that justifies the choice of data and logic of their interpretation (theory of change). Indicators are a particular type of quantification, that due to their ready association with specific targets, goals or problems have become ubiquitous in communicating about policy, corporate performance, and condensed trendlines regarding complex socio-economic phenomena. Indicators are indeed ubiquitous.

Indicators are one information element at PROMISE. The SUPER MoRRI empirical research programme generated primary data that has been used to construct a selection of indicators. There are also a number of relevant sources of secondary data that have provided indicators for PROMISE. The opportunity exists to continue this dual approach, using available open secondary data sources and generating new primary data for indicator development. A significant number of indicators drawn from secondary sources are made available at PROMISE. Some of these are 'indicators in the wild' (Ràfols 2018), providing an important avenue for sustainability and updating of PROMISE as they are based on continuing data collection processes. Table 1 (below) contains a summary of indicators based on secondary data provided at PROMISE. Detailed descriptions and indicator fiches for these indicators are contained in SUPER MoRRI Monitoring Report 2 (D2.3).

Table 1: Overview of Metrics based on Secondary Data

Indicator title	Source	Status
Intramural R&D expenditure per inhabitant in all sectors	Eurostat	Updated to include 2018 and 2019
Intramural R&D expenditure as a percentage of GDP in all sectors	Eurostat	Updated to include 2018 and 2019
Patent applications to the EPO by priority year per million inhabitants	Eurostat	Not updated
Share of female researchers by sectors of performance (all sectors)	Eurostat	Updated to include 2018 and 2019
Share of female researchers by sectors of performance (business enterprise sector)	Eurostat	Updated to include 2018 and 2019
Share of female researchers by sectors of performance (higher education sector)	Eurostat	Updated to include 2018 and 2019
Share of female researchers by sectors of performance (government sector)	Eurostat	Updated to include 2018 and 2019
The Glass Ceiling Index	She Figures	Updated to include 2015 and 2018
Dissimilarity Index (higher education sector)	She Figures	Updated to include 2014 and 2018



Indicator title	Source	Status
Dissimilarity Index (government sector)	She Figures	Updated to include 2014 and 2018
Gender pay gap (%) in the economic activity 'Scientific research & development'	She Figures	Not updated
Percentage of a country's publications with a sex or gender dimension in their research content	She Figures	Updated to include 2015-2019 (pooled)
Women to men ratio of inventorships, all International Patent Classification (IPC) sections	She Figures	Not updated
Women to men ratio of corresponding authorship in all fields of R&D	She Figures	Not updated
Percentage of open access publications	WoS and Unpaywall	Updated to include new data for the whole time series + 2020
Percentage of open access publications (Green)	WoS and Unpaywall	Updated to include new data for the whole time series + 2020
Percentage of open access publications (Gold)	WoS and Unpaywall	Updated to include new data for the whole time series + 2020
Percentage of open access publications (Hybrid)	WoS and Unpaywall	Updated to include new data for the whole time series + 2020
Percentage of open access publications (Bronze)	WoS and Unpaywall	Updated to include new data for the whole time series + 2020
Percentage of publications classified as industry co-publications	WoS and Unpaywall	Not updated
Percentage of the EU-public interested in scientific discoveries	Eurobarometer	Updated to include 2020
Percentage of the EU-public that feels informed about science	Eurobarometer	Updated to include 2020
Percentage of correct science quiz answers in the EU-public	Eurobarometer	Updated to include 2020
Percentage of the EU-public that believes that scientists are among the best qualified to explain the impact of scientific and technological developments	Eurobarometer	Updated to include 2020
Percentage of the EU-public that attends public meetings or debates about science and technology	Eurobarometer	Updated to include 2020
Percentage of the EU-public that sign petitions or join street demonstrations on science and technology matters	Eurobarometer	Updated to include 2020



3.1 The MoRRI Indicators

The MoRRI project produced a set of indicators based on the European Commission's RRI keys (Peter et al. 2018). These indicators were based on a number of original data collections and cherry-picking relevant indicators in the wild from other sources. A core criterion guiding the development of the MoRRI indicators was that they should be aggregated at European Union Member State (MS) level and cover all MS. The MoRRI indicators were also designed with a primarily policy accountability purpose in mind. However, several of the indicators developed appear potentially relevant for more diverse monitoring purposes.

