Deliverable 1.1

Societal Readiness Plan

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Public	Mark W. Kharas | Roger A. Søraa | Sofia Moratti

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Contributors

NAME	ORGANISATION
ANNELI ROOSE	**CE**
METTE HELLERUNG	**DBT**
METTE SIMONSEN	**DBT**
MINDAUGAS KELPŠA	**AFL**
MARCO LOPES	**LOBA**

Peer Reviews

NAME	ORGANISATION
LUCAS DE BONT	**CE**

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Table of Abbreviations and Acronyms

Abbreviation	Meaning
SR	Societal Readiness
SRL	Societal Readiness Level
RRI	Responsible Research and Innovation
CSA	Coordination and Support Action

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1 Executive Summary

This document presents the Societal Readiness Plan for the **Horizon Europe funded Coordination and Support Action project Robotics4EU (2020-2023)**. The plan includes both project-internal and stakeholder-external frameworks for ensuring that: (1) a **Responsible Research and Innovation (RRI) framework** is being developed, implemented, and followed throughout the project; and (2) a **Social Readiness Level (SRL) framework** is put into action, both as a tool within the project for a Maturity Assessment Mode (MAM), and for external evaluations of robotics-technologies. The goal of both RRI- and SRL-tools is to ensure that the project **meets its impact goals** of better integrating robotics-technologies into the European society.

First, we explain the concept of RRI (Chapter 3) and SRLs (Chapter 4) before proposing ways that these concepts can be integrated into our work (Chapter 5). This includes an inventory of project activities where RRI principles should be adhered to, the roles of each partner in carrying out these activities, and suggestions for how they will be integrated (Section 5.1). A framework for how RRI integration can be assessed is then presented (Section 5.2). Preliminary thoughts on how to assess SRLs are presented in Section 5.3. These criteria are then applied to the development process of the Maturity Assessment Model (Section 5.4.1) and initial thoughts about how robot producers could apply SRLs to their robots are provided in Section 5.4.2.

This deliverable is written at M3 and serves as a framework for how these concepts will be integrated into Robotics4EU. Specifically, it provides structure for how the project's research and consultation should be carried out (integration of RRI) and how the findings of the consultations can be valorised (integration with SRL). It is thus primarily an internal document. However, other projects can view this as an example for how these principles were applied at the beginning of a research project to the project's work, and thus provide inspiration for how they may undergo a similar process. This plan lays out what needs to be researched to determine how Societal Readiness Levels of robots can be assessed, the results of which will be provided in future deliverables.

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2 Introduction

The Robotics4EU (2021-2023) project aims to ensure a more widespread adoption of (AI-powered) robots in healthcare, inspection and maintenance of infrastructure, agri-food, and agile production. It will be reached through the awareness raising about the responsible robotics principles among the robotics community to make sure that societal readiness and impact of (AI-powered) robots is considered among the robotics community. The concept of the project is that consideration of the non-technological aspects, e.g. gender, cybersecurity, data protection, legal aspects, of robotics will lead towards greater societal acceptance of robots and thus, increased uptake of robots by professional end-users and citizens.

The project will implement the following set of activities: 1) assessing the needs and developing a responsible robotics maturity assessment model that is a practical tool for the robotics developers and helps them to strategically plan and the uptake of the legal, societal and ethical aspects of robotics; 2) empowering the robotics community by organising capacity building events in healthcare, agri-food, agile production and infrastructure; 3) ensure citizen acceptance of robotics (via citizen consultations) and assessing robotics ideas and applications provided by the industry with end-users (via online consultation and co-creation workshops); 4) reaching out to the policy makers by compiling a responsible robotics advocacy report, organising a high-level policy debate and transferring the results to the standardization bodies[1].

The research, innovation and coordination projects such as Robotics4EU are situated in disciplines, internal practices and norms – and have external impact on different sectors and societal stakeholders. Effective societal integration of project results is an essential component of ensuring that the project has maximum impact. This can be aided by proactively considering societal readiness from the beginning of projects and how the knowledge developed can be integrated into society throughout the entire project lifecycle.

Importantly, as Robotics4EU is about societal acceptance of robotics, it is crucial that the project itself will also follow the principles of Responsible Research and Innovation (RRI) and will provide an example on how to put into practice the Societal Readiness Levels (SRL) concept. One of the main outcomes of the Robotics4EU project will be the assessment tool—the Maturity Assessment Model (MAM)—that will aid robot developers in determining how ready their robot is for deployment in society by measuring the robot's Societal Readiness Level. For such a tool to be valid and useful, however, it must be developed in a manner that conforms to existing RRI principles. The concept of Societal Readiness Levels is related to, but distinct from RRI. SRLs aim to evaluate the societal readiness of the results of technological research and/or products, whereas RRI is more concerned with the process of how research is undertaken. Thus, the Robotics4EU project proposes A Societal Readiness Plan (SRP) for the project, that is a framework for how the project can engage in this reflection.

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[1] Project information from CORDIS: https://cordis.europa.eu/project/id/101017283

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3 Responsible Research and Innovation Concept and its Implementation in Robotics4EU

Research and innovation are not created in a vacuum. The technologies developed in R&I processes can have a large impact on society and transform it in a positive way, but they can also have potentially far-reaching, uncertain, and unpredictable social consequences. As such, researchers and project participants have important responsibilities of working in ethical and responsible ways with their topics of inquiry. In this chapter we describe how RRI can do just that and operationalize it for the project.

