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A Conceptual Evaluation Framework for Promoting Gender Equality in Research and Innovation

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General Information on EFFORTI

EFFORTI (Evaluation Framework for Promoting Gender Equality in R&I) seeks to analyse and model the influence of measures to promote gender equality on research and innovation outputs and on establishing more responsible and responsive RTDI (research, technology, development, innovation) systems. For this purpose, EFFORTI will:

- develop an evaluation framework which enables evaluators, science managers, policy-makers and programme owners to conduct a sound analysis of the research and innovation outputs, outcomes and impacts of gender equality measures across Europe, with a focus on the national level;
- design a differentiated concept to analyse a variety of policy measures and assess their performance, taking into account the diversity in the national policies as well as organisational contexts;
- derive general lessons for evidence-based and thus "good" policy-making in the field of gender equality within RTDI systems. This means that not only has progress towards more gender equality in RTDI been achieved, but also that RTDI has been able to benefit from this progress through enhanced scientific and innovation outputs and productivity, as well as through a higher responsiveness to societal needs and challenges.

Terms of use

This document was developed within the EFFORTI project, funded by the European Commission within Horizon 2020, by a consortium consisting of six partners, the Fraunhofer Society represented by the FRAUNHOFER ISI in Karlsruhe and the CeRRI in Berlin (coordinator, Germany), JOANNEUM Research (Austria), AU - AARHUS UNIVERSITY (Denmark), UOC - UNIVERSITY OF CATALONIA (Spain), NaTE - THE ASSOCIATION OF HUNGARIAN WOMEN IN SCIENCE (Hungary), and INTRASOFT International (Luxembourg).

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Executive Summary

Main Objectives

The main objective of WP3 was to identify links between gender equality promoting initiatives and impacts on research and innovation, and develop a conceptual evaluation framework and instruments to design and assess gender equality interventions and their effects in research and innovation. WP3 comprised the following subtasks:

- Development of a conceptual evaluation framework on how gender equality interventions can affect research and innovation output, outcome and impact (EFFORTI Toolbox 1.0). The evaluation framework has been tested and refined in the validation phase of the project and contributes to the development of the final toolbox (EFFORTI Toolbox 2.0). The conceptual evaluation framework addresses the three gender equality ERA objectives (more women in research and innovation, more women in leadership positions, and integration of the gender dimension in research content and curricula) for the different levels of intervention i.e. micro – individual/team; meso – organisational; macro – system/country.
- Collection and development of quantitative and qualitative indicators that are both sophisticated and practical for the design and evaluation of gender equality interventions in research and innovation across European countries.

Methodological Approach

Drawing on a comprehensive desk research, a methodological approach was initiated to develop the conceptual evaluation framework that involved the following steps:

- A literature review and systematic mapping of the state of the art with an extensive collection of gender equality intervention evaluation studies
- A collection of smart practices of interventions according to specific defined criteria
- Development of a typology of gender equality interventions based on the existing literature
- Development of a conceptual evaluation framework as a basis for the further work in the project
- Identification and development of indicators (quantitative and qualitative for the three ERA strategies and at different levels of intervention i.e. micro, meso, macro)
- Creation of the initial EFFORTI Toolbox 1.0 that has been validated in WP4 and further developed into the final Toolbox 2.0.

Strengths and weaknesses of the methodological approach

EFFORTI proposes a wide-ranging, well-developed framework for capturing the complexity of interventions and their impacts in complex systems. The EFFORTI conceptual evaluation framework opens the “black box” of the relationship between gender equality interventions and outputs, outcomes and impacts, pointing out which aspects of context are important for the design and evaluation of policy interventions.

It is a theory-based evaluation framework that goes beyond linearity and causality and focuses on contribution to achieve impact instead of attribution. The framework focuses on the questions (i) in which way and (ii) under which conditions an intervention causes the effects observed (Döring & Bortz, 2016) and explores “not only whether the intervention works but also how, for whom and in which context” (Van Belle,

Marchal, Dubourg & Kegels, 2010). This is articulated in an intervention logic model that explicitly states the assumptions of the intervention, which may help to understand the complex dynamics and linkages between inputs and outcomes and impacts (Kalpazidou Schmidt & Graversen, forthcoming).

Moreover, the framework suggests that data collection is conducted through rigorous procedures and a probabilistic perspective, moving away from using only traditional quantitative measures, towards including more sophisticated indicators. However, the framework needs to be tailored to adjust to local conditions, and be designed with context sensitivity, considering the challenges in assessing impact of gender equality interventions in research and innovation (Kalpazidou Schmidt & Graversen, forthcoming).

There are though a number of challenges linked to evaluation of gender equality interventions and their impact in research and innovation (cf. European Court of Auditors, 2008):

Attribution problems: It may be a challenge to state which effects are directly related to the intervention and how change has occurred because interventions are implemented in complex environments. Impact can have multiple causes, and thus identifying causal relations between interventions and impacts is not straightforward. The direct attribution of a long-term impact to a specific intervention may be rather challenging: Evaluators should rather focus on contributions given the complex and dynamic research and innovation environments.

Measurement problems:

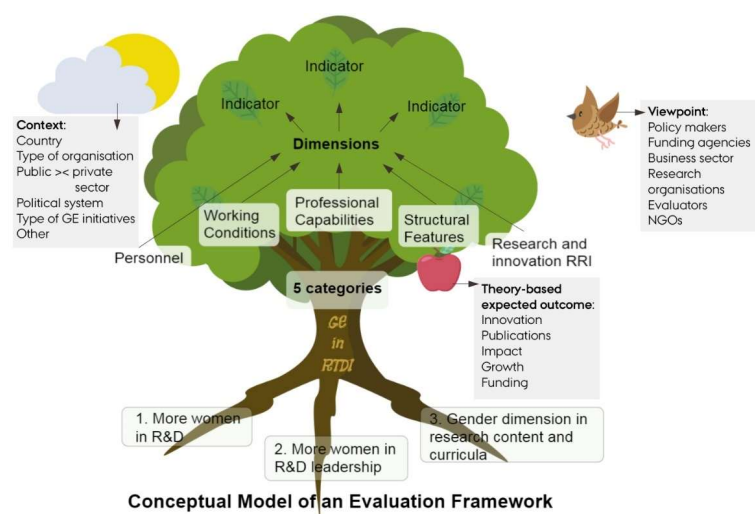
- data availability: Assessing impact may suffer from lack of data. For example, although assessing the status quo of gender equality is considered a prerequisite for developing and implementing initiatives, there are hardly any detailed data describing the ex-ante status besides some general indicators as regards the number of women researchers at different hierarchical levels.
- adequacy of indicators: A crucial question is whether evaluations are measuring the right thing. Institutions or organisations need to be confident that indicators used are appropriate and truthful. Therefore, it is very important to involve stakeholders in the process from the very beginning. Furthermore, a “measurable” indicator for output does not necessarily permit conclusions on outcomes or impacts to be drawn.
- lack of consensus on what data to collect. This is due to the fact that the different stakeholders involved in a specific evaluation try to promote their interests (Kalpazidou Schmidt & Cacace 2017).
- understanding the dynamics: Given the apparent difficulty to model the relations between inputs, outputs, outcome and impacts, the mechanisms of research and innovation processes and the role gender equality can play are unclear. Too narrow a perspective on outputs and outcomes may overlook the complex interactions between the initiatives and their context, and the potentially unintentional effects stemming from these interactions.
- comparability of results: As gender inequalities are quite different between fields and disciplines, interventions promoting gender equality and evaluation practices need to take specific disciplinary, organisational & national contexts into account.
- aggregation: Simplistic extrapolation of evaluation results in terms of outputs, outcomes and impacts attained at the lower level to a higher level is challenging and risks to result in non-representative aggregates.

Timing problems: Typically, there is a considerable time-lag from the gender equality intervention until the generation of outputs and outcomes so that impact can be assessed. Data need to be collected over the long-term so that meaningful and robust conclusions can be drawn. Then again, an evaluation performed after a long period may complicate the identification of the intervention contribution to change.

Main Results

The conceptual evaluation framework offers a non-linear concept, where the notion of contribution - instead of attribution - to achieve impact is central to the integration of team, organizational and system context factors in policy design and evaluation. The illustrative tree presented below is a visualization of the conceptual evaluation framework in EFFORTI. The three ERA gender equality strategies stand as the vision and foundation of the tree and set up the platform for all interventions. The branching of the tree corresponds to the categorization of the tools, i.e. the division of indicators into categories and dimensions, with the indicators as the level closest to actual operationalization, embodied by the leaves of the tree. In line with the theory of change approach, the developed indicators are both of quantitative and qualitative character. The theory-based evaluation approach adopted in EFFORTI helps to mitigate the risks related to complexity in dynamic contexts (Kalpazidou Schmidt & Graversen, forthcoming).

The contextual aspects of the framework are illustrated by the means of weather icons and refer to the varying structural and cultural features pertaining to any specific implemented intervention. Contextual elements may pertain to country, type of research system, sector type (i.e. public or private), type and position of organization in the R&I system, type of gender equality intervention, and previous experiences with policy interventions. The fruits of the tree represent the positive effect of the intended gender-equal R&I system and involve outcome and impact of interventions (i.e. innovation, patents, publications, funding, knowledge dissemination, science communication, research-based teaching, societal impact, etc.). A bird is pictured symbolizing the different perspectives available in the conceptual framework for a variety of stakeholder groups. The conceptual framework aims at providing interesting insights and instruments to policymakers and representatives of funding agencies, NGOs, the business sector, research organizations, and more (Kalpazidou Schmidt & Graversen, forthcoming).



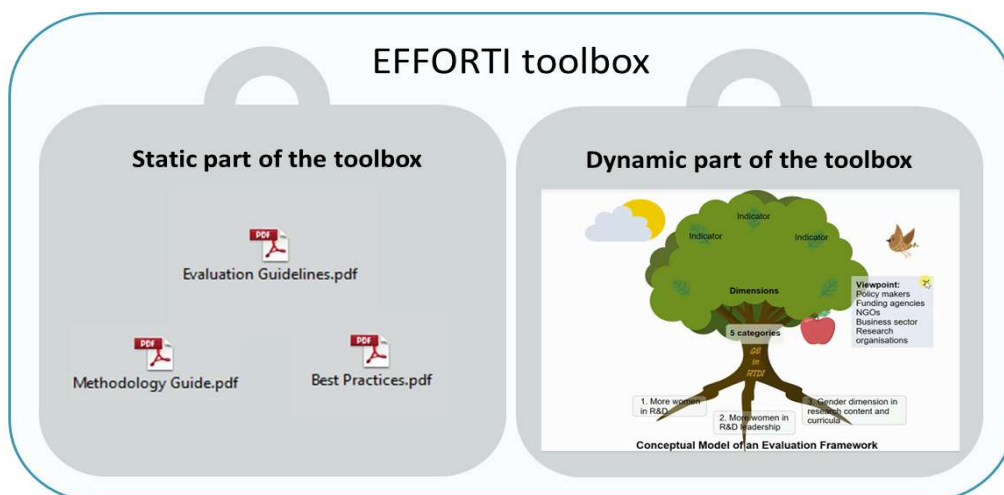
An illustration of the EFFORTI conceptual evaluation framework.

Source: Kalpazidou Schmidt et al. 2017

The first part of the toolbox consists of evaluation guidelines, the typology of interventions catalogue, and best practice examples. The user is supported in considering and understanding ‘under which conditions’ impact of a specific intervention is produced. The user is guided to systematically include team, organizational and system factors in a design or evaluation process. Guidance is provided in terms of criteria about how to assess quality and impact of interventions (Kalpazidou Schmidt & Cacace, 2017). This rather ‘static’ part of the toolbox consists of downloadable cross-referring documents for stakeholders use.

The second part of the EFFORTI toolbox assists the user in understanding ‘how’ gender equality interventions support the formulation of intervention theory, design and implementation. It consists of 17 impact stories to guide the input, output, outcome and impact chain of commonly used gender equality interventions. The conceptual framework guided the collection and development of relevant indicators while the case studies and corresponding impact stories were used to verify, refine and further develop the evaluation framework and the indicators.

The toolbox is thus constructed as a landscape of guidelines, best practices and indicators, which stakeholders may use as a catalogue, and a source of inspiration. Hence, the EFFORTI toolbox provides a basis for further refinement of the pool of indicators in a dynamic process that can meet the needs of policymakers, researchers, evaluators and intervention owners in different contexts.



An illustration of the EFFORTI toolbox structure as a static and a dynamic process.

Source: Kalpazidou Schmidt et al. 2017

Main Lessons Learned

- Context sensitivity and methodological pluralism is a quality criterion for evaluations.
- Evaluation is a complex concept itself implemented in complex systems – evaluation design and instrumentation have to consider the complex systems i.e. contextual factors.
- Reality cannot be presented as a simple causal model - the models used should address the complexity of systems. Linear casual relations between interventions and impacts are challenging to establish.
- The direct attribution of a broader long-term impact to specific intervention is not possible: Evaluators should rather consider contributions given the complex and dynamic environments.
- There is a dilemma between context sensitivity and reduction of complexity.

- Not only the intervention itself, but also its context is decisive for its impact.
- A theory-based evaluation approach may help to mitigate the risks related to complexity in dynamic contexts.
- A theory-based evaluation approach allows to open the black box and address the question - how and why a policy works, and in which context and how to assess it.
- Evaluation is always a unique process - a one-size-fits-all approach does not function.
- In formative evaluations with a focus on learning, stakeholder involvement might be a beneficial approach.
- Evaluation as a learning instrument can foster structural and cultural change by delivering empirical evidence for different kinds of benefits (financial, scientific, economic, societal etc.).
- Incorporate evaluation from the beginning in the design of intervention.

Main lessons for intervention design

- The ability of gender equality interventions to foster the right conditions for change is central in complex systems.
- Need to develop a tailor-made design involving stakeholders.
- Be aware of emerging issues and complexity, unexpected internal and external co-variables that influence evaluation processes.
- Adopt a holistic approach that considers the constantly emerging issues created by team, organizational and system dynamics.
- Attention to the contextual elements may support making the results more generalizable.
- Interventions should take into consideration the societal impact of gender equality interventions in research and innovation from the outset and embed relevant monitoring and evaluation processes and procedures into programme design.
- Start from theory and assumptions and not from instruments or methods.
- Assessing gender equality programmes, in particular in terms of their research and innovation impacts can enrich evaluations, but may not always be feasible.

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1 Introduction

The introduction provides a brief overview of the objectives of the EFFORTI project. It is followed by a description of the aims of WP3, as well as an introduction to the EFFORTI Intervention Logic Model. Finally, the introduction clarifies the aims of the conceptual evaluation framework report for relevant stakeholders.

1.1 EFFORTI objectives

EFFORTI - *Evaluation Framework for Promoting Gender Equality in Research and Innovation* – is a project funded under the European Commission's (EC) Research and Innovation Action programme (RIA), as part of Horizon 2020 *Science with and for Society* (SWAFS). The aim of the project is to systematise and deepen knowledge on the scope, relevance, effectiveness and efficiency of gender equality policies with regard to research, technology, development and innovation (RTDI) by designing a common analytical framework.

The overall objective of the EFFORTI project is to provide tools that are both sophisticated and practical for the evaluation of gender equality (GE) policies across European countries. This will be done by developing a novel and detailed evaluation framework, including a model for analysis and evaluation of possible impacts of GE measures on RTDI. The model will include a toolbox with measurable indicators at team, organisation and system levels. The toolbox will be tested in 26 case studies in seven countries. The EFFORTI evaluation framework will include tools for analyses and modelling of the influence of measures aimed at promoting gender equality in research and innovation (R&I) outputs, thereby supporting the establishment of a more responsible and more responsive RTDI system, which is in line with the current concept of responsible research and innovation (RRI) and targets societal needs and grand societal challenges of our time in the European context.¹

EFFORTI contains three distinct objectives:

- Developing an *evaluation framework* that enables European RTDI stakeholders, such as evaluators, science managers, policy-makers, and programme owners, to conduct sound analyses of projects or initiatives within R&I, using the most adequate gender equality measures;
- Designing a *differentiated concept* which includes a broad variety of policy measures and assesses their performance taking contextual perspectives, i.e. national or local perspectives, into consideration;
- Deriving general *lessons for evidence-based policy-making* in the field of gender equality in the RTDI system, emphasising both responsiveness to societal challenges and needs, including gender equality, and to specific RTDI measures.

1.1. WP3 objectives

The main objective of WP3, which deliverable D3.2 belongs to, is to identify patterns and links between GE-promoting initiatives and impacts on R&I, through meta-analyses of performed evaluations of gender

¹ For an overview of the currently prioritised grand challenges in the EU, see *Societal challenges* (EC n.d.-b).

equality policies and other existing approaches from RTDI evaluations. WP3 comprises of three main tasks and will deliver three main results:

- D3.1: Collection of quantitative and qualitative indicators for the three studied levels (micro – individuals/teams; meso – organisations; macro – national innovation systems/contexts)
- D3.2: Development of a tentative conceptual evaluation model on how measures can affect output and other outcomes
- D3.3: Draft proposal of the evaluation framework that can be tested and refined in the validation phase of WP4 (EFFORTI 1.0.)

WP3 will be based on the insights gained through WP2 (mapping and context analysis) and contribute to WP4 (case studies and evaluation framework validation) and, in particular, to WP5 (toolbox development and valorisation).

In the first deliverable of WP3 (D3.1) we identified and collected quantitative and qualitative indicators at three studied levels (micro – teams; meso – organisations; macro – system/country). This collection served as a review of different important GE and (responsible) research and innovation studies as well as smart practices. This provided a basis for elaborating, improving and refining the pool of indicators that meet the needs of the EFFORTI project. The indicators collected in deliverable 3.1 constitute a starting point and will be reviewed and adapted throughout the project, according to the evidence delivered by the case studies in WP4 or by new insights from academic literature and the workshops organised in the frame of the project. The input provided by the stakeholders will be incorporated in the project results.

The aim of the second report (D3.2) was to present a tentative conceptual evaluation model on GE effects and impacts of GE measures on output and outcomes in R&I/RRi. The focus of D3.2 was on the EFFORTI evaluation logic model that laid the groundwork for the conceptualisation, selection and construction of GE in R&I indicators, and the methodological steps taken in the development of the conceptual model. Moreover, contextual factors were discussed in this report.

The aim of the report at hand is to discuss the process, starting at the systematic review of the literature to the description of the evaluation model and further development of the overall tentative proposal of the evaluation framework of EFFORTI. This report summarises the work carried out in the entire WP. The point of attention in D3.3 is the core set of indicators developed based on the EFFORTI logic model for the conceptualisation and construction of the framework and the Toolbox EFFORTI 1.0. The core set of indicators is described and the use of indicators for different types of stakeholders is clarified. Besides the contextual issues, focus is on the theory-based impact models that are the point of departure for the design of the conceptual evaluation framework.

The content, aim and structure of the present report are described in more detail in 1.4 and 1.5 below.

1.2. The EFFORTI point of departure and Intervention Logic Model

In EFFORTI, the gender equality objectives defined in the European Research Area (ERA) constitute the starting point of the intervention logic model. Within the scope of Horizon 2020, gender equality is a cross-cutting issue. Three objectives for fostering GE in research and innovation are promoted: (1) the number of women in RTDI, (2) the number of women in leadership positions, and (3) the integration of the gender

dimension in research and curricula (EC 2015d). The objectives are briefly discussed in the following as they constitute the point of departure for the development of the conceptual evaluation framework.

1.1.1 More women in R&D

The European Union (EU) aims to make full use of its human capital in RTDI. Promoting gender equality contributes to higher research performance (EC 2012b), and research reveals that mixed-gender teams work more efficiently (if they are well-managed), are more creative and demonstrate better quality in terms of decision-making (EC 2014, 12).

Improving women's participation in research requires impartial selection and recruitment processes conscious about gender biases, open job advertisements, and considering atypical career patterns. To increase the attractiveness of RTDI for women, equal payment, opportunities for growth and progression, as well as access to grants and funding must be ensured (EC 2014, 10-14).

Moreover, it is essential that employers of researchers follow national and EU legislation on anti-discrimination and equal treatment. Research performing organisations (RPOs) and research funding organisations (RFOs) are encouraged to consider gender in connection with faculty recruitment, promotion, leaves and absences, and work climate, among other things (Lipinsky 2014, 11).

1.1.2 More women in leadership positions

A competitive global RTDI economy depends on involving female scientists also in leadership and decision-making positions. Excluding women from top positions in research may provoke social distrust, followed by reduced support for science and its institutions (EC 2012b).

The goal of having more women in decision-making positions addresses these problems and risks. This goal can be achieved by increasing the visibility of women who already work at the institution, for example, by nominating women for prizes and awards to provide role models for students and other female staff. Moreover, holding a decision-making position means having the possibility to influence research agenda and careers of young (female) researchers, to design curricula and be visible, for example, by participating in conferences as a (keynote) speaker (EC 2012b).

Getting more women into leadership positions in RTDI goes along with structural changes – EU-wide, nationwide and, in particular, within research organisations and teams. For instance, gender-balancing committees and boards in RPOs and RFOs require that criteria, nominations and elections to committees and boards must become more transparent (EC 2012b).

1.1.3 Integration of the gender dimension in research content and curricula

The third ERA goal, integrating the gender dimension in research content, means considering biological as well as evolving social and cultural characteristics of both women and men throughout the research process. The results of such consideration are so-called gendered innovations, which are capable of identifying gender biases and recognising how they operate in science and technology (EC 2016d; Schiebinger & Schraudner 2011). Society benefits from gendered innovations because research becomes more responsive to societal needs, and business gets higher value through new ideas, patents, and enhanced technology (EC 2013c).

The report *Gendered innovation – How gender analysis contributes to research* (EC 2013c) offers concrete case studies and methods of sex and gender analysis. Relevant subjects when developing gendered innovations include, for instance, rethinking research priorities and outcomes, analysing how sex and gender interact, and using participatory research designs. Enabling scientists and engineers to analyse sex and

gender criteria in basic and applied research produces excellence in research, policy and practice in the fields of science, health and medicine, and engineering (Ovseiko et al. 2016).

The third ERA goal further involves that the gender dimension is integrated in teaching and curricula. A gender-sensitive curriculum addresses the needs of women and girls with regard to how developments in RTDI may constitute a benefit or disadvantage for them. It also addresses the horizontal segregation between males and females in education and the labour market by portraying both groups in non-stereotypical ways and by making science and technology classes more attractive to girls and women (UN Women 2011, 5, 8).

1.1.4 The EFFORTI Intervention Logic

As seen in Figure 1, the Intervention Logic Model considers inputs, throughputs, and outputs, as well as results and impacts of the former two, and does so by differentiating between three levels (team, organisation, country). The Intervention Logic Model goes beyond the state of the art in evaluating GE initiatives by also focusing on outputs or effects related to RTDI. More specifically, the model aims at providing both theory and tools for analysing how GE-related measures contribute to the achievement of the three main objectives stated in the model below (more women in R&D, women in leadership, and integrating the gender dimension in research). The model also aims at showing how, once achieved, these objectives or effects can further affect desired RTDI effects, such as the number of patents and number of publications and citations, but also new RTDI effects, such as providing answers to grand challenges and further promoting RRI. Additionally, the model includes three levels, i.e. team level (research quality, productivity, innovative outputs, and other RRI effects), organisational/institutional level (workplace quality, recruitment capacity, efficiency, RRI orientation, competitiveness), and country/system/policy level (intensity, productivity, ERA orientation, etc.). However, some measures will most likely overlap between different levels, which will be taken into account in the development of the toolbox.

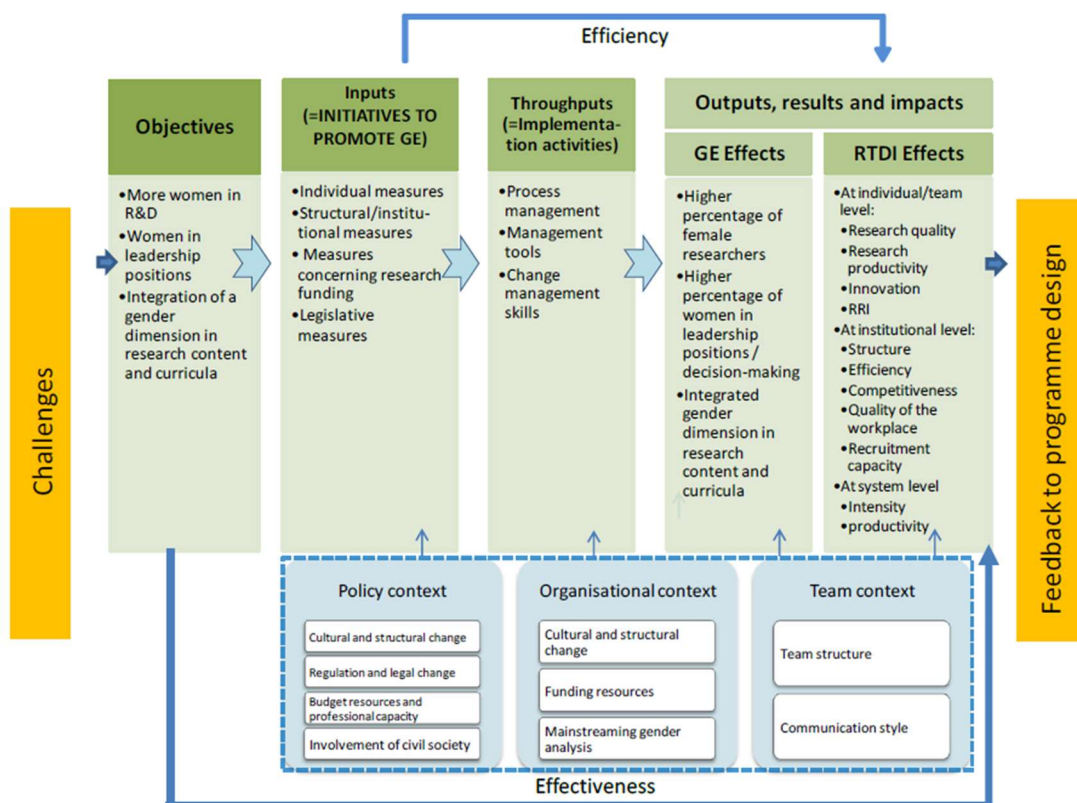


Figure 1: The EFFORTI Intervention Logic Model

1.2 Aims of the report and target users

As mentioned earlier, the final deliverable of WP3 (D3.3) presents a tentative proposal of the evaluation framework with a pool of indicators that will be tested in 26 cases in seven European countries and will be refined in the validation phase of WP4 and in the course of WP5. It must be emphasised, however, that testing, elaborating, and improving the collection of indicators is a continuous task during the whole duration of the EFFORTI project as indicated in Figure 2.

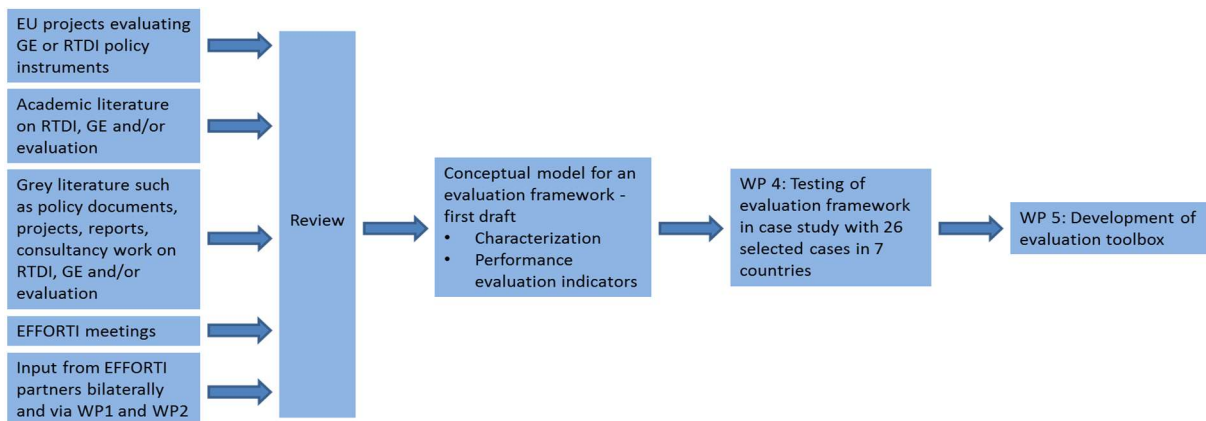


Figure 2: Graphical overview of WP3 process and contribution to WP4 and WP5

The target users of the EFFORTI project are ministries, research councils and other policy-makers, funding agencies, programme owners in the public and business sector, non-governmental organisations (NGOs), evaluators and other stakeholders interested in GE and RTDI.

1.3 Structure and focus of the report

The report at hand is a synthesis report and further development of reports D3.1. and D3.2, which were distributed exclusively among partners and to the European Commission and were hence of restricted character. In this report (D3.3), the content of some chapters is further developed based on the insights elaborated in mainly D3.2. However, some parts of the report are original D3.2 texts. Using content from D3.2 has, on the one hand, been necessary in order to describe in detail the philosophy of EFFORTI, and, on the other hand, to make the overall evaluation framework available to the public in its entirety. As the aim of the synthesis report is to reflect the entire process in developing the EFFORTI evaluation framework, the necessity to incorporate parts of D3.1 and D3.2 in D3.3 has been pertinent to understand the progress made and present it in the form of an independent publicly available publication.

