



PRISMA RRI EXEMPLAR ROADMAP

CEN workshop background document

Deliverable 5.2:

PRISMA RRI-CSR Roadmap -Part A – Exemplar Roadmap

(CEN workshop version)

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TITLE

Guidelines to develop a roadmap to integrate Responsible Research and Innovation (RRI) in industrial strategies

INTRODUCTION

Responsible Research and Innovation (RRI) addresses the development of products and processes that are safe, ethically acceptable, and responding to the needs and expectations of people and the society.

The essential difference of RRI with existing practices on CSR (Corporate Social Responsibility), risk, and quality management, is the focus on the ethical and social impacts during the research and innovation process, from the early stages to prototyping and go to market.

The initiatives to put in practice RRI in industry, for instance in the form of action plan, are still limited, most of them being related to cooperative projects within EU framework programs or national equivalents. Examples include projects such as Responsible Industry, Compass, Smart Map, Liv-In, Orbit.

The present guidelines have been developed by the PRISMA project, taking advantage of eight industrial pilots dealing with the application of transformative technologies in different sectors. The pilots were used to integrate RRI principles in their strategies and actions, in order to improve the societal value and overall performances of the outcomes of their R&D (Research & Development) activities, and develop specific 'pilot RRI roadmaps'.

For an effective RRI uptake it is essential to identify strategies and practices that fit with the realities and constraints in which the specific company operates. The PRISMA roadmap aims to do this.

At industry level, Technology Road-mapping is already a quite widely utilized method in strategy planning. A Technology Roadmap consists in the visualization of strategic aims (vision/development plans) of the organization and can be utilized to structure the research, development and business activities. In recent years, the concept of IPRM (Innovation Policy Road-mapping Methodology) has been developed to connect the development of technologies and innovations to a wider societal sphere¹. A main aspect of IPRM is to identify those societal needs which create a potential demand for new solutions and possibly favour the emergence of new products and markets. IPRM integrate a foresight exercise on enabling technologies, applications, products, markets with analysis of socio-economical and sectorial drivers, and policy and regulatory tools and strategies.

The RRI roadmap proposed in this guideline adapts the architecture of the generic IPRM to the definition of long-term visions and action plans for uptake of RRI within innovation strategies of companies. It provides the methodological and technical conditions to address RRI principles in the context of rapid (and possibly disruptive) scientific and technological developments, to ensure their relevance to society.

This document provides the methodological and technical conditions that characterize the PRISMA RRI roadmap.

In order to facilitate its possible future transferring into the standardisation system, if required by market players, the roadmap is structured to be consistent with the typical standardisation (CEN/ISO) deliverables.

¹ Ahlqvist, T., Valovirta, V., & Loikkanen, T. (2012). Innovation policy roadmapping as a systemic instrument for forward-looking policy design. *Science and Public Policy*, 39(2), 178-190

1. SCOPE

This document provides a framework to develop long-term strategies (roadmaps) to innovate responsibly, integrating technical, ethical, social, environmental, and economic issues into research and innovation practices, to improve the ethical and social impacts of final marketable outcomes.

The document is addressed to all organisations/agents involved in planning and performing research and innovation and technological development. The focus is on transformative and enabling technologies.

This document has been designed to be consistent, as far as possible, with existing management system standards and with management/governance standards (e.g. ISO 9001). Particular attention has been paid to social responsibility, i.e. ISO 26000.

2. NORMATIVE REFERENCES

The list of existing management standards and normative referenced in the document is given below. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- ISO 26000 Guidance on social responsibility
- ISO 31000 Risk management – Guidelines
- ISO 45001 Occupational health and safety management systems-Requirements with guidance for use
- EN ISO 9001 Quality management systems – Requirements
- Series CEN/TS 16555 Innovation Management
- Series CWA 17145 Ethics assessment for research and innovation
- IWA 26 Using ISO 26000:2010 in management systems
- UNI/PdR 27 Guidelines for management and processes development for responsible innovation
- UNI/PdR 18 Social responsibility in organizations - Guidance to the application of UNI ISO 26000
- ISO/DIS 56000 Innovation management -- Fundamentals and vocabulary
- ISO/FDIS 56002 Innovation management -- Innovation management system -- Guidance

3 TERMS AND DEFINITION

For the purposes of this document, the following terms and definitions apply.

3.1 ethics: is the systematic reflection on right and wrong conduct according to norms and values that we believe should be followed. Ethics refers to duties, responsibilities, rights, welfare, justice and the avoidance of harms. Typical moral values include autonomy, freedom, dignity, privacy, justice, well-being and responsibility [Series CWA 17145].

3.2 framework: an outline, or skeleton of interlinked items and actions which supports a particular approach to a specific objective, and serves as a guide that can be modified as required by adding or deleting items

3.3 human-centered Design (HCD) is characterized by:

- The design is based upon an explicit understanding of users, tasks and environment;
- Users are involved throughout design and development;
- The design is driven and refined by user-centered evaluation;
- The process is iterative;
- The design addresses the whole user experience;
- The design team includes multidisciplinary skills and perspectives.

[ISO 9241-210 :2010]

3.4 impact assessment: is the assessment of research and innovation for its projected or actual societal impacts [Series CWA 17145]

3.5 management system: set of interrelated or interacting elements of an organization to establish policies and objectives and processes to achieve those objectives

Note 1 to entry: A management system can address a single discipline or several disciplines.

Note 2 to entry: The system elements include the organization's structure, roles and responsibilities, planning, and operation.

Note 3 to entry: The scope of a management system may include the whole of the organization, specific and identified functions of the organization, specific and identified sections of the organization, or one or more functions across a group of organizations.

[ISO/TMB/JTCG Joint technical Coordination Group]

3.6 materiality: identification and understanding of priorities with respect to the context of social responsibility in which an organization operates. Priorities thus determined reflect the economic, social and environmental factors that deserve to be considered.

[UNI/PdR 18 Social responsibility in organizations - Guidance to the application of UNI ISO 26000]

3.7 organization: person or group of people that has its own functions with responsibilities, authorities and relationships to achieve its objectives

Note 1 to entry: The concept of organization includes, but is not limited to sole-trader, company, corporation, firm, enterprise, authority, partnership, charity or institution, or part or combination thereof, whether incorporated or not, public or private.

[ISO/TMB/JTCG Joint technical Coordination Group]

3.8 participatory design: is a “practice of collective creativity” that emphasizes active involvement by the users and all the stakeholders in design and development of new systems [Niemelä M., et al. 2014]

3.9 process: set of interrelated or interacting activities which transforms inputs into outputs

[ISO/TMB/JTCG Joint technical Coordination Group]

3.10 performance: measurable result

Note 1 to entry: Performance can relate either to quantitative or qualitative findings.

Note 2 to entry: Performance can relate to the management of activities, processes, products (including services), systems or organizations.

[ISO/TMB/JTCG Joint technical Coordination Group]

3.11 responsible research and innovation (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)

3.12 roadmap: is a strategic plan that defines a goal or desired outcomes, and includes the major steps or milestones needed to reach it.

3.12 roadmapping exercise: is a collaborative learning process and a tool for drawing up strategies, reaching consensus on requirements and needs, driving proactive planning and futures studies (VTT)

3.13 risk: effect of uncertainty on objectives

Note 1 to entry: An effect is a deviation from the expected. It can be positive, negative or both, and can address, create or result in opportunities and threats.

Note 2 to entry: Objectives can have different aspects and categories, and can be applied at different levels.