3.1. What is RRI?

In addition to being a scholarly field in itself, Responsible Research and Innovation (RRI) is a policy and self-regulation strategy that engages policy-makers, industry, experts, stakeholders and researchers. Various definitions of RRI have been given in the literature; we here report the ones that were most influential in policy-making. According to Rene von Schomberg (2011:9), RRI is "a transparent, interactive process by which societal actors and innovators become *mutually responsive to each other* with a view to the *(ethical) acceptability, sustainability and societal desirability* of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)" (our italics). This is echoed by the European Union's Horizon 2020 programme, which defines RRI as: "an inclusive approach to research and innovation (R&I), to ensure that societal actors work together during the whole research and innovation process. It aims to better align both the process and outcomes of R&I, with the values, needs and expectations of European society[2]." There are two major RRI models in Europe: **The European Commission six policy agendas** and **the 4-sectors Nordic model**. The European Commission has provided concrete normative orientation for RRI in the form of six policy keys[3]:

1. **ethics**, focusing on (a) research integrity (prevention of unacceptable research and research practices) and (b) science and society: the ethical acceptability of scientific and technological development;
2. **gender equality**, which is about promoting gender-balanced teams and decision-making bodies and considering the gender dimension in the content of R&I;
3. **governance**, meaning that in order to lead to acceptable and desirable futures, arrangements have to be (a) robust and adaptable to the unpredictable development of R&I; (b) familiar enough to align with existing practices in R&I; (c) share responsibility and accountability among all actors and (d) provide governance instruments to actually foster this shared responsibility;

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[2] From the European Commission's "Public Engagement and Responsible Research and Innovation" https://ec.europa.eu/programmes/horizon2020/en/h2020-section/public-engagement-responsible-research-and-innovation

[3] From the European commission's "Responsible Research and Innovation" https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation

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4. **open access**, of research and dissemination.
5. **public engagement,** which refers to fostering R&I processes that are collaborative and multi-actor and
6. **science education**, that focuses on (a) enhancing the current education process to better equip citizens with the necessary knowledge and skills so they can participate in R&I debates and (b) promote scientific vocations.

Numerous tools have been created though European projects, such as **rri-tools.eu** and **newhorrizon.eu/thinking-tool**.

Conversely, **the 4-sector Nordic RRI model** conceptualized by Stilgoe et al. (2013) describes RRI as consisting of four dimensions: **anticipation, inclusion, reflexivity** and **responsiveness**. The Nordic RRI model is more abstract in its conceptualization as it has been developed by RRI researchers, but it has been translated into concrete tools: notably, the STS (Science and Technology Studies) community at the University of Vienna has developed a card-based method called **"Imagine RRI"**, a set of activities to directly engage researchers in reflecting on RRI in their own research practice (Felt et al. 2018) and available under the Creative Commons License at phaidra.univie.ac.at/view/o:690945. We will draw on all these for our RRI activities.

3.2. End-user engagement

"The engagement of end-users and society (the public and civil society stakeholders), is a necessary path towards the implementation of RRI, making innovation with and for end-users and society more effective, ethical and socially desirable" (Cavallaro et al., 2014, p.4). **End-users and citizen engagement** are among the drivers of innovation in the **"Quadruple Helix Innovation Model"** as stated in the 2013 Dublin Declaration[4], along with the government and public sector, business and private sector, and higher education. In a nutshell, socially responsible innovation allows societal groups to become innovators (through engagement in product development) and beneficiaries (end-users) at the same time. Inclusive innovation allows marginalized groups to be both recipients and co-creators.

Therefore, developing an extensive, inclusive framework for end-user engagement throughout all aspects of the Robotics4EU project will be an essential component for realizing RRI principles in our work.

The 'upstream', inclusive, and transparent engagement of all societal actors, researchers, industry, policymakers and civil society in science governance decision-making is one of the key action points in the RRI framework for EU innovation. It is important to note that there is a difference between being *engaged* and *involved* in the innovation process. Engagement reaches deeper than involvement, as it is **"a *mutually beneficial* interaction** that results in participants feeling valued for their unique contribution" (Cavallaro et al. 2014; our italics).

Cavallaro et al. (2014) put forward the following models summarizing **the multiple modes of user-led innovation**, modified after Wise and Høgenhaven (2008):

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[4] https://ec.europa.eu/digital-single-market/en/news/"-dublin-innovation-declaration"-manifesto-ten-point-declaration-create-more-wealth-better

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Figure 1 from Cavallaro et al. (2014, p. 16) (modified after Wise and Høgenhaven (2008)): The multiple modes of user-led innovation.

The left side of the figure represents activities of conceptualization, prototyping, testing and implementation**.** "User innovation" means that users are members of the innovation team; "user test" means that they are not, and user-test activities include for example focus groups. In the area above the "participation line" in the figure, users are part of the innovation team. In the remaining three quadrants, user knowledge is accessed by asking, observing, or experimenting with users.

Citizens are no longer considered passive recipients of science; through participatory learning and training they become **"co-creators of innovation"** (Sutcliffe, 2013) and **"makers of knowledge"** (MacMillan and Benton, 2014). Diversity in employee demographics can be in itself a factor in end-user engagement, and in particular gender seems to be a key factor. Two large-scale surveys among European researchers carried out by Bührer and Wroblewski (2019) reveal significant differences between women and men researchers regarding their practice and perceptions of RRI. Particularly, women researchers are more involved in end-user engagement activities and dissemination of research.