D3.3 comprises 6 chapters. First, in chapter 2, we discuss issues beyond the state of the art in RTDI evaluation research. The emphasis lies on the fact that EFFORTI is not limited to measuring only gender equality effects – it goes further and considers the effects of gender equality on RTDI. Chapter 2 hence focuses on the evaluation logic model for the conceptualisation, identification, selection and construction of GE in RTDI indicators and the methodological steps taken in the development of the conceptual evaluation framework, starting by elaborating on the key concepts that constitute the point of departure for the framework. Challenges, limitations and constraints of the adopted approach are also discussed in this chapter.

Chapter 3 sets the scene for the following chapters by focusing on the theoretical aspects of change and the conditions that must be present for the different links to be realised in order to achieve GE effects on RTDI, i.e. how interventions are expected to bring about the desired results. Based on the state of the art and the existing evidence at different intervention levels (team, organisation, system/country), this chapter focuses on the context of GE measures and elaborates on how contextual issues influence GE evaluations of measures implemented in RTDI. Chapter 3 also offers a discussion of how data and indicators can be used and understood in their context.

Chapter 4 identifies the links between GE and RTDI by focusing on the possible impacts of GE measures on RTDI, including RRI, and describes how GE can produce RTDI effects.

Chapter 5 presents the core set of indicators and describes each indicator in detail based on a common template. The description contains the logic model applied (based on the inputs, outputs, outcomes and impact (I-O-O-I) chain), level of observation (team, organisation, country/system), data collection methods, source of data, feasibility issues, limitations, links to literature and best practices, etc.

Finally, chapter 6 identifies and outlines theory-based impact models for the concrete cases that will be studied in the frame of the EFFORTI project.

2 From concepts to indicators

EFFORTI aims at contributing to a better understanding of the impacts of current GE initiatives from the science-management and policy-making perspectives and providing evidence of good practice along with concepts and tools for monitoring and evaluating GE initiatives and their effects on RTDI. This section first describes how the notion of impact is conceptualised and addressed. Second, the development of a typology of GE intervention in RTDI is presented. Third, a description is provided of the methodological steps undertaken to develop the EFFORTI toolbox and its indicators along with its visualisation. Finally, limits and constraints are discussed.

2.1 Impact

A variety of models and contextualisations has been offered to evaluate the impact of projects, programmes, and policies in the field of RTDI. Impact can be construed as an overall term that sometimes includes indicators and assessments of performance, effectiveness, efficiency, output, outcome, along with short- and long-term effects of the evaluand; in other instances, impact is considered to cover a narrower spectrum of the above (Pedersen 2017, Klatt & Sandström 2016, Boekholt et al. 2014, Hansen & Jørgensen 1995).

The I-O-O-I (inputs, outputs, outcomes and impact) model constitutes the underlying analytical framework of EFFORTI which guides the understanding of the intervention logic in a linear, easily communicable manner. Obviously, this involves a simplification of a complex process. In theory, establishing a causal link between a policy intervention and an observed impact requires the attribution of the observed change to the policy intervention. In practice, however, complex social contexts make such pursuits problematic (Cartwright & Hardie 2012; Dahler-Larsen 2012; Albæk 1989; Larsen & Lassen 2001). Therefore, rather than attributing notions of effects, outcome and impact, in EFFORTI, these concepts are dealt with by means of evaluative approaches that pursue contributions to achieve impact. As underlined in the literature, the ability of programmes to foster the right conditions for change is central in complex interventions (see Reale, Nedeva, Thomas & Primeri 2014), and impact assessment has to account for whether adequate “conditions for impact” are in place (Kalpazidou Schmidt & Cacace 2017).

Therefore, the following section focuses on the challenges and practices within the field of RTDI impact assessment.

2.1.1 RTDI impact assessment

Evaluation and assessment of impacts are important parts of the policy process, also with respect to gender equality. However, establishing causal relationships between policy interventions and observed changes poses a theoretical challenge as well as empirical and methodological problems. Based on the work done by the European Court of Auditors (2008), we can summarise the most important challenges as follows:

attribution problems: In the context of gender equality, attribution problems are highly relevant when evaluating structural measures focused on changing organisational behaviour and cultures. It is often difficult to say which effects are directly related to the intervention and its actions and how change has occurred, because interventions are implemented in complex environments.

measurement problems:

- data availability: Although assessing the status quo of gender equality is considered a prerequisite for developing and implementing GE initiatives, there is hardly any detailed data describing the ex-ante status besides some general indicators regarding the number of women researchers at different hierarchical levels. Therefore, the assessment of effects, benefits or outcomes must be based on ex-post perceptions by people involved in these initiatives.
- understanding the dynamics: Given the apparent difficulty to model the relations between inputs and outputs, the inner workings of research and innovation processes and the role gender equality can play here is unclear. Too narrow a perspective on outputs overlooks the complex interactions between these initiatives/measures and their environments, and the potentially unintentional effects stemming from these interactions.
- comparability of results: As gender inequalities are quite different between disciplines, measures to promote gender equality need to take the specific disciplinary, organisational and national contexts into account. This also applies to evaluation studies.
- aggregation: Simplistic extrapolation of evaluation results in terms of outputs, outcomes and impacts attained at the lower level to the next higher level is challenging, if not impossible.
- adequacy of indicators: A crucial question is whether evaluators are measuring the right thing. Institutions or organisations need to be confident that these indicators are appropriate and truthful. Therefore, it is extremely important to involve stakeholders like programme managers and owners, but also RTDI and gender equality experts, during the whole EFFORTI process. Furthermore, a “measurable” indicator for output does not necessarily permit conclusions on outcomes or impacts to be drawn.

timing problems: Typically, there is a considerable time lag from the research or GE activity until the generation of outputs and outcomes so that impact can be assessed. Data needs to be collected over the long term so that meaningful and robust conclusions can be drawn.

A range of hybrid approaches seeks to address these challenges. Such approaches aim to bridge the divide between effects studies struggling to pursue a “strict” notion of causal mechanisms that provide meaning in actual practice, on the one side, and a range of more interactive and process-oriented evaluation models that are closer to practice, but further distanced from generalisability and transferability, on the other side. As earlier discussed, according to these approaches, causality is often dealt with as a problem of contribution rather than attribution (Leeuw 2012; Patton 2012; Krogstrup 2016). An example is theory-based impact

evaluation² (TBIE): in TBIE, “why and how” questions are asked instead of “how things would have been without” like counterfactual approaches do. The goal is to answer the “why it works” question by identifying the theory of change (“how things should logically work to produce the desired change”) behind the programme and assessing its success by comparing theory with actual implementation (Leeuw 2003; Leeuw & Vaessen 2009; Leeuw 2012; EC 2013a).

2.1.2 Assessing impact of GE initiatives in RTDI

In the EFFORTI project, a great deal of thought is given to how impact assessment should be performed, what concepts and methods appear to be adequate, and how to deal with theoretical and methodological challenges such as counterfactual reasoning, quantification, or time lags of effects. For evaluation in the field of RTDI policies, there is already a number of toolbox-like approaches that address these questions (incl. Miles & Cunningham 2005; Fahrenkrog, Polt, Rojo, Tübke & Zinöcker 2002; Rhomberg, Steindl & Weber 2006; White 2009), which we can build upon in this more specific field of interest – GE instruments for science and innovation systems.

The effects of policy measures can occur at different points in time (short-, mid-, and long-term) and spread differently (at the direct level of participants or at the indirect level, i.e. beyond the participants). The effects can be distinguished between the following terms: outputs (short-term (measurable) results of funded projects); outcomes (effects on the programme’s participants); and impacts (mid- or long-term indirect effects beyond the programme’s participants, also known as spill-overs). Impacts can be further differentiated between direct and indirect, intended and unintended, and types of impacts, such as scientific, economic, social, environmental etc. (see e.g. Horvat 2011, but also EC 2009c and EC 2005), or constitutive effects (see Dahler-Larsen 2014; Dahler-Larsen 2012; Dahler-Larsen & Krogstrup 2001a).

2.1.3 Impact assessment in context

Economic impacts are at the core of conventional RTDI impact assessment, but public policy’s recent orientation towards grand challenges implies that public funding must better integrate different impact dimensions. In the EFFORTI context, social impacts seem particularly important: for instance, acceptance of GE measures, changes in the gendered substructures of organisations or attitudes towards better integration of gender in the innovation system.

Impact assessments require that out of the complex set of programme goals, one has to state clearly the relevance and rank of different impact dimensions and whether a large set of impact dimensions can realistically be achieved by one single measure (see Kalpazidou Schmidt & Cacace 2017). With regard to policy design, this means that programme objectives must correspond to an appropriate mix of policy instruments.

² TBIE bears some resemblance to theory-based evaluation (Chen 1990), realistic evaluation (Pawson & Tilley 1997), and the intervention theory method (Vedung 2009).

Therefore, the EFFORTI evaluation framework will dedicate a lot of attention to context variables like the national policy context as well as organisational incentive structures, as outlined in chapters 5, 6 and 7.

2.2 Intervention typology

In advance of the development of the EFFORTI toolbox offering indicators and methods useful for assessment of GE interventions in the RTDI field, we briefly provide a broad overview of such interventions. Synthesising the typologies developed by Kalpazidou Schmidt and Cacace (2017) and the issues promoted by the [GENERA](#) project and building on partner input made on the basis of theoretical and empirical experiences, we developed the intervention typology presented in Tab. 1 below.

Tab. 1. Overview of the developed intervention typology

Type of intervention	Intervention format	Level
Visibility	Networking	Individual/team level
Knowledge	Dissemination of information material	Structural/organisational level
Advancement	Mentoring programmes	Individual/team level
Gender Awareness and Bias	Training courses (different targets)	Individual/team level
Advancement	Empowerment schemes	Individual/team level
Policies	Mainstreaming actions	Structural/organisational level and policy level
Leadership Accountability	Implementation of gender-sensitive leadership and personnel development	Structural/organisational level
Advancement	Gender-sensitive practices for assessment	Structural/organisational level
Non-discrimination	Gender-sensitive practices for the attribution of tasks	Structural/organisational level
Visibility	Activities to make women (and their research) visible (e.g. introduction of awards reserved for women)	Individual/team level and structural/organisational level
Monitoring	Monitoring appointments, promotions, or attributions of tasks	Structural/organisational level and policy level
Deconstructing Excellence	Revision of internal policies regarding promotions	Structural/organisational level and policy level
Deconstructing Excellence	Revision of internal policies regarding staff appointments	Structural/organisational level and policy level
Care & Family Life	Support in period of absence for family needs	Individual/team level
Care & Family Life	Schemes for women returners	Individual/team level
Funding	Targeting funding practices to improve women's access to research funding	Structural/organisational level

Care & Family Life	Care services and facilities (for children, the elderly, and others)	Structural/organisational level
Composition & Integration	Definition of targets regarding gender balance in decision-making positions	Structural/organisational level and policy level
Care & Family Life	Support to mobility, including spouse relocation schemes	Individual/team level and structural/organisational level
Composition & Integration	Definition of targets regarding gender balance in research groups	Structural/organisational level and policy level
Advancement	Introduction of chairs and positions reserved to women	Structural/organisational level and policy level
Knowledge	Revision of teaching curricula and texts	Structural/organisational level
Advancement	Support to career development (counselling)	Individual/team level
Composition & Integration	Institution of quotas	Structural/organisational level
Knowledge	Introduction of single-sex degree and specialisation courses	Structural/organisational level
Knowledge	Provision of Gender and Women Studies or modules	Individual/team level and structural/organisational level
Research	Gendered user involvement	Structural/organisational level
Non-discrimination	Guidelines regarding gender specifics	Structural/organisational level
Policies	Gender Equality / Action Plan	Structural/organisational level and policy level
Work-Life Balance	Inclusion & monitoring the integration of the gender dimension & impact	Structural/organisational level
Work-Life Balance	Introduction of flexible working hours	Individual/team level and structural/organisational level
Funding	(Targeted) funding to improve the integration of gender dimension in research	Structural/organisational level
Policies	Gender budgeting	Policy level
Knowledge	Scholarships for women	Structural/organisational level
Visibility	Role models	Individual/team level and structural/organisational level
Funding	Special funding for women researchers	Structural/organisational level
Non-discrimination	Gender-sensitive study and working conditions (e.g. alternative study plans for pregnancy during laboratory work period)	Individual/team level and structural/organisational level
Recruitment	Campaigns for inspiring women for MINT ³ subjects	Structural/organisational level

³ Mathematics, information technology, natural sciences and technology.

Drawing on the developed intervention typology, the interventions of each of the case studies of the EFFORTI project were analysed and mapped accordingly. Examples of impact stories were developed for a broad spectrum of these intervention types in order to provide examples of the mechanisms regarding intervention intentions (see also chapter 3 for more on theory of change and chapter 6 on the impact stories) and to provide a common framework for understanding the multi-faceted interventions of the cases that will serve as a testing ground for the further EFFORTI toolbox development in the next phases of the project.

2.3 Development of indicators

Drawing on already developed and applied indicators in GE and innovation research (i.e. the Innovation Indicator 2005, the European Innovation Scoreboard 2016, the RIO Observatory, the OECD STI Scoreboard 2015, the OECD STI Outlook 2014), but also on recent studies on how to enlarge the conventional set of RTDI indicators by taking into account new policy approaches like RRI (Ravn et al. 2015a, 2015b, European Commission 2015), the study team carried out comprehensive desk research as a basis for the collection of a preliminary list of relevant indicators. Particular emphasis was laid on mapping the existing evaluation concepts of GE measures and instruments, concepts for the measurement of research and innovation outputs, approaches for impact assessment and studies in monitoring of RRI.

Based on the existing evidence, the project team undertook the following steps:

- First, identifying the most relevant indicators according to the available literature.
- Second, clustering these indicators into different categories, dimensions and sub-dimensions which are based on GE-related literature and smart practice examples implemented in different organisations and contexts.
- Third, substantiating and conceptualising these indicators according to an evaluation logic model differentiating between input, (throughput), output, outcome and impact aspects.
- Fourth, illustrating the indicators at micro/individual or team level, meso/organisational level and macro/policy or country level. Contextual indicators are treated as cross-cutting indicators which have comprehensive influence on indicators from input to outcome.

Due to our acknowledgement of the complex connections between inputs, throughputs, outputs, outcomes and impacts in relation to evaluations of interventions and GE measures, a linear understanding of causalities is challenging (Kalpazidou Schmidt and Cacace 2017). The interventions and measures for which the EFFORTI toolbox aims to provide evaluation support are embedded in different contexts with regard to socio-economic and political systems and organisational settings and thus develop differently with its context. For this purpose, seven country notes have been written (for Austria, Denmark, France, Germany, Hungary, Spain and Sweden) where contextual framework conditions, such as the structure and performance of the innovation systems, gender equality in the labour market, welfare policies related to childcare and governance of gender equality in RTDI, on structuring the situation of women in RTDI, their career opportunities and relevance of gender equality in RTDI have been described. These reports also mapped the existing evaluations of initiatives and programmes to promote gender equality in RTDI and the dominant

evaluation culture in each country. Hence, the collection and determination of GE-related indicators which form the evaluation framework is based on a literature review of mainly process and implementation, output, outcome and impact evaluations that were embedded in various contexts and differed in their core objectives. Moreover, the indicators are based on the collection and review of “smart practices” implemented in Europe and beyond. The smart practices demonstrate practices and experiences in methodologies or techniques that seek to measure the link between gender equality and RTDI at different levels, implemented by different kinds of actors. They are characterised as smart practices because they have been relevant, effective and efficient in the context they operated in. Smart practice examples evaluated measures of different nature and length: some constituted large national programmes with a long-term perspective while others were of a narrower character.

2.3.1 Smart practice methodology

The identification of smart practices was based on an assessment of the practices that were relevant, effective and efficient in the context that they operate in as to their quality of both evaluation and measurement (Kalpazidou Schmidt et al. 2017). Smart practice examples evaluated measures of different nature and length: some constituted large national programmes with a long-term perspective, while others were of a more limited character. Some of the smart practices aimed, for example, at evaluating (1) the policies and practices to eliminate gender bias and promote an inclusive culture that values female staff (the Athena SWAN programme); (2) the visibility of female accomplishments in science (Laura Bassi Centres of Expertise); (3) the effect of motivating women with young children to re-enter the labour market earlier; (4) the participation and advancement of women in academic science and engineering careers (Advance IT programme); (5) the gender integration in leadership (AKKA); (6) the mentoring programmes for women in atmospheric sciences (ESWN); (7) the advancement of female faculty in science, technology, engineering and mathematics (STEM) (LEAP); or (8) the gender equality measures implemented within higher education (in the Netherlands).

Evaluation literature has the following understanding of a smart practice: it allows us to learn from others, produce considerable synergies and facilitate successful, innovative and effective evaluation practices, and provides orientation for the development of new innovative evaluation tools. Furthermore, a smart practice is an evaluation that takes contextual and systemic factors into consideration when assessing an intervention or a measure. Finally, a smart practice demonstrates a reliable and consistent evaluation of positive or negative effects of gender equality measures on RTDI.

The selection of 15⁴ smart practices was based on the criteria of (1) the quality of the implemented measures, and (2) the impact of the measures. The *quality of the measures* was assessed based on the parameters of relevance, effectiveness, efficiency, and sustainability of the interventions, while *the impact of the measures* was assessed in relation to its subjective/objective dimension (Kalpazidou Schmidt & Cacace 2017). A brief explanation of the different criteria used to identify the smart practices is presented below:

⁴ Further interventions were studied at a later stage providing additional smart indicators.

- **Relevance** refers to the adequacy of the initiatives included in the intervention to the situation of the team/organisation/system in which they are conducted and/or the wider social, cultural and economic contexts of reference for RTDI in the countries involved.
- **Effectiveness** addresses the capacity to implement the measure according to stated objectives and attain the objectives outlined in the design of the activities (i.e. planned measures and activities, completed activities, compliance with planned schedules).
- **Efficiency** refers to the capacity to make the best use of available resources, complying with the timeframes and procedures contemplated for expenses in the context of good managerial capacity (compliance with schedules in granting funds for different initiatives, compliance with expenses criteria, management issues, etc.).
- **Sustainability** refers to the capacity of the measure to continue producing effects even after the end of the programme/intervention (such as new measures in direct continuity of those promoted by the intervention).

As to the **impact** of smart practices, we considered both the subjective and objective impact of the implemented measures. The criteria used are briefly explained below, with some examples of impact in both qualitative and quantitative terms. **Subjective impact** addresses the satisfaction of the targeted beneficiaries of the intervention (as well as the capacity to promote consensus among other stakeholders involved in the programme/measure). Subjective impact indicators could include, for example, job satisfaction or improved work climate. **Objective impact** refers to the effects obtained in terms of real change due to the measure, which may be expressed in numerical/quantitative terms (such as an increase in the proportion of women in senior and decision-making positions), but may also be of a cultural, structural or policy character, expressed in qualitative terms (such as a change in policies or work procedures of institutions implementing the measure or a change in the organisation's ability to generate innovation that reflects societal needs). Based on the smart practice review, objective impact indicators were thus identified, such as increased recruitment of talented women or increased presence of women in key roles in innovation processes.

Having the above-mentioned criteria as a point of departure and mapping the existing practices as regards context, objectives, methodology, instrumentation and impact, smart practice evaluations were identified and indicators for the three levels (micro, meso, macro) were derived that fulfilled the following conditions.

As to the measure itself:

- The smart practice met the **needs and priorities of the programme initiator**.
- The smart practice achieved its initial goal (**effectiveness**) with the allocated resources.
- The smart practice had a **demonstrable impact**.
- The smart practice was **sustainable**: the results were maintained even after the initiative/intervention.
- The smart practice had **learning potential** for other researchers, organisations and policy-makers.

As to the evaluation:

- The smart practice built on a variety of **evaluation concepts of GE measures** and instruments.
- The smart practice framed a variety of different **concepts for the measurement of research and innovation outputs**.
- The smart practice represented a variety of **impact assessment approaches**.

- The smart practice has been exercised within **diverse R&I frameworks**.
- The smart practice was characterised by various **theoretical and empirical tendencies** in the field of evaluation of GE interventions in R&I.

All in all, grounded on these prerequisites, scientific literature dealing with the link between GE and RTDI has been reviewed with the aim of identifying the most promising practices in Europe and beyond.

2.3.2 Identification, selection and construction of indicators

The collection of existing knowledge and practices of initiating and evaluating GE and RTDI policy measures took place through a review of relevant research publications and a range of evaluations of GE and/or RTDI measures. The review focused on smart practices within the field of GE and RRI. Furthermore, progress and recommendations of previous projects undertaken within the EU programmes (GARCIA, GENERA, GENDERNET, INTEGER, PRAGES, STAGES, etc.) were taken into consideration.

Both qualitative and quantitative indicators are included in the tentative conceptual framework for the toolbox. The collected indicators cover all three levels of policy interventions, namely micro (dealing with individuals or teams), meso (focusing on organisational issues such as institutional rules, incentives, structures, and processes), and macro (referring to rules, incentives, structures, and processes at regional, national or supranational level). In practice, the distinction between micro, meso and macro levels may not be entirely clear-cut, since the levels are interrelated and many indicators can be applied at more than one of these levels.

Indicators aiming at assessment at all stages (inputs, throughputs, outputs, outcomes and impact) of an intervention/measure are included. The distinction between different policy stages is analytically derived. This means that the applied I-O-O-I model (inputs, outputs, outcomes and impact) is the underlying analytical framework guiding the understanding of the intervention logic in a linear, easily communicable manner. In practice, however, any single GE measure interacts with other interventions in a dynamic and adaptive system of complex interwoven mechanisms. Thanks to its inclusivity and flexibility, the EFFORTI toolbox aims at enhancing evaluation procedures that collect rich data in new ways that are better suited to assess GE interventions in RTDI in complex contexts, where experiment-based knowledge may not be adequate or meaningful and easily transferable.

The indicators are obviously not mutually exclusive. Identification and labelling of the indicators and methods used to characterise and assess RTDI/GE policy measures took place in several steps as an extraction process with an increasing number of indicators included at a decreasing level of detail. Several specific examples of GE policy analyses were selected, representing a large variation in terms of geographical and institutional/organisational contexts as well as scope and type of policy instrument and evaluation methods. These examples include the smart practices collected by all EFFORTI partners.

From a dense list of dimensions and subdimensions, five main categories have been identified and presented in an indicator scheme to support the design, instrumentation and assessment of future evaluations of the link between GE and RTDI (see Kalpazidou Schmidt et al. 2017, 14). An overview of the indicator categorisation with different dimensions and subdimensions is presented in the following section.

2.3.3 Overview of indicator categorisation

Since one of the aims of the EFFORTI project is to develop an evaluation model emphasising the interconnections between GE and RTDI, the model – and the toolbox – aim at including categories and dimensions specifically relevant in terms of evaluating initiatives where a link between GE and RTDI can be established. The EFFORTI toolbox 1.0 will be based on five main categories derived from an overview of relevant evaluation cases and smart practices as described above.

As the indicator scheme with the full list of identified indicators is rather detailed, the table below has been developed in order to provide an overview of the five main categories included in the EFFORTI model as well as the respective dimensions and subdimensions. A full, more elaborated list of all indicators within each subdimension can be found in Annex I. It should, however, be noted that the lists of categories, dimensions and indicators derived in EFFORTI serve as a schematic overview of possible indicators for use in future evaluations of policy measures and GE interventions in RTDI. This implies that the scheme cannot be exhaustive or static; therefore, future GE in RTDI measures and evaluations of interventions (such as the ones carried out in connection with the case studies in WP4) may uncover the need to revise the scheme and reveal additional categories, dimensions, subdimensions or indicators not included in the EFFORTI toolbox at the present stage.

The five main categories identified are:

1. **Personnel**
2. **Working conditions**
3. **Professional capabilities**
4. **Structural features**
5. **Research and innovation/RRI**

Tab. 2: List of categories, dimensions and subdimensions identified and developed for the EFFORTI Toolbox 1.0

Category	Dimension	Subdimension
1. Personnel	1.1 Positions	1.1.1 Increased number of women in academic and other RTDI positions
		1.1.2 Increased number of women in decision-making positions
	1.2 Recruitment capacity	1.2.1 Improved recruitment of talented women
2. Working Conditions	2.1 Work-life balance	2.1.1 Improved compatibility of family and career
	2.2 Job satisfaction	2.2.1 Appropriate respect/recognition for (academic/scientific/leadership) work
		2.2.2 Positive individual job rating
		2.2.3 Overall work climate
		2.2.4 Allocation of workload
2.3 Competitiveness/promotion and career	2.3.1 Transparent, non-biased and flexible promotion/tenure criteria	

		2.3.2 Strengthened confidence for promotion and responsible positions 2.3.3 Improved support to advance research career
	2.4 Workplace	2.4.1 Equal workspace/facilities allocation
3. Professional Capabilities	3.1 Leadership	3.1.1 Increased confidence and ability of leadership roles
	3.2 Professional achievements	3.2.1 Increased professional development of work skills (for career success)
		3.2.2 Improvement of network building and use
	3.3 Awareness of/commitment to GE	3.3.1 Increased gender awareness
3.4 Funding to promote GE in terms of female careers	3.4.1 Increased funding to promote GE	
4. Structural Features	4.1 GE challenges/barriers	4.1.1 Decrease of GE barriers
	4.2 Organisational/cultural change with regard to GE	4.2.1 Organisational/cultural change with regard to GE
	4.3 Preferential treatment	4.3.1 Equal treatment
	4.4 Funding for structural transformation	4.4.1 Increased funding to achieve structural transformation
5. R&I/RRI	5.1 Research outputs and impacts	5.1.1 Scientific outputs
		5.1.2 Networks
		5.1.3 Training/human capital
		5.1.4 Strengthened R&I capacities/excellence
		5.1.5 Research priorities and outcomes in terms of GE
	5.2 Innovation outputs and impacts (incl. technological impacts)	5.2.1 Conventional innovation indicators
		5.2.2 Diffusion of innovation in products, services, processes
		5.2.3 Knowledge about sex and gender incorporated into engineering innovation processes
	5.3 Economic outputs and impacts (incl. entrepreneurships)	5.3.1 Economic impacts
		5.3.2 Entrepreneurship
		5.3.3 Strengthened framework conditions for R&I
		5.3.4 Jobs, growth & competitiveness of participants (incl. small and medium enterprises (SMEs))
	5.4 Gender-sensitive research	5.4.1 Achieved gender equality in research process

		5.4.2 Research quality: integration of a gender dimension/perspective in research and content, in research projects, patents, and agreements
		5.4.3 Contributions to strengthening gender-sensitive research
	5.5 Responsible Research and Innovation (RRI)	5.5.1 Gender equality
		5.5.2 Ethics
		5.5.3 Public engagement
		5.5.4 Science education
		5.5.5 Open access
		5.5.6 RRI/governance
	5.6 Societal challenges	5.6.1 Research priorities & outcomes in terms of GE
		5.6.2 R&I indicators
	5.7 Societal and environmental impacts	5.7.1 Societal impacts
		5.7.2 Environmental impacts

Category 1, personnel, refers to personnel in research organisations, universities and ministries, as well as personnel in companies. In dimension **1.1**, (development in the) composition of academic and RTDI *positions*, it is relevant to evaluate GE in regard to personnel in terms of both *gender equality in decision-making* and *increased number of women in academic and other RTDI positions* (subdimension **1.1.1**). Relevant indicators can be related to gender segregation and history of tenure/promotion in personnel groups, contextual circumstances or barriers for change, etc. *Equality in decision-making* includes parameters such as funding programmes that include gender requirements, encouragement to engage in decision-making, probability of women reaching a top position (e.g. full professorship), gender wage gap, etc. *Academic and other RTDI positions* (i.e. positions in RFOs, economic sector, etc.) include, for instance, women in decision-making positions (top academic positions, heads of RFOs, etc.), doctorates, professors, principal investigators (PIs), administrative staff, etc. Subdimension **1.1.2**, *increased number of women in decision-making positions*, – more specifically than subdimension **1.1.1** – provides indicators for measurements specifically targeting the number or share of women in top leadership positions (e.g. company leader, company board leader/member, recruitment/promotion board member, reviewer/head of review or evaluation panel, rector, professor, dean, centre director, head of institution/department), different leadership roles, etc.

Dimension **1.2**, *recruitment capacity*, is relevant in, for instance, evaluations focusing on changes in terms of recruitment, including (recent) recruitment history – procedures and structures (e.g. whether and/or how there have been improvements/changes in the overall recruitment of talented women, and whether this was an intentional strategy). The respective subdimension, *improved recruitment of talented women (1.2.1)*, includes indicators such as initiatives targeting female personnel, composition of search/recruitment committees, applicant pool, mobility of researchers, contracts, job negotiations, recruitment evaluations, etc.

Category 2, working conditions, relates to institutional[ised] factors as well as factors related to e.g. family policy, employees' perceptions of the working conditions, and internal career/tenure possibilities (such as promotion issues).