Note 3 to entry: Risk is usually expressed in terms of risk sources , potential events , their consequences and their likelihood

[ISO 31000:2018 Risk management — Guidelines]

3.13 risk assessment: overall process of risk identification, risk analysis and risk evaluation

3.15 risk identification: process of finding, recognizing and describing risks

3.16 risk analysis: process to comprehend the nature of risk and to determine the level of risk

3.17 risk evaluation: process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable

[ISO Guide 73:2009 Risk management – Vocabulary]

3.18 social responsibility: responsibility of an organization for the impacts of its decisions and activities on society and the environment, through transparent and ethical behavior that:

- contributes to sustainable development, including health and the welfare of society;
- takes into account the expectations of stakeholders;
- is in compliance with applicable law and consistent with international norms of behavior; and
- is integrated throughout the organization and practiced in its relationships.

NOTE 1 Activities include products, services and processes.

NOTE 2 Relationships refer to an organization's activities within its sphere of influence.

[ISO 26000:2010]

3.19 Corporate social responsibility (CSR): has been defined as “a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis”, as well as “the responsibility of enterprises for their impacts on society” [European Commission, 2011].

3.20 stakeholder: individual or group that has an interest in any decision or activity of an organization

[ISO 26000:2010 Guidance on social responsibility]

3.21 technology assessment (TA): is a scientific, interactive and communicative process which aims to contribute to the formation of public and political opinion on societal aspects of science and technology [TAMI, 2005]

3.22 top management: person or group of people who directs and controls an organization at the highest level

Note 1 to entry: top management has the power to delegate authority and provide resources within the organization.

Note 2 to entry: If the scope of the management system covers only part of an organization then top management refers to those who direct and control that part of the organization.

[ISO 9000:2015]

3.23 usability: is the extent to which specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [ISO/IEC 1998] can use a product

3.24 user-centered design (UCD) is an approach to interactive system development that focuses specifically on making systems or applications easy to use [ISO/IEC 13407, 1999]

3.25 user committees: This method involves users and other stakeholders in the formal monitoring and steering of the research and innovation process. Typically, there is a kick-off, a mid-term, and a final workshop [Engage2020 Project, 2014]

3.26 context of the organization: combination of internal and external issues that can have an effect on an organization's (3.2.1) approach to developing and achieving its objectives (3.7.1)

Note 1 to entry: The organization's objectives can be related to its *products* (3.7.6) and *services* (3.7.7), investments and behaviour towards its *interested parties* (3.2.3).

Note 2 to entry: The concept of context of the organization is equally applicable to not-for-profit or public service organizations as it is to those seeking profits.

Note 3 to entry: In English, this concept is often referred to by other terms such as "business environment", "organizational environment" or "ecosystem of an organization".

Note 4 to entry: Understanding the *infrastructure* (3.5.2) can help to define the context of the organization. [ISO 9000:2015 Quality management systems -- Fundamentals and vocabulary]

3.27 sustained success: organization success (3.7.3) over a period of time.

Note 1 to entry: Sustained success emphasizes the need for a balance between economic-financial interests of an organization (3.2.1) and those of the social and ecological environment.

Note 2 to entry: Sustained success relates to the interested parties (3.2.3) of an organization, such as customers (3.2.4), owners, people in an organization, providers (3.2.5), bankers, unions, partners or society.

[ISO 9000:2015 Quality management systems -- Fundamentals and vocabulary]

3.28 quality management: management (3.3.3) with regard to quality (3.6.2)

Note 1 to entry: Quality management can include establishing quality policies (3.5.9) and quality objectives (3.7.2), and processes (3.4.1) to achieve these quality objectives through quality planning (3.3.5), quality assurance (3.3.6), quality control (3.3.7), and quality improvement (3.3.8).

[ISO 9000:2015 Quality management systems -- Fundamentals and vocabulary]

3.29 engagement: involvement (3.1.3) in, and contribution to, activities to achieve shared objectives (3.7.1)

[ISO 9000:2015 Quality management systems -- Fundamentals and vocabulary]

3.30 involvement: taking part in an activity, event or situation

[ISO 9000:2015 Quality management systems -- Fundamentals and vocabulary]

3.31 monitoring: determining the status of a system, a process (3.12) or an activity

Note 1 to entry: To determine the status, there may be a need to check, supervise or critically observe.

[ISO/TMB/JTCG Joint technical Coordination Group]

3.32 innovation: new or changed *entity*, realizing or redistributing *value*

Note 1 to entry: Novelty and value are relative to, and determined by the perception of, the *organization* and *interested parties*.

Note 2 to entry: An innovation can be a *product*, *service*, *process*, model, method etc.

Note 3 to entry: Innovation is an outcome. The word "innovation" sometimes refers to *activities* or *processes* resulting in, or aiming for, innovation. When "innovation" is used in this sense, it should always be used with some form of qualifier, e.g. "innovation activities".

Note 4 to entry: For the purpose of statistical measurement, refer to the Oslo Manual (OECD/Eurostat 2018): 'New or changed entity' corresponds to 'a new or improved product or process, or combination thereof, that differs significantly from the unit's previous products or processes'. 'Realising or redistributing value' corresponds to 'and that has been made available to potential users or brought into use by the unit'.

[ISO/CD 50500.2 "Innovation management system – Fundamentals and vocabulary"]

3.33 innovation ecosystem: system (4.1.3) of organizations (4.2.2), people and resources, complementing each other and contributing to a common objective (4.3.3) with regards to innovation (4.1.1)

Note 1 to entry: An innovation ecosystem can include private companies, public authorities, universities, institutes, individual entrepreneurs, investors, researchers as well as funding and infrastructures.

Note 2 to entry: An innovation ecosystem generally includes intangible and qualitative interactions and relationships necessary for its effectiveness (4.7.4).

[ISO/CD 50500.2 "Innovation management system – Fundamentals and vocabulary"]

3.34 strategy: plan to achieve a long-term or overall objective

[ISO 9000:2015 Quality management systems -- Fundamentals and vocabulary]

3.35 transformative/enabling technologies: knowledge intensive, associated with high R&D intensity, rapid innovation cycles, high capital expenditure and high-skilled employment. They enable innovation in process, goods and service innovation throughout the economy and are of systemic relevance. They are multidisciplinary, cutting across many technology areas with a trend towards convergence and integration. KETs have the capacity to improve people's health, safety and security, supporting sustainable development and secure connectivity and communication among systems and individuals.

[European Commission, High-Level Strategy Group on Industrial Technologies, 2009 and 2018]

3.36 management standard: management standard designed to be widely applicable across economic sectors, various types and sizes of organizations and diverse geographical, cultural and social conditions.

[ISO/IEC Directives, Part 1, Consolidated ISO Supplement, 2018]

3.37 management system standard (MSS): MSS designed to be widely applicable across economic sectors, various types and sizes of organizations and diverse geographical, cultural and social conditions.

[ISO/IEC Directives, Part 1, Consolidated ISO Supplement, 2018]

3.38 documented information

information required to be controlled and maintained by an organization (3.1) and the medium on which it is contained

Note 1 to entry: Documented information can be in any format and media, and from any source.

Note 2 to entry: Documented information can refer to:

- the management system (3.4), including related processes (3.12);
- information created in order for the organization to operate (documentation);
- evidence of results achieved (records).

3.39: RRI product: Research and Innovation project or product of the organization to focus on in the design of the RRI roadmap

4. PRINCIPLES FOR IMPLEMENTING RRI

There is a wide set of papers providing different definitions and principles for RRI. The definition selected for this guideline, i.e. *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*², focuses on the social value in product development. This definition has been created considering the EU normative framework, with explicit reference to the Charter of Fundamental Rights of the European Union³.