3.3 Implementing RRI in Robotics4EU

Our RRI activities are a hybrid of the two RRI models (the EC and the Nordic). We created a model **tailored for responsible robotics** for the Robotics4EU project. Primarily, we will use questions and inquiries based on the two sets of RRI tools described above: the "Imagine RRI"-cards and the RRI self-reflection tools included in the RRI-tools and NewHoRRIzon projects. Specifically, we will do the following steps:

1. **Develop a "Robotics-RRI"questionnaire for gathering responses from all project participants** (in practice we will use an online survey tool which will allow us to collect responses in an orderly and efficient manner). It is important that each partner has most (ideally all) of their staff working on the Robotics4EU projects respond to the questionnaire. We will draw key questions from the above-mentioned tools and add additional reflective questions that are key for the project. This will generate responses that take all opinions, thoughts and considerations into account on these issues. We envision that the questionnaire would take 20 minutes to fill out – and it will be an important activity in *self-reflection* for project participants.
2. Based on the answers, we will then hold an **internal project workshop** where selected reflective questions will form the basis for discussions that are specifically important for the consortium, with groups of circa zoom breakout-rooms. The suggested duration of this workshop is two hours (including a 15-minute break). This workshop will take place in May 2021 (M5 of the project). Similar workshops will be held annually in this three-year project and will be done three times in total (beginning, midway and towards the end of the project) to ensure a continuum in reflective thinking. Ideally, one of these should be done in person, connected to in-person project consortium meetings if possible). These are called Societal Readiness workshops (**SR workshops**).

Our chosen method for ensuring good RRI and SRL development and self-reflection for the Robotics4EU project is to engage with project internal workshops, in addition to the aforementioned survey.

Societal Readiness Workshops (2 hours each)			
Number	When	RRI focus (1st hour)	SRL focus (2nd hour)
1	May 2021	Anticipation & inclusion	Steps 1-3
2	February 2022	Reflexivity	Steps 4-6
3	August 2023	Responsiveness	Steps 7-9

Table 1 Societal Readiness Workshops

The responses to our "Robotics-RRI" questionnaire along with the discussion output from the internal workshop will be used to **direct future tasks of the project and their associated deliverables**. We will develop a procedure to regularly report to the consortium partners on the results of the internal RRI workshops and assess whether these conclusions have been appropriately implemented.

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4 Societal Readiness Level (SRL) strategy

Through the practical SRL strategy detailed below, we will nudge project participants into reflecting on the societal appropriateness of their work multiple times, at **critical stages in the project life-cycle**. The SRL-strategy will be connected to the RRI-strategy above, offering guidance for the consortium on the **concrete implementation** of the principles of RRI in their innovation work. Our inclusive approach will consider social, cultural and gender aspects.

3.4 What is SRL?

One of the key goals of the RRI responsibility frameworks is to better **align research and innovation with broader societal needs and expectations** (Pellé and Reber 2015). Through RRI, "societal actors and innovators become *mutually responsive* to each other" (Schomberg 2011, our italics). Among other aspects, this *responsivity-responsibility* invests "the societal desirability of the innovation process and its marketable products… to allow a proper embedding of scientific and technological advances in our society" (Schomberg 2011). **Societal Readiness Level (SRL)** is "a way of assessing *the level of societal adaptation* of… a particular social project, a technology, a product, a process, or an innovation" that must be "integrated into society" (Innovation Fund Denmark; our italics). Low SRL means, in essence, that society is not quite ready for a particular innovation. The social adaptation of the innovation will then require a well thought-through transition plan: "the lower the SRL, the better the plan for the transition must be" (Innovation Fund Denmark). We base our conceptualization on the **nine-stage SRL model** developed by Innovation Fund Denmark, as described below[5]:

- **SRL 1 –** Identifying the problem and identifying societal readiness
- **SRL 2 –** Formulation of the problem, proposed solution(s) and potential impact, expected societal readiness, identifying relevant stakeholders for the project
- **SRL 3** – Initial testing of proposed solution(s) together with relevant stakeholders
- **SRL 4** – problem validated through pilot testing in relevant environment to substantiate proposed impact and societal readiness
- **SRL 5** – proposed solution(s) validated, now by relevant stakeholders in the area
- **SRL 6** – solution(s) demonstrated in relevant environment and in co-operation with relevant stakeholders to gain initial feedback on potential impact
- **SRL 7** – refinement of project and/or solution and, if needed, retesting in relevant environment with relevant stakeholders
- **SRL 8** – proposed solution(s) as well as a plan for societal adaptation complete and qualified
- **SRL 9** – actual project solution(s) proven in relevant environment.