Dimension **2.1, work-life balance**, is especially relevant for evaluations that take into account employees' possibilities of balancing career objectives and private/family life. This is also illustrated in subdimension **2.1.1, improved compatibility of family and career**, which includes indicators such as career planning, influence of work breaks on career progress, parental leave policy and flexibility, (actual) working time, possibilities for reduced working time/part-time, etc.

Dimension **2.2, job satisfaction**, includes four subdimensions ranging from *appropriate respect/recognition for work* (**2.2.1**) and *positive individual job rating* (**2.2.2**), to *overall work climate* (**2.2.3**) and *allocation of workload* (**2.2.4**). Indicators in the first subdimensions are mainly concerned with aspects of e.g. sex discrimination and gender pay gap (**2.2.1**), as well as inter-collegial relations, scientific contribution, received funding, and perceptions of career opportunities (**2.2.2**). Subdimensions **2.2.3** and **2.2.4** include indicators such as employees' social well-being and (results from) employee well-being studies (**2.2.3**), as well as workload compositions, working time/time spent on paid and unpaid tasks, and (guidelines for) negotiating workload or work tasks (**2.2.4**).⁵

Dimension **2.3, competitiveness/promotion and career**, is specifically oriented towards parameters concerning promotions/possibilities for future promotion, the history of/possibilities for career progression, employees' perceptions/experiences of career competitiveness, and other career parameters. Subdimension **2.3.1, transparent and flexible promotion/tenure criteria**, is relevant for evaluators particularly interested in measuring tenure and includes indicators such as fixed-term vs. permanent positions, (contractual) handling of major life events, promotion policies, flexibility in promotion arrangements, etc. Subdimension **2.3.2, strengthened confidence for promotion and responsible positions/improved support to advance research career**, consists of indicators for evaluators interested in how employees navigate in regard to possibilities for promotion and career progression, e.g. developments in the participation of men and women in RTDI (e.g. proportion of scientists and engineers), but also employees' awareness of research [project] opportunities, personal as well as professional institutional/managerial support, career obstacles/challenges, etc.

Dimension **2.4, workplace**, relates to the quality of the workplace: for instance, subdimension **2.4.1, equal workspace/facilities allocation**, includes indicators such as employees' access to appropriate workspace as well as other facilities and services.

Category 3, professional capabilities, is concerned with aspects regarding (female) leadership (**3.1**), different kinds of measurable achievements (e.g. skills, networks, collaborations, mentoring) and women's visibility

⁵ While, for instance, subdimensions 2.1.1 and 2.2.4 include similar indicators regarding working time, workload and flexibility of working arrangements, indicators in dimension 2.1 *work-life balance* mainly have employees with family responsibilities as their focus, while indicators in dimension 2.2 *job satisfaction* do not (necessarily) take family responsibilities as their point of departure – here the interest is in the more general (perceived) fairness of different aspects of the working conditions (some of which might also be found in studies with a particular focus on employees with children, as in dimension 2.1 and its subdimensions).

(3.2), overall organisational awareness of or commitment to gender equality goals (3.3), as well as funding promoting women's careers (3.4).

As the title of dimension 3.1, *leadership*, reveals, the subdimension *confidence and ability of leadership roles* (3.1.1), consists of indicators such as leadership positions, leadership skills, leadership development programmes, organisational culture, support to women's opportunities (e.g. mentoring systems), etc.

Dimension 3.2, *professional achievements*, provides a variety of indicators measuring achievements related to *professional developments of work skills* (3.2.1) and *network building and use* (3.2.2). Subdimension 3.2.1 contains indicators such as organisational understanding, improvements in time and budget management, participation in and development of career activities (e.g. networks, coaching, career plans), support for writing applications and for publishing, available workshops, etc. Subdimension 3.2.2 consists of indicators related to contacts/networks, collaborations, coaching and mentoring/mentoring programmes (including indicators for measuring women's visibility and arrangements/networks for women).

Dimension 3.3, *awareness of/commitment to gender equality*, is primarily concerned with indicators aiming to measure commitment to gender equality. Subdimension 3.3.1, *gender awareness*, includes indicators such as national strategies, legislation and goals, overall promotion of gender equality and diversity (as a value), (history) of gender equality and diversity initiatives and campaigns, studies initiated on GE issues and initiatives, inclusion of the gender dimension in teaching/curricula, etc.

Dimension 3.4, *funding to promote gender equality in terms of female careers*, and subdimension 3.4.1 are particularly concerned with indicators for evaluating which funding and grants are available and how they are distributed in terms of gender equality, e.g. funding requirements promoting GE, proportion of women receiving grants, average size of grants distributed by gender, etc.

Category 4, structural features, contains broader aspects related not to the women in question, but to relevant structures in organisations (e.g. RPOs, universities, companies), such as the organisational logic and culture in which barriers for gender equality can be found.

Dimension 4.1, *gender equality challenges/barriers*, is especially relevant when analysing institutionalised inequalities/barriers for gender equality in organisations. Consequently, subdimension 4.1.1, *decrease of gender equality barriers*, provides the evaluator with a diverse range of indicators at team, organisational and policy/country levels, centred around structural matters such as general acknowledgement of and attentiveness to GE issues and challenges, perceptions of gender roles in STEM, initiation of cultural change, citizen science activities in RPOs, RPOs with gender in research content, employees' experiences of sexism, etc.

Dimension 4.2, *organisational/cultural change (with regard to gender equality, 4.2.1)*, also provides the evaluator with indicators at all three levels of evaluative analysis, including indicators such as GE policy initiatives and policy-oriented engagement with science and gender equality, clear communication paths and transparency in decision-making bodies, ethics in universities/RPOs, and adoption of GE plans/actions targeting gender bias in organisational culture in RPOs. Subdimension 4.2.1 also includes indicators such as (experiences of) successful implementation of cultural changes/shifts, career development capacity, etc.

Dimension 4.3, *preferential treatment*, places particular focus on the gender perspective regarding (perceptions of) differences in the work culture and climate for women and men. Consequently, subdimension 4.3.1, *equal treatment*, contains indicators for the evaluation of perceptions of preferential

treatment, differences in women's and men's academic careers, time available for academic activities such as idea stimulation, discussions, etc., as well as indicators such as GE legislation and policies and existence of a GE unit/committee.

Dimension **4.4**, *funding for structural transformation*, pays attention to increased funding to achieve structural and cultural change in organisations, and budget spent on gender equality measures; it also considers offers and opportunities of grants to women researchers and focuses on the proportion of women receiving grants.

Category 5, research and innovation/RRI, provides evaluators with an overview of the most important research and innovations indicators including RRI mentioned in the respective academic literature but also reflecting recent discourses at the EU level regarding the evaluation of H2020 and the collection of RRI indicators. Category 5 is divided into seven dimensions and 25 sub-dimensions. Dimension **5.1** is dedicated to *research outputs*. Different types of scientific outputs play a prominent role and build the subdimension **5.1.1.**, reflecting a variety of primarily bibliometric indicators like number of articles and number of citations, but also international co-publications and interdisciplinarity. A further subdimension is constituted by scientific networks which are assumed to differ between male and female researchers (**5.1.2**), training and human capital effects like number of researchers trained, but also (gendered) attractiveness of research careers, (**5.1.3**), strengthened R&I capacities (**5.1.4**) as well as research priorities and outcomes in terms of GE (**5.1.5**).

Dimension **5.2**, *innovation outputs and impacts including technological ones*, is divided into three sub-dimensions. The first one, called "conventional innovation indicators" collects the most frequently mentioned indicators from comparative overview reports compiled by the OECD or the EC. It involves patent indicators as well as effects on norms and standards, spill-over and spin-offers but also product and process innovations (**5.2.1**). Subdimension **5.2.2** collects indicators which measure the diffusion of innovations (**5.2.3**), laying special emphasis on innovations that foster sustainable economies. The last subdimension refers to the incorporation of knowledge about sex and gender into engineering and innovation processes (**5.2.3**) and asks, for example, whether innovation and technologies serve certain groups of women or men more than others, or examines the degree of competition by image shaping by gendered productivity.

Dimension **5.3**, *economic outputs and impacts including entrepreneurship*, involves four subdimensions. In this area, one can find numerous indicators used in classical impact evaluation studies at the European level: for example, within subdimension **5.3.1** (*economic impacts*) – indicators on growth and job creation, turnover, co-patents between science and industry. Subdimension **5.3.2**, *entrepreneurship*, involves indicators regarding risk financing as well as share of women founding a company. Subdimensions **5.3.3** (*strengthened framework conditions*) and **5.3.4** (*jobs, growth, competitiveness*) mention only indicators at the macro level which will presumably be only measurable in the long run, i.e. opening up of new markets, jobs maintained and created and growth of SMEs, to mention some of them.

Dimension **5.4**, *gender-sensitive research*, provides suggestions for measuring research from a gender perspective. Where subdimension **5.4.1**, *achieved gender equality in research process*, contains indicators addressing the share of female project leaders, gender balance in research teams and in authorships, team building, awareness of/support for gender-sensitive research in RFOs, etc., subdimension **5.4.2** is centred around questions of *research quality*, i.e. whether a *gender dimension/perspective in research and content, in research projects, patents, agreements* is integrated into the research in question. This includes measures

such as exclusion of issues related to procreation as well as “emotional issues” and gender mainstreaming in research/research content. The latter includes indicators such as RPOs providing support for the inclusion of a gender dimension, RFOs promoting gender content, gender balance in research evaluation panels in RFOs, sample composition by sex/analysis of sex differences (e.g. regarding product usability or social media and open access (OA) outreach), share of research projects including gender analysis/gender dimension, inclusion of analysis of power relations and gender inequalities, (awareness of) hierarchical dimensions in perceptions of scientific validity, etc.

The subdimension **5.4.3**, *contribution to strengthening gender-sensitive research agenda*, consists of indicators related to different aspects of reflexivity, ethics and responsibility as well as diversity and gender awareness. The indicators included in this subdimension are, for instance, (support for engagement in) participatory, creative and inclusive research, (perceptions towards and) awareness of (gendered) power relations, awareness of the relationship between researcher and informant/participator, inclusion of concepts of and techniques for gender mainstreaming in public policies and policies on the inclusion of gender analysis in research funding programmes, (senior managers involved in the) implementation/integration of gender analysis in research funding/calls and proposals (including senior managers involved, measures related to public engagement, share of calls that include dissemination material/guidelines for applicants, research calls that include a “comply or explain” principle, share of budget spent on this matter, etc.), increase of scientific knowledge on gender, (programmes targeting the) inclusion of the gender dimension in research contents, etc.

Dimension **5.5** is dedicated to the collection of *RRI* indicators at the micro, meso and macro level. Basis for this collection are EU-funded projects and expert groups and thus follow the EC approach to define RRI as consisting of 5 crucial RRI keys, i.e. gender equality (subdimension **5.5.1**), ethics (**5.5.2**), public engagement (**5.5.3**), science education (**5.5.4**), open access (**5.5.5**) and, lastly, RRI/governance (**5.5.6**). The gender equality indicators collected here refer to all three ERA objectives, e.g. more women in R&I, more women in leadership positions and better consideration of gender aspects in research. *Ethics* shows indicators which describe new standards or guidelines or a National Ethics Committee Index but also, for instance, the percentage of research proposals for which ethics reviews required any changes. *Public engagement* addresses questions about the role the general public plays during all stages of research and innovation processes but also includes indicators which refer to organisational strategies to foster public engagement. *Science education* involves indicators to describe the development of science education material, engagement in partnership with schools, science communication culture and budget in the EU member states. *Open access* involves the most recent indicators at the macro level like open access literature and public perception of open access, but also indicators which describe the relevance of OA for the daily practice of European researchers. Finally, *RRI/governance* reflects the emergence of formal and informal RRI networks as well as the number of projects showing co-creation of scientific agendas or the existence of RRI-related trainings at RPOs.

Dimension **5.6**, *societal challenges*, involves research priorities and outcomes in terms of GE (subdimension **5.6.1**), as well as more traditional research and innovation indicators like publications and patents but with a special focus on the societal challenges (subdimension **5.6.2**). Lastly, we added the dimension **5.7** to describe further societal (**5.7.1**) and environmental impacts (**5.7.2**) which both refer primarily to the macro level and are partly linked to the RRI indicators above.

2.3.4 Visualisation of the conceptual evaluation framework

As outlined above, the EFFORTI approach has its point of departure in theory-based evaluation models. In a theory-based evaluation, the assessed variables are chosen according to a theory that formulates assumptions about interventions and which factors will be relevant to achieve desired outcomes (Fitz-Gibbon and Morris 1996, Kalpazidou Schmidt & Cacace 2017). Special attention is paid to the singularity of each intervention's context of implementation (Stufflebeam 2011) – consisting of specific team, organisational, regional and system constellations.

Theory-based approaches are the opposite of impact-oriented evaluation models which are limited to the question whether an intervention in general achieves its intended impact (Döring and Bortz 2016, 998). Central in impact-oriented evaluation is the proof of causality. An intervention is only effective, if it is possible to verify that the observed positive effects would not be present without the intervention (ibidem: 998 f). In contrast, theory-based evaluation models go beyond 'black box' causality and try to reconstruct impact mechanisms in a detailed way (ibidem: 1008). Social interventions are understood as assumptions about social betterment that work or do not work in practice and, if they do not show the intended positive effects, need realignment (Chen 1990, 39 ff; Pawson and Tilley 1997; Riché 2012).

Theory-based evaluation models follow a process tracing logic. Process tracing itself is an established qualitative method for the analysis of small samples or even only one case – like it is often necessary for programme evaluations that only rarely have data to the extent that allows to draw statistical inferences. The method has the goal to reconstruct a causal relationship between a research object and one or more research subjects on the basis of indications and proofs (Beach and Pedersen 2013, 1 ff; Collier 2011; Bennet 2008). In contrast to other qualitative methods, process tracing works with iterative deductive and inductive conclusions. The presence of the particular factors of a causal chain is only assessed by means of case knowledge (Beach and Pedersen 2013, 4 f).

Within the stream of theory-based models, EFFORTI makes use of theory-driven evaluation (Döring and Bortz 2016, 1011). Theory-driven evaluations, especially in the form of change models, focus on the questions (i) in which way and (ii) under which conditions a programme intervention causes the intended and unintended effects (Döring and Bortz 2016, 1011).

This division of theory-driven evaluation into 'how' and 'when' also results in a division of the EFFORTI toolbox (see figure 3). The first part of the toolbox will consist of guidelines, smart practice examples and indicator descriptions. The user of EFFORTI is supported in considering and understanding the 'when' (input and context dimensions) of the concrete gender equality measure. The user will be able to systematically include team, organisational and national/system context in a design or evaluation process. Guidance will be provided in terms of universal criteria about, for instance, how to assess quality, impact or transferability of a gender equality measure (Kalpazidou Schmidt and Cacace 2017). This rather 'static' part of the toolbox will mainly consist of downloadable documents.

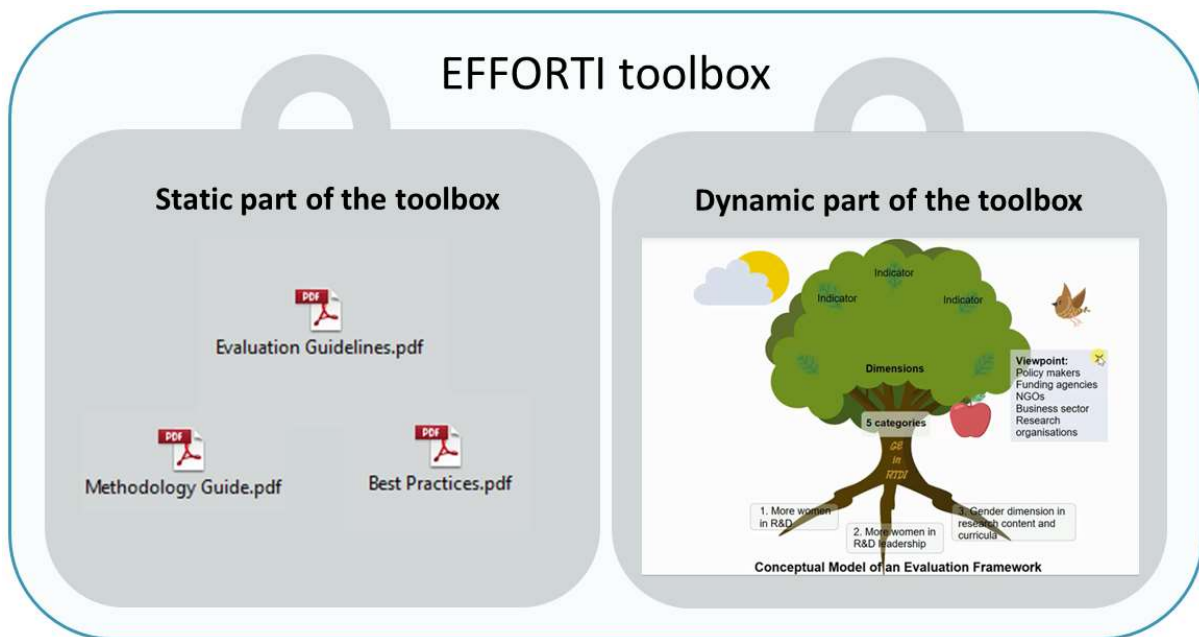


Figure 3: Illustration of the EFFORTI toolbox as a static and a dynamic process

The second part of the EFFORTI toolbox assists the user in understanding ‘how’ gender equality measures support the formulation of intervention theories. It will consist of approximately twenty so-called impact stories to guide the I-O-O-I chain (input, output, outcome and impact) of commonly used gender equality measures. The impact stories and their use are described in detail below (see chapter 6).

The first draft of the conceptual evaluation framework can be considered as a landscape of potential guidelines, best practices and indicators that may find different configurations in actualised specific national, organisational and team contexts, which future evaluators, policy-makers, etc., may use as a source of inspiration. Hence, the EFFORTI conceptual evaluation framework provides a basis for further refinement of the pool of indicators that meet the needs of EFFORTI.

The EFFORTI tree presented below (see Figure 4) is a visualisation of the dynamic part of the conceptual framework. A three-dimensional, interactive version of the tree is planned for online communication of the EFFORTI project. The communicative strength of the tree lies in the possibility to navigate between different elements of the evaluation instruments and the conceptual framework. The three ERA gender equality strategies stand as the foundation of the tree and are intended to form the platform for all GE initiatives. The branching of the tree corresponds to the categorisation of the indicators into categories and dimensions, with the indicators as the level closest to actual operationalisation being embodied by the leaves of the tree. The contextual aspects of the conceptual framework are emphasised by means of weather icons and refer to the varying structural/cultural features pertaining to any specific implemented programme or intervention. Contextual elements may pertain to country, type of research system, sector type (i.e. public or private), type and position of organisation, type of GE initiative, and previous experiences with policy interventions of similar or dissimilar types. The fruits of the tree represent the positive outcome of the intended gender-equal RTDI system and involve outcome, effects and impact of interventions such as innovation, patents, publications, funding, knowledge dissemination, science communication, research-based teaching, and all sorts of societal impacts. A bird is pictured to symbolise the different viewpoints or perspectives available in the conceptual framework for a variety of target groups. As mentioned, the EFFORTI

toolbox aims at providing interesting insights and instruments to policy-makers and representatives of funding agencies, NGOs, the business sector, research organisations and more.

Multiple examples of I-O-O-I chains constitute a three-dimensional perspective in order to convey the understanding that various GE interventions may take place in different ways and evaluations may focus on each of the stages in the chain. Hence, leaves of the tree can be situated closer to the trunk or further away, just as the focus of an evaluation can be at the stage of input, output, outcome or impact in relation to a GE initiative. Furthermore, the leaves may take three different colours indicating their focus on micro, meso or macro levels. Indicators that are suited to evaluate GE initiatives at more than one level can be found in more than one example.

The interactive version of the tree is designed in such a way that clicking on one item of the tree should lead the user further into the tree structure so that the potential indicator list narrows down according to the routes in the branching.

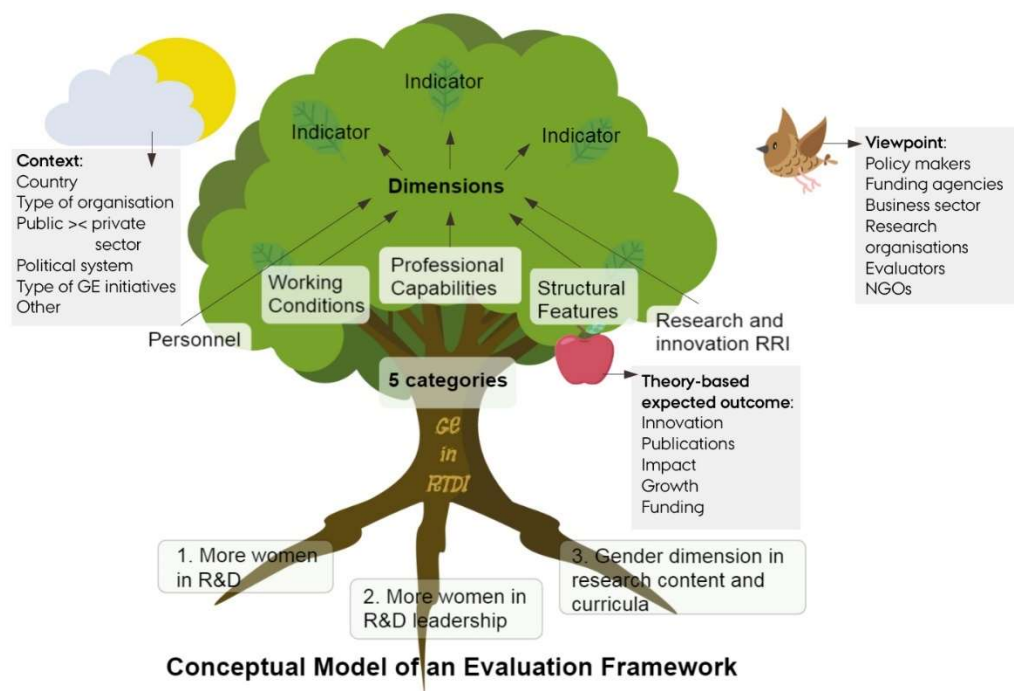


Figure 4: An illustration of the EFFORTI conceptual evaluation framework (designed by the Aarhus University team)

2.4 Limitations and constraints of the adopted approach

There is no smart fix to replace actual immersion in the toolbox elements and critically assessment of the adequacy of each of its indicators for future evaluation of GE initiatives in RTDI. The inclusivity of the EFFORTI toolbox development and the insistence to encompass traditional socio-economic indicators as well as a range of new, more innovative suggestions for ways to assess impact, specifically in relation to societal impact and RRI, is central. This inclusivity happens at the expense of clear, uni-dimensional guidelines for further use. The toolbox includes indicators that have a narrow operationalisable form and can be meaningfully compared across organisational, cultural, and national contexts. However, we have also

included indicators that need specific local translation to be meaningfully applicable in a specific future use. Some indicators may cover intervention effects at more than one level in the micro, meso, macro perspective, and the indicators have not been sorted unambiguously according to their positioning in the evaluation logic model (e.g. indicators of input or output), since this would have been too simplistic and would leave out the often-found possibility for a specific indicator to contain elements at several levels. Furthermore, timing must also be considered, as some indicators are better suited during an intervention or immediately after, whereas indicators of some types of effects require some time to pass. A specific operationalisation of an indicator will often have to re-formulate indicator focus and feasibility in order to maximise indicator validity and value for the purpose. An assessment of relevant data sources that can contribute to the use of a specific indicator must also be made. In sum, the sheer number of indicators might seem overwhelming. Therefore, we have made several different entry points that are meant as tools aiding the diverse EFFORTI toolbox users in the direction that will provide them with the most meaningful selection of indicators. Such entry points include the thematic sorting of the indicators into dimensions and categories.

The adopted approach in EFFORTI is based on the existing evidence and new theoretical and empirical trends in the evaluation field. At the same time, it is targeted towards the field of GE. Hence, it is developed from the observed practices and the literature and reflects the corresponding limitations and constraints in the evaluation model. The present section comments on these limitations in relation to the adopted approach.

In an ideal experiment, the effect of a measure is identifiable due to the experiment's ability to construct a comparable base population not influenced by the measure but identical on all other dimensions. The effect is then observed in a form of differences between the population exposed to the measure and the base population. However, similar to intervention measures in social sciences in general, none of the identified measures in the smart practice cases fulfils the requirement to construct an identical base case. Another observed characteristic from the smart practice cases is that the involved units are often small in numbers, meaning that quantitative statistics and law of large numbers do not apply well. Consequently, many of the smart practice cases prove effects through exhaustive and thorough circumstantial evidence collection, i.e. indirect and inferred evidence.

Based on an assessment of 125 GE programmes, Kalpazidou Schmidt and Cacace (2017) argue that holistic approaches and multidimensional frames of reference are needed for impact assessment in order to capture the intended outcomes of a GE intervention. Besides serving as an inspiration for evaluations of GE interventions, the study presents six potential challenges in assessing impact of interventions in complex systems, namely establishing attribution, lack of information and indicators, timing and persistence, expected scale and intensity, context dependence, and assessment of societal interventions in general. These are all aspects that need to be considered in the translation of an intervention logic model into an empirical evaluation approach.

In the adopted approach in EFFORTI, the focus is on the intervention logic model in relation to the single measure and its implementation, i.e. throughput and expected effects. The proposed indicators are meant to inspire policy-makers, evaluators and other stakeholders and be used as contributions to support the expected intervention logic by categories and levels of interventions. It thus becomes possible to measure an effect or change of an intervention linking input and observed effects.

One constraint of the approach is the risk to misinterpret the found evidence caused by the complex connections between inputs, outcomes and impacts of the interventions. Here, the intervention logic model guides the evaluator in identifying sound and credible effects of the interventions, having in mind that it may not be the sole or direct cause for an observed change (i.e. expected, linear or immediate causality). Furthermore and equally important, interventions and measures are embedded in different contexts and

interact differently with their contextual environment. Consequently, the design of measures needs to take into consideration the prerequisites for change, i.e. how national/system, organisational and team contexts and incentive structures affect the anticipated effectiveness and efficiency of the interventions.

As discussed above, the establishment of causal relations between interventions and observed effects can be based on theoretically founded hypotheses and a consequential intervention logic model. Hence, theory guides the empirical and methodological issues of attribution, measurement and timing that can be addressed through the intervention logic model and the consequent evaluation framework or model.

However, the non-linearity in evaluation logic still needs to be taken into consideration. As further developed in chapter 4, the theory of change can serve as the foundation for developing or defining the contribution of an intervention to achieve effects (see also chapter 4). The intervention logic model of the anticipated effects can then be used to confirm or question effects at a certain point and context for the exposed population.⁶ Hence, effects of interventions or measures may be found in one context but be absent in another.

Overall, a common constraint in evaluations of GE interventions concerns the complex interacting links between processes, outputs, outcomes and impacts that are usually non-linear in time and direction and therefore often need clarification, i.e. an intervention logic model. The I-O-O-I approach is useful to structure thinking in the evaluation logic, but it is important to emphasise and keep in mind the non-linearity of inputs from an intervention over processes to actual and measurable I-O-O-I and types of RTDI effects. Again, the intervention logic model supports and guides choices of relevant indicators, e.g. identified through the EFFORTI toolbox, to be included in the actual GE evaluation.

⁶ This indirect evidence gathering is in opposition to trying to prove and attribute causal long-run effects of an intervention in a complex and dynamic system where everything else is held constant. The latter is very seldom possible in a convincing manner in complex processes.

3 Theory of change: Identifying assumptions, risks and contextual factors

This chapter sets the scene for the following chapters by focusing on the theoretical aspects of change and the conditions that must be present for the different links to be realised in order to achieve GE effects on RTDI. The theory of change may explain what conditions must be present for the different links to be realised, i.e. how the intervention is expected to bring about the desired results.

Why do we need to develop theories of change in relation to gender equality and RTDI?

Gender equality programmes and initiatives in RTDI are about change. They are an attempt to overcome the well-known underrepresentation of women as researchers and the lack of gender balance in decision-making (positions of leadership and bodies) latterly taking an institutional transformation approach to tackling the barriers that women in research organisations face. Interventions have also been developed to integrate the gender dimension into research content with an increasing acknowledgement of the negative effects of a predominantly androcentric research agenda and subsequent applications. The European Commission and member states have been, to varying degrees, active in formulating recommendations, policy initiatives and programmes to effect change for greater gender equality and gender-inclusive research and applications at the team level, at the institutional level and at the research system level. Vogel (2012, 8) highlights three main drivers that have contributed to the mainstreaming of a theory of change approach: the importance of context; an increased emphasis on impact; and a recognition of complexity. All three elements have become increasingly important in the field of gender equality and science interventions.

Research that explicitly examines the effects and impact of GE programmes is relatively scarce and uneven throughout Europe. It is, in fact, very difficult to attribute changes in gender equality (be it measured by the number of women researchers/in leadership positions and on decision-making committees, or perceptions of impact/lack of impact on career development, work climate, etc.) to the GE programmes themselves, rather than attributing these developments to wider contextual trends and factors. Some research has even shown a negative correlation between the existence of certain equality measures and the proportion of women scientists (EC 2008). This can be explained by a compound of contributory factors – but the real explanatory power lies in the field of context, e.g. the size of a country's business enterprise sector negatively affects women's representation in research (see also chapter 5) (EC 2008, 8). Taking a theory of change approach enables and indeed requires one to factor the context into any explanation of change.