Starting from this definition, a set of principles has been developed in literature⁴ in order to support the implementation of RRI in different kind of decisional and operative structure and practices. In this guideline, these “management” principles are connected to specific actions lines for RRI implementation along the R&I value chain and product life-cycle, as reported in Table 1.

Table 1: set of principles and actions for RRI implementation

Principles for RRI implementation	Action lines
Reflection & Anticipation	Integrate analysis of ethical, legal and social impacts (ELSI) since the early stages of product development
Inclusiveness	Perform stakeholder engagement to inform all phases of product development
Responsiveness	Integrate monitoring, learning and adaptive mechanisms to address public and social values and normative principles in product development

These principles are further described in the following⁵:

- Reflection:** scrutinize each activity, commitment and assumption in order to connect them with a moral value system and the good practices of science, taking into account the limits of knowledge and that a particular framing of an issue may not be universally held.
Reflexivity in RRI context is not to be referred to the moral responsibility of the single researcher or developer, and is not a self-critique of the single professional, but it is intended as an institutional practice. It can also be intended as a public matter and people external to the organization can be part of reflexivity actions. Reflexivity is important also with respect to the other phases of the product value chain or other functions inside the organization (besides the R&D), that could be affected by an R&I action or result.
- Anticipation:** systematically extrapolate all the plausible scenarios for the application of the R&I results; identify in these scenarios the possible risks, opportunities, uncertainties, critical issues, and draw possible ways to prevent, manage or exploit them.

² Von Schomberg, R. (2012). Prospects for Technology Assessment in a Framework of Responsible Research and Innovation. In D. Marc. & B. Richard (Eds.), *Technikfolgen abschätzen lehren* (pp. 1–19). VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-93468-6_2

³ See https://www.europarl.europa.eu/charter/pdf/text_en.pdf

⁴ Lubberink, R., Blok, V., van Ophem, J., & Omta, O. (2017). Lessons for Responsible Innovation in the Business Context: A Systematic Literature Review of Responsible, Social and Sustainable Innovation Practices. *Sustainability*, 9(5), 721. <https://doi.org/10.3390/su9050721>

⁵ Stilgoe, J., Owen, R., & Macnaghten, P. (2013). Developing a framework for responsible innovation. *Research Policy*, 42(9), 1568–1580. <https://doi.org/10.1016/j.respol.2013.05.008>

Anticipation isn't only intended to prevent undesirable events, but also to shape desirable futures and organize activities and resources towards them. When describing desirable futures, anticipation should be realistic and avoid to overestimate the benefits of the innovation.

- **Inclusiveness:** introduce participatory approaches in the R&I processes from the very early stages, in order to engage people interested with the innovation process or results. Inclusion is referred to the engagement of both internal and external stakeholders. Inclusion is also connected to the other dimensions of RRI, because the reflexivity, anticipation and responsiveness can be improved by a broad participation of different stakeholders.
- **Responsiveness:** change the direction of the innovation process to answer to stakeholder and public indications, needs, and values or to react to changing circumstances. It could be necessary also to adjust innovation actions when recognizing insufficiency of knowledge and control, or in response to new knowledge, perspectives or regulatory requirements. The entire R&I processes should be shaped to be as responsive as possible.

The Box includes a collection of scope, principles and values of some ISO management systems, providing a useful reference for the implementation of the RRI approach described above.



Scope, principles and values of ISO standards on social responsibility, risk management, quality and innovation management

ISO 26000 (Social Responsibility)	ISO31000 (Risk Management)	ISO 9001 (Quality Management)	ISO 56000 (Innovation Management)
Guidance to integrate, implement and promote socially responsible behavior throughout the organization and, through its policies and practices, within its sphere of influence.	Guidance on a common approach to managing any type of risk throughout the life of the organization.	Requirements to demonstrate ability of the organization to consistently provide products and services that meet customer needs (conformity) and applicable statutory and regulatory requirements	Describes the fundamental concepts, principles, and vocabulary of innovation management
➤ Accountability ➤ Transparency ➤ Ethical behavior ➤ Respect for stakeholder interests ➤ Respect of the rule of law ➤ Respect for international norms of behavior ➤ Respect for human rights	A risk management framework: ➤ Integrated in all organizational activities ➤ Structured and comprehensive ➤ Customized to the organization's external and internal context ➤ Inclusive, considering knowledge, views and perceptions of stakeholders ➤ Dynamic and adaptable ➤ Based on best available information ➤ Taking into account human and cultural factors ➤ Based on continual improvement, through learning and experience.	➤ Customer focus ➤ Ensuring leadership on the management system ➤ Engagement of people ➤ Process approach, to operate as an integrated and complete system. ➤ Based on continuous improvement to meet customer requirements and enhance customer satisfaction. ➤ Evidence- based- decision making ➤ Relationship management	➤ Realization of value, as the ultimate objective, for organizations to engage in innovation activities ➤ Future focus leader, driven by curiosity and courage, challenge the status quo ➤ Strategic direction for innovation ➤ Culture ➤ Exploiting insights: using a diverse range of internal and external sources ➤ Managing uncertainty ➤ Adaptability ➤ System approach

5. METHODOLOGICAL APPROACH

Based on the principles described in clause 4, the methodological approach to the different steps of the process leading to the implementation of the RRI in the industrial practice are synthetically indicated in the Figure 1 and explained in detail in clause 6. The final goal is the definition of a RRI Roadmap setting a strategy, indicating a vision and specific actions for RRI implementation in product development. The structure and visualization of the roadmap is provided in Figure 2. The roadmap design includes definition of the following elements:

- The Research and Innovation product (s) on which to focus the RRI roadmap
- The vision for RRI implementation in the product development
- The time-scale for the implementation of the RRI roadmap
- The drivers and challenges, risks and barriers to achieve the vision, based on the assessment of the present status
- The RRI actions to pursue, as possible path(s) between present and future to reach the vision
- The resources and process owners needed, their feasibility and consistency with the overall organization strategy and the innovation eco-system

The list of the methodological steps for the roadmap design is reported in Table 2, including indication of the different phases of development of the roadmap structure, leading to the roadmap design.

The process proposed in this guideline is circular: top management commitment prompt and facilitate the process of roadmap design and as well is informed by it.

The approach has been tested in practice by implementing it with eight pilots referring to industrial research projects related to transformative technologies (described in Prisma deliverable 5.2, part B). In particular nanotechnologies, biotechnologies, the Internet of Things and autonomous vehicles. This exercise helped to refine, and deepen the different issues, steps and actions. The outcomes have been translated into the framework described below.