3.2 Eurobarometers

The Eurobarometer surveys related to public values, perceptions, and attitudes in relation to science and controversial technologies have been carried out since 1978. Numerous surveys have been fielded since, and collectively they offer complex time-series data that shed light on the evolution of the relationship between science and society. Core markers of the social robustness of the interaction of research, innovation, and citizens, such as citizens' trust in scientists, optimism about new technologies, literacy and efficacy in relation to science, and patterns of engagement with science, are captured by the Eurobarometer series. In Spring 2020 a new Eurobarometer purposively restoring some of the main time-series was fielded. This important resource has been used for building updated indicators, particularly for public engagement, science literacy and education, and open access.



4. DEVELOPING MONITORING ELEMENTS FROM PRIMARY DATA

The SUPER MoRRI project that developed the initial iteration of the PROMISE portal was a research and innovation action (RIA) funded through the Horizon 2020 Framework Programme. As such it designed and conducted a programme of research studies that generated primary data for the purpose of monitoring open and responsible research and innovation. The SUPER MoRRI research programme was managed through two thematic streams: Pattern Studies and Pathway Studies. The different studies generated data at different levels of analysis, focusing on a range of different actors in the research and innovation system. To do this, a number of different methodological innovations were developed, some of which may provide opportunities for future repeat data collections. The variety of methods and objects of analysis support the development of diverse monitoring elements that are suitable for different monitoring purposes.

Data vehicles were developed that provided the opportunity to analyse patterns of different sorts, including geo-spatial, disciplinary, or organisational comparisons. A range of quantitative and qualitative data sources were used to develop new data and information. Empirical studies related to research funding organisations, research performing organisations, and researchers. Details of the role of data vehicles in the SUPER MoRRI empirical work, including their key role in pattern studies, were set out in the SUPER MoRRI Implementation Plan (D2.1).

A number of research projects focused on improving our understanding of processes and practices related to the institutionalisation of responsibility in research and innovation. These studies highlighted how diverse sets of actors contribute individually to these efforts. These studies provided opportunities for developing narratives of the institutionalisation of openness and responsibility in a variety of research and innovation contexts. The process for designing and selecting SUPER MoRRI pathways studies and details on their research approach and timing were set out in a separate Case Research Plan (deliverable D5.1).

4.1 Country Correspondents Network

The SUPER MoRRI project established a Country Correspondents Network (CCN) to conduct studies that were distributed across Europe. The CCN was composed of one correspondent from each of the European Member States and selected additional countries. Individual correspondents were appointed based on their knowledge of the national research and innovation system, their expertise in matters related to open and responsible research and innovation, and their ability to carry out data collection in local languages. The CCN constituted an important resource for developing the monitoring framework, as it provided the opportunity for carrying out comparative, qualitative research with very broad geographical coverage, in a way that is culturally sensitive and based on deep knowledge of the particularities of the respective country contexts. For the seven countries represented in the consortium (Austria, Denmark, Germany, The Netherlands, Norway, Spain and the UK), representatives of the consortium members functioned as correspondents, while for the remaining countries, country correspondents were recruited through an open call and paid. The CCN



enabled qualitative studies of research performing and research funding organisations, combining desk research, document analysis, and interviewing.

4.2 International Satellite Partners

A set of International Satellite Partners (ISPs) were recruited to provide an international benchmarking dimension to the monitoring framework. ISPs from Argentina, Australia, Brasil, Canada, China, Iran, Japan, South Africa and the USA developed a set of recommendations concerning the relevance and feasibility of monitoring open and responsible research and innovation in non-European contexts. Some ISPs also examined the nature of potential data and information sources in their countries. Collaboration with ISPs was done through a series of interviews and web-based consultations. In 2019, the ISPs provided a set of written critical comments and feedback on the SUPER MoRRI Briefing Paper on the purposes and needs of organisations for RRI monitoring from a global perspective (deliverable 4.1).

4.3 Experimenting with a Project Ecosystem Invested in Change

A rich array of RRI projects and partners contributed to and benefited from collaborating on the development of a monitoring framework for RRI. The project RRI ecosystem connected participants from H2020 SwafS funded projects concerned with RRI project implementation and monitoring issues. The project ecosystem consisted of a virtual meeting space, which convened monthly. The early meetings were primarily about understanding the needs and expectations of participants. The Ecosystem then functioned as a responsive interactive focal point for sharing relevant resources created through the diversity of RRI projects. Every second month the focus was on the monitoring and evaluation needs and activities of the different projects. Through these interactions, monitoring approaches were shared and evolved, and learning accrued to both the collective of project participants and the SUPER MoRRI team led by Leiden University.