In recent years, the field of policy-making has also seen an increasing trend towards measuring impact (Vogel 2012). Impact assessments that attempt to measure and therefore demonstrate the societal and economic impact of policies have gained currency in times when resources for social policies are increasingly limited and programmes need to be justified in terms of cost effectiveness. Kalpazidou Schmidt and Cacace (2017, 2) note how most approaches to societal impact assessments focus on simple, linear models and these often embed a reductive causal chain logic. For example, the World Bank's *Impact evaluation in practice* states that "the focus on causality and attribution is the hallmark of impact evaluations and determines the methodologies that can be used" (Gertler, Martinez, Premand, Rawlings & Vermeersch 2011, 8). In line with the increasing recognition of the importance of context, notions of "attribution" have therefore generally been replaced by ideas of "contribution." An approach that "attempts to provide rigorous accounts of how and why an intervention *contributed* to producing the observed effects" seems to offer a more promising approach that can factor in complexity as well as context (Mayne and Johnson 2015). Kalpazidou Schmidt and Cacace (2017, 2) cite Cullen, Junge and Ramsden (2008, 127) highlighting that there is a "substantial body

of evidence that the complex combination of structural, cultural, institutional and economic factors that create barriers for women in science, engineering and technology (SET) require a correspondingly integrated and sophisticated strategic and operational response.”

Theories of change

“‘Theory of change’ is an outcomes-based approach which applies critical thinking to the design, implementation and evaluation of initiatives and programmes intended to support change in their contexts” (Vogel 2012, 3). In her review of the use of “theory of change” (ToC) in international development, Vogel highlights that there is consensus on those basic elements that make up a theory of change approach (see Figure 5). She identifies that at a minimum a theory of change encompasses the following points (Vogel 2012, 4):

- **Context** for the initiative, including social, political and environmental conditions, the current state of the problem the project is seeking to influence, and other actors able to influence change
- **Long-term change** that the initiative seeks to support and for whose ultimate benefit
- **Process/sequence of change** anticipated to lead to the desired long-term outcome
- **Assumptions** about how these changes might happen, as a check on whether the activities and outputs are appropriate for influencing change in the desired direction in this context
- **Diagram and narrative summary** that captures the outcomes of the discussion

Amongst her review findings, the following points are highlighted:

- Theory of change is both a process and a product.
- The quality of a theory of change process rests on “making assumptions explicit” and making strategic thinking realistic and transparent.
- Critical thinking is cross-checked with evidence from research (qualitative and quantitative) and wider learning that brings other analytical perspectives, referenced to stakeholders’, partners’ and beneficiaries’ contextual knowledge.
- A number of theories of change are identified as relevant “pathways” to impact for any given initiative, rather than a single pathway, with acknowledgement of the non-linearity and emergent nature of these.

A theory of change has two main elements. First, it can be seen as a tool or methodology that explicitly maps out the logical sequence of an initiative from the activities of the initiative to the change that it has contributed to (Vogel 2012, 9). Second, it encompasses a deeper reflective process where assumptions of change linked to the programme are made explicit. As Mayne and Johnson state, “ToCs set out the framework for telling a credible performance story of an intervention. As such, a verified or partially verified ToC can be used as the basis for reporting on what contribution the intervention has made” (2015, 419-420).

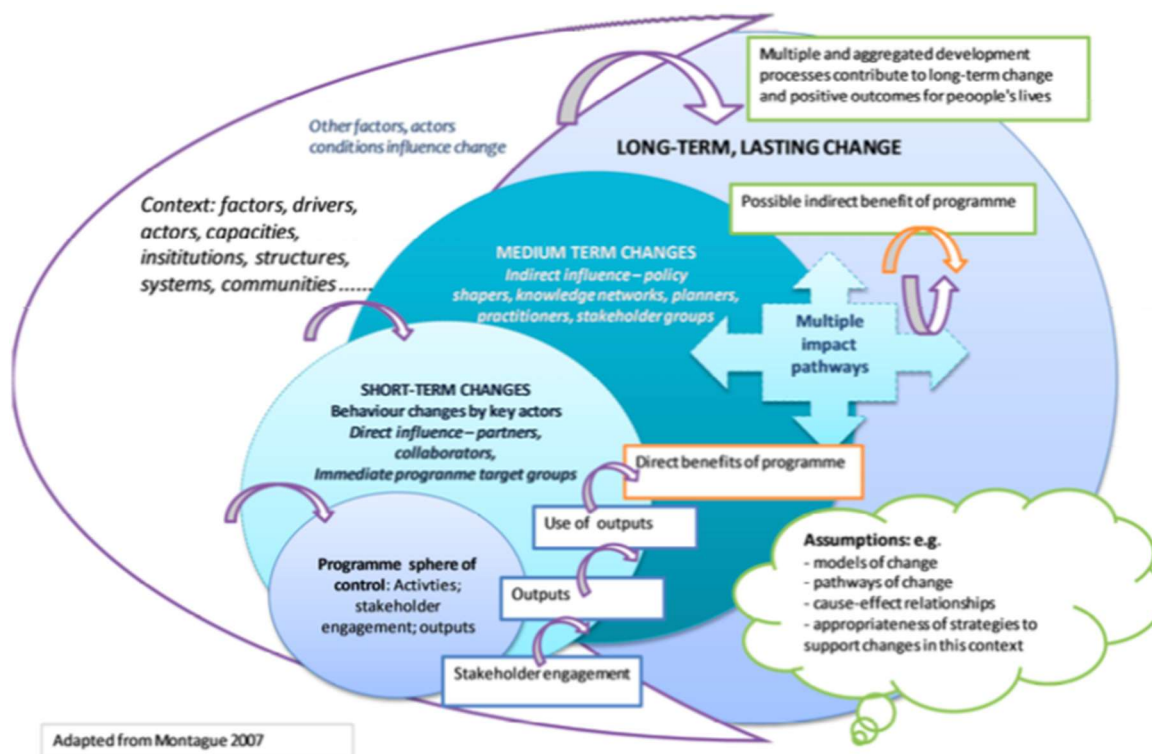


Figure 5: Theory of change thinking (Vogel 2012, 22)

Articulating assumptions is the main part of developing a theory of change. These assumptions have been described as *support factors*, i.e. events and conditions needed to bring about a contribution to effecting change (Cartwright & Hardie 2012, cited in Mayne 2015, 128). Using evidence to identify, check and challenge these key assumptions and map the implicit and explicit linkages of the intervention (input/resource, throughput, output, outcome/result, impact and context) forms part of developing a theory of change (Vogel 2012, 40). This approach can represent the specific components and context of each programme/initiative and its interaction with contextual variables whilst at the same time remaining scalable.

Mayne and Johnson (2015) identify that theories of change can be used at various stages of an intervention:

Designing/planning interventions:

- 1) Designing interventions
- 2) Understanding and agreeing on interventions with stakeholders
- 3) Identifying and addressing equity, gender and empowerment issues
- 4) Ex-ante evaluation of proposed intervention

Managing interventions:

- 5) Designing monitoring systems
- 6) Understanding implementation, managing adaptively, and learning

Assessing interventions:

- 7) Designing evaluation questions, methods, and tools
- 8) Making causal claims about impact

9) Reporting performance

Scaling:

10) Generalising to theory, to other location and for scaling up and out

Theories of change can be used as a model of how change is expected to happen (ex-ante case) or how change has happened (ex-post case) (Mayne & Johnson 2015, 416). In this project, theories of change could specifically be used as a tool to examine how change has happened, particularly focusing on assessing impact. This is in line with a growing line of research that values the contributions that ToCs can make to evaluating interventions. Developing a ToC is an iterative process that requires time to revisit, validate and refine initial configurations. The process of ToC development should also include stakeholder involvement – for example, programme managers need to be asked to validate or at least confirm that configurations developed accurately explain impact.

In the following chapters, we discuss the contextual factors of importance for GE in RTDI influencing process, outcome and impact at national, organisational and team levels.

3.1 Contextual and cultural issues influencing evaluation at national/system level

Gender equality policies do not take place in a vacuum but are situated in specific national contexts, comprising legal regulations and policies that are formed by cultural factors (Schiffbänker 2009, 66). This context influences the impact of gender equality measures, also in RTDI (Arnold 2004; Edler et al. 2010; Streicher 2017). Therefore, in this chapter we focus on how the national/system level affects the progress towards attaining the GE-related ERA objectives. Consequently, the present chapter describes those framework conditions which are considered to hinder or promote the achievement of the ERA objectives and should therefore be taken into account in evaluations of GE-specific measures/policies in RTDI.

3.1.1 Proportion of women in RTDI

As discussed earlier, the first ERA target regarding gender equality in RTDI is fostering gender balance in research teams in order to close the gaps in the participation of women (EC 2015d). The share of women in RTDI depends, first of all, on the general labour market participation of women. In countries where the participation is comparatively low, fewer women are present in the RTDI sector (EC 2008, 26). One of the main barriers for women to participate in the labour market and, subsequently, to be employed in science is the unequal gender division of labour related to housework and family care in combination with the lack of childcare facilities (EC 2008, 39; Godfroy-Genin 2009, 87).

The division of labour regarding paid and unpaid work and, subsequently, the compatibility of family and work is culturally influenced and enshrined in laws, e.g. in the tax law. Joint taxation, in comparison to individual taxation, favours the traditional division of labour between a male primary earner and a female homemaker or secondary earner (Plantenga 2014, 13f). European welfare systems, however, also differ in how they share the responsibility for childcare among the state, market and individual (Esping-Andersen 1996; Pfau-Effinger 2004). If countries do not provide sufficient childcare facilities, this is at the expense of the labour market participation of women. It contributes to longer parental leave periods and higher shares of part-time work for women.

The cultural influence on compatibility of work and family is also reflected in the design of the parental leave system. According to Ray, Gornick Janet and Schmitt (2008, 19), five policy practices promote a fair division

of parental leave between men and women: (1) generous paid leave; (2) non-transferable quotas of leave for each parent; (3) universal coverage combined with modest eligibility restrictions; (4) financing structures that pool risk among many employers; and (5) scheduling flexibility. On the other hand, poorly designed parental leave policies can reinforce tendencies towards gender inequality, also in RTDI: for instance, providing mothers – but not fathers – with leave that is both long and generous may seem to benefit mothers relative to fathers. In practice, however, such a policy would more than likely increase the childcare responsibilities for mothers, while at the same time reduce their long-term earnings relative to fathers (Ray et al. 2008, 10) and hamper their re-entry into the labour market (Schiffbänker & Holzinger 2014, 37; Richter 2011, 248).

If national welfare policies ascribe the main responsibility for childcare to women, it is particularly difficult for them to succeed in the RTDI sector (see also the ERA objective 2). The typical career path in RTDI is currently based on the male life course: in other words, a linear course of full-time employment without breaks (Krais 2000; Metz-Göckel, Selent, Schürmann, Möller & Heusgen 2009). Long periods of parental leave are not advisable in occupations where knowledge is quickly outdated, as is the case in RTDI (Nyberg 2004, 20). Female scientists therefore try to interrupt employment only as briefly as possible (Althaber, Hess & Pfahl 2011, 113) because maternity leave is the most important factor negatively influencing their career (Schiffbänker 2009, 66, 73). Subsequently, the expectation of availability, coupled with the lack of childcare facilities and mobility demands in academia, makes the compatibility of work and family more difficult for scientists (Lind 2012; Lind & Samjeske 2009).

At universities, the compatibility of work and family is also influenced by employment conditions which are regulated by law. The scientific systems of European states differ in the time of an academic career to which a permanent position is possible (IDEA Consult et al. 2013, 68). A long period of precarious employment implies low planning security, low financial security and lack of professional establishment and has a negative impact on family planning (Bundesministerium für Bildung und Forschung 2010). Under such conditions, women are more likely not to have children or leave the research sector (Lind & Samjeske 2009; Lind 2010).

In addition to the factors described above, horizontal segregation in the society also influences the proportion of women in research. Despite the rise in women's level of education and in their proportion among PhD graduates, there remains a significant degree of segregation in terms of fields of study (Meulders, Plasman, Rigo & O'Dorchai 2010, 40). All over Europe, there are two fields where women are least well represented: engineering, manufacturing and construction, and science, mathematics and computing (Meulders et al. 2010, 77). But industrial research relies mostly on professionals in the STEM fields: mathematics, natural sciences, life sciences, computing and engineering (EC 2012a, 135). Reasons for gender-different study choices can be found in gender-specific education in the school system. According to Alaluf et al. (2003), stereotypes still play an important role in schools. A lot of studies have proven that girls are not less gifted than boys. Success in school is more a function of the social origin or the form of the educational system. Van Langen, Bosker and Dekkers (2006) found integrated educational systems more favourable to the achievement of girls than differentiated educational systems. Therefore, a starting point to increase the proportion of women in science may be examining the degree of integration/differentiation which characterises a country's educational system (Van Langen et al. 2006, 174). In addition to the question of whether girls and boys are equally promoted in the school system, gender-specific socialisation also plays a role. Even if girls are performing better at school, their choice of career orientation does not follow the same tendency as that of boys, and they tend to select into socially less "valued" options or orientations (Alaluf et al. 2003).

Gender-specific choices of studies are therefore a reason for the lower proportion of women in the business enterprise sector (BES), since STEM qualifications are in demand there. The proportion of women is also lower in BES than in other sectors because the national equality promotion in science in Europe focuses mainly on the public sector because it can be better influenced by policy measures than the private sector (EC 2008, 23-24). The different relevance of sectors in a country is also crucial for the share of women in RTDI: in BES-dominated economies, it is more difficult to increase the share of women in RTDI.

3.1.2 Proportion of women in RTDI in decision-making positions

Ensuring gender balance in decision-making is the second ERA objective to foster gender equality in RTDI. The European Commission (2015d) specifies that the target is 40 % participation of the underrepresented sex in panels and 50 % in advisory groups. In addition, all panels and committees should have at least one expert (of any gender) with explicit expertise in gender.

The achievement of the second ERA objective is strongly linked to the attainment of the first ERA objective; the higher the proportion of women in RTDI, the higher the likelihood that they occupy leadership positions. A statistical analysis among the Enwise⁷ countries revealed that the proportion of women professors Grade A is influenced by the proportion of women among ISCED 6 graduates (EC 2008, 29-31). Framework conditions regarding childcare facilities, parental leave regulations and employment conditions as described above do not only influence the decision of women to enter the RTDI sector and remain there, but they also have a strong impact on whether women can make a career in RTDI. In regard to employment conditions, the rigidity or, on the contrary, flexibility of scientific career schemes at the universities play an important role in female career advancement. For instance, if dissertations and habilitations must be completed within a certain period of time, it may create barriers for women in academic careers when private obligations must be combined with professional ones (Leitner 2009; Forster 2001; Kramer 2000; Georgsdóttir 2001; Ulmi & Maurer 2005; Acar 1994; Hegemann White 1994). However, the apparent incompatibility of work and family may not be the main reason why women are marginalised in this field. Even the mere expectation that women in general will not be able to combine family and academic work life can lead to structural discrimination after and even before they have children. This discrimination consists of fewer opportunities for women to take over challenging tasks which subsequently makes career advancement difficult (Schiffbänker 2009, 65, 75-76; Schiffbänker 2011, 199).

This example makes evident that the gendered organisational culture of higher education institutions and other RPOs is a major factor explaining vertical segregation (Meulders et al. 2010, 103), as it influences everyday working practices, limits the opportunities of women for career advancement and undermines family-friendly policies (Howe-Walsh & Turnbull 2014). The question is therefore whether the change in organisational cultures in RTDI is listed as an objective in national strategy documents. If universities are obliged by law to work towards gender balance – e.g. in recruiting (Lind & Löther 2007, 257) or even in having to implement a GE plan that also considers women in decision-making – they need to deal with implicit bias and GE in their recruitment and selection procedures. Another national policy may be to implement quotas for women in management positions and committees (Reidl et al. 2017), addressing not only the higher education sector (HES) but also the BES. As a large number of studies (e.g. Zvinkliene 2003; Palomba 2004; Lažnjak & Gaurina Međimurec 1997; Husu 2005; Novelskaite 2008; Bruun, Eskola & Suolinna 1982) conclude,

⁷ Eastern and Central European countries and the Baltic states.

the small number of women in the highest RTDI positions is due to discriminatory practices rather than to the low level of professional ambition of women in academia. Consequently, there is a need for GE policies that counteract this trend.

However, RTDI policy cannot address only RPOs in order to raise the proportion of women in leadership positions – research funding policies are also essential. Possible policies already in place in some EU countries are gender-balanced RFO committees, monitoring and reporting requirements of RFOs regarding GE activities, and also evaluations of RFO committees regarding gender bias (Reidl et al. 2017, 46). Moreover, special funding for women in science has a positive impact on the proportion of women professors Grade A (EC 2008, 29-31).

3.1.3 Integration of the gender dimension in research and teaching

The integration of the gender dimension in research and teaching should not only promote gender equality in RTDI but also serve as a strategy to improve scientific quality and excellence as well as social relevance of RTDI. Therefore, strategies and policies are developed which require researchers to integrate gender analysis into their research endeavours (Schiebinger & Schraudner 2011). However, mainstreaming gender analysis in research is confronted with several challenges:

- *Methods of sex and gender analysis are only now being developed in an international context.*
- *Scientists, engineers, and policy makers are not yet trained in methods of sex and gender analysis.*
- *Methods of sex and gender analysis are not yet mainstreamed into curricula from primary through tertiary [science and technology] S&T education. (EC 2012a, 156)*

A further challenge can be identified from the results of the ERA survey from 2014 (EC 2015c), reporting that provisions for integrating gender analysis in research contents or programmes are not widely spread among member states. Only a few countries are supporting the inclusion of the gender dimension in research programmes and content (EC 2015c; see also GENDER-NET 2015). Policies to promote the inclusion of the gender dimension in research still need to be developed and implemented to provide incentives for researchers to take it into account.

Therefore, it is important to build capacities for gender in research: for instance, gender studies facilities, knowledge hubs, and gender-sensitive curricula or trainings for researchers, reviewers and stakeholders to enable sound and efficient integration of gender analysis in research activities. Furthermore, the available knowledge, theories and methods need to be distributed and made publicly available.

Based on this short assessment, a following hypothesis can be formulated: in countries with higher capacities and policies to promote the inclusion of gender in research programmes and content, the research will be more gender-sensitive. Therefore, to evaluate effects of policies regarding gender in research and teaching in a specific national context, it seems relevant to take the following national framework conditions into account:

- Do national RTDI programmes require researchers to include the gender dimension in their research proposals and projects? Therefore, evaluations must consider how research funders promote the inclusion of the gender dimension in research and how this affects the assessment of research proposals and the execution of research projects.
- Do research institutions provide training/support for researchers in regard to the inclusion of gender dimensions in the content of research? It is important to know if researchers are supported by their

organisations in setting up and executing research projects that include gender analysis. Support is important as most researchers are not yet trained in applying gender analysis in RTDI projects.

- Furthermore, it seems important whether there are other capacities like centres for gender studies or networks of gender study experts or practitioners available which can support researchers in applying gender analysis in RTDI projects.
- Additionally, it seems relevant to consider the integration of the gender dimension in courses and curricula in higher education institutions that train researchers of all disciplines in basic knowledge on gender studies and in applying methods of gender analysis in RTDI projects.

3.1.4 The role of the evaluation culture

The effects of gender equality measures in RTDI depend on the quality of the design of the measure and their implementation. This quality can be improved by the evaluation of the measure as this allows policy learning (Biegelbauer 2013, 50). The advancement of measures is therefore dependent on the extent to which the evaluation culture of a country has developed: are there explicit rules and legislation on evaluation in RTDI in place? Are evaluations regarded as part of a broader system to ensure accountability? Has institutionalisation of evaluation taken place? Is evaluation more the exception or the rule? And how are evaluation outcomes utilised in RTDI?

Gender equality interventions in RTDI that explicitly target the team level are rare. Despite this fact, the team unit is beginning to be recognised as an important arena for gender balance. This emphasis coincides with the increasing acknowledgement of the importance of the team level, especially in regard to performance. What precisely is the link between gender equality or gender diversity at the team level and performance? And what are the factors at the team level that influence RTDI evaluations?

Callerstig and Müller (2016) provide a word of warning on three main counts. The very notions of both “gender diversity” and explanations for optimal “performance” need unpacking. Gender diversity is still often conflated with “sex” diversity, i.e. the proportion of women and men in a team and those associated fixed biological attributes of women and men. A focus on gender differences as opposed to sex differences highlights those societal factors that shape these differences, i.e. socialisation processes and stereotypes that can be transmitted in the family, educational and organisational spheres (Callerstig & Müller 2016, 74). Increasingly, research has highlighted how sex and gender similarities and differences interact (Wood & Eagly 2012), whilst it has been recognised that these very distinctions between gender and sex are in fact gendered and reproduced by the literature on how gender affects teamwork (Callerstig & Müller 2016, 74). The very notion of gender diversity needs to be scrutinised. The team science literature highlights the very complex nature and configuration of a wide range of different variables that may account for team performance. Whilst gender is an important element, unpacking this from the wide range of other variables that interact with and subsequently impact on team performance is complex. Lastly, a simplistic and reductionist approach that links gender diversity, often conceived as the proportion of women and men in teams (input), to their performance (output/outcome) is no longer valid.

This section of the conceptual framework therefore examines key variables and phenomena that might affect performance at the team level.

This conceptual framework tries to identify some of the empirical research that looks specifically at gender diversity at the team level in RTDI. The main themes that have been highlighted in the literature that have been operationalised as indicators for the EFFORTI framework for this unit of analysis are the following:

- Gendered competency expectations
- Level of team deference
- Scale of empathy
- Diversity in team structure concerning tenure
- Acknowledgement of gender issues in the team
- Perceived extent and pace of cultural change at the team level
- Gender balance in research team/research team composition
- Perception of rebalancing power, especially in relation to women at the team level

This conceptual framework will focus on gendered competency expectations, scale of empathy and gender balance in research team/research team composition.

3.1.5 Gendered competency expectations

Müller, Klatt, Sandström and Callerstig (2016, 4) identify how a review of the literature in this field demonstrates that one of the main effects of gender diversity on team performance is related to gender bias – i.e. how this can negatively impact on performance through underutilisation of available expertise in teams. There is a range of factors linked to gender bias that can undermine the optimal sharing of information: status differentials, formal power relations, homophily or sexual harassment amongst team members (Müller et al. 2016). Ridgeway (2014) looks at how gender affects and is affected by hierarchical relations in groups. She builds on Berger, Cohen and Zeldich's (1972) expectation status theory which attempts to explain it as follows: "When a task-oriented group is differentiated with respect to some external status characteristic, this status difference determines the observable power and prestige within the group whether or not the external status characteristic is related to the group task." Ridgeway (2014, 5-6) explains that biased expectations for competence and authority are important because their effects are self-fulfilling and that these are intrinsically linked to status beliefs. Status beliefs about social difference are activated in contexts where people differ in terms of social distinction and where this is deemed relevant for context goals (Ridgeway 2014). The effects of these status beliefs – specifically in relation to gender – have been shown to be amplified in male/female-dominated contexts. Gender competency expectations vary across scientific disciplines, depending on the relative minority status of women. This means that competency expectations for women in male-dominated teams, for example in engineering, are particularly strong (Callerstig & Müller 2016, 88). This can have important effects – limiting optimal information sharing: "silencing often non-redundant and most valuable information from low status-low power members" (Callerstig & Müller 2016, 87).

3.1.6 Gender and sex differences in social sensitivity/empathy

A key research strand in the debate regarding the impact of gender diversity on research teams is based on assumptions regarding sex differences and social sensitivity and empathy (Callerstig & Müller 2016, 89). Research has shown that women are better at recognising and interpreting an individual's non-verbal emotional expressions and mental states (see, for example, Baron-Cohen, Wheelwright, Hill, Raste & Plumb 2001). The *Reading the mind in the eyes* test developed by Baron-Cohen to demonstrate "social intelligence" – i.e. the ability to read emotions of others at the team level – is linked to performance on team-based

problem-solving tasks, and women tend to score better on the test (Baron-Cohen et al. 2001). This may begin to explain some of the research that looks at collective intelligence in groups. Woolley, Chabris, Pentland, Hashmi and Malone (2010) state that collective intelligence can be predicted by the proportion of women in groups. They have conducted further research which identifies that it is not so much the sum of individual intelligence but the average social perceptiveness of group members that can predict the collective intelligence of a group (Woolley, Aggarwal & Malone 2015). Callerstig and Müller highlight how different socialisation processes for women towards more communal behaviour combined with certain sex differences, i.e. empathy and emotion processing, can begin to explain some of the observed differences linked to social sensitivity in Wooley et al.'s research (2016, 89-90). Other research has identified the crucial role of women in developing collective emotional intelligence (Curşeu, Pluut, Boroş & Meslec 2014). This is defined as the ability of the group to develop a set of norms that promote awareness and regulation of member and group emotions. It has been noted how women promote the emergence of collective competences – partly due to their higher social sensitivity and relational focus and facilitating the coordination of individual competencies throughout social interactions (Callerstig & Müller 2016, 90).

3.1.7 Sex-gender balance in research team/research team composition

At the policy level, there has been increased recognition of the importance of “gender balance” in research teams (see the criteria for good practices developed by the EGERA project) as well as in key decision-making positions and committees. The EGERA guidelines identify the resolutions on gender equality in research teams by the EC Horizon 2020 programme that could be used as an established benchmark: “Fostering gender balance in Horizon 2020 research teams, in order to address the gaps in the participation of women in the Framework Programme’s projects” (EGERA 2016, 9).

The notion of “gender balance” in science, however, has been problematised by gender scholars (see the GenPORT (2017) online discussion on gender balance). World experts came together to discuss the issue online – and whilst generally welcoming the desire to foster “more collective knowledge and expertise putting women’s and feminist concerns more fully on scientific agendas, developing more democratic processes” to tackle largely male-dominated science – notions of gender balance were criticised for a variety of different reasons. Gender scholars have problematised the notion of “gender balance” as it can reinforce assumptions about “heterosexual complementarity between men and women.” It may also put forward a very simple solution to a very complex phenomenon. Jeff Hearn stated: “But, is ‘gender balance’ really so simple, and is it the complete answer? As far as I can see, at the same time as agreeing with and promoting gender balance, the term ‘gender balance’ in decision-making is perhaps not really quite right; it can suggest a natural, heterosexual complementarity between women and men. Gender balance may also suggest that all we need is counting the numbers of women and men. It may even play down other differences both among women, men and further genders (queer, intersex, transgender, non-binary), and also differences other than gender, such as age, class, racialisation and ethnicity. It would be a mistake to see greater gender balance in the numbers of women automatically producing better decisions in every situation. The evidence on this is more diverse” (GenPORT 2017).

3.1.8 Beyond the team level

The team level is also heavily influenced by other units of analysis – i.e. the wider context. For example, the team is embedded within an “organisation” and a “discipline” which have their own shaping structures, processes and cultures. For example, in male-dominated disciplines – where women are the minority – the majority of men do not recognise women’s expertise: “If the discipline in which the team is embedded is

male-dominated, team members may not have had exposure to visible symbols of female success. Team members may assume that female team members are generally less qualified than men, and gender may therefore significantly predict expertise recognition and utilization (e.g. Ibarra 1992; Ely 1994)” (Joshi 2014, 5). Joshi’s research demonstrates how undervaluing the expertise of the minority can negatively affect team performance:

Teams with greater proportion of highly educated women were significantly more productive in gender-balanced disciplines than in male dominated disciplines. These findings support the argument that the level of gender integration in any given discipline can shape the salience of gender as bias for the status differences or role expectations among women and men in science and engineering. (2014, 27)

The proportion of women in a discipline affects the extent to which their expertise is recognised – which is also partly dependent on the degree to which men identify with their gender: “Male actors who strongly identify with their gender are more likely to favour men irrespective of their educational status [...]” penalising women with high educational status (Joshi 2014, 19).

4 GE measures and RTDI impact and indicators

This chapter summarises recent knowledge on the interlinkage between gender equality and research and innovation indicators. Based on the standard literature on RTDI indicators (Innovation Indicator 2012 (Frietsch, Rammer, Schubert, Bühler & Neuhäusler 2012); the European Innovation Scoreboard 2016 (EC 2016a); the RIO Observatory (EC 2016b); the OECD STI Scoreboard 2015 (OECD 2015); the OECD STI Outlook 2014 (OECD 2014)), we can summarise that most of the indicators mentioned refer to framework conditions and input factors at the macro level, whereas the output and impact area is not fully elaborated. Thus we suggest, according to the relevant literature (see Annex II), to consider the following indicators:

- **Scientific impacts:** number of publications, number of citations, interdisciplinarity of the publications, international co-publications, publications in emerging fields;
- **Technology and innovation impacts:** patent applications, patent citations, new instruments, products, processes, services, standardisation, new datasets, spin-offs;
- **Economic impacts:** increased business performance, increased competitiveness, access to markets;
- **Social impacts:** social responsibility, consumer interests, social cohesion, liveable communities, and also contribution to solving grand challenges;⁸
- Impacts in the field of **responsible research and innovation:** following the conceptualisation of the European Commission, one of the most important drivers of the concept of RRI, we ground our considerations on the five keys which recently reflect RRI, i.e. ethics, science literacy and science education, open access, public engagement, and gender equality.