Table 2: List of methodological steps for the roadmap design

	STEP	GOAL	ROADMAP PREPARATION
	Section 6.2: TOP MANAGEMENT COMMITTMENT AND LEADERSHIP	Ensure endorsement of the organization toward RRI values and approach	Setting of the initial RRI vision, and selection of RRI product candidates
	6.3: CONTEXT ANALYSIS	Analyze the organization, the R&I product(s) and technologies to focus on; Identify ethical, social and legal impacts of the product and stakeholders of the product innovation eco-system	Compilation of the 4 th line of the roadmap (R&I tech and products)
	6.4: MATERIALITY	Identify and prioritize: drivers and challenges for RRI; risks and barriers to overcome; stakeholders to work with; significant RRI actions to pursue	Compilation of 1 st and 2 nd lines of the roadmap; refinement of the vision; first version of the RRI actions (3 rd line)
	6.5: EXPERIMENT & ENGAGE	Perform exploratory/pilot RRI actions, engaging with stakeholders to inform the RRI roadmap	Review of the overall roadmap with stakeholders
	6.6: VALIDATE	Evaluate impact of the roadmap on both the product development and the organization (Key Performance Indicators)	Review of RRI actions, in view of their technical, ethical, social, environmental, and economic impacts
	6.7: ROADMAP DESIGN	Consolidate and visualize the long-term RRI strategy, covering all the R&I value chain (time to market) and product life-cycle.	FINAL ROADMAP

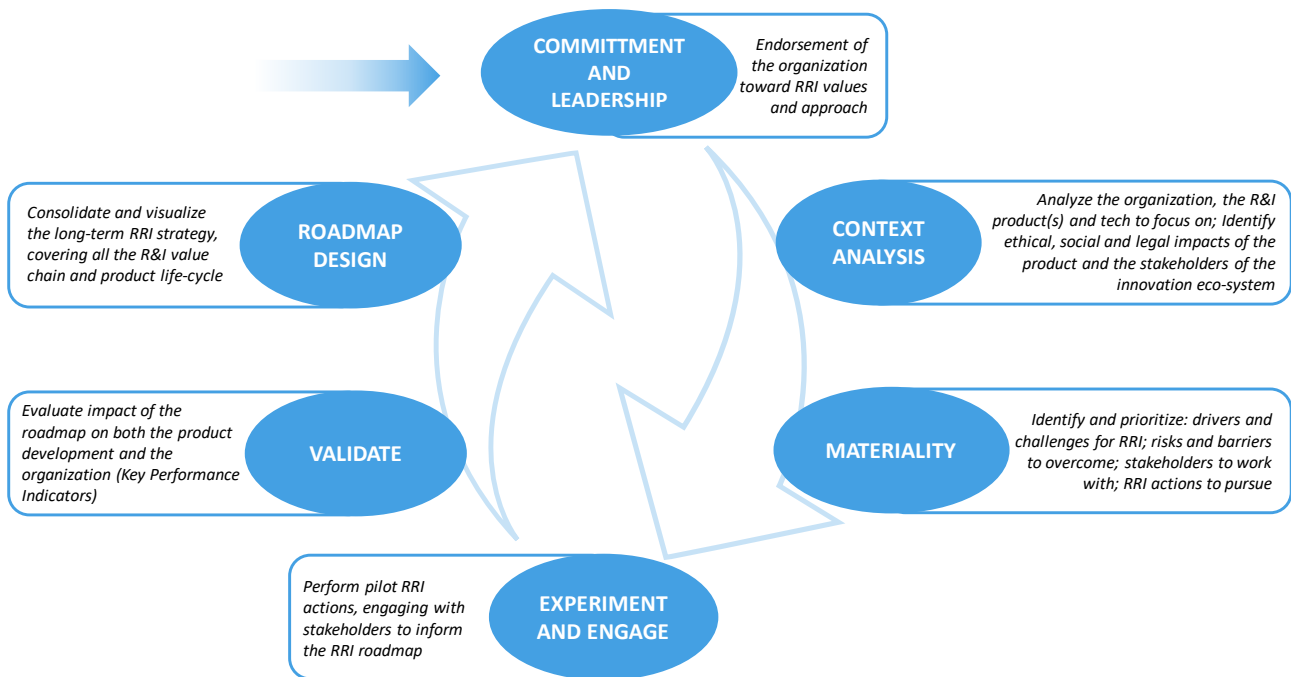


Figure 1: Overall approach and steps leading to the definition of the RRI roadmap

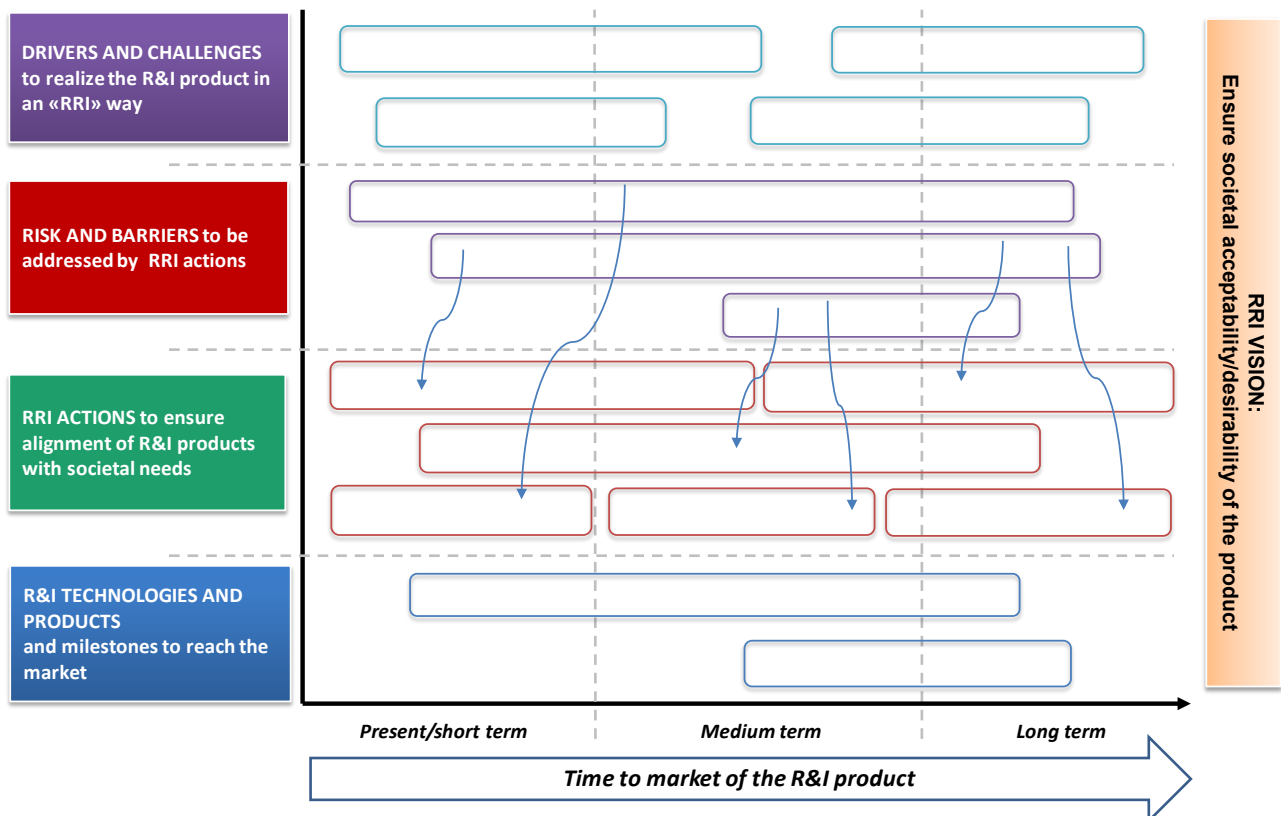


Figure 2: Visualization of the RRI Roadmap

6. FRAMEWORK FOR DEVELOPING THE RRI ROADMAP

6.1 General

In developing the framework from clause 6.2 to 6.7, the high-level structure (HLS), i.e. identical core text, common terms and core definitions for all ISO management system standards, as well as other relevant management standards, have been considered.