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[5] "Societal Readiness Levels (SRL) defined according to Innovation Fund Denmark" https://innovationsfonden.dk/sites/default/files/2019-03/societal_readiness_levels_-_srl.pdf
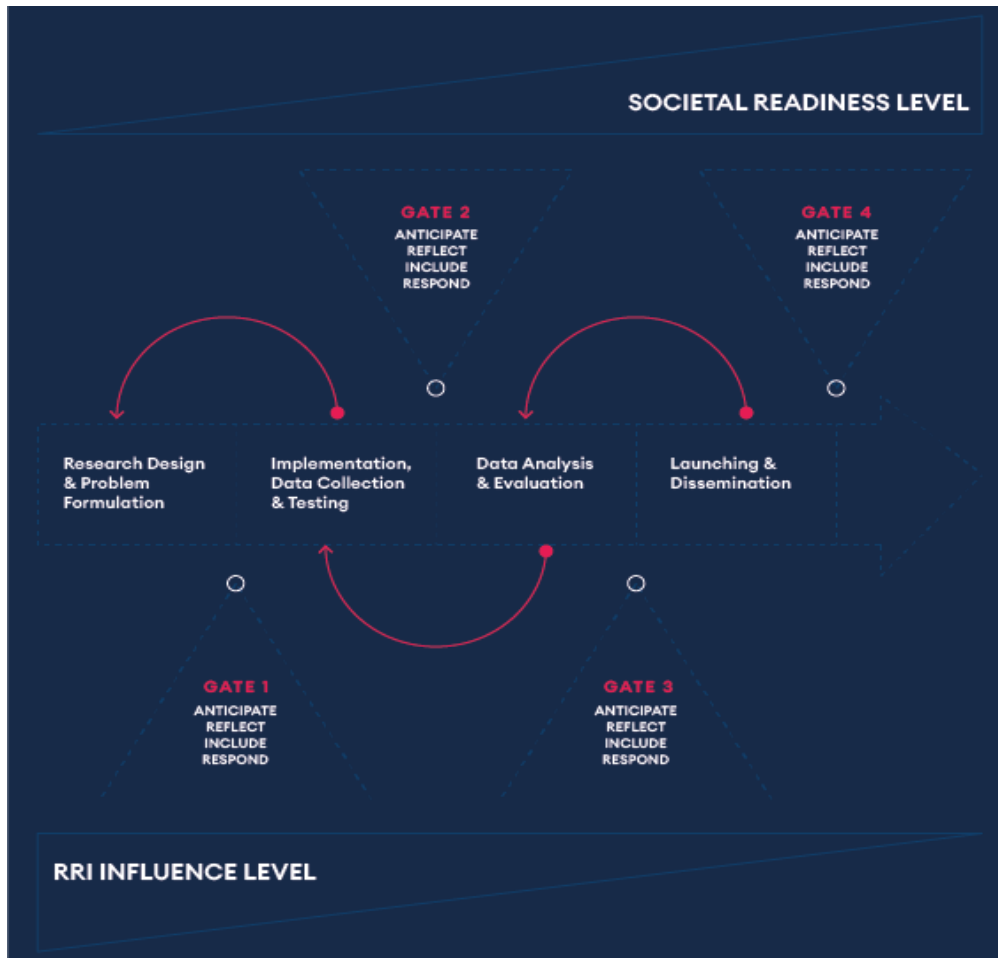
Figure 2 Relation between RRI influence level and SRL (taken from Wullum Nielsen et al., 2018, p. 11; inspired by Figure 9.1 in Lettice et al., 2017).

The rectangular boxes are modelled after a familiar process of technical development where the corresponding societal readiness levels of the solution can also increase. The first box represents SRL 1–3 where the problem is initially defined, and a plan of action developed. The second two boxes represent the successive steps where the solution is formulated, tested, evaluated, and modified in an iterative fashion, and the final box represents a high level of SRL, e.g. 6–9, where the solution is ready to be deployed.

The triangles represent opportunities to engage in RRI reflections of the project such that the iterative design process has RRI principles intentionally and holistically integrated into it. A big component of these reflections will be the annual SR workshops outlined in Section 2.3. These workshops will prompt the research team to engage in reflection on how RRI principles are integrated into our own research. Thus, they will not assess whether the SRLs have been achieved, but they will ensure that the activities we engage in to reach successive SRLs outlined below take RRI principles into account in terms of their recruitment of participants, how they are carried out and how the data is analysed.

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3.5   Formulating Expected SRL throughout Robotics4EU

Robotics4EU will develop a **Maturity Assessment Model (MAM)** to assess the societal readiness of a given robotic solution. The goal of this Model is for companies, policymakers, regulatory bodies, or other interested stakeholders to assess different aspects of a robotic system to arrive at a measurement of that solution's societal readiness. Robotics4EU is *also* facilitating citizen consultations in parallel to these industry events, some of which will involve companies presenting actual business plans or robotic solutions.

These two parallel aspects have defined SRL goals to be reached at the conclusion of Robotics4EU:

- The Maturity Assessment Model is expected to be at SRL 6–9
- Business plans and robotic solutions are expected to be at SRL 4–6

For the Maturity Assessment Model to reach a high SRL it:

1. Must be easy for stakeholders to use and have their buy-in as to the accuracy of its results.
2. Must assess technology using criteria that will determine its acceptance by society.

The 1st aspect can be developed, tested, refined, and validated during a series of engagements with relevant stakeholders in the robotics communities. These engagements will take the form of surveys, interviews, online consultations, or workshops that cover topics such as legal, ethical, privacy, security, and socio-economic factors that are important both when implementing RRI principles and for achieving high levels of societal readiness.

The 2nd aspect can be tested/evaluated/refined during a series of consultations with citizens and end-users where they can comment on issues that are important to them. These will take the form of facilitated discussions and co-creation workshops where citizens can present their concerns in an open-ended fashion as well as ones where they respond to specific robotic systems or business plans for their implementation. The events primarily focus on helping business plans and robotic solutions reach successive SRL goals outlined above, but they can be useful for thinking about the Model as well. The Model will not be presented during the events but, following the events, we can evaluate whether the aspects of the Model measuring societal acceptance align with that citizens and end-users themselves raise as important considerations that drive their acceptance of robots.

The Model will be continuously revised throughout the project, responding to feedback from the stakeholders who will use the Model regarding its robustness and usability. The Model can also be evaluated in light of the citizen consultations.