In the following, we summarise the existing knowledge as to some of the indicators mentioned above. In the course of EFFORTI, these considerations will be continuously complemented by academic or practice-oriented insights and can thus be understood as an intermediate state.

4.1 Scientific impacts

There are numerous academic articles that investigate the effects of female authorship on publication outputs (Abramo, D'Angelo & Caprasecca 2009; Allison & Long 1990; Campbell, Mehtani, Dozier & Rinehart 2013; Cole & Zuckerman 1984; Dundar & Lewis 1998; Pan & Kalinaki 2015; Frietsch, Haller, Funken-Vrohling & Grupp 2009; Hunter & Leahey 2010; Long 1992; Prpic 2002; Symonds, Gemmell, Braisher, Gorringer & Elgar 2006; van Arensbergen, van der Weijden & van den Besselaar 2012; Xie & Shaumann 1998). Overall, the most important results can be summarised as follows:⁹

⁸ The grand challenges are: Health, demographic change and wellbeing; Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy; Secure, clean and efficient energy; Smart, green and integrated transport; Climate action, environment, resource efficiency and raw materials; Europe in a changing world - inclusive, innovative and reflective societies; Secure societies - protecting freedom and security of Europe and its citizens.

⁹ Depending on the concrete bibliometric method, the results differ: for example, there are also studies that do not show any productivity gaps between male and female authors. However, the results listed below present a common understanding shared by the majority of the studies.

- The share of *female authors* increased during the past decade, accounting for 33 % in 2014, reflecting the general share of women among researchers (Frietsch, Bühler & Helmich 2016).
- Female authors publish *less in terms of quantity* (van Arensbergen et al. 2012; Xie & Shaumann 1998; Penas & Willett 2006; Xie & Shaumann 2003), but this gap has been decreasing during the past years (Pan & Kalinaki 2015; Cole & Zuckerman 1984; Long 1992; Xie & Shaumann 1998; Prpic 2002; Symonds et al. 2006; Abramo et al. 2009; Nakhaie 2002; Penas & Willett 2006; Taylor, Fender & Burke 2006; Ledin, Bornmann, Gannon & Wallon 2007).
- There are also studies which show that women produce fewer publications than men during the first decade of their career, but later in their career they more or less catch up with male researchers (Long 1992; Symonds et al. 2006).
- Publications of mixed teams, i.e. with a high share of female authors, receive higher citation rates than homogenous teams; respectively, women have higher citation rates than men (Campbell et al. 2013; Long 1992; Penas & Willett 2006; Tower, Plummer & Ridgewell 2007; Powell, Hassan, Dainty & Carter 2009; Ledin et al. 2007).
- Men and women differ significantly regarding the *scientific fields* where they publish. *Higher presence* of female authors can be observed in: food/nutrition; social sciences, other; humanities; pharmacy; medicine; biology/biotechnology. *Low presence*: computers, mathematics, physics, engineering (Frietsch et al. 2016).
- In subject areas with skewed gender ratios in favour of males, female researchers are more likely to focus on similar topics as their male counterparts. In contrast, in subject areas with more balanced gender distribution, women *tend to focus on different topics* (Pan & Kalinaki 2015).
- Mixed-gender publications are more interdisciplinary but less internationally collaborative than mono-gender publications, but female-only publications are the most internationally collaborative (Pan & Kalinaki 2015).
- The team size of female authors is larger than that of men (Frietsch et al. 2016).

The reasons for this overall picture described above are manifold and can be clustered as follows:

- *Individual characteristics*: Marriage and motherhood can keep women away from publishing (Long 1992). The relevant mechanism in this regard is that women more often interrupt their career to have children and start a family (Prozesky 2008). Having children also causes a decline in research productivity growth, more for women than for men (Hunter & Leahey 2010; Fuchs, van Stebut & Allmendinger 2001). Finally, women were found to initiate their careers at a later age than men (Karamessini 2004; Prozesky 2008).
- *Structural and institutional support factors*: Women seem to be more active in institutional settings where publishing is not expected or encouraged. Women seem to be less encouraged than men to publish (Bunker-Whittington 2006; Bunker-Whittington & Smith-Doerr 2005). Women also work, on average, at lower ranks and in less prestigious institutions. Thus, men outnumber women in positions of formal power, authority and high income (Xie & Shaumann 1998; Timmers et al. 2010).
- *Access to resources*: According to Zuckerman, Cole and Bruer (1991), women do not have equal access to research instrumentation like funding, laboratory space and time allocation, i.e. women

often remain in “the outer circle” of the scientific community. Especially the variable “time” seems to play a crucial role.

- *Access to networks and social capital:* Male researchers generally have better networks than female researchers (Kyvik & Teigen 1996; Fuchs et al. 2001) and collaboration influences performance (Lee & Bozeman 2005). Moreover, women receive less academic support and mentoring than men (Landino & Owen 1988; Fuchs et al. 2001).
- *Research topics:* Women specialise less clearly in their topic than men (Leahey 2006) and they often choose less exploitable research areas (Bunker-Whittington 2006; Bunker-Whittington & Smith-Doerr 2005).
- Women concentrate more often on teaching and service and therefore spend less time on research (Taylor et al. 2006; Snell, Sorensen & Rodrigues 2009).

4.2 Technological and innovation impacts

Even if the exact share of women among inventors differs according to different authors and their respective patent analysis methods,¹⁰ it can be concluded that women are considerably underrepresented among inventors in Europe. The percentage of female inventors (related to the total number of inventors of an EU member state) is even lower than the percentage of female researchers in all EU member states, even if there is generally a positive correlation between the proportion of women researchers and the proportion of women inventors (Busolt & Kugele 2009). Frietsch et al. (2016) show that the share of female inventors remains below 10 % (EU28) despite a steady increase during the past years.

The horizontal segregation of women is also confirmed by the patent data, i.e. men and women differ significantly regarding the scientific fields where they invent: *higher presence* of women can be observed within biotechnology; pharmaceuticals; food chemistry; organic fine chemistry; analysis of biological materials; and macromolecular chemistry, polymers; *low presence* can particularly be found in engineering (Frietsch et al. 2016).

An important result which corresponds to the results of the bibliometric literature is that despite the low quantity of female inventors, the opposite is true for their quality: the percentage of cited patents is higher for women than for men and there are more citations per patent for women than for men (Frietsch et al. 2016).

One main reason for the strong underrepresentation of women among European inventors is the fact that most of the patent applications are done by the business enterprise sector where women are still largely underrepresented (EC 2016c, 49f). Further reasons mentioned by Busolt and Kugele (2009) are that female researchers often experience a lack of professional high-quality time compared to men. This is due to maternity leave, part-time work, home office work and possible differences in work duties, motivation and obligations, as well as salary differences, etc. Female researchers are also confronted with a lack of resources

¹⁰ Whereas Ding, Murray and Stuart (2006) report that female academic scientists patent at about 40 % of the rate of men (database: random sample of 4227 life scientists over a 30-year period), Bunker Whittington & Smith-Doerr (2005) state that women enter the patenting system at similar rates to men. Fraunhofer investigations (Frietsch et al. 2009; Frietsch et al. 2012; Frietsch et al. 2016), however, confirm a strong gender gap in patent applications.

like project money, laboratory space, equipment (hardware and software, computing time), number and quality of co-workers, secretaries, etc., which hinders exhaustive research activities.

4.3 Economic impacts

Since the early 1990s, the presence of women in science has gained increased interest in political as well as scientific debates. The debate was first supported by *social justice arguments* and embedded in the development of general anti-discrimination policy at national as well as European levels aiming at equal rights for women in employment. Research focused on career paths of men and women as well as on the complex interplay between institutional arrangements and personal preferences that might explain the underrepresentation of women, especially at the top levels (EC 2004; Caprile et al. 2012). Since the turn of the century, *economic arguments* have been used increasingly to support gender equality policies:

- In the view of the European Commission (2003), to realise Europe's ambitions in achieving a *competitive knowledge-based society*, the number of researchers must be increased. In 2012, the EC (2012b) claimed again that boosting innovation in the EU means increasing the number of researchers in Europe by at least one million. In order to achieve goals such as higher "competitiveness," "innovation" and "knowledge-based society," it is obvious that the talents and potential of women must be mobilised and used.
- In the view of science and technology, *gendered innovations* enhance excellence in science, medicine, and engineering both in terms of knowledge and personnel. They lead to gender-responsible science and technology, and seek to enhance the lives of women and men globally. The term "gendered innovations" is defined as the process that integrates sex and gender analysis into all phases of basic and applied research to assure excellence and quality in outcomes (Schiebinger & Schraudner 2011; EC 2013c).
- In the view of business sector, the reasons why *gender diversity*¹¹ should be taken into consideration seriously lie in women's talents, their economic power, the changing market structure, and women's positive impact on organisational excellence and financial performance. Many studies thus indicate the "*business case*," i.e. the positive benefit that can be generated if more women are represented in companies, at top level but also within the different working units (Hoogendoorn, Osterbeek & van Praag 2013; Stvilia et al. 2011; Woolley & Baer 2011). These benefits refer to *better products* through gendered product development but also to a higher turnover through more women in boards (EC 2006; Catalyst 2004; McKinsey & Company 2007).
- The European Institute for Gender Equality (2017b) recently published an investigation about economic benefits of gender equality in the EU which showed a strong impact of GE on higher employment, more jobs and increased gross domestic product (GDP).

Gender in research content

The discussion of gender aspects in research and innovation content emerged several years ago and is part of a shift towards a "*benefit-orientation*" in the debate about gender equality. The benefit-oriented argument

¹¹ Catalyst (2004) defines gender diversity as "recruiting, retaining and advancing women."

emphasises the *improvement of performance* through more diversity within RTDI teams. Regarding excellence in science, for example, several studies show a positive impact of the heterogeneity of (research) teams on creativity and output.

In a large explorative study, the Fraunhofer Society developed a conceptual framework and subsequent guidelines that aim to support researchers in the identification of gender aspects in their research processes (Bührer & Schraudner 2006). Additionally, a checklist has been developed which helps guarantee proper consideration of gender aspects when applying methods of empirical social research like surveys, interviews, focus groups, etc. (Bührer 2006; Kane & Macaulay 1993). The conceptual framework of the Fraunhofer project elaborated four different aspects of the gender construct (Bessing 2006): (1) biological aspects (i.e. sex), (2) psychological aspects (individual attitudes and needs), (3) social aspects (role patterns, differences in the way of life, availability of financial, social, cultural resources, etc.), and (4) ideological aspects (values, norms, stereotypes) that are intended to help identify gender aspects in research. Meanwhile, many other checklists and collections of examples exist (see e.g. Oertelt-Prigione & Regitz-Zagrosek 2012; Schenck-Gustafsson, DeCola, Pfaff & Pisetsky 2012; Regitz-Zagrosek 2012; and the database¹² of references in major clinical disciplines).

The *Gendered Innovations Website*¹³ offers a series of tools and case studies aiming to help researchers and innovators identify gender aspects in research. The conceptual framework covers the whole research and development process, starting with the identification and determination of topics up to the utilisation of the results. It is pointed out, for example, that the *definition of research priorities* is largely shaped by the availability of (public) funding, but also by the dominant reward systems for the respective careers and existing norms and stereotypes (Schiebinger & Klinge 2010).

There are numerous examples how the negligence of gender aspects leads (Wajcman 2010) to sub-optimal or even *harmful results* (for examples from the health sector, see Institute of Medicine 2010). There are also examples of *dysfunctional product development*: for example, household robots for elderly people neglecting the fact that the main target group – elderly women – are not tall and strong enough to manoeuvre the robots; voice recognition systems that were not able to identify female voices, etc. (for further examples, see Schraudner & Lukoschat 2006). The potential of improved user orientation through participatory research and design involving both female and male target groups, is described in several studies (see Schraudner & Lukoschat 2006; Leung, Yen & Minkler 2004; Oudshoorn & Pinch 2003; Greenwood, Whyte & Harkavy 1993).

Gender and corporate social responsibility

At the intersection between social and economic impacts we can rely on several studies that show that the number of women in (top positions of) companies influences corporate social responsibility (CSR) strategies (Bernardi & Threadgill 2010; Soares, Marquis & Lee 2011; Vilké, Raišienė & Simanavičienė 2014).

As several studies show, the number of women in (top-positions of) a company influences the CSR strategies and activities. Bernardi and Threadgill (2010) prove, for example, that companies with a higher share of women on their boards are more socially responsible, with responsibility measured as a multi-dimensional construct consisting of charitable giving, community involvement and outside recognition of employees'

¹² The database can be found at <http://bioinformatics.charite.de/gender/> (restricted access).

¹³ The *Gendered Innovations Website*'s address is <http://genderedinnovations.stanford.edu/>.

benefits. The authors also found that companies with a higher share of women on their boards implemented more policies towards female employees; these companies were more likely to sponsor or create charity organisations and have a formal employee volunteer programme and stronger self-commitment towards charitable giving (Bernardi & Threadgill 2010, 20). Furthermore, their literature review identified the following impacts of better representation of women on boards and thus of higher diversity: (1) broader range of knowledge and professional contacts; (2) higher probability to be listed on *Fortune's Best companies to work for* and *Ephisphere's Most ethical companies*; (3) reduction of unethical decisions and thus of the danger that the company's image is harmed; (4) less corporate corruption; (5) consideration of the needs of a wider range of stakeholders; (6) wider use of non-financial performance measures; (7) higher probability to have company codes of conduct and, respectively, conflict of interest guidelines; (8) attraction of more women in the workforce at other levels too; (9) better access to markets ("women are a huge market force, and understanding the female perspective is essential in generating goods and services that meet consumer wants and needs" (Bernardi & Threadgill 2010, 16)); (10) diverse effects on key financial figures (better return on investment, profitability, shareholder value, etc.).

Soares et al. (2011) showed a strong link between gender-inclusive leadership and CSR as well, especially a significant higher amount of philanthropic contributions in companies with more female directors and corporate officers. They cite further studies that documented an interrelationship between gendered leadership and environmental CSR, improved quality of CSR initiatives and different definition of fairness.

Other studies, cited in an article written by Vilké et al. (2014), state that "companies with a significant number of women at the top are better practitioners of CSR and sustainability than other firms and are delivering big wins for business and society" (Babcock 2012, cited in Vilké et al. 2014, 199). One crucial challenge identified by the authors is the lack of continuous and systematic monitoring and reporting of relevant gender equality information. In this context, they point to the publication of Scholz (2012) who gives an overview of the effects of women in corporate governance on results like increased shareholder accountability, better legal compliance, and stronger financial performance.

4.4 Responsible Research and Innovation

With regard to the new concept of RRI, we can base our indicator development on primarily two sources: the work carried out in the context of the EU-funded MoRRI – *Monitoring the Evolution and Benefits of Responsible Research and Innovation* – project (Ravn, Nielsen & Mejlgaard 2015b; Ravn, Nielsen & Mejlgaard 2015a) and the results of an expert group on policy indicators for RRI (EC 2015b). As Annex III illustrates, almost all indicators refer to the macro level (national level) and frequently inputs, whereas the indicators of the expert group focus on process, outcome and perception indicators.

Based on two large-scale surveys conducted among European researchers, the MoRRI study team found that a gender effect can be observed primarily within the gender equality pillar, i.e. that women support female colleagues and consider gender aspects in their research design more frequently than men (Bührer et al. 2017; Bührer & Lindener 2017). The framework set up by the European Commission also makes a difference to the practice of responsible research and innovation: EU-funded researchers are more familiar with the concept of RRI; they associate more benefits and supporting factors with RRI than researchers from the control group; and they are more likely to practise activities related to the five main pillars of RRI, i.e. open access, gender equality, science education, public engagement and ethics. The institutional environment can also positively influence the degree of RRI activities and the general attitudes towards more responsible

research and innovation: researchers working in an institutional environment that systematically supports the practice of RRI are more active in RRI practices than researchers who cannot rely on such structures. For the gender equality dimension, this means that institutions that have a gender equality plan in place are more inclined to support female researchers than institutions without such institutional incentives. Further factors which influence the practice of RRI (including its five keys) and its perceived benefits are the scientific age and scientific discipline of the respondents (Bührer et al. 2017; Bührer & Lindener 2017).

5 Core set of indicators and descriptions

This chapter summarises and discusses the selection of the most promising indicators based on a systematic assessment of each indicator and the coverage of the different categories identified during the progress of the project. At large, this chapter is an attempt to synthesise a great amount of data and reduce complexity by providing a systematic, yet simplified assessment of data coverage and related implications for a set of promising indicators and within each category, dimension or subdimension.

Thus, in order to provide further exemplification of indicator meaning and ways to work with indicators, partners were asked to immerse themselves into one of the main EFFORTI toolbox categories and select the 10 indicators that are the most promising or relevant (for the stakeholders) within each category. This was processed on the basis of key parameters such as relevance, effectiveness, efficiency, sustainability and impact of the considered indicators. The concrete analytical steps taken in the task of quality classifications have been specified in chapter 2.

In the selection of the core set, both qualitative and quantitative indicators were taken into consideration, as well as indicators that address all the ERA strategies/objectives, and allow for variation in terms of the selected level of the indicators, so that micro, meso and macro level indicators are included in the core set. With much attention paid to the balancing of the level of abstraction allowing for both adequate general appeal and practical relevance, the partners then developed a brief description of each indicator to elaborate what we understand by it and how this indicator can be addressed. A template was thus developed to guide the process of describing the core set of indicators. The indicator descriptions were next circulated among all partners and adjustments were made for overall cohesion and variation. The synthesis and quality appraisal are not offered as a final version of the core set of indicators but is rather meant to provide an overview of the gathered data and, considering various levels of interventions and quality parameters, make a qualified appraisal of indicators. This appraisal calls for further verification in the following project work. The core indicators will hence be further developed and revised based on the 26 case studies and insights from the national and international workshops. The selected core indicator descriptions in each category are presented in five schemes, one for each category, in the following.

Indicator Description		Category 1. PERSONNEL	
Name of indicator		Relative size of business enterprise in R&D sector / Researchers by sector of performance 2013, in percent of total R&D personnel	
Brief description		This quantitative indicator displays the size of the business enterprise sector in R&D in relation to the governmental, higher education and private non-profit subsectors by comparing the number of researchers employed in the subsectors concerned. It is available for the EU28 member states, which makes an EU-wide comparison possible.	
Name of indicator		Number of tenured/tenure-track/non-tenured faculty	
Brief description		This quantitative indicator shows the distribution of women and men in the institutionalised career path "tenure track" and in the group of employees without involvement in the programme. An equal distribution is intended as underrepresentation of women in the tenure-track group may indicate a lack of career support for women and, therefore, gender bias in the personnel development in the organisation concerned.	
Name of indicator		Comparison between the proportion of female faculty during the most recent academic year to the proportion hired in the period of the past 3 years	

Brief description	It is a quantitative indicator for measuring development in hiring processes and illustrating gender bias in recruitment by comparing the proportion of men and women in the most recent academic year to the proportion hired in the past 3 years.
Name of indicator	Horizontal gender segregation in occupations and in economic sectors
Brief description	The index of gender segregation in occupation describes the percentage of employees who would have to change work if an equal proportion of men and women across occupations was to be achieved. It ranges from 0 (no horizontal segregation) to 50 (complete horizontal segregation), meaning the lower the number the more equal the society. Since it is conducted by Eurostat, an EU-wide comparison is possible.
Name of indicator	Success rates of men and women applicants to positions
Brief description	Quantitative differences in the success rates of men and women applicants to positions may indicate a gender bias in the recruiting process of the organisation concerned. The indicator is calculated by dividing the number of recruited male and female applicants by the total number of male and female applicants; it may be useful to break the data down by field, department, academic positions, part-/full-time positions, temporary/permanent positions.
Name of indicator	Percentage of research evaluation panels in RFOs that included the target of at least 40% of underrepresented sex in boards
Brief description	One of the targets of the European Commission's Horizon 2020 programme is to ensure gender balance in decision-making. Therefore, another important issue concerns the participation of the underrepresented sex in evaluation and recruitment panels. A target of a minimum of 40 % for all panels has been agreed upon; it can be achieved through various policies, e.g. targets, quotas. According to the results of the 2014 ERA survey, 36 % of research evaluation panels in the EU28 include at least 40 % of the underrepresented sex in their composition. The indicator shows the percentage of gender-balanced research evaluation panels in 2013 in 27 EU countries, as there is no data available for Croatia.
Name of indicator	Proportion of women grade A staff by main field of science
Brief description	This quantitative indicator shows the proportion of women grade A staff across fields of science; therefore displaying the horizontal segregation in the academic field at professorial level.
Name of indicator	Encouragement to engage in decision-making
Brief description	The subjective perception of encouragement to engage in decision-making can be a valuable outcome and indicator of success of human resource development programmes.
Name of indicator	Gendered composition of boards or committees
Brief description	This indicator displays the representation of both genders in boards or committees. Equal gender representation in these decision-making groups is considered crucial to enable a change in practice; as gatekeepers, they have the influence to enforce or hinder the development of equal gender opportunities. The composition can also be an indicator for the permeation of gender equality policies (Munir et al., 2013, 104; Frehill et al. 2005, 13).
Name of indicator	Percentage of professional staff at employment levels differentiated by gender
Brief description	This quantitative indicator can show either the current state or the development of gender equality at different employment levels, therefore reflecting vertical segregation

	or leaky pipeline in the organisation concerned. It may be used to evaluate the results of a human resource development programme in a longitudinal study (Harris et al. 2011).
Name of indicator	Distribution of gender in recruitment or promotion boards
Brief description	A quantitative indicator that shows the share of women and men, hence the representation of both genders in recruitment or promotion boards of the organisation concerned, analysing decision-making groups which play a crucial role in regard to the career development. It may be useful to break the data down to scientific fields or departments.

Indicator Description	Category 2. WORKING CONDITIONS
Name of indicator	Extent of experienced work-family conflict
Brief description	Qualitative outcome indicator on the self-reported extent of the conflict perceived by employees between the demands of their work and family roles in teams, organisations and Member States to illustrate satisfaction with work-life balance.
Name of indicator	Possibility of paternity leave
Brief description	Qualitative/quantitative context indicator to reveal whether employment-protected leave of absence for employed fathers exists in Member States as a part of their parental leave systems to illustrate the more equal sharing of family responsibilities.
Name of indicator	Employment rate in RTDI by age of children and sex
Brief description	Quantitative context indicator on the proportion of employed persons aged 25-49 by age of youngest child, sex, country and year to show the differences in men's and women's participation in the labour force and to describe the impact of having children on the employment of women (and men).
Name of indicator	Gender pay gap in RTDI
Brief description	Quantitative context/outcome indicator on the difference between the average gross hourly earnings of men and women in the RTDI sector expressed as a percentage of the average gross hourly earnings of men. It illustrates the extent of gender equality in the labour market.
Name of indicator	Perceptions of work climate
Brief description	Qualitative outcome indicator on the self-reported perceptions of workplace environment to illustrate the satisfaction with one's work environment and equal opportunities.
Name of indicator	Main differences of working hours between men and women in full-time employment
Brief description	Quantitative context indicator on the actual amount of weekly working hours of full-time workers by gender and country to illustrate the extent of well-being, satisfaction with work and gender equality in the labour market.
Name of indicator	Time spent on unpaid work

Brief description	Quantitative context indicator that reveals how much time women and men aged 15-64 invest in unpaid, paid and total work in minutes per day to illustrate gender inequalities stemming from stereotypical family roles.
Name of indicator	Transparent promotion system
Brief description	Qualitative outcome/impact indicator on the openness, accountability, auditability of all promotions made by decision-making bodies to illustrate potential gender discrimination and inequality in decision-making and promotion procedures.
Name of indicator	Confidence in own ability
Brief description	Qualitative outcome indicator on the self-assessment of employees regarding their own professional value and capabilities. It is assumed that self-confidence can be dependent on performance reviews and feedback; therefore, the indicator reflects the negative effects of potential discrimination, gender bias, stereotypical or sexist acts and remarks, etc.
Name of indicator	Study of actual space allocation of faculty at organisational level
Brief description	Quantitative/qualitative output indicator that measures the specifics of space allocation of faculties in organisations (e.g. access to labs, square footage, proximity to electrical power, years since last renovation, services, etc.) to illustrate the satisfaction with one's work environment and equal opportunities.

Indicator Description	Category 3. PROFESSIONAL CAPABILITIES
Name of indicator	Proportion of women heads of institutions
Brief description	Quantitative indicator that measures the proportion of head positions occupied by women at the national level. Women continue to be underrepresented in RTDI in part due to the 'continuous exit' of women throughout career progression in this field. Heads of institutions are also instrumental in guiding decision-making in European research (She Figures Handbook 2015, 93).
Name of indicator	Availability of positions in the RTDI system and in the research organisation
Brief description	Quantitative contextual composite indicator. In many countries, there are not many research positions or permanent positions (such as professor positions) available due to economic constraints and cuts in funding. We see a development towards more external funding to finance positions, increase in non-tenure positions, etc. At the same time, the autonomy of the universities has been increased, which means that universities in many countries receive less basic funding and have difficulties in recruiting personnel, in particular at A & B level. The share of external funding is increasing in general but that means also temporary positions until funds are used.
Name of indicator	Scale of organisational commitment to gender diversity (measurement through regulations, contract reformulation, founding of new initiatives)
Brief description	Measures the overall organisational awareness and commitment to gender diversity goals through identifying the presence of gender-inclusive regulations, contracts, initiatives, processes and procedures.

Name of indicator	Percentage of staff/researchers who have received training on IGAR
Brief description	Quantitative indicator to measure the level of staff/researchers know-how of integrating sex and gender considerations into policies, programmes, and projects, and to measure the awareness about the importance of sex and gender in research and innovation.
Name of indicator	Proportion of budget allocated to GE monitoring of total budget
Brief description	Quantitative indicator that measures the proportion of the total budget allocated to GE monitoring. This indicates how seriously the institution takes implementing gender equality measures by monitoring their progress.
Name of indicator	Funding success rate difference between women and men
Brief description	Quantitative indicator to measure research funding success rate differences between women and men – indicative of a gendered process of resource allocation. The European Research Council has recognised that imbalances persist in the success of women in their calls for funding, whilst these imbalances vary across countries. There are great differences in women's propensity to apply for funding, so this indicator looks at the differences in success rates of women and men when applying for research funding (She Figures Handbook 2015, 95).
Name of indicator	Average size of grant for women and men
Brief description	Quantitative indicator of resource distribution between men and women, indicative of a gendered resource allocation process. This indicator should be broken down by scientific field, funding scheme, academic age, number of years since obtaining a PhD. If relevant, this indicator can also be broken down by academic position and/or sector (Science Europe 2017).
Name of indicator	Promotion of gender equality as a funding requirement
Brief description	Promotion of gender equality as demonstrated by the existence of a Gender Equality Plan, improved action (demonstrated by monitoring) or impact (demonstrated by evaluation of a plan) as an explicit criterion in order to receive funding. This is a powerful RFO steering mechanism to influence the uptake and implementation of gender equality measures in RPOs.
Name of indicator	Percentage of men and women among main applicants
Brief description	Quantitative indicator recommended for gender equality monitoring in RFOs. This indicator should be broken down by scientific field, funding scheme, age, academic age – number of years since obtaining a PhD. If relevant, this indicator can also be broken down by academic position and/or sector (Science Europe 2017).
Name of indicator	Percentage of men and women among successful applicants
Brief description	Quantitative indicator recommended for gender equality monitoring in RFOs. This indicator should be broken down by scientific field, funding scheme, age, academic age – number of years since obtaining a PhD. If relevant, this indicator can also be broken down by academic position and/or sector. Success rate is the number of successful applications from women/men divided by the total number of applications from women/men. It can also be compared against the gender distribution of the national pool of researchers (Science Europe 2017).