NOTE for what concern ISO management system standards ISO 9001 series and ISO/FDIS 56000 series were considered. As far as management standards are concerned ISO 26000 and ISO 31000 were taken as references.

It is envisaged that a third-party organization is engaged by the organization, in order to advise and oversee the implementation of these guidelines. The third-party organization should have a specific expertise on RRI related issues (e.g. ethical, social, legal impacts analysis).

6.2 Top Management commitment and leadership

A pre-requisite for RRI implementation is top management commitment. This commitment is necessary but not sufficient to achieve RRI intended outcomes, as the top-down approach should be integrated with a bottom-up approach, involving other roles providing leadership.

Top management shall demonstrate leadership and commitment with respect to the RRI by:

- ensuring that the RRI roadmap, related actions, objectives and vision are established and are compatible with the values and identity and stakeholders the organization is referring to
- identifying and sustaining the motivation for the company to engage with RRI
- ensuring that RRI principles are integrated into the organization's management systems and governance to ensure that the RRI achieves its intended outcome(s)
- ensuring that the resources needed for both the roadmap design and its future implementation are available (also on the long term)
- communicating the importance of effective RRI, supporting the application of the guidance provided in this document
- supporting other relevant roles for RRI implementation, for example supporting RRI promoters

This process will lead to an initial formulation of the vision for the RRI roadmap and a selection of possible Research and Innovation projects or products to focus on in the design of the RRI roadmap ("RRI product")

6.3 Context analysis

RRI is connected to a broad spectrum of factors related to the type and management policies of a company, the technology and products it works on, the sectors and markets, the pertinent regulatory frameworks and stakeholders involved. For an effective and efficient RRI uptake, it is essential to identify strategies and practices that fit with the realities and constraints in which the organization operate.

The following elements are identified, at least in draft form:

1. **The ethical, legal and societal impacts, and as well as the technical, strategic, organizational, economic impacts concerning the RRI product.** This analysis is expected to influence the selection of all the roadmap elements and the setting of the vision, and will feed into clause 6.2 (materiality)
2. **The specific technologies and products,** and related R&I projects, on which to focus the RRI roadmap design (“RRI product”)
3. **The development stages of the RRI product,** from the start of the analysis to the expected time to market of the product. (4th line of the roadmap)
4. **The stakeholders interested/involved in the development of the RRI product** throughout the innovation eco-system, including an initial understanding of their needs and perspectives (based on desk analysis)

Note: If the RRI roadmap is meant to cover the whole life cycle of the product, the roadmap time frame could include the product end of life.

Internal and external issues of the organization and of the specific RRI product concerned with the roadmap design contribute to shape the analysis. For what concerns the **internal issues**, it is essential to consider the identity of the organization and to take into account:

- a) mission: the organization’s purpose for existing
- b) vision: aspiration of what an organization would like to become
- c) values: principles and/or thinking patterns intended to play a role in shaping the organization’s culture and to determine what is important to the organization, in support of the mission and vision
- d) culture: beliefs, history, ethics, observed behavior and attitudes that are interrelated with the identity of the organization
- f) The management models used in research and innovation
- e) the formal and informal policies and procedures implemented by the organization for social responsibility, and quality and risk management
- f) The impact of research and innovation on the core business of the organization
- g) The characteristics of the RRI product, in terms of the type of technology and innovation, the expected applications, the technology readiness level (TRL) and time to market, the expected R&I steps to develop the final RRI product,

Notes: part of these points is derived from [ISO 9004:2018, 6]; The specific type of technology can be classified in terms of: front runner, directly product oriented, incremental or radical innovation.

For a proper understanding of the **external issues**, at least the following aspects should be considered:

- h) the market segments and structure, in terms of opportunities and barriers for exploitation and deployment of the RRI product within the innovation eco-system and in the market
- i) the normative and regulatory regimes concerned with the RRI product
- l) the public and stakeholder awareness on the technology and product developed
- m) the type of information that could or couldn’t be disclosed to stakeholders (IPR and trade secrets)
- n) what stakeholders (and procedures) are usually considered within the innovation ecosystem

For the analysis of internal and external issues, tools such as SWOT (analysis of strength, weaknesses, opportunities, and threats) and PESTLE (analysis of political, economic, socio-cultural and technological, legal and environmental factors) can be used.

Based on the identification and analysis of internal and external issues, the organization shall map relevant stakeholders and understand their needs and expectations, by taking into account those parties that are relevant for RRI implementation and in particular linked to the organization innovation ecosystem. Consideration of the needs and expectations of interested parties can help the organization:

- a) to achieve objectives effectively and efficiently
- b) to eliminate conflicting responsibilities and relationships
- c) to harmonize and optimize practices
- d) to create consistency
- e) to improve communication
- f) to facilitate training, learning and personal development
- h) to manage risks and opportunities to its brand or reputation
- i) to acquire and share knowledge

This activity can be considered as a context analysis.



Model of a questionnaire to compile information for the context analysis

Facts and figure:

- Field of activity
- Company ownership
- Size of the organisation
- Date of establishment
- Member of trade organisation

Type of organization:

- Organisational structure
- Business model
- Organisational culture
- Gender balance and gender policy (focus on R&I)

R&D and Innovation function:

- Size
- Relevance for the organization
- Type of research activity
- Characteristics of personnel: age, education, sex, home country, race
- role of the R&I compared to the CSR strategy of the organization
- Innovation management model

Experience with CSR and RRI:

- CSR, sustainability, risk and quality strategies
- Responsibilities within the organization
- Experience on stakeholder engagement

Case description:

- Project description
- Technologies
- Regulatory regimes
- Type of R&I activities
- Type of business
- Time to market

6.4 Materiality analysis

A key aspect of RRI is anticipation. Identify materiality aspects of the RRI product and the organization early on in the R&I value chain is essential to anticipate impacts, and thus have time to change and adapt the process to ensure creation of value (e.g. maximize positive impacts and minimize negative ones).

The term materiality brings two concepts into play:

- understanding what (contents) is **relevant** in terms of RRI with respect to the context in which the RRI product and the organization finds itself and operates
- understanding how much the relevant content is **significant**

The goals of this phase are thus the following:

1. Identify **relevant ethical, social and legal impacts** of the RRI product, and describe them in terms of **drivers** (creation of value, positive impacts), and **challenges** (of the organization in achieving the impacts)

2. **Identify the risks and barriers** (uncertainties) to address in order to achieve the impacts. Scientific, technical, strategical, organizational, economic, ethical and social aspects should be considered in determining risks and barriers
3. **Select stakeholders within the innovation eco-system** of the RRI product to engage with
4. **Select significant RRI actions** that can contribute to achieve impacts and as well address risks and barriers
5. **Set an initial vision of the roadmap**, addressing drivers and challenges

A first complete version of the roadmap is prepared based on these elements. Examples of specific RRI actions are reported in the appendix.

Note: In the elaboration of the roadmap, the materiality analysis needs to be linked to the technology readiness level of the product, and the time to market (1st line of the roadmap). It has to be defined when a specific issue will arise along the product development phase, and thus what actions to be done when.

The goal of this phase is to identify what impacts and what RRI actions are relevant to decisions and activities of the organizations, and develop a set of criteria that help decide which of them are most significant.

This means determining which issues are more important to the organization in terms of priority, e.g. the extent of the impact on stakeholders, society or sustainable development, consequences arising from a non-management of that very issue, perceptions and expectations of stakeholders, and the overall impact on the product development and the organization.

A particular attention should be given to the “agents” of the innovation eco-system, whose actions and decisions can affect the organization and on which the organization activities may have an effect and/or an impact (positive and/or negative).