4.4 Enabling Self-Assessment at Various Levels or Units of Organisation

An online assessment method was developed, designed to be of assistance to all types of stakeholder organisations to plan and review their own policies and practices related to responsibility in research and innovation. It might also be used by them as a background to compare their responsibility profile against similar organisations. Different types of stakeholders will be encouraged to tailor their approach to suit their institutional culture, their operational context and objectives, and the content of their RRI strategy and commitments. Each stakeholder will be able to use the dashboard to better understand what RRI means in practice, by looking at existing examples. The self-assessment tool could therefore also serve to supplement policy and practice learning about RRI, whilst potentially building a new user-driven data ecosystem centred on innovation.



4.5 Monitoring Change at the Organisational Level

The CCN was used to conduct studies of institutional change among a selection of 122 European Universities (RPO study) and 55 research funding organisations (RFO study). These studies produced categorical data on organisation level efforts to shape research and innovation cultures to be more open and responsible. The RPO study examined the policy settings of universities in relation to Public Engagement, Open Science, the Third Mission, Research Ethics and Integrity, and Gender Equality. The extent to which the public policies of universities are backed by units or processes that actively implement these policies was also assessed. The RFO study assessed the efforts of funders to exert pressure for change toward enhanced responsibility in research cultures and practices. Data on these efforts were collected in relation to strategic priority setting, funding instrument design and criteria, and the conduct of research and researcher assessments. The aim of both these studies was to not generate ‘horserace’ comparisons at national or regional levels, but rather to take the pulse of how key actors in the research and innovation system are driving change through their own policies and practices. The reproduction of all or part of these studies at some point in the future should be assessed in terms of the feasibility and efficiency of the relatively labour- and time-intensive methodologies trialled by SUPER MoRRI.

4.6 Researcher practices and motivations

As a complement to the RPO study in particular, a survey of researchers was conducted in the same set of 122 European Universities (RESU study). The survey focused on the same areas of responsibility as the RPO study, asking researchers to report on their current practices and motivations. Response rates to the survey were extremely variable, placing some restrictions on data analyses. The fulfilment of the original design approach that enabled some connections to be made between policy environments and research practices and motivations is possible to a more limited extent than planned. In a repeat of an analysis conducted by the MoRRI project survey (Bührer et al. 2018), the impact of funding from the European Union on researchers’ reported behaviour and motivations was also included in the RESU study. The aim of this study was to both provide a picture of what researchers consider important dimensions of responsibility in their work, as well as what intrinsic and extrinsic motivations impact on their practices. A periodic survey of researchers remains a valuable tool for monitoring purposes, although ‘research fatigue’ on the part of the researcher community is a serious and rising challenge to confront in this regard.

4.7 Responsible Innovation

Taking inspiration from the Expert Group report on monitoring RRI (Strand et al. 2015), SUPER MoRRI conducted a study of gendered eco-innovations (GenEcolInno study). The quantitative part of this mixed methods study developed new indicators on responsible innovation focusing on patenting activity in technology areas supporting sustainability. Patent data was genderized by the SUPER MoRRI team, enabling indicators of women’s inventorship of sustainable technologies to be developed (see D2.3 Section 8 for details). These indicators fill a notable gap in monitoring the innovation side. The indicators also respond to the thematic priority of sustainability identified by the Expert Group and



contribute further to the expanding range of data and indicators available on gender participation in research and innovation. These indicators can be interrogated as extended time-series and can be updated with the regular waves of PATSTAT data releases.

4.8 Narratives of Transformation

Work package five of the SUPER MoRRI project included a set of quantitative, qualitative, and mixed methods case studies. These studies undertook investigations of the processes and activities that account for patterns of, or construct pathways toward, open and responsible research and innovation. These studies covered a range of topical and thematic issues considered relevant and worthy by the SUPER MoRRI team through an internal development process. While some of these studies were delayed or restricted somewhat by effects related to the Covid-19 pandemic, each one successfully delivered a final case report and narrative following an internal process of quality review.

The topics of these studies were:

- Ethics in artificial intelligence;
- Funding research for societal transformation in the context of climate change;
- Women inventors in green technologies;
- Public value research careers;
- Organisational public engagement repertoires and researchers' public engagement practices; and
- CSOs at the science-society interface.