5 Assessing RRI integration and SRLs

This document has provided guidelines for the integration of RRI principles into Robotics4EU activities as well as specific SRL goals for the Maturity Assessment Model and robot solutions. We here provide guidelines for assessing whether those goals have been achieved.

5.1 Need for RRI in Robotics4EU

Robotics4EU has planned multiple activities with both citizen and industry stakeholders who will provide input both to the development the MAM in distinct ways:

- Identify what aspects a robot must have in order to attain a high SRL (e.g. citizen consultations)
- Ensure that these aspects are practical for developers to incorporate into their design practices
- Ensure that the MAM assessment itself is trusted by developers and can be easily used such that it will be implemented in practice following the conclusion of Robotics4EU

Robotics4EU has planned multiple rounds of consultations with both citizens and robotics community. Different partners are responsible for designing the methodologies for these activities and nearly all partners are jointly responsible for implementing the activities. Partners designing the methodologies must ensure that these incorporate RRI principles of ethics, gender equality, governance, open-access, public engagement, science education, anticipation, inclusion, reflexivity, and responsiveness. Partners responsible for implementing the activities must ensure that these principles are adhered to in practice.

These activities include:

Activity:	Expert interviews
Target groups:	Robotics community, especially developers, scholars, policymakers, civil society representatives
Purpose:	Gain a baseline of expert opinion about what hinders societal acceptance of robots and how such concerns could be addressed. These will later be evaluated against what citizens identify
Partners responsible:	Civitta leading development of methodology, all partners conducting interviews
Special RRI considerations:	Gender equality of interviewees, open dissemination of findings from interviews, making interview structure flexible enough to respond to unexpected areas of analysis
Activity:	Sector specific knowledge transfer workshops
Target groups:	Members of the robotics community in four application areas: healthcare, agrifood, agile production, and inspection and maintenance of infrastructure.

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Purpose:	Test and validate information gathered during expert interviews and surveys; do broader members of the robotics community share the views of experts regarding societal acceptance. Share preliminary aspects of the MAM
Partners responsible:	AFL leading development of methodology, NTNU, AFL, Civitta, and Robotex leading workshop series
Special RRI considerations:	Gender equality of participants, keynote speakers, gender aspects of robotics taken account of in workshop program; openness and transparency of the MAM under development, credible pathways for opinions of participants to impact future work, thus demonstrating responsiveness
Activity:	**Citizen consultations using Global Say methodology**
Target groups:	Regular citizens with no expert knowledge in robotics
Purpose:	Raise awareness for citizens about the capability of robots and what non-technical aspects of robotics are important for societal acceptance. Solicit and collect opinions of citizens about these topics.
Partners responsible:	DBT responsible for developing methodology; all partners responsible for recruiting hosts and aiding them in facilitating events
Special RRI considerations:	Gender equality in hosts and participants, ensuring that gender aspects of robotics are addressed, open access to conclusions from workshops, use workshops as an opportunity for public engagement and science education, make methodology flexible enough to allow for spontaneous citizen brainstorming/debate
Activity:	**Online citizen consultation to validate business ideas**
Target groups:	Robot developers/producers and citizens
Purpose:	12 different robot solutions across the Robotics4EU application areas will be presented to citizens through a brief but comprehensive online introduction. Citizens will then be asked to evaluate the societal acceptability based on criteria discovered through earlier citizen and expert consultations
Partners responsible:	DBT responsible for designing online introductions and survey methodology; all partners responsible for recruiting robot producers and citizens
Special RRI considerations:	Gender equality in citizens, transparency in how robots are created, who they are created for, what the business interests are, realistic pathway for how results will influence robot producers, policymakers, science education of citizens taking part in consultation about actual capabilities of real robotic systems, demonstration for how robot producers have taken ethical considerations into account or how they could improve

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Activity:	**Co-creation workshops to test robotics solutions in application areas**
Target groups:	Robot developers/producers and robot users in application areas. Because robots in these application areas are generally not targeted towards consumers, the workshops will focus more on the actual users of the robots, after previous activities have focused on citizen engagement
Purpose:	Robot producers will physically gather with robot end-users across application areas to present their robot systems and get feedback in a co-creative manner. Societal readiness of the robots will be assessed according to criteria determined by all previous citizen and expert consultation and through piloting an early version of the MAM
Partners responsible:	DBT for designing leading design of workshop methodology and facilitating workshops; Civitta, NTNU, LNE, AFL, Robotex responsible for recruiting participants assisting in methodology design and workshop facilitation
Special RRI considerations:	Gender representation, emphasizing ethical considerations companies have already taken and how they can improve, transparency about criteria used to assess societal readiness and how the criteria were developed, flexible workshop design to be anticipatory and responsive to unexpected contributions, realistic pathway to how results can affect future robot creation and governance
Activity:	**Policy advocacy and debate**
Target groups:	Policymakers, robot companies/producers
Purpose:	Transfer results from all previous engagement activities to policymaking bodies
Partners responsible:	Civitta leading in writing report, developing overall strategy; Robotex, AFL, LNE, NTNU responsible for contributing policy recommendations
Special RRI considerations:	Actionable recommendations around ethics and governance, transparency in how recommendations were arrived at.
Activity:	**Transfer to standardization bodies**
Target groups:	Standardization bodies and, through them, policymakers, robot producers/companies
Purpose:	Make concrete recommendations to standardization bodies, or recommendations about how further work can be done to inform standardization efforts in the future
Partners responsible:	LNE responsible for leading effort, all partners responsible for contributing suggestions
Special RRI considerations:	Actionable recommendations around ethics and governance, transparency in how recommendations were arrived at.