Additionally, it seems clear how much an approach to the determination of materiality should be based on:

- a) a strong link to organizational governance and to the determinants of the value chain and of the creation of economic value (value drivers)
- b) a set of clear and transparent criteria that support the organization in deciding what is "material"
- c) an integration with the governance itself

The understanding of the 'context' and the sphere of influence of the organization is critical in this exercise, as it implies the ability to reflect with a broad vision on the impact that the actions and decisions of the organization have, or might have, within the organization itself, and also on stakeholders and on RRI (and vice versa).

As acknowledged by the experience in the social responsibility field (e.g. ISO 26000), the identification of material issues to address is not a simple exercise. While the methods developed from the perspective of economic and financial materiality capture only those relevant areas that impact performance or risks in the short term, from the perspective of RRI the time frame shall consider not only short-term impacts and effects, but also ones in the medium to long term, including both tangible and intangible aspects.

It is important that the views of the stakeholders are always considered and appropriately integrated into the reflections internal to the organization. The stakeholder's analysis involves the identification of relevant groups, organizations and people, their perspectives and relevance. Having this in mind, stakeholders can then be mapped, using one of the many tools available for this purpose. An example of stakeholder analysis is presented in the box. Examples of tools for this purpose are the materiality matrix and the interest/influence grid (see appendix).

The materiality analysis started in this phase, is then complemented by the other phases. Clause 6.5 require the organization to perform inclusiveness actions (e.g. stakeholder engagement), a fundamental element in

determining significance, both to broaden perspectives on issues and impacts, and to capture inputs on prospects and emerging needs that, at the moment, do not seem particularly critical but could become such in the future.

The validation phase (clause 6.6.) helps the organization to identify a set of criteria to evaluate the impact of the identified RRI actions on product development and the organization and thus complete the materiality analysis.

An example of questions to deal in a materiality analysis, are the safety and privacy issues related to operations of autonomous vehicle devices. What are the safety concerns (both actual and perceived by stakeholders) related to the different conditions of work of the device? How to manage the data the device could or have to collect during its operations? Is the collection of these data critical from a social, ethical and legal point of view? What could be the ethical issues related to autonomous decisions that these vehicles might have to take during their operations? All these aspects are relevant, but depending from the specific device (e.g. autonomous cars or drones), the technology (e.g. the type of data collected, the way these are managed by the device, etc.), the use scenarios (e.g. use of the device in buildings, cities, farms, etc.) and the stakeholders concerned, the definition of significant issues for the specific products (materiality) could completely change.



Example of an exercise for stakeholder analysis in the innovation eco-system

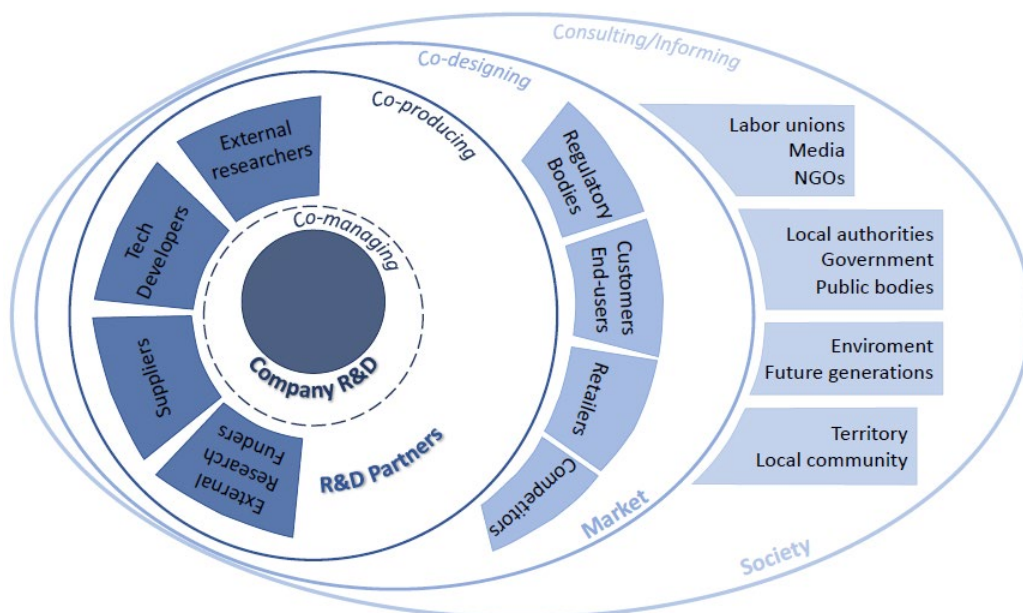
Stakeholder analysis consists in identifying all the relevant stakeholders and their interests connected to a specific topic. This can be done by following four main steps:

- Identify: relevant groups, organizations, and people
- Analyze: the contribution that each stakeholder can provide, their legitimacy or willingness to be engaged, how much influence does each stakeholder have (and who/what is able to influence) or how could they delegitimize the process if not involved
- Map: the core part of the “mapping exercise” consists in putting together the information about the stakeholders in a graphical way in order to visualize which stakeholders is must useful to engage with, based on selected criteria (see the appendix to have some practical examples)
- Prioritizing: ranking stakeholder relevance, in order to understand who has to be engaged from the beginning or more intensively, being clear in establishing why each stakeholder has been selected (this is important to save time and also to interact with them in the right moment with a proper motivation)

It is important to implement RRI with an innovation ecosystem approach. The ecosystem has to be identified and built (or strengthened, if already on place). Some useful actions could be:

- Identify the role of all the stakeholders sharing benefits and risks of innovation
- Select instruments enabling interaction of these actors at all levels
- Establish common (RRI compliant) standards/processes/procedures/certifications within the innovation ecosystem

The following figure is an example of mapping of stakeholders in the innovation eco-system, including indication of their potential role in product development



6.5 Experiment and engage

Stakeholder engagement is one of the pillars of RRI, and it is as well essential in order to validate the materiality analysis and the design of the roadmap. On the basis of the previous steps, it is possible to identify one or few RRI pilot actions that the organization should perform in order to ascertain the appropriateness and the feasibility of the RRI roadmap. Thus, in this phase the following aspects are addressed:

1. **At least one inclusiveness action is performed**, involving stakeholders within the innovation eco-system in discussing and analyzing key ethical and social impacts of the project and in reviewing the draft roadmap
2. **Additional RRI actions are performed**, as a way to practice and pilot activities planned in the roadmap

In the selection of the actions, is suggested to make a step further compared to usual organization practices (out of the “comfort zone” of the organization, in terms of issues discussed, information provided, stakeholders engaged, methods used, etc.).

There are plenty of methods available to perform stakeholder engagement, and different goals that could be pursued (e.g. inform, consult, involve and collaborate).

The main objective in this phase is to create a dialogue with stakeholders of the innovation eco-system (as selected in the materiality analysis) to discuss their views and perspectives on the RRI product and its ethical, legal and social impacts, and on the specific elements included in the roadmap.

Examples of suitable methods include focus groups, plenary sessions, multi-stakeholder workshops, world-café, and fish-bowl exercises. A more detailed list of the methods is provided in the appendix. Recommendations to perform stakeholder engagement are provided in the box.

Initiatives aiming only at informing on product development, observing and studying people’s behaviour, testing of a product should be avoided.

The outcome of this phase is a complete materiality analysis, in terms of significant ethical, social and legal impacts to address, and stakeholders of the innovation eco-system and a consolidated version of the roadmap.