What connects these diverse studies is their focus on a logic of transformation or implicit 'theory of change' that problematises and brings into focus the opportunities and challenges associated with efforts to make research and innovation more open and responsible. As an accompaniment to these studies a Position Paper was produced, summarising some of the conceptual and technical challenges associated with monitoring the impacts and benefits of such transformation processes (Wicher et al. 2021). These studies are not intended for replication or even updating. Rather they provide a set of examples that could inform possible future monitoring efforts based on cases. Two reports summarise the patterns of (D5.2) and pathways toward (D5.3) impacts of responsible research and innovation, accompanied by a synthesis report that aims to identify and analyse cross-cutting themes, patterns and pathways (D5.4).



5. FUTURE DIRECTION AND LESSONS LEARNED

5.1 Sustainability of Monitoring to Support Open and Responsible Research and Innovation

The major output of the SUPER MoRRI project is the PROMISE portal (promise4era.eu). PROMISE contains a range of data and information that are designed to support institutional transformation toward more open and responsible cultures and practices of research and innovation. From a strategic point of view the finalisation of the SUPER MoRRI project has overlapped with the initiation of a Horizon Europe project, REINFORCING (GA no. 101094435), that will take over custodianship of PROMISE and its underlying resources and tools.

The next phase of developing PROMISE is supported by a number of contributory outputs produced by the SUPER MoRRI project. Three Monitoring Reports contain details on datasets, measures used and indicators created. The Annotated Methodological Procedures Report specifies the research designs and methods used to generate primary data, ensuring future replication of any part of the SUPER MoRRI research programme is feasible. In addition, detailed project Protocols were developed for each of the research studies conducted in SUPER MoRRI, which are publicly available from the project site at Open Science Framework.³ The Sustainability Plan details the provision of underlying datasets and their status (open/part-open/closed). Together these resources are designed to ensure the continuity of monitoring to support open and responsible research innovation through PROMISE.

The PROMISE portal contains access to raw data and information alongside pre-formatted selections and visualisations of these data and information resources, as prepared by the SUPER MoRRI team. However, possible exploitations of the available data and information were not exhausted during SUPER MoRRI. This was partly due to Covid-19 interruptions, but also due to the volume of data generated by the various empirical studies conducted. Further indicators, visualisations, and other resources will certainly be possible as part of continuing development of PROMISE. It is anticipated that the handover of PROMISE will be a seamless transition that will quickly allow its new managers to be creative and develop new outputs to further populate and enhance the site.

5.2 Embracing Strategic Uncertainty

The transition from Horizon 2020 to the Horizon Europe framework programme meant changes to the policy context for responsible research and innovation (RRI). From the perspective of planning and developing a monitoring framework, the effects of this policy transition could not be entirely foreseen. The discontinuation of the SwafS work programme in Horizon Europe was known and taken into account in the SUPER MoRRI project. The termination of the process of building a community of practice around the European Commission's conception of the RRI Key Areas, has to some extent come to an end. This will have consequences for how monitoring of open and responsible research and

³ <https://osf.io/z95gw/>



innovation continues. For example, the opportunity to build a RRI-project-based data ecosystem, as was trialled in SUPER MoRRI, now looks less likely to be part of future monitoring work.

SUPER MoRRI took the view that responsibility in research and innovation overflows any specific framing in theory, policy, or otherwise. The strategic vision of SUPER MoRRI was to provide a monitoring framework and set of user tools that can be continued and developed. The focus on missions and societal challenges within research and innovation policy and funding circles presents a new horizon for thinking and monitoring the institutionalisation of responsible cultures and practices in research and innovation. However, it should also be foreseen that motivations to continue or experiment with labour or cost intensive ways of generating monitoring data and information may recede. Strategic uncertainty can thus be considered the default, at least in the short-term, with regard to the interest and commitment of R&I stakeholders of all types to maintaining a heterogeneous, multifaceted approach to monitoring, both in general and specifically in relation to supporting transitions to more open and responsible research and innovation.

5.3 Some Lessons Learned

The major output of the SUPER MoRRI project is the PROMISE monitoring portal. Many of the challenges faced in arriving at the genesis of PROMISE could not be foreseen, while others might be more understandable of (now different) funding and work agreements. To some extent flexibility and adaptability have become the key performance indicators of research and innovation performance in the Covid-19 pandemic affected period. Covid-19 caused delays and changes in some key tasks of the SUPER MoRRI project. The cohesion of the project team, which had previous collaboration experience together in the case of most partners, was undoubtedly a factor that enhanced the project's resilience. From the perspective of the finalisation of SUPER MoRRI and the launch of the initial iteration of PROMISE, there are three main lessons relevant to the future of monitoring open and responsible research and innovation (however defined) in the medium-term future.