Table 2 RRI activities within R4EU

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5.2   How to assess RRI integration

The project contains many levels of consultations with experts and stakeholders in the robotics community as well as regular citizens. Integrating RRI into our activities will depend on **who** is engaged and **how** they are engaged during these consultations. We must ensure that these groups are meaningfully diverse and that the events themselves include meaningful participation from people of diverse backgrounds (Anticipation & Inclusion). We must also be open to changing our assumptions and practices based on issues raised during the consultations (Reflexivity & Responsiveness).

When assessing **who** is engaged and **how** they are engaged, both in consultations with stakeholders outside the project and within our own implementation activities in the project consortium, we can consider Søraa et al.'s (2020) recommendations for diversifying research projects as an example. This was originally developed for evaluating gender engagement in a different H2020 CSA project. We can reframe the questions to encompass diversity more broadly which, in addition to gender, includes race/ethnicity, age, ability, sexual orientation, or level of seniority in an organization. "*By implementing these questions, an inclusive engagement of multiple key stakeholders that represent key societal groups can be included and engaged. This can be done prior, during- and post discussions of a chosen topic by providing agency and autonomy both in the owning of problems, and the development of solutions*" (Søraa et al., 2020):

1. Is the value of diversity perspectives highlighted? There are deliverables that focus on gender and diversity issues in specific, and we can ensure that this is thematized in the project's expert group.

2. Are diversity goals translated to the project's participants and stakeholders in a coherent manner? It is important that we as a consortium build a culture of diversity and inclusion that reach within and outward the consortium and having three workshops specifically on RRI will help ensure this.

3. Are there allocated research tools and training opportunities on diversity issues? Diversity questions will be thematized through the SR workshops within the project, where we will develop key choices for how to include widely throughout and outward from the project.

4. Are linguistic problems with representation of diversity issues taken into account? Robotics4EU consists of a wide variety of nationalities and cultures and draws on stakeholders across Europe and beyond – therefore ensuring that the language we use is gender-inclusive and free of bias is important. Having gender-neutral titles included in questionnaires is one example, and using a wide variety of examples of stakeholders e.g. with different nationalities, gender, age, age and abilities.

5. Are diversity perspectives understood in intersectional contexts? It is important that stakeholders are not tokenized and included "just because they are a person who is [diversity criteria]. Likewise, intersectional inclusive clustering of e.g. having people of colour, women, abilities etc. be all held by one or few people is not really diverse if the rest consists of white male able bodied men.

When project activities undergo formal evaluations (for example, the workshops with sector-specific stakeholders will each have an internal Impact Assessment), such assessments will include questions like these. Additionally, the annual SR workshops will provide an opportunity for reflection on other events with external stakeholders as

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well as internal project activities in regard to RRI principles. Such workshops may result in including other questions for RRI assessment. The results of these workshops will be formally reported to the consortium so that RRI principles remain part of the project conversation throughout its entire duration.

Such questions will also be asked about large project activities in addition to individual consultation events. For example:

- The Maturity Assessment Model is developed largely through consultation with a wide variety of stakeholders. Were the views of diverse stakeholders considered as the Model was created? Were there noticeable differences in these views and concerns between different groups of stakeholders? How were these differences accounted for in the Model? How does the Model prompt stakeholders to explicitly include diverse constituencies in their evaluation of their solution?

- Are Dissemination and Communication activities targeted to reach and engage a diverse audience?

5.3   How to assess Societal Readiness Level

Societal Readiness Levels as conceived by Innovation Fund Denmark are essentially about the solution being evaluated by increasingly large potential user-groups in increasingly broader settings. At each step along the way we can ask:

1. Does the solution solve the identified problem by delivering the envisioned impact?

2. Will the solution be broadly accepted by society?

3. What aspects of the solution might hinder its societal acceptance, and does the solution address these concerns?

4. Are there any unforeseen societal consequences that are created by the solution?

These general questions, especially the 3rd, can have very different implications in different contexts. Different solutions might have widely differing aspects that must be addressed to ensure societal acceptance. For robots in the four Robotics4EU sectors we have identified the following areas that should be addressed: legal, ethical, cyber-security, data-protection, socioeconomic issues, privacy, and diversity and inclusion. This may not be an exhaustive list, and our citizen consultations may indeed identify other areas that need to be addressed when assessing SRL.

Additionally, the incorporation of RRI principles into the development and evaluation process is essential for it to achieve a high SRL. This is true for our own project activities as well as for the development of any other technology that will measure itself on the SRL scale. If the above questions can be meaningfully answered for a diverse constituency, then the SRL level is likely to be high for a broad cross-section of society. If it is limited, the SRL determination is likely to be less reliable. Therefore, the following general question can be asked when assessing an SRL:

- How might the solution effect diverse constituencies differently? How are the concerns of diverse constituencies incorporated into the solution?

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There are two aspects of Robotics4EU that have defined SRL goals: The Maturity Assessment Model and specific robotic solutions and business plans. To assess these SRLs we can continually ask, in relation to the questions outlined above:

5.3.1 Assessment of Maturity Assessment Model

The goal of Robotics4EU is to have the MAM be at SRL 7–9 at the end of the project. Overall evaluation of the MAM in relation to SRL can be done by asking the following questions:

- Does the Maturity Assessment Model lead to an accurate assessment of whether a robotic solution will be accepted by society?

- Do the societal acceptance dimensions measured by the Model correspond to what issues citizen groups identify as importance when determining their acceptance?

- Is the Model easy to use by stakeholders such that it can be widely implemented?