Indicator Description		Category 4. STRUCTURAL FEATURES	
Name of indicator	GE-dedicated administrative staff		
Brief description	Qualitative process indicator that measures if and to what extent staff is dedicated to the conception, implementation and/or monitoring of GE measures at a research institution. It is assumed that clear responsibilities are needed for the effective and sustainable anchoring of GE measures.		
Name of indicator	Value of gender equality promoting measures		
Brief description	Quantitative outcome indicator on various personal gains a participant of a GE measure may have experienced as a result of the measure to illustrate the effectiveness of the measure (e.g. access to role models and/or mentors, ability to identify networking opportunities, confidence in voicing one's opinion).		
Name of indicator	Perception of preferential treatment such as advice, access to lab or equipment, resources, recruitment, promotion, attention to meetings		
Brief description	Quantitative outcome indicator on the self-assessment of equal opportunities limited or promoted by leader behaviour or the informal and formal rules at the workplace to illustrate the perceived satisfaction with one's work environment and equal opportunities.		
Name of indicator	Rating of communication paths and processes		
Brief description	Quantitative outcome indicator on the self-assessment of the usefulness of several ways (e-mail, regular meetings, staff appraisals) and arenas (research group, social events, seminars) of communication to illustrate equal opportunities by men and women in communication procedures.		
Name of indicator	Rating of transparency regarding decision-making bodies and criteria		
Brief description	Quantitative outcome indicator on the self-assessment of the perceived auditability of made decisions by an organisation's decision-making bodies to illustrate potential gender bias in decision-making procedures.		
Name of indicator	Sustainability of gender equality initiatives		
Brief description	Qualitative process indicator to illustrate if a GE measure led to ongoing engagement of a research institution regarding GE. Sustainability is indicated, for instance, by the incorporation of GE measures at strategic (GE in key strategic documents) and operational levels (e.g. promotion guidelines), through permanent dedication of staff to GE affairs, permanent data collection and monitoring of key indicators.		
Name of indicator	Percentage of RPOs that document specific actions aiming to change aspects of their organisational culture that reinforce gender bias		
Brief description	Quantitative indicator on the share of organisations that establish actions to change their organisational culture in order to reduce gender bias compared to the total number of organisations in a field.		
Name of indicator	Share of RPOs with gender in research content		
Brief description	Quantitative indicator on the share of research performing organisations which included the gender dimension in research programmes compared to the total number of RPOs.		
Name of indicator	GE unit/committee in place		

Brief description	Quantitative process indicator that measures if an organisation has set up structures dedicated to gender equality and/or the implementation of a GEP, including the creation of a dedicated budget for staffing gender equality offices and committees and ensuring the institutional anchoring of equal opportunities at department/faculty level.
Name of indicator	Composition of applicants and those who received funding
Brief description	Quantitative indicators on the gender distribution of applicants for funding and the gender distribution of successful applicants. A comparison of both indicators allows a conclusion on a potential gender bias in funding processes.
Name of indicator	Adoption of GE plans
Brief description	Quantitative process indicator that measures if a research performing organisation (RPO) has a gender equality plan and applies it in its work. GE plans are assumed to be a prerequisite of an effective and sustainable GE strategy.

Indicator Description	Category 5. (Responsible) Research and Innovation
Name of indicator	Publication's interdisciplinarity
Brief description	This indicator shows the degree of interdisciplinarity of scientific publications and relates this to the share of women within the research teams. It requires expertise in analysing bibliometric databases like Web of Science or Scopus.
Name of indicator	Number of citations
Brief description	This indicator is a proxy variable for the quality of a scientific publication by analysing how frequently the article was cited. It requires expertise in analysing bibliometric databases like Web of Science or Scopus.
Name of indicator	Percentage of international scientific co-publications
Brief description	This indicator shows to what extent a scientific publication is based on an author team with a variety of national backgrounds. It requires expertise in analysing bibliometric databases like Web of Science or Scopus.
Name of indicator	Networks of developers, providers and users of solutions involved in co-creation (value chain)
Brief description	This indicator requires information on the number and kind of participants of research and innovations projects. Presumably this information is accessible for funded projects, for example, H2020 projects.
Name of indicator	Patents' citations
Brief description	This indicator shows how frequently patents are cited and can thus be understood as a measure of quality of patents. It requires expertise in analysing patent databases like Patstat.

Name of indicator	Share of women founding a company
Brief description	This indicator is intended as a proxy that estimates knowledge flow from academia to private start-up companies with economic growth potentials, for example, via research based spinouts. The indicator provides a gender-segregated statistical probability of entrepreneurial activity, i.e. knowledge transfers by starting up a company, of people at different levels of academic career trajectory (EI).
Name of indicator	Share of RFOs promoting gender content in research
Brief description	This indicator illustrates the integration of gender as part of the research design and process. It entails sex and gender analysis being integrated into basic and applied research. Possible question: When allocating research and development funding in 2014, did your organisation include the gender dimension in research content? (Yes, in half or more of the projects/programmes / Yes, in less than half of the projects/programmes / No / Not known / Not applicable)
Name of indicator	Active consideration about how the research and innovation results will be perceived and used
Brief description	This indicator illustrates an operationalisation of a public engagement item used in the course of a large-scale survey among European researchers where these researchers were asked whether they take actively into account how the research and innovation results will be perceived and used.
Name of indicator	Science competence in secondary school pupils
Brief description	Indicator describing science competence of secondary school pupils in science subjects (biology, chemistry, physics and earth science) (Source of data: PISA).
Name of indicator	Societal challenges – number of joint public-private publications
Brief description	This indicator describes the number and percentage of joint public-private publications out of all relevant publications.
Name of indicator	Better societal acceptance of innovative solutions
Brief description	This indicator describes expected impact from research and innovation projects, up to 20 years after the project has received funding. It requires data from large-scale surveys among citizens like Eurobarometer.

6 Theory-based impact stories – Concept, relevance and structure

As discussed earlier (see chapter 2), the EFFORTI toolbox will consist of two parts, a ‘static’ part, which will mainly consist of downloadable documents and a dynamic one. The latter will provide the user with the necessary tools to understand ‘how’ gender equality measures are supposed to work and will support the formulation of programme theories. This part will contain approximately twenty “impact stories.” The impact stories are (1) ideal type impact chains, describing the outputs (immediate technical results), outcomes (direct social effects) and impacts (intended middle- or long-term effects) of commonly used gender equality measures. Furthermore, the impact stories explain (2) how the elements of the I-O-O-I chain (input, output, outcome and impact dimensions) causally interact with each other, (3) through which indicators the expected positive effects can be verified, and (4) which positive as well as negative unintended effects have to be taken into account and how they can be fostered or, respectively, avoided.

The impact stories will be compiled into a database and made accessible through a user interface. The interface allows filtering of the impact stories for specific goals, measures or indicators (see figure 6). The separate items of the tree structure (goals, measures, outcomes/impacts, indicators; see also the ‘EFFORTI tree’ in chapter 2) will be dynamically selectable. By selecting one item, its vertical connections on the goal, outcome, impact or indicator level will be displayed. By selecting two or more items, also the horizontal interrelations between the particular gender equality measures, goals, effects or indicators will be available for the user.

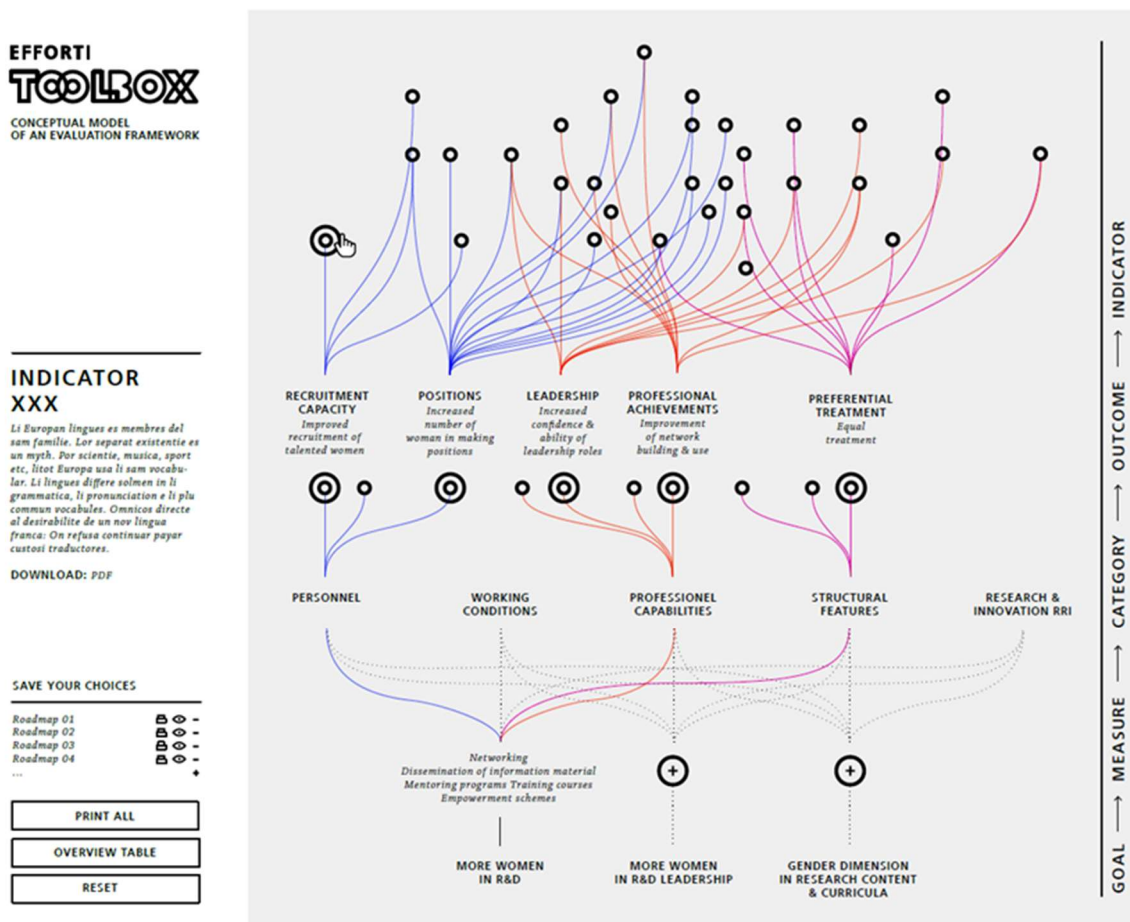


Figure 6: Early user interface draft of the dynamic part of the EFFORTI toolbox (designed by Fraunhofer CeRRI)

Giving systematic access to the impact story database, the dynamic part of the EFFORTI toolbox makes it possible to compile a customised gender equality intervention programme or evaluation design and to simulate ideal-type process, outcomes and impacts. One of the basic premises of EFFORTI is that the specific context of a gender equality measure substantially affects the measure's outcome and impact. Taking into consideration the specificity of each context implies that the EFFORTI impact story database cannot assert the claim to enable the construction of universal and "one size fits all" impact chains. The database has to be understood as an expert system. An expert system is a subtype of artificial intelligence. It is a knowledge-based system with inference or problem-solving capability and (sometimes) highly developed interaction capability for application in a very limited special field (Styczynski, Rudion, and Naumann 2017, 9).

The knowledge base of the EFFORTI expert system consists of the impact stories, prepared by the EFFORTI team members and substantiated by their collective experience from different and complementary fields of science, empirical findings in the literature and the 26 case studies that will be conducted in WP4. Metaphorically, the EFFORTI toolbox will allow the user to have a discourse with the EFFORTI experts on plausible impact chains and programme theories. Behind the user interface of the EFFORTI expert system lays a limited inference component that uses rudimentary IF-THEN rules, e.g. "IF measure X and measure Y are selected, THEN this may cause overlaps at the impact level," or "IF goal X is selected, THEN measure X, measure Y and measure Z should be part of the programme design."

Output, outcome and impact are classified according to a system of categories that was developed in the context of Deliverable 3.2 and further elaborated during the course of the project (see Annex I). Hereby, it will be possible to visualise the intersections between the particular gender equality measures. The typology of gender equality measures that are included in the EFFORTI impact story database is derived from multiple sources. The basic typology is adapted from Kalpazidou Schmidt and Cacace (2017), who assessed 125 gender equality programmes in research organisations worldwide. The initial typology was extended by the EFFORTI team and its advisory board during a workshop meeting for further measures that promote the inclusion of gender in research content. During the last step, the resulting typology was compared to the extensive list of fields and sub-fields of action of the GENERA project (Oetke, Holzinger and Baraban 2017).

Figure 7 shows the logic of the impact story approach by the means of an exemplary gender equality measure 'revision of internal policies regarding promotions'. The measure aims at the immediate output of a more transparent and formalised promotion process. An increase in transparency can lead to an increase of performance-related justice in promotions as an outcome, and to stronger performance-orientation of the whole research organisation/system as an impact. Figure 7 also visualises the theoretical assumptions that are present to validate the superior intervention logic (in the green boxes of figure 7). First, the measure is split into its particular activities, and then the output, outcome and impact are further specified. For example, increased transparency in promotion processes enables better career planning, increases work climate and job satisfaction (as promotions are perceived as more justified) and may also lead to higher performance incentives for all team members (as performance requirements are clarified). In the long run, because of a weakening of institutional gender bias, the number of women at all hierarchy levels is expected to increase and research performance is expected to improve. Suitable quantitative and qualitative indicators are attributed to all levels of the impact chain (output, outcome, impact). Consequently, the impact stories are

also used to decide which of the versatile set of indicators that was compiled during the previous research steps will be part of the EFFORTI toolbox.

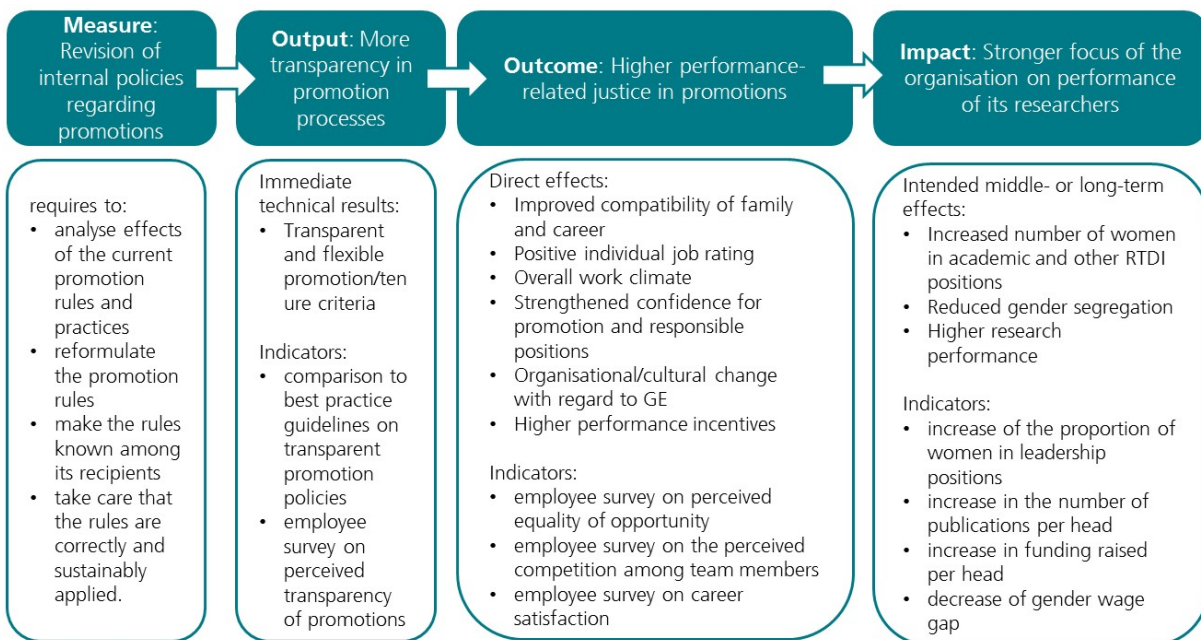


Figure 7: Logic of an exemplary impact story

Methodologically, the impact stories not only form the core of the EFFORTI expert system, they also set a cornerstone for the case studies. In preparation of the case studies, change models of the examined programmes are built on the basis of the impact stories. During the case studies, the change models are assessed for their reliability and functionality. In turn, the case studies allow for validation, refining or readjustment of the impact stories. All impact stories follow the same structure:

1. Definition of the gender equality measure
2. Output: description of the measure’s immediate technical results and output indicators
3. Outcome: description of the measure’s direct social effects and outcome indicators
4. Impact: description of the measure’s intended middle- or long-term effects and impact indicators
5. Description of possible positive and/or negative unintended effects and strategies to foster or avoid those effects

Below, two examples of impact stories are presented, one on gendered user involvement (see Tab. 3) and one on mentoring (see Tab. 4) to illustrate the impact chain of an intervention/measure.

Tab. 3. An exemplary impact story on gendered user involvement

Impact	story
Gendered user involvement	
Measure	definition
The GE intervention “gendered user involvement” describes an approach in the development of new products that focuses on usability for women and men (and other diversity dimensions). This will be	

<p>achieved by involving (future) female and male users of a product in the development process (see Schraudner et al. 2013) and identifying their needs and requirements for the product. If technologies are developed based on "I Methodology", this can lead to non-target-group-adequate products. "I Methodology" describes a development process in which (mostly male) researchers and designers see themselves as a typical user and develop products based on their needs (see Akrich 1995, Oudshroon et al, 2004). This can be problematic because (male) researchers have a special "insider relationship" with technology that makes their world view different from that of other male and female users of their product.</p>		
<p>Goal Gender dimension in research content & curricula, responsible research and innovation, research performance</p>		
<p>Output The measure's short-term output aims at the integration of gendered user involvement activities into technology development processes like gender-divided test groups, gendered needs assessments, usability tests, participatory co-designing, etc., ideally from the very beginning (see Nedopil/Schauber/Glende 2013; Rommes 2014). The result of this changed technology development process is information on gender-specific (and diversity-specific) user requirements for the product to be developed.</p>		
Output		dimension
<p>Research outputs and impacts; innovation outputs and impacts; gender-sensitive research; RRI</p>		
Output		subdimension
<p>Research priorities and outcomes of GE; scientific output; knowledge about sex and gender is incorporated into engineering innovation processes; research quality: integration of a gender dimension in research and content, patents, agreements; civil engagement</p>		
Output	indicators	short
<p>Composition of gendered product development; New, altered or improved research tools & techniques, models and simulations; New advanced capabilities, methods, systems, infrastructures and technologies; Development of user-driven innovation/design innovation; sample composition by sex; needs and expectations of research subjects and gender assumptions have been considered and included; involvement of citizens in the phases of research</p>		
<p>Outcome The measure's middle-term outcome aims at products that meet the different needs of various user groups. Considering diversity dimensions can lead to an extension of the target group of a product and thus to an increase in market opportunities (Schraudner / Lukoschat 2006) and an increase in sales figures (for example, due to customer satisfaction and recommendations). In addition, an early involvement of users in development processes can help avoid mistakes and thus reduce possible development costs (e.g. cost reduction by solving usability problems right at the beginning of the development process, reducing costs for future revisions, reducing the cost of usage instructions) (Bevan 2005, 3). "Early societal intervention in the (...) process can help avoid technologies failing to embed in society and / or help that</p>		

their positive and negative impacts are better governed and exploited at a much earlier stage” (von Schomberg 2013, 64f).		
Outcome		dimension
Innovation outputs and impacts; economic outputs and impacts; gender-sensitive research		
Outcome		subdimension
Conventional innovation indicators; Diffusion of innovation in products, services, processes; Economic impacts; Research quality:		
Outcome	indicators	short
Demonstrators of innovative solutions; new context-adapted solutions; new products, processes and methods launched into the market; turnover from innovation; sales of new to market and new to firm innovations; improved market uptake and replication of tested technologies; improved cost-effectiveness and sustainability of solutions; improved time-to-market; turnover of company; competitive advantage through increased usability of products		
Impact		
Taking into account different diversity dimensions of potential users when developing technological products, creates an added value since research and development is aligned to the demands of society and the excellence and quality of the results is encouraged (see genSET 2010; Von Schomberg 2013, Kristensson/Gustafsson/Archer 2004, Lüthje 2003, Rauterberg 2003). When gendered user involvement is practiced by many companies of an economy, this can also have economic effects at the national level (hypothesis).		
Impact		dimension
Scientific outputs; innovation outputs and impacts; economic outputs and impacts		
Impact		subdimension
Strengthened R&I capabilities/excellence; conventional innovation indicators; economic impacts; jobs, growth & competitiveness of participants		
Impact	indicators	short
Reputation and excellence of Europe in technological research; better innovation capability of EU firms; EU technological leadership & strengthened competitive position of European industry; enhanced innovation capability and competitiveness of European enterprises in global market; improved performance of existing businesses		
Condition	of	effectiveness
In order to avoid mistakes, it is essential to introduce participatory designs for the entire development process and not only when testing prototypes or end products (Rommes 2014, 51f, Sarodnick and Brau 2011). It is also important to ensure that the test persons are representative for potential users. Therefore, other diversity dimensions of the consumers in addition to gender must be taken into account in the sample selection (i.e. do not test products with students simply because they are easily accessible). This is also important to counteract the risk of gender stereotyping (see Siehe Rommes 2014, Erharter and Xharo 2014). Due to the lack of comprehensive methodological knowledge, standardised usability tests are frequently used in the form of questionnaires to cover user orientation. Adaptation to the specific research context often does not take place; in addition, only very few qualitative methods are used to better		

interpret the quantitative results (Ohl and Schade 2015). The use of qualitative and creative methods is, however, central to making the "tacit knowledge" of the test persons available.

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Tab. 4. An exemplary impact story on a mentoring programme

Impact	story
Mentoring programme	
Measure	definition
<p>The share of women within RTDI fields, as well as in research in general, decreases with every career step (so-called 'leaky pipeline'). Women are not only underrepresented among researchers, but also in leadership positions within academia (Göransson 2011, She Figures 2015). Mentoring is assumed to contribute to improving the female talent pool for career progression by strengthening women mentees' professional and/or leadership skills and career prospects through planning, network, and insights into organisational norms, processes, and politics. Other mentoring relationships are close and caring with a focus on personal development and emotional support (Caffarella 1992 cited by Hansman, 1998: 64). According to the literature, mentoring schemes may take different forms and have different objectives. However, most definitions agree that a mentoring relationship typically involves an experienced (older) mentor who guides, advises, and supports a less experienced mentee (Chandler 1996: 79). Finally, some scholars stress that mentoring relationships are reciprocal and benefit not only the mentee but the mentor as well (Kalpazidou Schmidt & Faber, 2016: 5). In practice, mentoring usually entails a recruitment process of mentors and mentees, followed by matching of well-suited mentor-mentee pairs. Depending on degree of formalisation, a mentoring scheme may be commenced by a launch meeting or workshop, or mentor-mentee pairs may start the mentoring meetings directly from the outset. Formal requirements may also determine how often mentor-mentee pairs should meet and what they should discuss, whereas in informal mentoring relationships, meetings and content may be agreed upon on an ad hoc basis. As the mentor-mentee pair gets to know each other, level of mutual trust and self-disclosure increases which, ideally, adds to psychosocial support and benefits of to both parties (Kram & Isabella 1988 cited by Hansman 1998).</p>	
Goal	
More women in research, more women in leadership positions, improved research performance/output	
Output	
<p>The measure's short-term output is the fostering of confidence, well-being and job satisfaction of individual mentees. Mentees further stress improved knowledge and understanding of advancement prerequisites and career strategies as valuable output. Mentoring may also concern leadership career ambitions and competences specifically. Additional outputs include, for example, the formulation of mentoring scheme policies and guidelines for the mentoring relationship, including ensuring adequate</p>	

mentoring infrastructure such as introduction meeting, workshops, etc., as well as the recruitment and matching of mentors and mentees. Lastly, increased intrinsic motivation and satisfaction of mentors to 'do something good' for a young researcher may be considered a positive side effect of mentoring (Kalpazidou Schmidt & Faber, 2016).		
Output		subdimension
Strengthened confidence for promotion and responsible positions; Decrease of GE barriers		
Output		short
Increased mentee confidence, well-being, and job satisfaction; increased intrinsic motivation of mentors; formulation of mentoring policies, guidelines, and establishment of infrastructure; recruiting and matching of mentors/mentees		
Output	indicators	short
<p><i>Individual mentees:</i> Confidence and preparedness in long-and short term goals/path; Value of having a mentor (male/ female); Satisfaction with career; Perceptions of work climate; Benefits of coaching/mentoring; Short and long-term career plans are developed; Improved understanding of different departments/sections culture and procedures; Ability to apply and exercise learned leadership skills; Growth of knowledge about local leadership and organisation culture; <i>Individual mentors:</i> Supervising/mentoring others; <i>Organisational level:</i> Implementation of mentoring/coaching programmes/sessions; Ability to identify and access mentors</p>		
Outcome		
The measure's direct outcomes include attraction and, perhaps particularly, retention of competent researchers, as mentors teach mentees about career 'paths, shortcuts and minefields' within research environments (Kalpazidou Schmidt & Faber, 2016: 13). Effects may also reside in the mentees' improved efficiency when mentors give advice on time management and prioritising work assignments. Mentees may also feel more confident and goal focused when mentors help clarify competences and strengths and identify learning potential. Finally, mentees benefit from the mentoring relationship by gaining access to the professional network of the mentor (Kalpazidou Schmidt & Faber, 2016).		
Outcome		dimension
1.1 Positions; 1.2 Recruitment capacity; 3.1 Leadership; 3.2 Professional achievements		
Outcome		subdimension
1.1.1 Increased number of women in academic and other RTDI positions; 1.2.1 Improved recruitment of talented women; 3.2.1 Increased professional development of work skills (for career success); 3.2.2 Improvement of network building and use		
Outcome	indicators	short
<p><i>Individual level:</i> Network was built/has extended and is used to advance career; Clarity about own value as a scientist; Attaining of competence awareness; Knowledge about own career paths and potential obstacles; Share of hours spent on research/teaching/other activities per sex; Ability to</p>		

create/enhance/sustain new networks/contacts/collaborations; Use of mentoring (promoting of career, obtaining of resources, useful advice to early career researchers regarding visibility and publications, etc.); Knowledge about leadership and university governance; Improved understanding of different departments/sections culture and procedures		
Impact Mentoring potentially improves research impact by increasing collegial support, knowledge sharing and collaboration across seniority ranks, clarifying pathways to qualifying for permanent positions, as well as better understanding of the norms and culture of the research environment and increased awareness on gender structures in the organisation (Kalpazidou Schmidt & Faber, 2016; Gardiner et al. 2007). Furthermore, when senior mentors learn about the (gendered) struggles of young researchers, this may ideally contribute to increased awareness at the organisational level about gender issues and change organisational structures and culture in the long run and better integration of women in the research environment (Kalpazidou Schmidt & Faber, 2016).		
Impact		dimension
4.1 Gender equality challenges/barriers; 4.2 Organisational/cultural change with regard to GE		
Impact		subdimension
4.1.1 Decrease of GE barriers; 4.2.1 Organisational/cultural change with regard to GE		
Impact	indicators	short
<i>Organisational level:</i> Number of publications in peer-reviewed high impact journals; Number of citations / field-specific citation rates; Number of awarded patents (EU 2015b); Acknowledgement of gender issues; Acceptance of cultural change; Cultural/professional features of work environment		
Conditions	of	effectiveness
The success of mentoring schemes may be impeded by factors such as lack of women mentors, lack of clearly established goals, lack of guidelines for interaction, and challenges of men mentoring women (Hunt & Michael 1986; Collard and Stalker 1991; Burke et al. 1990; Stalker 1994, all cited by Hansman 1998). Mentoring scheme owners further need to consider whether the mentor role should be assumed on a voluntary basis (intrinsic motivation, doing it for the 'greater good'), or whether reimbursement is offered (extrinsic motivation) (Kalpazidou Schmidt & Faber, 2016). Critics point to how mentoring schemes target individual women as opposed to organisational structures and culture, in efforts to 'fix the women' as opposed to 'fixing the organisation'. As such, mentoring cannot stand alone in improving gender equality in organisations (van den Brink & Benschop, 2012). Finally, to be effective, mentoring schemes need to be intersectional in order to successfully include and positively support women of colour, disabled women, etc. (Chandler, 1996).		