5.3.1 Evolving Policy Settings

The SUPER MoRRI project consortium recognised the need for reflexivity about its own assumptions from the outset of the project. This was not least due to uncertainty regarding future policy settings and the currency of the concept of RRI as based on the six 'key areas'. Accordingly, from the outset, SUPER MoRRI adopted a broad and open definition of responsibility in research and innovation cultures and practices. This was believed to increase the potential for the outputs generated to have relevance and value beyond the lifespan of the project itself. At the time of the Second Interim Review of SUPER MoRRI in March 2022, it was suggested that the project should indeed pay close attention to the changing policy environment in Europe and within the European Commission. The conceptualisation of responsibility adopted in the project thus seems justified in retrospect.

Through the formal project review process for SUPER MoRRI, the Consortium received advice that the policy climate had shifted toward a heightened emphasis on the value of Open Science and Citizen Science as drivers of responsible practices and cultures in R&I. This shift seems to reflect and understanding of different areas of focus for institutional change as valuable in their own terms, rather



than as components of an overarching concept (RRI). Whilst RRI may now be a less prominent concept in institutional change processes addressed to R&I, its constituent elements and principles were continued in the ongoing development of PROMISE.

While some adjustments to planned outputs were made that increased the resources eventually provided in relation to Open Science, more work is required to enhance the monitoring of Citizen Science. This remains an opportunity for the next iteration of PROMISE under its new management. A general point that can be noted is that the project format as managed under Horizon 2020 (as was SUPER MoRRI's case) included some rigidities that did not make adaptation to take account of shifting policy priorities as easy as it might have been. Changes to funding arrangements that have now been made may assist in improving the need for flexibility and adaptability that can arise under such evolving policy conditions.

5.3.2 Evolution in Digital Technology

The digital transition moves rapidly (European Parliament and the Council 2022). This includes in the realm of the available platforms and visualisation options for presenting data and information online. SUPER MoRRI began with a detailed description of the anticipated online presence that would be the major output of the project. The rapid evolution of what constitutes an attractive and user-friendly interface for interrogating, visualising, and retrieving data had to be dealt with in the context of the RIA project structure, in which expected deliverables are described in some detail at the outset. This required some coordination effort and redistribution of financial resources to better take advantage of emergent opportunities in digital space.

In order that PROMISE reflects the kind of online experience and presence that characterises digital data and information environments in 2023, an upgrading of the initial design of the online monitoring portal was thus required. From a strategic perspective, this revision has led to a more prominent role for content management systems (CMS) that do not require extensive programming efforts. Basing much of PROMISE on such a CMS will enable simpler updating and seamless expansion of monitoring elements at PROMISE in the future.

5.3.3 The Ongoing Value of Multilevel and Multipurpose Monitoring Efforts

PROMISE provides a heterogeneous range of monitoring elements. These elements range from 'national dashboard' indicators to categorical indicators at organisational level, to narratives of specific qualitative cases. This variety of indicators are suitable for different monitoring purposes. The efforts required to produce these different elements varied quite significantly, as discussed in the Annotated Methodological Procedures Report (D2.4). The feasibility or efficiency of replicating these data generation processes thus also varies considerably.

Regardless of future decisions about what aspects of PROMISE might be updated, the experimentation and new research conducted by SUPER MoRRI has produced monitoring elements that are innovative and insightful for understanding the institutionalisation of open and responsible research and innovation from multiple perspectives. This seems to be a value worth pursuing also to develop future iterations of PROMISE.



The extensive programme carried out by SUPER MoRRI commenced in a critical policy environment, in which influential interventions such as the Leiden Manifesto (Hicks et al. 2015) and the Metric Tide (Wilsdon et al. 2015) had captured considerable policy attention and energy. In relation to monitoring, critical attention to responsible use of metrics and to making appropriate interpretations of data for comparative purposes was considered important. It seems questionable that such a reflexive and critical context for monitoring continues today. In particular, the rise of web-scraping, machine learning, and artificial intelligence tools seems to be leading toward a return to a naïve positivism in which extraordinary volumes of data seem to function as a proxy ‘reflection of reality’.

Big data and language learning model-based tools will no doubt become useful components of future monitoring efforts. However, the SUPER MoRRI experience and the PROMISE portal would suggest that the need for context-sensitive and the value of reflexive approaches to monitoring should not be overlooked in the rush to ‘scrape and dump’ data. A balanced approach to monitoring should maintain a consistent emphasis also on diverse and critical monitoring approaches in order to engage with the multiple challenges involved in supporting institutional change toward more open and responsible cultures and practices in research and innovation.



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SUPER MoRRI

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