We also offer a more comprehensive, speculative way to plan for increasing SRL of the MAM throughout the project. These are more process oriented, as we do not know what features will specifically impact SRL concerning usability and trust at the outset of the project. However, these can be useful questions to consider during the project and can also serve as a useful starting point for other projects that seem to develop and evaluate a similar metric. There are two important user groups for the MAM: robot producers and citizens. Robot producers will primarily be concerned with usability of the MAM and confidence that it gives meaningful results. Citizens will not actively use the MAM and so will be less concerned with specifics of the MAM; they will instead be chiefly concerned with whether citizen concerns are accurately taken into consideration in constructing the MAM

SRL	Relevant project activity	Comments regarding robot producers	Comments regarding citizens
1: Identifying the problem and identifying societal readiness	Project application phase: we know that many robots, although technically sound, are not broadly accepted by society or have not been seriously evaluated for societal acceptance	Robot producers face a risk of their robots being not accepted by society and thus not bought/utilized or the reputation of the company at risk if major incidents that highlight societal unacceptability of their robot	Citizen concerns are not actively considered in a robust way during robot development, thus solutions that can impact their lives don't reflect their concerns

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2: Formulation of the problem, proposed solution(s) and potential impact, expected societal readiness; identifying relevant stakeholders for the project	Project application phase: a tool could be created that can easily assess whether a robot is ready for society; initial solution proposed during expert consultations to gauge whether such a solution would be feasible, gather initial ideas of what should be evaluated	A tool could impact robot producers by assuring them that a robot will be socially accepted or provide recommendations for how it can be designed to maximize societal acceptance	A tool could impact citizens by ensuring that robots do indeed respond to their wishes and concerns
3: Initial testing of proposed solution (s) together with relevant stakeholders	Sector-specific workshops and initial citizen consultations—the general idea of a MAM shared broadly with citizens and robot producers in application areas.	Robot producers share initial thoughts about societal readiness in sector specific workshops as well as what parts or robot development could easily be designed to take societal readiness concerns into account	Citizens provide initial feedback about idea for a MAM. Specific concerns for each application area elicited as well as brainstorm what actions could be taken to address these concerns
4: Problem validated through pilot testing in relevant environment to substantiate proposed impact and societal readiness			
5: Proposed solution(s)_ validated, now by relevant stakeholders in the area	Online validation of robot business ideas—businesses present their robots to citizens who then evaluate them based on criteria elicited through earlier consultations	Are robot producers able to present their robots in an understandable way to citizens? Have they considered what areas could cause societal concerns. Do the criteria for societal readiness previously identified apply to specific robots in a meaningful way?	Citizens can provide feedback on specific robots based upon the criteria developed earlier

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6: Solution(s) demonstrated in relevant environment and in co-operation with relevant stakeholders to gain initial feedback on potential impact	Co-creation workshops with robot producers across application areas. These workshops will test a somewhat more mature version of the MAM	Is the MAM easy to use in practice. Does it provide results that they feel are credible. Does it provide concrete suggestions for improvement that can be actionable by the designers and producers	Does the MAM address areas raised by citizens earlier as being of special concern.
7: Refinement of solution and, if needed, retesting in relevant environment with relevant stakeholders	Following initial piloting of the MAM engage in discussions, interviews, or consultations on how it can be improved. Can continue after completion of the project	Further iterations should continuously respond to suggestions for increased usability, and relevance	Further iterations should continuously respond to suggestions for increased usability, and relevance
8: Proposed solution(s) as well as a plan for societal adaptation complete and qualified	Policy consultations and transfer to standardization bodies should provide guidance both in how the specific tool can be used and in how learnings from the process can be applied to other areas of concern.	Policy and standardization recommendations should take feedback from robot producers into account. Recommendations should be practical and actionable for robot producers.	Policy and standardization recommendations should take feedback from citizens into account. Attentions should be paid to how other forms of citizen consultation through political processes can be integrated with Robotics4EU work
9: Actual project solutions(s) proven in relevant environment	Following the conclusion of the project the MAM should be able to be used by robot producers. If the general framework of the MAM proves to be useful, it should be further developed.		

Table 3 RRI and the Maturity Assessment Model

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5.3.2 Assessment of robotic solutions and business plans

A robot producer that is assessing the SRL of their robot solution is essentially asking the question:

- Will citizen groups accept the robots that are presented to them?

SRLs are modelled closely after the more familiar Technology Readiness Levels (TRLs) and uses language about "demonstration" "validated" and "proven". When assessing a technology from a technical perspective this terminology is much easier to quantify and define. A piece of technology either works or it doesn't and, if it doesn't, understanding why it doesn't is a straightforward (although still difficult) technical exercise.

The language of SRLs, as well its close relationship with TRLs, suggests that SRLs can be measured using quantitative means. This does have some precedence in European approaches towards addressing equity and diversity, two aspects that are important for RRI activities and SRL assessment; several Horizon 2020 and FP7 projects[6] have put forth tools that are quantitative in nature, e.g., how many women are in management positions or have won staff awards.[7] However, these projects also acknowledge that "progress towards gender equality in research is difficult to monitor" (Sekuła & Pustułka 2016, p. 13). Our focus on SRLs differs in two main ways: we are dealing with even more diffuse categories like "ethics" or "privacy" and we are focusing on the results of projects, not merely how institutions structure themselves.