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7 Glossary

BES	business enterprise sector
CSR	corporate social responsibility
EA	Equity Advisor
EC	European Commission
EFFORTI	Evaluation Framework for Promoting Gender Equality in Research and Innovation
EIGE	European Institute for Gender Equality
ERA	European Research Area
EU	European Union
FTE	full-time equivalent
GE	gender equality
HEI	higher education institution
HES	higher education sector
I-O-O-I	inputs, outputs, outcomes and impact
ISCED	International Standard Classification of Education
MORRI	Monitoring the Evolution and Benefits of Responsible Research and Innovation
NGO	non-governmental organisation
OA	open access
OECD	Organisation for Economic Cooperation and Development
PhD	Doctor of Philosophy
PI	principal investigator
R&D	research and development
R&I	research and innovation
RFO	research funding organisation
RIA	Research and Innovation Action
RIO	Research and Innovation Observatory
RPO	research performing organisation
RRI	responsible research and innovation
RTD	research and technological development
RTDI	research, technological development and innovation
S&T	science and technology
SET	science, engineering and technology
STEM	science, technology, engineering and mathematics

STI	sciency, technology and industry
SWAFS	Science with and for Society
TBIE	theory-based impact evaluation
ToC	Theory of Change
TRO	translational research organisation
UK	United Kingdom
UN	United Nations
WP	work package

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with regard to research organization, universities, ministries, companies




PERSONNEL

RESULTS/ POLICY MEASURE STRATEGIES	INDICATORS AT TEAM LEVEL 	INDICATORS ORGANISATIONAL LEVEL 	INDICATORS POLICY/ COUNTRY LEVEL 
1.1 GENDER EQUALITY DIMENSION: POSITION			
<p><i>STRATEGY 1. More women in R & D</i> <i>STRATEGY 2. More women in leadership positions</i></p> <p>1.1.1 Increased number of women in academic and</p>	<ul style="list-style-type: none"> • Composition of academic positions per team (AKKA, LDW, LEAP, NL, Rice, Stanford) • Number of tenured/tenure-track/non-tenured faculty (Toolkit) • Perception of hampering performance due to increased costs of coordination and negotiating between diverse members (UoC A4) • Gendered competency expectations (GenPORT) 	<ul style="list-style-type: none"> • Horizontal/vertical segregation in positions (AU) • Relative probability between the ability of men and women reaching a top position (NL) • Period of time spent in academic positions (LEAP) • Cohort/event history analyses of tenure and promotion (Toolkit) 	<ul style="list-style-type: none"> • Relative size of business enterprise in R&D sector (FI) • Models of public involvement in S&T decision making (MoRRI) • Horizontal/vertical gender segregation in occupations and in economic sectors (ECNGD, p.53 ff.) • Distribution of grade A staff across age groups by sex (ECNGD, p.64) • Distribution of staff across gender

<p>other positions</p>	<p>RTDI</p> <ul style="list-style-type: none"> • Women’s participation in paid work (MoRRI) 	<ul style="list-style-type: none"> • Proportion of doctorates becoming professors within a 12-year period (VINNMER) • Comparison between the proportion of female faculty during the most recent academic year to the proportion hired in the period of the past 3 years (Michigan) • Rate of change in composition of faculty (Stanford) • Number of newly appointed full professors (hired or promoted) (Stanford) • Encouragement to engage in decision-making (LDW) • Share of female heads of research performance organizations (MoRRI) • Citizen preferences for active participation in S&T decision-making (MoRRI) 	<ul style="list-style-type: none"> • Distribution of RFOs across gender • Success rates of men and women applicants to positions • Percentage of research evaluation panels in RFOs that included the targeted at least 40% of underrepresented sex in boards (ECNGD, p.64) • Proportion of women in grade A positions (ECNGD, p.63) • Proportion of women grade A staff by main field of science (ECNGD, p.63) • Dissimilarity Index (MoRRI) • Glass Ceiling Index (MoRRI) • Gender Wage Gap (MoRRI) • Percentage of Member State funding programmes explicitly including gender requirements (MoRRI)
<p><i>STRATEGY 2. More women in leadership positions</i></p> <p>1.1.2 Increased number of women in decision-making positions</p>	<ul style="list-style-type: none"> • Increase in leadership positions by women who participated in the programme (Uppsala, NZWIL) • Experiences to be sought for leadership roles (NZWIL) 	<ul style="list-style-type: none"> • Taken up leadership positions such as rector, associate professor, dean/associate dean, centre director, head of department, leader of research (AKKA) • Composition of boards or committees (AKKA, Athena SWAN, Toolkit) • Percentage of professional staff at employment levels (NZWIL) • Kinds of leadership roles engaged since the programme (NZWIL) • Proportion of women on (company) boards, members and leaders (ECNGD, p.64) • Share of male and female members of boards in largest quoted companies, 	<ul style="list-style-type: none"> • Measures addressing Gender balance in decision making (ECNGD, p.41) • Proportion of women heads of institutions in the higher education sector (ECNGD, p.64) • Proportion of women in leadership positions (AU) • Distribution of gender among rectors • Distribution of gender among reviewers • Distribution of gender among heads of review panels • Distribution of gender in recruitment or promotion boards

		<p>supervisory board or board of directors (ECNGD, p.58)</p> <ul style="list-style-type: none"> • Percentage of women in advisory committees (MoRRI) • Percentage of women in expert groups (MoRRI) • Percentage of women in proposal evaluation panels (MoRRI) 	
<h2>1.2 GENDER EQUALITY DIMENSION: RECRUITMENT CAPACITY</h2>			
<p><i>STRATEGY 1. More women in R & D</i> <i>STRATEGY 2. More women in leadership positions</i></p> <p>1.2.1 Improved recruitment of talented women</p>	<ul style="list-style-type: none"> • Number of new hired faculty (Toolkit) • Negotiation of job offers (concerning salary, workload, office space) (LEAP) • Reaction on female supporting treatment (Athena SWAN, ESWN) 	<ul style="list-style-type: none"> • Fairness of evaluation (Advance IT) • Guideline for recommendation letters (e.g. content; length; solid recommendation; professional portrayal) (Advance IT) • Composition of search committees and applicant pool (Advance IT) • Facts about contracts of newly hired faculty (e.g. base salary, funding source, benefits, technical support) (Toolkit) • Relation between gender composition and success rate of the candidate pool (Stanford) • Share of gender-balanced recruitment committees at RPOs (MoRRI) 	<ul style="list-style-type: none"> • Openness of labour market for researchers (ECNGD, p.6) • Degree of institutional autonomy (ECNGD, p.6) • Sex differences in international mobility of researchers during PhD/in post-PhD careers (ECNGD, p.63)

2 WORKING CONDITIONS

RESULTS/ POLICY MEASURE STRATEGIES	INDICATORS AT TEAM LEVEL 	INDICATORS ORGANISATIONAL LEVEL AT 	INDICATORS AT POLICY/ COUNTRY LEVEL 
2.1 GENDER EQUALITY DIMENSION: WORK/LIFE BALANCE			
<p>STRATEGY 1. More women in R & D STRATEGY 2. More women in leadership positions</p> <p>2.1.1 Improved compatibility of family and career</p>	<ul style="list-style-type: none"> • Extent of experienced work-family conflict (Rice) • Perceived challenges in balancing private life and work (AKKA, Athena SWAN) • Satisfaction with current work-life balance (ESWN) • Perception of influence of career break on career progress (Athena SWAN) • Ability to balance work-life (LDW) • Who is entitled to take parental leave (ECNGD, p.32) 	<ul style="list-style-type: none"> • On-site child care is seen to reduce job stress (Rice) • Range of institutional support (child-care; partner/spousal hiring; health accommodations; career planning; etc.) (LEAP) • Work/life culture points enables work-life balance (family-friendly working conditions; flex-time, work-family policies, etc.) (Athena SWAN) • Working time culture – average working time compared to contracts, 	<ul style="list-style-type: none"> • Possible duration of maternity leave (ECNGD, p.31) • Possibility of paternity leave (ECNGD, p.31) • Possible duration of parental leave (ECNGD, p.32) • Legal right to reduce working time on request (Elternteilzeit) (ECNGD. p.35) • Compensation rate for wages for maternity/parental leave (ECNGD, p.34) • Protection against dismissal (ECNGD, p.35)

	<ul style="list-style-type: none"> • Flexibility of parental leave arrangements (ECNGD, p.33) • Average duration of parental leave periods by sex (ECNGD, p.36) • Amount of professional high quality time (FI) • Perceived interpersonal conflicts related to family obligations (“mothers leave earlier from work” etc.) (NaTE) 	<ul style="list-style-type: none"> • all inclusive contracts, working on weekends, during the night, etc. (JR) • Opportunity to bring family along during stay abroad (VINNMER) • Modified duties in response to personal needs (Advance IT) • Support for returners (Athena SWAN) • Possibility of paternity Leave (ECNGD, p.31) • Share of entitled men and women using parental leave (ECNGD, p.35) • Regulations and initiatives supporting parents returning to work (ECNGD, p.33) • Number of sick days (NaTE) • Fluctuation at the department/sex (NaTE) • Who is entitled to take parental leave (ECNGD, p.32) • Flexibility of parental leave arrangements (ECNGD, p.33) • Average duration of parental leave periods by sex (ECNGD, p.36) • Culture and attitude towards parental leave (AU) 	<ul style="list-style-type: none"> • Additional paid leave for working parents (ECNGD, p.34) • Who is entitled to take parental leave (ECNGD, p.32) • Flexibility of parental leave arrangements (ECNGD, p.33) • Average duration of parental leave periods by sex (ECNGD, p.36) • Employment rate by age of children and sex (ECNGD, p.46)
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		<ul style="list-style-type: none"> • Employment by full-time and part-time status, sex (ECNGD, p.49) • Administrative/organisational practices on space allocation (Toolkit) 	
<h2>2.2 GENDER EQUALITY DIMENSION: JOB SATISFACTION</h2>			
<p><i>STRATEGY 1. More women in R & D</i></p> <p>2.2.1 Appropriate respect/recognition for (academic/scientific/leadership) work</p>	<ul style="list-style-type: none"> • Range of respect by boss/colleagues/students (ESWN) • Perception by others as a legitimate scholar (LEAP) • Changes in salary and position from entry to exit/current position (JR LBC) • Transparent promotion system (NaTE) • Salary compared to colleagues (ESWN) • Equality of attention (ESWN) • Experienced sex discrimination/sexist remarks (ESWN) 	<ul style="list-style-type: none"> • Award or honour by institution (Toolkit) • Events to create visibility and credibility and specific types of recognition for women (Advance IT, AKKA) • Transparent promotion system (NaTE) 	<ul style="list-style-type: none"> • General Gender Pay Gap (ECNGD,p.62) • Gender Pay Gap in RTDI (ECNGD, p.62)
<p><i>STRATEGY 1. More women in R & D</i> <i>STRATEGY 2. More women in leadership positions</i></p> <p>2.2.2 Positive individual job rating</p>	<ul style="list-style-type: none"> • Satisfaction with career (ESWN) • Amount of social interaction in unit/team (ESWN) • Contribution in scientific field (ESWN) • Day-to-day intellectual stimulation (ESWN) • Level of funding (ESWN) 	<ul style="list-style-type: none"> • Sense of valuing scholars and colleagues (ESWN) • Perception of people working in the area of R&I in regard to gender equality, e.g. percentage of women in R&I, who believe they have equal opportunities to pursue their careers in comparison to men (MoRRI) 	

	<ul style="list-style-type: none"> • Involvement in unit/team decision-making (ESWN) 		
<p><i>STRATEGY 1. More women in R & D</i></p> <p>2.2.3 Overall work climate</p>	<ul style="list-style-type: none"> • Perceptions of work climate (Athena SWAN) • Feelings of social isolation (ESWN) • Sense of belonging to group (Athena SWAN, LDW) • Sense of community (ESWN) 	<ul style="list-style-type: none"> • Measures on work environment/work practices (LEAP) • Cultural/professional features of work environment (LEAP) 	
<p><i>STRATEGY 1. More women in R & D</i></p> <p>2.2.4 Allocation of workload</p>	<ul style="list-style-type: none"> • Composition of faculty workload (in terms of number of taught courses and supervised graduate students) (Toolkit) • Workload by gender (AU) • Main differences of working hours between men and women in full time employment (ECNGD, p.59) 	<ul style="list-style-type: none"> • Share of hours spend on research/teaching/other activities per sex (AU) • Measures led to renegotiation of workload (LDW) • Guidelines on how to argue a release from one kind of activity (for example teaching) to focus on research (LEAP) 	<ul style="list-style-type: none"> • Measures due to labour law (AU) • Time spent on unpaid work (ECNGD, p.39) • Actual weekly working hours of full-time employed persons in academic/scientific professions by gender and country (ECNGD, p.60) • Actual weekly working hours of full-time employed persons in leadership positions by gender and country (ECNGD, p.60)
<p>2.3 GENDER EQUALITY DIMENSION: COMPETITIVENESS/PROMOTION AND CAREER</p>			
<p><i>STRATEGY 1. More women in R & D</i> <i>STRATEGY 2. More women in leadership positions</i></p>	<ul style="list-style-type: none"> • Diversity in team structure concerning tenure (Toolkit) • Career opportunities (ECNGD, p.61) 	<ul style="list-style-type: none"> • Contracts take major life events into account (e.g. child birth) (Advance IT, VINNMER) • Flexibility in promotion policy (Athena SWAN) 	

<p>2.3.1 Transparent, non-biased and flexible promotion/tenure criteria</p>		<ul style="list-style-type: none"> • Assessment of number of submitted tenure applications and number of awarded tenures (Toolkit) • Assessment of number of promotion applications and number of admissions (Toolkit) • Assessment of fixed-term contracts vs. permanent positions/contracts (ECNGD, p.61) 	
<p><i>STRATEGY 2. More women in leadership positions</i></p> <p>2.3.2 Strengthened confidence for promotion and responsible positions/</p> <p>2.3.3 Improved support to progress research career</p>	<ul style="list-style-type: none"> • Knowledge of criteria for promotion (Athena SWAN) • Rating of obstacles to get promotion/responsible position (ESWN) • Rating of own contribution (ESWN) • Awareness of research opportunities (Athena SWAN) • Confidence in own ability (Athena SWAN) • Revisions of career plan (VINNMER, LDW) • Considerations about leaving current positions (Athena SWAN) • Number of participants who were promoted after the programme (NZWIL) • Change in motivation to invest more effort in scientific career (Uppsala) 	<ul style="list-style-type: none"> • Existence of rewards and incentives (Athena SWAN) • Received personal and professional support from institution (VINNMER) • Extent of support and encouragement from institution to adopt and enact the content of promotion programmes (Uppsala) • Implementation of new tasks/responsibilities (VINNMER, LDW) • Development of the number and proportion of women ISCED 5 graduates within a certain period of time (ECNGD, p.44) • Development of the proportion of women ISCED 6 graduates (ECNGD, p.44) • Development of the number and pro- 	<ul style="list-style-type: none"> • Awareness of gender specific knowledge (AU) • Participation of women and men in RTDI (ECNGD, p.50) • Gender specific research funding programme in place (Gendernet) • Proportion of scientists and engineers (ECNGD, p.15) • Share of International Standard Classification of Education (ISCED) 6 STEM graduates in the whole population (ECNGD, p.14) • Share of tertiary educated population among the group of 25 to 34 years old by sex (ECNGD, p.18)

	<ul style="list-style-type: none"> • Perception of own improvement of profession (Uppsala) • Description of academic future (Uppsala) • Perceived challenges to get a scientific position (Athena SWAN) • Possibility to approach senior staff for assistance and tips (measuring the confidence) (LDW) • Acts of support through upper manager (NZWIL) • Received personal and professional support from unit/team (VINNMER) • Experienced extent of support and encouragement from unit/team to adopt and enact the content of promotion programmes (Uppsala) 	<p>portion of women ISCED 6 graduates differentiated by field of study (ECNGD, p.44)</p> <ul style="list-style-type: none"> • Development of the proportion of women ISCED 6 graduates differentiated by narrow fields of study (ECNGD, p.45) • Employment rate by sex (p.46) • Distribution of researchers across economic activities (NACE Rev. 2) in the business enterprise sector, by sex (ECNGD, p.57) 	
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2.4 GENDER EQUALITY DIMENSION: **WORKPLACE**




<p><i>STRATEGY 1. More women in R & D</i> <i>STRATEGY 2. More women in leadership positions</i></p> <p>2.4.1 Equal work-space/facilities allocation</p>	<ul style="list-style-type: none"> • Perceived space allocation of faculty (Toolkit) • Access to necessary facilities and work space (VINNMER) • Ranking of workplace's quality (Toolkit) • Gender resource gap 	<ul style="list-style-type: none"> • Parking zones for pregnant women (AU) • Study of actual space allocation of faculty at organisational level (access to the lab, square footage, proximity to electrical power, years since last renovation, services) (Toolkit) 	
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		<ul style="list-style-type: none"> Study of perceived space allocation of faculty (Toolkit) 	
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3

PROFESSIONAL CAPABILITIES

RESULTS/ POLICY MEASURE STRATEGIES	INDICATORS AT TEAM LEVEL 	INDICATORS ORGANISATIONAL LEVEL AT 	INDICATORS AT POLICY/ COUNTRY LEVEL 
3.1 GENDER EQUALITY DIMENSION: LEADERSHIP			
<p><i>STRATEGY 2. More women in leadership positions</i></p> <p>3.1.1 Increased confidence and ability of leadership roles</p>	<p>Ability to apply and exercise learned leadership skills (LDW, Uppsala)</p> <p>Attractiveness and personal motives to take up leadership positions (AKKA)</p> <p>Growth of knowledge about local leadership and organisation culture (LDW)</p>	<p>Implementation of leadership development programme (VINNMER)</p> <p>Assessing deans/chairs/committee leaders by assessment criteria, professional requirements, stereotypes (Advance IT)</p>	<p>Women with leadership positions (AU)</p> <p>Visibility of women at national level (AU)</p>

	<p>Perception of own role being a leader concerned with supporting women's opportunities (LDW)</p> <p>Contribution to the participant's self-perception as a primary investigator/project leader (YDUN)</p> <p>Tangible examples of leadership development skills in daily work (Uppsala)</p> <p>Visibility in the unit/team (AKKA)</p> <p>Strength of identification as a female leader (Uppsala)</p> <p>Increased self-awareness (Uppsala)</p> <p>Contributed to and/or leading meetings (LDW)</p> <p>Initiation/involvement in projects (LDW)</p>	<p>Organisational views of the advancement of women by structural features (Athena SWAN)</p> <p>Mentoring system from the very beginning when one enters the organisation (NaTE)</p> <p>Visibility of women at the university/organisation (AKKA)</p> <p>Share of projects directed by women (LDW)</p>	
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3.2 GENDER EQUALITY DIMENSION: PROFESSIONAL ACHIEVEMENTS

<p><i>STRATEGY 1. More women in R & D</i></p> <p><i>STRATEGY 2. More women in leadership positions</i></p> <p>3.2.1 Professional development of work skills (for career success) has increased</p>	<ul style="list-style-type: none"> • Time management has improved (ESWN) • Network was built/has extended and is used to advance career (ESWN) • Long-term career plan is developed (ESWN) • Ability of managing budgets is improved (ESWN) • Knowledge of own discipline is deepened (ESWN) • Clarity about own value as a scientist (ESWN) 	<ul style="list-style-type: none"> • Availability of positions in the organisation (AU) • Support and opportunities to publish (AU) • Availability of training and workshops (Advance IT) • Support to management of grant writing (Advance IT) 	<ul style="list-style-type: none"> • Availability of positions in the RTDI system (AU) • Availability of research grants (AU) • Availability of grants for staying abroad (AU) • Availability of publishing grants (AU)
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	<ul style="list-style-type: none"> • Encouragement to undertake further training and pursue personal development opportunities (Athena SWAN) • Knowledge about own career path and potential obstacles (ESWN) • Knowledge about leadership and university governance (AKKA) • Improved understanding of different departments/sections culture and procedures (AKKA) • Improved negotiation skills (ESWN) • Improved voicing opinion/confidence to argue one's position (ESWN) • Confidence and preparedness in long- and short term goals/path (ESWN) • Ability to identify and access mentors (ESWN) • Improved self-promotion skills (ESWN) • Supervising/mentoring others (ESWN) • Gaining a research or mission statement (ESWN) • Participation/strategic behaviour in committees (LDW) • Opportunities for publishing (MINNMER) • Number and level of career activities: participation in training, coaching, conferences, etc. (JR LBC) • Quality of the activities for the support of a scientific career (JR LBC) • Gender differences in research focus (FI) 		
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<p>STRATEGY 1. More women in R & D STRATEGY 2. More women in leadership positions</p> <p>3.2.2 Improvement of network building and use</p>	<ul style="list-style-type: none"> • Ability to create/enhance/sustain new networks/contacts/collaborations (AKKA, Athena SWAN, Uppsala) • Use of mentoring (promoting of career, obtaining of resources, useful advices, etc.) (LEAP) • Identification of useful local “allies” in encouraging GE (Michigan) • Experienced value of the opportunity to network and discuss with peers (NZWIL) • Value of having a mentor (male/female) (Rice) • Benefits of coaching/mentoring (Uppsala) 	<ul style="list-style-type: none"> • Support to create/sustain networks (AU) • Implementation of mentoring/coaching programmes/sessions (Advance IT, Athena SWAN) • Invitations of visiting scholars (Advance IT, Athena SWAN) • Invitation of female speakers (AU) • Invitation of female panelists (AU) • Facilitation of informal get-together events (Advance IT, Athena SWAN) • Existence of women-only groups/networks (AKKA, Athena SWAN) • Share of women local researchers who are considered as mentors (LEAP) 	
<p>3.3 GENDER EQUALITY DIMENSION: AWARENESS OF/COMMITMENT TO GENDER EQUALITY</p>			
<p>STRATEGY 1. More women in R & D STRATEGY 2. More women in leadership positions STRATEGY 3. Gender dimension in research content and curricula</p> <p>3.3.1 Gender awareness has increased</p>	<ul style="list-style-type: none"> • Scale of personal commitment to gender diversity (LEAP) • Scale of empathy (GenPORT) • Concernment in terms of gender awareness/knowledge (Michigan) • Motivation and confidence in actively promoting gender equality (Michigan) • Level of team deference (GenPORT A23) 	<ul style="list-style-type: none"> • Scale of organisational commitment to gender diversity (measurement through regulations, contract’s reformulation, founding of new initiatives) (AU) • The perceived commitment of the university/institution to promote equality and diversity (Athena SWAN) • Raised credibility to former and current GE work (Athena SWAN) • Establishment of institutional data-gathering (Advance IT, AU) 	<ul style="list-style-type: none"> • Content and manner of appropriate GE campaigns (AU) • National R&I strategy/goals per country (ECNGD, p.9) • Equal opportunity/anti-discrimination legislation (ECNGD, p.25) • Overall strategic gender equality policies in RTDI in place (ECNGD, p.39) • Measures addressing GE in scientific careers (ECNGD, p.41) • Measures addressing GE in leadership positions in RTDI (AU)

		<ul style="list-style-type: none"> • Effect of data collection on the application process (Athena SWAN) • Perceived general gender egalitarianism (Rice) • Inclusion of the gender dimension in teaching/curricula (ECNGD, p.66) • Institution's commitment to promote equality and diversity (Athena SWAN) • Share of staff/researchers who have received training on IGAR¹⁴ (Gendernet) • Budget allocated to GE monitoring (NaTE) • Dedicated person/department/team in charge of GE monitoring (NaTE) 	<ul style="list-style-type: none"> • Bodies responsible for GE monitoring (AU)
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3.4 GENDER EQUALITY DIMENSION: FUNDING TO PROMOTE GE IN TERMS OF FEMALE CAREERS

<p>STRATEGY 1. More women in R & D</p> <p>STRATEGY 2. More women in leadership positions</p> <p>STRATEGY 3. Gender dimension in research content and curricula</p> <p>3.4.1 Funding to promote GE has increased</p>	<ul style="list-style-type: none"> • Proportion of women receiving a grant (AKKA) • Average size of grant distributed by gender (AU) • Reasons for potential applicants not to apply/to apply for funding • Offers of grants (AU) 	<ul style="list-style-type: none"> • Grants for early career development (Advance IT) • Support for career and life transitions /e.g. returners), fieldwork, conferences, professional development (Advance IT) • Proportion of women receiving a grant (AKKA) • Offer of grants (AU) 	<ul style="list-style-type: none"> • Major Funding Agencies (national & regional) (ECNGD, p.22) • Requirements for funding to promote GE (AU) • Existence of formal governance structures for RRI within research funding and performing organisations (MoRRI) • Share of research funding and performing organisations promoting RRI (MoRRI)
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¹⁴ Integrating Gender Analysis into Research

		<ul style="list-style-type: none"> • Distribution of project funds among men and women (AU) • Research Funding Organizations Index (MoRRI) 	<ul style="list-style-type: none"> • Funder mandates (MoRRI) • Share of men and women among applicants (AU) • Share of men and women among successful applicants (AU)
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<p><i>STRATEGY 1. More women in R & D</i> <i>STRATEGY 2. More women in leadership positions</i></p> <p>4.1.1 Decrease of GE barriers</p>	<p>Perception of a gender-orientated receipt of attention (Athena SWAN)</p> <p>Perception of working up effort with respect to gender (Athena SWAN)</p> <p>Acknowledgement of gender issues in team (AKKA)</p> <p>Acceptance of cultural change (Athena SWAN)</p> <p>Value of gender promoting measures (ESWN)</p> <p>Experienced sex discrimination/sexist remarks (ESWN)</p> <p>Gender bias in task allocation (Gendernet)</p> <p>Level of visibility (Rice)</p>	<p>Acknowledgement of gender issues (AKKA)</p> <p>Acceptance of cultural change (Athena SWAN)</p> <p>Engagement of decision makers (Integer)</p> <p>Gender monitoring/reporting in regular monitoring instruments (Integer)</p> <p>Sustainability of gender equality initiatives (Athena SWAN, LDW)</p> <p>GE dedicated administrative staff (Athena SWAN)</p> <p>Enacting of policy change (Advance IT)</p> <p>Science communication culture (MoRRI)</p> <p>Citizen science activities in RPOs (MoRRI)</p> <p>RPO support structures for researchers as regards incentives and barriers for data sharing (MoRRI)</p> <p>Integration of GE in KPIs (FI)</p> <p>Percentage of women taking part in research mobility programmes (MoRRI)</p>	<p>Main challenges concerning GE in RTDI (ECNGD, p.41)</p> <p>Percentage of schools (primary and secondary) that have programmes promoting GE issues in regard to career choices (MoRRI)</p> <p>Perception of gender roles in science amongst young people and their parents (MoRRI)</p> <p>Percentage of parents who believe their children (daughters) will have equal opportunities to pursue a career in STEM (MoRRI)</p> <p>Percentage of research institutions that document specific actions that minimize/reduce barriers in work/environment that disadvantage one sex (e.g. flexibility of working hours) (MoRRI)</p> <p>Share of RPOs with gender in research content (MoRRI)</p>
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4.2 GENDER EQUALITY DIMENSION: ORGANISATIONAL/CULTURAL CHANGE

STRATEGY 1. More women in R & D
STRATEGY 2. More women in leadership positions

4.2.1. Organisational/cultural change with regard to GE

- Perceived extent and pace of cultural change on team level (Athena SWAN)
- Experience of a cultural shift during career (LDW)
- Advices to a successful cultural/organisational change (Rice)
- Rating of communication paths and processes (Integer http://www.integer-tools-for-action.eu/sites/www.integer-tools-for-action.eu/files/file_fields/2015/07/01/integerprocessreporttemplate_0.pdf)
- Rating of transparency regarding decision-making bodies and criteria (Athena SWAN)

- Establishment of gender equality structures and procedures (Gendernet)
- Perceived extent and pace of cultural change on organisational level (Athena SWAN)
- Adaptations in guidelines, employee rights, spousal appointments (Rice)
- Capacity building as to GE (e.g. career development centre) (AU)
- General organisational consciousness and messages with symbolic value (Advance IT)
- Assessment of the effectiveness of existing equal opportunity/anti-discrimination legislation/measures (ECNGD, p.28)
- Adoption of GE plans (ECNGD, p.44)
- Ethics at the level of universities/RPOs (MoRRI)

- Perceived extent and pace of cultural change on policy level (Athena SWAN)
- Ministries responsible for R&I and GE (ECNGD, p.21)
- Structures for GE (ECNGD, p.26)
- Relevant policy initiatives to foster equality (ECNGD, p.26)
- Policy-oriented engagement with science and GE (MoRRI)
- Percentage of RPOs that document specific actions aiming to change aspects of their organisational culture that reinforce gender bias (MoRRI)

4.3 GENDER EQUALITY DIMENSION: PREFERENTIAL TREATMENT

STRATEGY 1. More women in R & D
STRATEGY 2. More women in leadership positions
STRATEGY 3. Gender dimension in research content and curricula

4.3.1 Equal treatment

- Perception of preferential treatment such as advice, access to lab or equipment, resources, recruitment, promotion, attention to meetings (Athena SWAN, ESWN)
- Perception of likelihood of male/female success in academia (Athena SWAN)
- Amount of free time, i.e. high quality time for the researcher to stimulate ideas, discussion, etc. (FI)

- GE unit/committee in place (Gendemet)
- Gender in Research Content unit/committee in place (Gendernet)
- Facilitating mobility of female researchers (Gendernet)

- Legislation in place

4.4 GENDER EQUALITY DIMENSION: FUNDING FOR STRUCTURAL TRANSFORMATION




<p><i>STRATEGY 1. More women in R & D</i> <i>STRATEGY 2. More women in leadership positions</i> <i>STRATEGY 3. Gender dimension in research content and curricula</i></p> <p>4.4.1 Increased funding to achieve structural transformation</p>	<p>Proportion of women receiving a grant (<u>AKKA</u>)</p> <p>Average size of grant distributed by gender (AU)</p> <p>Reasons for potential applicants not to apply/to apply for funding</p> <p>Offers of grants (AU)</p>	<p>Budget spent on GE measures (Integer)</p> <p>Grants for early career development (Advance IT)</p> <p>Support for career and life transitions /e.g. returners), fieldwork, conferences, professional development (Advance IT)</p> <p>Proportion of women receiving a grant (<u>AKKA</u>)</p> <p>Composition of applicants and those who received a funding (<u>YDUN</u>)</p> <p>Offer of grants (AU)</p> <p>Distribution of project funds among men and women (AU)</p> <p>Research Funding Organizations Index (<u>MoRRI</u>)</p>	<p>Major Funding Agencies (national & regional) (ECNGD, p.22)</p> <p>Requirements for funding to promote GE (AU)</p> <p>Existence of formal governance structures for RRI within research funding and performing organisations (<u>MoRRI</u>)</p> <p>Share of research funding and performing organisations promoting RRI (<u>MoRRI</u>)</p> <p>Funder mandates (<u>MoRRI</u>)</p> <p>Share of men and women among applicants (AU)</p> <p>Share of men and women among successful applicants (AU)</p>
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5