Practical recommendations for stakeholder engagement:

- Learn from past and on-going engagements. Make a reflection on the positive aspects and possibilities for improvement
- Identify and communicate in advance to all stakeholders the goals and expected outcomes
- Ensure most representative stakeholders along the value and supply chain are engaged. If appropriate, consider different type of engagement activities for the different stakeholders (e.g. a focus group with research and business partners, a workshop with authorities, a multi-stakeholder initiative to involve users, together with research and business partners)
- Be social. Social medias provide a perfect opportunity to identify and reach lesser-known stakeholders groups
- Select the engagement method, taking into account the number of stakeholders to be involved, their level of interest and knowledge, their willingness to participate and the kind of contribution they could provide (as identified in the materiality analysis)
- Look for diversity of participants, in terms of experience and skills, geography, as well as gender and age
- Set clear rules for engaging stakeholders (e.g. confidentiality, decision making process)
- Identify motivation for stakeholders to contribute, if appropriate consider rewarding mechanism for them
- Carefully design/select: the information to be provided in advance and during the event; the structure of the event; moderators/facilitators; the ways for reporting outcomes; feedback mechanism and/or evaluation methodology; the tools for communication and dissemination.
- Look for interactive ways of engaging stakeholders, consider to assign active roles to the participants
- Consider stakeholder expectations, ensure an equal possibility to all, avoid polarization and mitigate the possible tensions, stick the discussion to the agenda and the objectives and avoid off-topics
- Provide documented information on the engagement activities. Include at least: a summary of stakeholder concerns, expectations and perceptions; a summary of key discussions and interventions; and outputs (e.g. queries, proposals, recommendations, agreed decisions and actions)
- Ensure follow up of the event (e.g. share presentations, distribute a report of the event, give the opportunity to all participants to comment, communicate decision taken based on the event results, organize follow up initiatives, etc.)
- Keep in mind that stakeholder engagement is a process, not an event or a one-off exercise

6.6 Validation

The success of RRI up-take is strongly context-dependent and is affected by several factors, as underlined in the context analysis clause (e.g. company size, complexity of the organization, features of the technology, the level of innovation and the associated risks). RRI actions could have both tangible and intangible impacts, spanning from long-term strategic factors at the company level (e.g. company reputation) to short-term factors in product development (e.g. alignment with user needs and stakeholder values).

In this phase the organization evaluate and validate the added value of the roadmap in terms of its impact on the product development and the company, based on selected criteria. This process is needed both to evaluate the feasibility of the roadmap for the organization, and, if necessary, to refine it.

The definition of criteria is also helpful to provide documented information on the roadmap, that could be controlled and maintained by the organization during the uptake of the roadmap actions. Thus, in this phase the following aspects are address:

1. **Identify what needs to be measured and monitored**, selecting criteria to perform evaluation of impacts of RRI actions
2. **Select the methods for measuring, monitoring, and evaluating the impacts** of the roadmap on the RRI product and the organization
3. **Evaluate (at least qualitative) the impacts of the RRI actions** defined in the roadmap, focusing on the added values both tangible and intangible, based on the selected criteria
4. Explore whether and to what extent the roadmap could be embedded in the usual innovation, risk, quality, social responsibility policies of the organization. This includes identification of Key Performance Indicators to measure impact of RRI actions on the organization

Relevant examples are provided in the appendix with respect to: a set of criteria and a qualitative methodology for the evaluation of the impact of the RRI roadmap on product development (points 1,2,3); quantitative Key Performance Indicators to evaluate impact of RRI on the organization (point 4).

The organization should as well determine resources and processes needed to operationalize the actions indicated in the roadmap, namely:

- 1) People
- 2) Time
- 3) Knowledge
- 4) Finance
- 5) Infrastructures, i.e. tangible and intangible assets and technological infrastructures

The role and contribution of relevant “agents” (i.e. relevant interested parties within the innovation ecosystem) to implement the roadmap should also be considered.

The organization shall retain appropriate documented information as evidence of the results.

This step might lead to changes in the planned RRI actions, to ensure these are aligned with the overall strategy of the organization and the resources available. This will lead to the final version of the RRI roadmap (6.7).

6.7 Roadmap design

Based on the outcomes of the above-mentioned steps, a RRI roadmap is designed to guide an organization to put in practice the key RRI implementation principles already indicated in clause 4:

1. **Anticipation & Reflection:** Integrate analysis of ethical, legal and social impacts since the early stages of product development
2. **Inclusiveness:** Perform stakeholder engagement to inform all phases of product development
3. **Responsiveness:** Integrate monitoring, learning and adaptive mechanisms to address public and social values and normative principles in product development

The RRI roadmap of the organization should include at least one specific action for each of the above three key principles. Examples of specific actions are reported in the appendix.

The PRISMA RRI roadmap is built taking advantage of the experience made with the industrial pilots mentioned above, to cope with the RRI principles and tools in the context of rapid (and possibly disruptive)

scientific and technological developments associated with transformative technologies. Its guidelines and actions, however, have a general validity. Its design adapts the architecture of the generic IPRM to decision-making on RRI strategies as shown in the figure below, already anticipated in clause 5.