Given these differences, such quantitative language becomes more difficult to employ (Gianni 2020; Jasanoff 2016; Horckheimer & Adorno 2002). Indeed, the use of quantitative measures when qualitative assessment is more appropriate is a known difficulty in the field (Von Schonberg 2013, 2014; Wickson & Forsberg 2015) and can lead to a "bureaucratization of thought" that does not allow for nuance: "the risks stemming from the bureaucratization of thought and the supremacy of technique over politics urge us to focus on humanistic and social ends" (Gianni 2020, pp. 12–13). No matter how diverse a group of stakeholders we engage, there is likely never going to be perfect agreement about what "privacy" is or how a robot can perfectly address it. Therefore, the division between SRLs is likely to be much fuzzier than TRLs.

We therefore anticipate that many of the feedback received from citizens will initially consist of general areas of concern as well as suggestions for how these areas of concern could be addressed. The specifics of how these areas of concern and mitigation efforts apply to a particular robot will likely become clearer through the online consultations and co-creation workshops and be very specific for that particular robot. We therefore anticipate that the MAM may be useful for robot producers to identify areas of concern for their robot that they may not otherwise have considered and provide suggestions for how such a concern could be addressed. The MAM would therefore be able to give a quantitative score for how extensively the robot producer has already engaged in this self-evaluation, but it will then require the producer to engage in qualitative analysis of their robot. Indeed, whereas the ascending TRLs envision a

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[6] Some examples are PLOTINA (https://www.plotina.eu/plotina-formative-toolkit/); GenderTime (https://gendertime.org/Toolbox); CASPER (https://www.caspergender.eu); EFFORTI (https://efforti.eu); and GEDII (https://www.gedii.eu/self-assessment-tool/).
[7] https://gendertime.org/node/233

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technology being able to perform its task in less and less controlled environments with greater levels of reliability, the increasing SRLs can be approached as analysing the robot's impact in a larger and larger societal context. The MAM will attain higher SRLs by continual testing with larger groups of stakeholders in conditions that become more and more like the actual current business and societal environment. Robot producers will likely have to go through a similar process.

Robotics4EU aims to partner with robot producers in our four application areas to evaluate the SRLs of their robots and consult with them on how to increase their SRL. This has the dual goal of helping the robot producers in respect to their specific products and piloting the MAM so that it itself reaches a higher SRL. The criteria used by the MAM to assess the SRL of a robot will be determined through the various citizen and industry consultation activities. We hope that these consultations will lead to very concrete suggestions—actions that either the robot must do or must be prevented from doing, specific qualities that it must possess—that can be easily evaluated and be made actionable. We therefore offer these following questions as a jumping off point for how SRL for robots can be approached from a producer's standpoint. The specific questions will change as we engage in citizen and industry consultation, and what these actually entail for specific robots will likely be highly context dependent. Robotics4EU aims to have specific robots/business plans reach an SRL of 4–6; therefore, the questions for higher SRLs are especially speculative.

SRL	Possible considerations for robot producers
1: Identifying the problem and identifying societal readiness	Has a robot producer given any initial thought to how their specific robot could be positively or negatively perceived by the general public?
2: Formulation of the problem, proposed solution(s) and potential impact, expected societal readiness; identifying relevant stakeholders for the project	Has a robot producer done any initial analysis of how the robot could negatively affect society? Has the robot producer identified what citizen groups are likely to be most impacted by the robots? Has the robot producer had any consideration of what concrete actions they could take in respect to the robot's design that could ameliorate the negative societal impact?
3: Initial testing of proposed solution(s) together with relevant stakeholders	Has the robot producer consulted relevant stakeholders to present the proposed solution?
4: problem validated through pilot testing in relevant environment to substantiate proposed impact and societal readiness	Has the robot producer tested the proposed solution to ensure it can be feasibly implemented? Has the proposed solution been tested with the stakeholders to determine if it addresses the problem?
5: proposed solution(s) validated, now by relevant stakeholders in the area	Has the robot producer expanded the scope of stakeholders to reflect the application area more accurately?
6: solution(s) demonstrated in relevant environment and in co-operation with relevant stakeholders to gain initial feedback on potential impact	Has the robot producer been able to test the robot with proposed changes in a realistic environment; were stakeholders

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	involved in this testing in a cooperative manner?
7: refinement of project and/or solution and, if needed, retesting in relevant environment with relevant stakeholders	To what extent has the robot producer revised their proposed solution based on increased level of stakeholder consultation and testing?
8: proposed solution(s) as well as a plan for societal adaptation complete and qualified	Has the robot producer been able to describe sufficiently and transparently what it has done—both technically and in terms of stakeholder consultation—to increase societal acceptance of their robot? Have they created a plan to continue to monitor societal acceptance?
9: actual project solution(s) proven in relevant environment.	Robot producers deploy robots in everyday life that they have subjected to rigorous SLR assessment. The robot producers continue to assess as they gain more experience of the day-to-day use of the robot.

Table 4 RRI and the assessment of robotic solutions and business plans

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6 Conclusion: Key insights

This Societal Readiness Plan for the **Horizon Europe funded Coordination and Support Action project Robotics4EU (2020-2023)** includes both project-internal and stakeholder-external frameworks for RRI and SRL. This first deliverable of the project describes how a **Responsible Research and Innovation (RRI) framework** will be developed, implemented and followed throughout the project. It also describes how a **Social Readiness Level (SRL) framework** is put into action, both as a tool within the project for a Maturity Assessment Calculator, and for external evaluations of robotics-technologies. We provide practical insight for how the project can ensure that it follows good RRI practices, ensuring that the project **meets its impact goals** of better integrating robotics-technologies into the European society.

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