RESEARCH



INNOVATION/RRI

RESULTS/ POLICY MEASURE STRATEGIES	INDICATORS AT TEAM LEVEL 	INDICATORS ORGANISATIONAL LEVEL AT 	INDICATORS AT POLICY/ COUNTRY LEVEL 
5.1: RESEARCH AND INNOVATION DIMENSION: Research Outputs and Impacts			
5.1.1 Scientific Outputs	<ul style="list-style-type: none"> • H-index (Campbell et al. (2013: 2-3) • Number of presentations at conferences • New, altered or improved research tools & techniques, models and simulations (EU 2016) • New advanced capabilities, methods, systems, infrastructures and technologies (EU 2016) • Science prizes / rewards (WR) • Stipends / Scholarships / Grants (WR) 	<ul style="list-style-type: none"> • Percentage of publications from projects which are among the top 1 % highly cited (EU 2015b) • Number of publications in peer-reviewed high impact journals (EU 2015b) • Percentage of publications published in the top 10% impact ranked journals (EU 2015b) • Publication's interdisciplinarity (FI) 	<ul style="list-style-type: none"> • Publication's interdisciplinarity (FI) • Number of citations (FI) • Country's share of publications (ECNGD, p.6) • Number and share of female authors (MoRRI 2015a) • Scientific breakthroughs spurring innovation across sectors (EU 2016) • Emergence of new technologies or field of science in the EU (EU 2016)

	<ul style="list-style-type: none"> • Consulting activities (WR) • Membership in editorial boards / editors (WR) • Licence income (patent, software, know-how, patents, trade marks) (WR) 	<ul style="list-style-type: none"> • Number of citations / field-specific citation rates (FI) • Percentage of women that are first authors of research papers (EU 2015a) • Conferences/ workshops papers and proceedings (EU 2016) 	<ul style="list-style-type: none"> • EU world-class excellence in science (EU 2016) • Number of scientific papers in relation to the population size (ECNGD, p.17) •
5.1.2 Networks	<ul style="list-style-type: none"> • Scientific collaboration across disciplines on new, high-risk ideas (EU 2016) • Cross-country (also beyond EU) and cross-disciplinary research and innovation networks (incl. SMEs) (EU 2016) • 	<ul style="list-style-type: none"> • Publication's international collaboration (FI) • Number and percentage of joint public-private-publications out of all publications (EU 2015b) • 	<ul style="list-style-type: none"> • Publication's international collaboration (FI) • Percentage of international scientific co-publications (ECNGD, p.6) • Public-private co-publications (ECNGD, p.6) • Stronger pan-European collaboration across disciplines, sectors, value chains & technology levels (EU 2016)
5.1.3 Training / Human Capital	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Researchers trained (inc. PhD, post-docs, gender balanced) (EU 2016) 	<ul style="list-style-type: none"> • Improved attractiveness of researchers' careers across the EU (EU 2016) • Strengthened human potential in R&D in business and academia (incl gender balance) across EU countries
5.1.4 Strengthened R&I capacities/excellence	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Reputation and excellence of Europe in scientific and technological research (modernisation of research institutions, vitality of research environment, quality of research outputs in basic & applied research) (EU 2016)
5.1.5 Research priorities and	Personal experience and interests (Stanford)	Professional career tracks and standards for promotion (Stanford)	Initiatives of public and private funders and other stakeholders (Stanford)

<p>outcomes terms of GE</p>	<p>in</p> <p>Beliefs and unconscious assumptions (Stanford)</p> <p>Women's perception of their ability to be an entrepreneur and to hold themselves to a stricter standard of competence (FI, A29)</p> <p>Women's perception to hold themselves to a stricter standard of competence (FI, A29)</p> <p>Degree of fear of failure (FI, A28)</p>	<p>Turnover in RPOs (FI, A7)</p> <p>Composition of gendered product development (FI, A7)</p>	<p>Industrial funding and lobbying (Stanford)</p> <p>Military funding priorities and lobby-ing (Stanford)</p> <p>Health funding priorities and lobbying (Stanford)</p> <p>Regulatory environment (Stanford)</p> <p>Market research on competitors or particular market segments (Stanford)</p> <p>The configuration of academic disciplines (Stanford)</p> <p>Political and cultural initiatives and movements (Stanford)</p> <p>RTDI tax incentives (ECNGD, p.9)</p> <p>Expenditures on RTDI sector in comparison to remaining sectors by public sector/domestic business (ECNGD,p.7)</p> <p>Share of research projects with specific GE actions (MoRRI 2015b)</p>
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5.2 RESEARCH AND INNOVATION DIMENSION: Innovation Outputs and Impacts (incl. technological impacts)

<p>5.2.1 Conventional innovation indicators</p>	<ul style="list-style-type: none"> • Joint databases, platforms, testbeds (EU 2016) • New common methodologies (EU 2016) • Technology roadmaps (EU 2016) • New or improved standards (EU 2016) • Proof of scientific & technological feasibility (EU 2016) • Awareness on market and end-user needs (EU 2016) 	<ul style="list-style-type: none"> • Number of patent applications EU 2015b) • Number of awarded patents (EU 2015b) • Number of patent applications by Theme (EU 2015b) • Number of awarded patents by theme (EU 2015b) 	<ul style="list-style-type: none"> • Women's representation among inventors in Europe (FI) • RTDI expenditures in the business sector (ECNGD, p.6) • Community designs (ECNGD, p.6) • Community trademarks (ECNGD, p.6) • Number of patents per inhabitant/citizen (ECNGD, p.18) • Number and share of female inventors (MoRRI 2015a)
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	<ul style="list-style-type: none"> • Demonstrators of innovative solutions • Business plans (EU 2016) • New context-adapted solutions (technological & non-technological e.g financial, regulatory or business models) (EU 2016) • Innovative processes, products& service delivery systems (EU 2016) • Projects having sought additional or follow-up funding - private or public - incl. from regional/national schemes (EU 2016) • 	<ul style="list-style-type: none"> • New products, processes, and methods launched into the market (EU 2015b), according to SC • Improved products, services, processes launched onto the market (EU 2015b) • Standardisation / norm setting (Horvat 2007) • New instruments / demonstrators • Industrial spill-overs • Spin-offs (WR) • Set-up of Knowledge and Innovation Communities gathering research, innovation and higher education (EU 2016) • Networks of developers, providers and users of solutions involved in cocreation (value chain) (EU 2016) • Private companies introducing innovations (Self-reporting (yes/no) of participating firms, based on a common definition of “innovations new to the company or the market” (EU 2015b) • Number and % of participating SMEs that have introduced innovations to the company or to the market (EU 2015b) • New, altered or improved ideas, products, designs, processes, services and business models (EU 2016) 	<ul style="list-style-type: none"> • Better innovation capability of EU firms (EU 2016) • Number of young patenting firms (per GDP (Fan)
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		<ul style="list-style-type: none"> • Turnover from innovation; sales of new to market and new to firm innovations (Fan) • License and patent revenues from abroad (Fan) 	
5.2.2 Diffusion of innovation products, services, processes	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Portfolio of demonstrated replicable, up-scalable and “contextualisable” innovative solutions (EU 2016) • All forms of innovation that enable the transition to more sustainable economies fostered incl. through digital systems (EU 2016) • Improved market uptake and replication of tested technologies (EU 2016) • Solutions brought closer to market (increase in TRL) (EU 2016) • Improved cost-effectiveness and sustainability of solutions (EU 2016) • Improved manufacturing processes & equipment of EU industry (EU 2016) • Improved time-to-market for European manufacturers and service providers (EU 2016) • Improved sustainability across the entire product-service lifecycle (EU 2016) • Increased digitisation of industry and economy (EU 2016)

			<ul style="list-style-type: none"> • New and better product-service offerings addressing customer needs (EU 2016) • Creation of smart global value chains that enable value capture to Europe (EU 2016)
5.2.3 Knowledge about sex and gender is incorporated into engineering innovation processes			<ul style="list-style-type: none"> • Do innovations and technologies serve certain groups of women or men more than others? (Stanford) • Development of user-driven innovation/design innovation (JR, A33) • Degree of competition by image shaping by gendered productivity (JR,A33)
5.3 RESEARCH AND INNOVATION DIMENSION: Economic Outputs and Impacts (incl. entrepreneurships)			
5.3.1 Economic Impacts	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Growth and job creation in participating SMEs (EU 2015b) • Turnover of company, number of employees (EU 2015b) 	<ul style="list-style-type: none"> • EU technological leadership & strengthened competitive position of European industry (incl. SMEs, start-ups (EU 2016) • Diffusion of innovation in the economy (incl. in SMEs) generating jobs, growth and investments (EU 2016) • Share of enterprises cooperation with academia (e.g. patents filed by unis and public labs per GDP) (Fan)
5.3.2 Entrepreneurship	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Risk Finance -Total investments mobilised via debt financing and Venture Capital investments (EU 2015b) • Number of business ideas incubated (EU 2015b) 	<ul style="list-style-type: none"> • Share of women founding a company (FI) • Average number of full-time equivalents in women owned businesses (FI) • Employment in fast growing firms of innovative sectors (FAN)

			<p>Ease of entrepreneurship index (FAN)</p> <p>Venture capital investments per GDP (Fan)</p> <p>Innovative enterprises as % of total enterprises by size and type of innovation (Fan)</p>
<p>5.3.3 Strengthened framework conditions for R&I</p>	•	•	<ul style="list-style-type: none"> • Leveraged private and public investment in R&I (EU 2016) • Leveraged demand for solutions for tackling societal challenges (EU 2016) • More innovation conducive regulatory frameworks (EU 2016) • Innovative financing, business and governance models for innovative solutions adopting trans-disciplinary and participatory approaches and promoting citizens' engagement (co-creation processes) (EU 2016) • Increased availability of debt & equity finance for R&D and innovation-driven companies (EU 2016)
<p>5.3.4 Jobs, growth & competitiveness of participants (incl. SMEs)</p>			<ul style="list-style-type: none"> • Enhanced innovation capability and competitiveness of European enterprises in global market for innovative solutions (esp. SMEs) (EU 2016) • Jobs maintained and created in business and academia (EU 2016) • New business entities created or improved performance of existing businesses (EU 2016)

			<ul style="list-style-type: none"> • Opening up of new markets for participants (EU 2016) • Growth & internationalisation of participating SMEs (EU 2016)
5.4 GENDER EQUALITY DIMENSION: GENDER SENSITIVE RESEARCH			
<p><i>STRATEGY 1. More 20 women in R & D</i> <i>STRATEGY 3. Gender dimension in research content and curricula</i></p> <p>5.3.1 Achieved Gender Equality in research process</p>	<ul style="list-style-type: none"> • Gender balance in research team/research team composition (GPGSR, p.9) • Number of projects lead by women (GPGSR, p.9) 	<ul style="list-style-type: none"> • The research has included or fostered participation of all agents in the process of investigation (GPGSR, p.11) • Equitably published results to ensure a balance of authorship in research (GPGSR, p.12) • Measures for research team building and their regularity (JR LBC) 	<ul style="list-style-type: none"> • Awareness of and support to gender sensitive research at system level (research councils, other research funding organisations) (AU)
<p><i>STRATEGY 3. Gender dimension in research content and curricula</i></p> <p>5.3.2 Research quality: A gender dimension/perspective in research and content, in research projects, patents, agreements is integrated</p>	<ul style="list-style-type: none"> • Research question has been delimited (Stanford) 	<ul style="list-style-type: none"> • Percentage of research projects including gender analysis/gender dimensions in the content of research (MoRRI 2015b) • Scientific production infused with power relations and based on hierarchical relationships between different fields of knowledge (GPGSR, p.6) • Gender, sexuality and the body of are part of the processes of control in work organisations, specially of women (GPGSR, p.6) • Issues related to procreation and emotions are abandoned and excluded (GPGSR, p.6) • Reconsiderations of the significance of scientific validity in order to visibilize 	<ul style="list-style-type: none"> • Share of research projects with gender dimension in content (MoRRI 2015b) • Share of RFOs promoting gender content in research (MoRRI 2015b) • Share of gender-balanced research evaluation panels in Research Funding Organisations (RFOs) (MoRRI 2015b) • Percentage of research institutions that provide training/support for researchers in regard to the inclusion of gender dimensions in the content of research (EU 2015a) • Competitive advantage through increased usability of products (FI, A32)

		<p>hidden hierarchy of organisations (GPGSR, p.6)</p> <ul style="list-style-type: none"> • Importance in scientific analyses to attach to everything related to gender inequalities and power relationships (GPGSR, p.6) • Gender appears in studies of any subject (GPGSR, p.6) • The project's title in terms of gender and gender equality to describe project (GPGSR, p.9) • Existence/absence of knowledge on sex and gender in research field (GPGSR, p.10) • Definition of research priorities considering who will benefit/be ignored by research projects (GPGSR, p.10) • Sample composition by sex (GPGSR, p.11) • Needs and expectations of research subjects as well as power relationships and gender assumptions (of researchers and research subjects) have been considered and included (GPGSR, p.10) • Sex differences have been analysed (GPGSR, p.11) • Other "biological and socio-cultural" differences have been taken into account (GPGSR, p.11) • The analysis of gender has been set out and clearly explained in the 	<ul style="list-style-type: none"> • Measures addressing the integration of gender dimension in research (ECNGD, p.42) •
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		<p>dissemination of research results (GPGSR, p.12)</p> <ul style="list-style-type: none"> • Gender-neutral, non-sexist language is used (GPGSR, p.12) • Active information search about controversial technology (Meijer et al. 2016) 	
<p><i>STRATEGY 3. Gender dimension in research content and curricula</i></p> <p>5.3.3 Contributions to strengthening the gender sensitive research are made</p>	<ul style="list-style-type: none"> • People/employees feel empowered making research more participatory, creative and inclusive (GPGSR, p.7) • Perception of improvement of people's and social groups' lives (GPGSR, p.7) • Perception of rebalancing power especially in relation to women on team level (GPGSR, p.7) 	<ul style="list-style-type: none"> • Perception of rebalancing power especially in relation to women on organisational level (GPGSR, p.7) • Level of scientific reflection of research projects (GPGSR, p.7) • Level of taking the role of the researchers and their relationship with their participants into account (GPGSR, p.7) • Research tools are adapted to the subject's language and worldview (GPGSR, p.7) • Legal concepts related to gender and of analysis techniques about mainstreaming gender perspectives in public policies are included (GPGSR, p.7) • Senior managers (clarify their specific role!) are involved in the implementation of the policy that integrates gender analysis into research funding (Gendernet) • Amount of calls that include dissemination materials and guidelines to support applicants in the integration of 	<ul style="list-style-type: none"> • Perception of rebalancing power especially in relation to women on country level (GPGSR, p.7) • Increase of scientific knowledge about gender (GPGSR, p.8) • A policy requiring the integration of the gender analysis into research funding programmes in place (Gendernet) • Support to the inclusion of gender contents in research agendas by funders (ECNGD, p.65) • Inclusion of the gender dimension in research contents (ECNGD, p.65) • Relevance of national and regional levels in R&I policy and financing (ECNGD, p.23) • Amount of programmes which include measures aimed at integrating the gender analysis (Gendernet) • Amount of topics which are gender flagged/tagged (explicit cross-cutting gender analysis) (Gendernet) • Amount of calls that include a mandatory requirement for applicants to

		<p>the gender analysis into research proposals (Gendernet)</p> <ul style="list-style-type: none"> • Explicit integration of sex/gender analysis as one of the issues to be monitored in mid-term/final project reporting (Gendernet) 	<p>indicate whether sex and/or gender is relevant to their research proposal (Gendernet)</p> <ul style="list-style-type: none"> • Amount of calls that include a mandatory requirement for applicants who do not include sex and gender analysis to explain why not (Gendernet) • Amount and % of proposals sub-mitted that have responded YES to the sex/gender relevance question (Gendernet) • Amount and % of YES respondents to the sex/gender relevance question that: Do not include explicit consideration to sex/gender in the content of the research approach/cycle; Provide inappropriate (inconsistent, apparent ...) explicit inclusion of sex/gender considerations in the research approach/cycle; Appropriately include sex/gender analysis across the research approach/cycle. (Gendernet) • Amount and % of the total call budget spent on projects which include sex/gender analysis (Gendernet) • Amount and % of overall budget dedicated to enforcing the gender integration in research contents, please clarify budget lines (e.g. gender training, gender experts, gender eligible costs in calls etc.) (Gendernet)
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5.5 GENDER EQUALITY DIMENSION: RESPONSIBLE RESEARCH AND INNOVATION (RRI)

<p>5.5.1 Gender Equality</p>	<ul style="list-style-type: none"> • Encouragement of gender-balanced teams in the work environment (MoRRI 2017) • active support of female colleagues within the teams (MoRRI 2017) • considering gender aspects in the research design (MoRRI 2017) • using a gender-sensitive language in publications (MoRRI 2017) • explicitly dealing with gender issues in research projects (MoRRI 2017) • Percentage of women participants in [Horizon 2020] projects (EU 2015b) • Percentage of women project coordinators [in Horizon 2020] ((EU 2015b) • Percentage of projects king into account the gender dimension in research and innovation content (EU2015b) 	<ul style="list-style-type: none"> • Percentage of Member State funding programmes explicitly including gender requirements (EU 2015a) • Percentage of research institutions (including universities) that (a) have gender equality plans and (b) provide documentation of their implementation (EU 2015a) • Percentage of research institutions that document specific actions that minimise / reduce barriers in work environment that disadvantage one sex (e.g. flexibility of working hours) (EU 2015a). • Percentage of research institutions that document specific actions aiming to change aspects of their organisational culture that reinforce gender bias (EU 2015a) • Percentage of research institutions that provide training/support for researchers in regard to the inclusion of gender dimensions in the content of research (EU 2015a). • Percentage of schools (primary and secondary) that have programmes promoting gender equality issues in regard to career choices (EU 2015a). • Percentage of women on advisory committees (EU 2015a). 	<ul style="list-style-type: none"> • Share of female heads of RPOs (MoRRI 2015a) • Share of female researchers by sector (MoRRI 2015a) • Share of RFOs promoting gender content in research (MoRRI 2015a) • Dissemilarity index (MoRRI 2015a) • Share of RPOs with gender in research content (MoRRI 2015a) • Glass ceiling index (MoRRI 2015a) • Gender wage gap (MoRRI 2015a) • Share of female heads of RPOs (MoRRI 2015a) • Share of gender-balanced recruitment committees at RPOs (MoRRI 2015a) • Number and share of female inventors and authors (MoRRI 2015a) • Percentage of women in [EC] advisory groups, expert groups, evaluation panels, individual experts, etc. (EU 2015b) • <i>Share of gender-balanced recruitment committees of RPOs (MoRRI 2015b)</i> • <i>Share of RPOs with GE plans (MoRRI 2015b)</i> • <i>Share of organisations with organisational structures for GE (MoRRI 2015b)</i>
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		<ul style="list-style-type: none"> • Percentage of women in expert groups (EU 2015a) • Percentage of women on proposal evaluation panels (EU 2015a) • Percentage of women in projects throughout the whole life cycle (in full-time equivalent) (EU 2015a) • Percentage of women that are principal investigators on a project (EU 2015a) • Percentage of research projects including gender analysis/gender dimensions in the content of research (EU 2015a) • Percentage of women taking part in research mobility programmes (EU 2015a) 	<ul style="list-style-type: none"> • <i>Share of RPOs with female recruitment and promotion policies (MoRRI 2015b)</i> • <i>Gender of individual participants with contact person roles in signed grant agreements (MoRRI 2015b)</i> • <i>Years to achieve gender equality in research participation (MoRRI 2015b)</i> • <i>Female graduates and academic staff by grade (MoRRI 2015b)</i> • <i>Development of number of researchers in the whole RTDI sector and its subsectors (ECNGD, p.10)</i>
5.5.2 Ethics	<ul style="list-style-type: none"> • Submission of projects to ethical reviews) (MoRRI 2017) • Conduction of ethical reviews of projects (MoRRI 2017) • considering ethical issues when designing research (MoRRI 2017) • contributing to the development of ethical standards (MoRRI 2017) • contributing to training on ethical issues (MoRRI 2017) 	<ul style="list-style-type: none"> • Documented change in R & I priorities attributable to appraisal of ethical acceptability (EU 2015a) • Percentage of research proposals for which ethics review/IRB clearance process requires substantive changes in grant application or second ethics assessment (EU 2015a) 	<ul style="list-style-type: none"> • New or improved ethical standards or guidelines (EU 2016) • Ethics at the level of Universities (MoRRI 2015a) • National Ethics Committees Index (NEC index) (MoRRI 2015a) • Research Funding Organisations Index (MoRRI 2015a)
5.5.3 Public Engagement	1) Information for non-academics about research results through	<ul style="list-style-type: none"> • PE funding percentage from R&I (EU 2015a) 	<ul style="list-style-type: none"> • Models of public involvement in S&T decision making (MoRRI 2015a)

	<ul style="list-style-type: none"> • Written outputs (popular science books, chapters, articles in newspapers/ magazines/blogs) (MoRRi 2017) • public lectures (MoRRi 2017) • appearances on TV/radio (MoRRi 2017) • science cafés, science festivals, researchers' nights (MoRRi 2017) <p>2) Involvement of citizens in the following phase(s) of the research by</p> <ul style="list-style-type: none"> • determining what research should be performed (MoRRi 2017) • conducting the research (data collection, data analysis) (MoRRi 2017) • Discussing the consequences of research/its application (including technology assessment) (MoRRi 2017) • Communicating and disseminating the results of the project (MoRRi 2017) • Commercialisation / Exploitation of results (MoRRi 2017) <p>3) Active consideration how the research and innovation results will be perceived and used (MoRRi 2017)</p> <p>4) Collaborating with people who specialise in dialogue with citizens and civil society (e.g. professional mediator; communication company, science museums) (MoRRi 2017)</p>	<ul style="list-style-type: none"> • public influence on research agendas (EU 2015a) • Share of PE in R&I projects based on consultation, deliberation or collaboration (EU 2015a) • Media coverage (EU 2015a) • Social media /web 2.0 attention (EU 2015a) • Museum visits and impacts (on visitors, stakeholders, local communities) (EU 2015a) • Civil society organisation activities and impacts (EU 2015a) • Training of communicators (EU 2015a) • Training of scientists / engineers (EU 2015a) • PR staffing (EU 2015a) • Social scientists collaboration (EU 2015a) • In-house / outsourced consultancies (EU 2015a) • The stat of science journalism (EU 2015a) 	<ul style="list-style-type: none"> • Policy-oriented engagement with science (MoRRi 2015a) • Citizen preferences for active participation in S&T decision making (MoRRi 2015a) • Active information search about controversial technology (MoRRi 2015a) • Public engagement performance mechanisms at the level of research institutions (MoRRi 2015a) • Dedicated resources for PE (MoRRi 2015a) • Embedment of PE activities in the funding structure of key public research funding agencies (MoRRi 2015a) • PE elements as evaluative criteria in research proposal evaluations (MoRRi 2015a) • R&I democratization index (MoRRi 2015a) • National infrastructure for involvement of citizens and societal actors in research and innovation (MoRRi 2015a)
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<p>5.5.4 Science Education</p>	<ul style="list-style-type: none"> • Work with school pupils (e.g. open days, joint projects) (MoRRI 2017) • Development of science education material (e.g. kits, websites, explanatory booklets, DVDs) (MoRRI 2017) • work in partnership with schools and/or teachers (MoRRI 2017) 	<ul style="list-style-type: none"> • Education institutions/research disciplines: presence of RRI education/training (EU 2015a) • R & I project level: do they encourage or require RRI education/training (e.g. in an integrated ELSA model)? (EU 2015a) • Percentage of research projects with at least one educational resource deliverable (EU 2015a) • Percentage of research projects involving STEM teachers or students (EU 2015a) • Number of projects registered (EU 2015a) 	<ul style="list-style-type: none"> • Textbook knowledge about science and technology (MoRRI 2015a) • Share of STEM graduates (MoRRI 2015a) • Science competence in secondary school pupils (PISA) (MoRRI 2015a) • School hours in Stem subjects in primary and secondary school (MoRRI 2015a) • Science communication culture (MoRRI 2015a) • Science communication budget (MoRRI 2015a) • Number of science museum visitors per million inhabitants of a country (MoRRI 2015a) • Strategic approach to citizen science (MoRRI 2015a) • Citizen science projects (MoRRI 2015a -xls) • Importance of societal aspects of science in science curricula (MoRRI 2015a -xls) • EU and national levels: presence of RRI descriptors in the qualification frameworks for lower and higher education (EU 2015a) • Science and innovation awareness raising activities (incl science shops, science cafés, exhibitions) (EU 2016)
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5.5.5 Open Access	<ul style="list-style-type: none"> • use of open access publications (MoRRI 2017) • publish open access (green or gold) (MoRRI 2017) • use of publicly available data (MoRRI 2017) • providing publicly available data (MoRRI 2017) • implementing research data management plans (MoRRI 2017) 	<ul style="list-style-type: none"> • Percentage of research projects with a virtual environment that is updated and actively used with a threshold frequency (to be defined) (EU 2015a) • Percentage of data repositories that include explanation and commentary to facilitate use (EU 2015a) • Percentage of research projects with daily laboratory notebooks online (EU 2015a) • Percentage of research projects that report real added value by an open science mechanism (for themselves and/or other actors) (EU 2015a) 	<ul style="list-style-type: none"> • OAL (Open Access Literature) (MoRRI 2015a) • Data publications and citations per country (MoRRI 2015a) • Social media outreach / take up of open access literature and open research data (MoRRI 2015a) • PPOA (Public perception of open access) (MoRRI 2015a) • FM (Funder Mandates) for open access publishing (MoRRI 2015a) • RPO support structures for researchers as regards incentives and barriers for data sharing (MoRRI 2015a) • Number of OA journals/publications per country (MoRRI) • Number of OA repositories (MoRRI) • ODB (Open Data Barometer) (MoRRI)
5.5.6 RRI / Governance	<ul style="list-style-type: none"> • Percentage of projects where citizens, Civil Society Organisations (CSOs) and other societal actors contribute to the co-creation of scientific agendas and scientific contents (EU 2015b) • 	<ul style="list-style-type: none"> • Activities of funders to promote RRI (EU 2015a) • Number of funding mechanisms to support RRI activities (EU 2015a) • Number of euros invested in RRI projects (EU 2015a) • Number of references in applications to RRI (EU 2015a) • Number of collaborative RRI projects (EU 2015a) 	<ul style="list-style-type: none"> • Identification of formal and informal networks of R&I that promote RRI, at both the national and the EU level (EU 2015a) • Involvement of the wider public in RRI debates, measured e.g. through social media (EU 2015a) • Involvement of the wider public in RRI policy, the development of policy, protocols (EU 2015a)

		<ul style="list-style-type: none"> • RRI-related training at RPOs (MoRRI) • Responsible R&I principles embedded in EU Higher Education (EU 2016) 	<ul style="list-style-type: none"> • <i>EKS: RRI awareness and support to implementation at system level (AU)</i> • Composite indicator of RRI governance (MoRRI 2015a) • Existence of formal governance structures for RRI within RFO and RPO (MoRRI 2015a) • Share of RFO and RPO promoting RRI (MoRRI 2015a)
5.6 RESEARCH AND INNOVATION DIMENSION: SOCIETAL CHALLENGES			
5.6.1 Research priorities & outcomes in terms of GE	<ul style="list-style-type: none"> • A desire to address societal problems (Stanford) 	<ul style="list-style-type: none"> • A desire to address societal problems (Stanford) • 	Composition of innovation policy putting more emphasis on social and service innovations (JR, A26)
5.6.2 R&I indicators	<ul style="list-style-type: none"> • 	<p>Publications in peer-reviewed high impact journals in the area of the different Societal Challenges (EU 2015b)</p> <p>The percentage of publications published in the top 10% impact ranked journals by subject category (EU 2015b)</p> <p>Number of Patent applications and patents awarded in the area of the different Societal Challenges, by theme (EU 2015b)</p> <p>Number of prototypes, testing (feasibility/demo) activities, clinical trials (EU 2015b)</p> <p>Societal Challenges -Number of joint public-private publications (EU 2015b)</p>	<ul style="list-style-type: none"> • Better contribution of R&I to tackling societal challenges (EU 2016) • Stronger global role of the EU, steering the international agenda to tackle global societal challenges (EU 2016) •

		<p>Number of projects with new innovative products, processes and methods</p> <ul style="list-style-type: none"> • New products, processes, and methods launched into the market (EU 2015b), according to SC 	
5.7 RESEARCH AND INNOVATION DIMENSION: SOCIETAL and ENVIRONMENTAL Impacts			
5.7.1 Societal Impacts		<ul style="list-style-type: none"> • Responsible R&I principles embedded in EU Higher Education (EU 2016) 	<ul style="list-style-type: none"> • Improvement of societal awareness, understanding and engagement to tackle societal challenges through R&I (EU 2016) • Better societal acceptance of innovative solutions (EU 2016) • Increased awareness of the new innovations among industry, research, user and policy communities (EU 2016) • Reinforced research integrity and ethics standards (EU 2016) • More effective promotion of gender equality and the gender dimension in research and innovation content (EU 2016) • Improved quality of life • Reduced direct and indirect costs linked to societal issues (EU 2016) • Improved research and innovation culture in EU (EU 2016)
5.7.2 Environmental Impacts		<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Improved environmental performance (climate change, biodiversity, sustainability) (EU 2016)