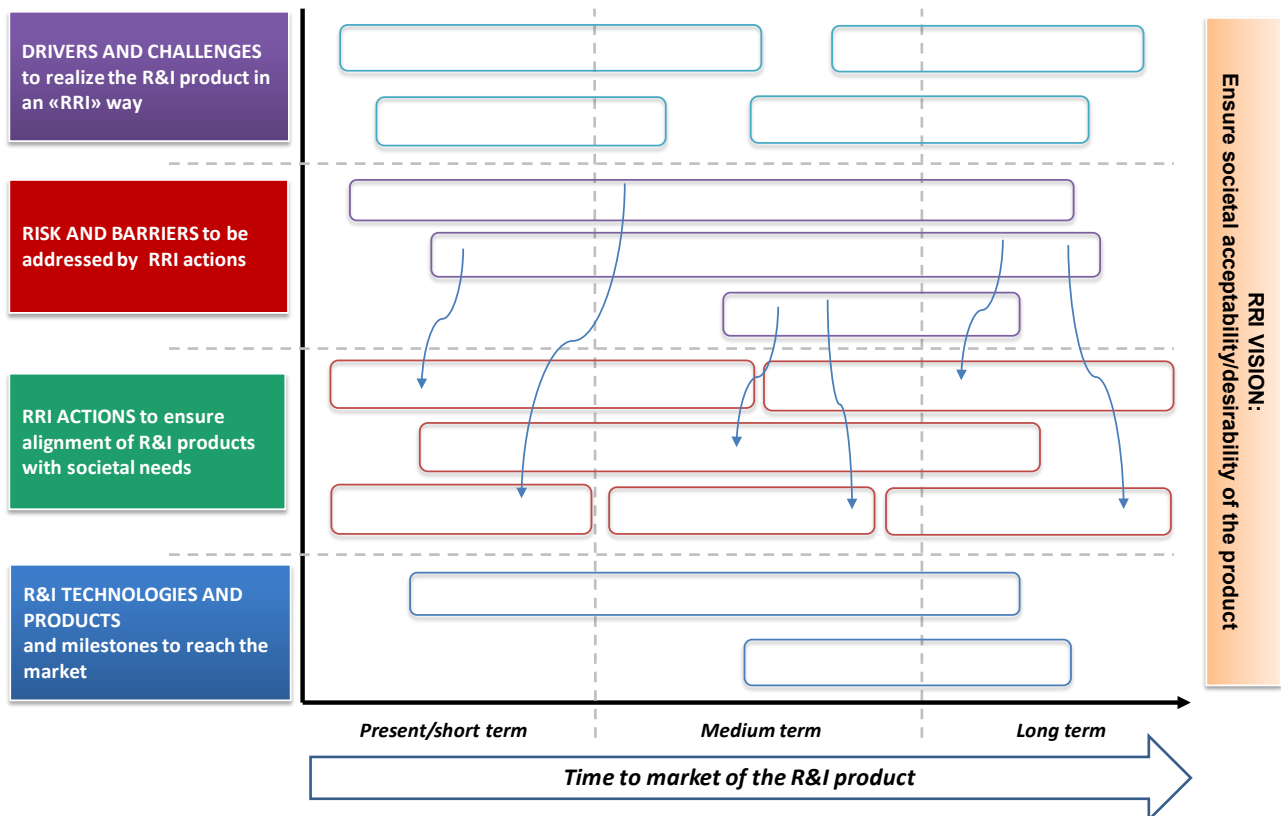


Figure 3: PRISMARRI roadmap template

As shown in the template (Figure 3), the PRISMA RRI roadmap has four areas of action and its design starts with the definition of the desired outcome of RRI implementation (vision) (6.2). That means:

- 1st line (compilation starts at 6.3): the definition of the drivers and the challenges, based on consideration of the significant ethical, social and legal impacts, and strategic, organizational and economic issues at stake, for both the organization and the specific RRI product
- 2nd (compilation start at 6.4): the identification of the risks and barriers addresses by the RRI actions
- 3rd (compilation starts at 6.4): identification of an action plan to implement RRI all along the steps for product development, core part of the roadmap
- 4th (compilation starts at 6.3): identification of the innovative technologies that enable to address the objectives of the research and innovation (RRI product)

The X-axis of the RRI roadmap shows the expected duration of the research and product development, until the entry into the market (time to market). It might include also the use and end of life of the product, if a life cycle perspective is considered in the definition of the roadmap (in this case time to market is replaced by life cycle).

The market demand plays an important role on the technology-based solutions under investigation and the societal implications may affect the technological developments.

Stakeholder involvement plays an important role at all levels.

The construction of the proposed roadmap is a flexible and adaptable process using a “toolbox” with different modules and consists of several levels. The starting point, is the long term RRI vision. All the intermediate targets should be designed in relation to long term RRI targets and include the RRI anticipatory, reflective, deliberative and responsive principles (clause 4).

Important elements for the design of the roadmap and its implementation are also the RRI pilot actions that the organization should perform in order to ascertain its feasibility (6.5) and the evaluation and validation of the added value given by the roadmap on product development, as well in terms of resources to put actions into practice (6.6).

Besides the graphical representation in the Figure 3, document information will be provided describing in more detail the RRI roadmap policy. An example of contents is indicated in the box.



Template of documented information to be provided on the RRI roadmap

Case description

- The Company
- RRI commitment
 - Functions of the organization endorsing the roadmap
 - Motivation to implement the roadmap
- Context
 - Size and ownership of the organization
 - Date of establishment, country
 - RRI product selected
 - Technologies
 - Regulatory regimes relevant for the RRI product
 - Type of R&I activities
 - Type of business
 - Time to Market
 - CSR policies
 - Gender balance and gender policy in R&D/R&I
 - RRI Maturity Level
- Materiality & experimentation
 - Significant stakeholders
 - Significant ethical, social and legal impacts
- Validation aspects
 - Criteria to evaluate impact of RRI actions on the RRI product
 - Key Performance Indicators to monitor RRI aspects within the organization

RRI Roadmap

- RRI vision
- R&I Technologies and products
- Drivers and challenges for RRI
- Risks and barriers to be addressed by RRI actions
- RRI actions
- Roadmap design

APPENDIX

RRI Actions

In Table 3, Table 4 and Table 5 are indicated examples of main actions to implement RRI in product development at company level, with reference to expected benefits, the R&I value chain, the corporate functions the stakeholders involved, and the term of investment. These actions are derived from the experience of PRISMA, and literature review (in particular outcomes of other initiatives dealing with RRI implementation in companies).

Table 3: Key action on REFLECTION & ANTICIPATION:
Integrate analysis of ethical, legal and social impacts (ELSI) throughout all stages of product development

Actions	Benefits	R&I Value chain phase	Corporate functions involved	Stakeholders involved	Investment Term
Including RRI principles in company's mission and vision, including reflection on Creating Shared Value	-Improve product quality, desirability and acceptability - Improve product sustainability, safety and reliability -Address uncertainties, prevent and mitigate risks	All	Management	R&I partners	Short
Ethical analysis, through foresight, scenario analysis, social phenomena and trends evaluation, etc.		Basic and applied research, engineering and testing	Management, R&D	R&I partners end users, policy makers	Short, Medium
Design for values, stakeholder and value inventory/scenarios (values hierarchy, conflicting values, etc.)			R&D	R&I partners, suppliers, end-users	Short, Medium
Internal meetings with R&D personnel to reflect on ethical issues			R&D	Internal to the company	Short
Advice from (independent and external) experts on ELSI, on a need basis			R&D, CSR, Legal	Internal to the company	Short
Develop and introduce ethical frameworks, code of conducts	- Motivate workers	All	Management, legal, R&D, CSR, quality	Internal to the company	Medium
Implement Life Cycle Assessment (LCA) and Social-LCA		Applied research, engineering and testing	Management, R&D, Quality, CSR	Suppliers	Long
Re-evaluate expected impacts prior to the market launch		Go to market	R&D, Quality, CSR	R&I partners, End-users	Short

Table 4: Key action on INCLUSIVENESS:
Perform stakeholder engagement to inform all phases of product development

Actions	Benefits	R&I Value chain phase	Corporate functions involved	Stakeholders involved	Investment Term
Set and implement a communication and dialogue strategy on ELSI	-Strengthen relations and trust with all stakeholders, networks building	Engineering and testing, Go to market	R&D, CSR, Marketing	All	Long
Work with business and social actors sharing values and create positive ethical networks		All	CSR	All	Medium
Co-design product through dialogue with policy actors and authorities and normative bodies (EU, regional and local)	- Reconcile opposing views and bridging opposing values	Applied research, engineering and testing	R&D, Quality, Legal	Policy makers, regulators	Short
Organize public dialogues, build/use public platforms for expressing needs and concerns			R&D, CSR	End users and consumers	Medium
Living labs and social experimentation, participatory methods	- New values creation		CSR, R&D	End users and consumers	Short, Medium
Build user-based communities of practice	- Anticipate potential regulatory change		R&D, CSR	End users and consumers	Medium
Promote initiatives for social inclusion, provide consumers an official role in the innovation process	- Product quality, desirability and acceptability	All	CSR	End users, policy makers	Medium
Capacity building with vulnerable actors in the value chain		Engineering and testing, Go to market		End users	Medium

Table 5: Key action on RESPONSIVENESS:
Integrate monitoring, learning and adaptive mechanisms to address public and social values and normative principles in product development

Actions	Benefits	R&I Value chain phase	Corporate functions involved	Stakeholders involved	Investment Term
User-centered design, user innovation, flexible and adaptive design, co-creation approaches	- Create value, increase the social value/impact of R&D	Applied research, Engineering and testing	R&D, Management, Legal, Marketing	R&I partners, supply chain suppliers, end-users and consumers	Long
Screen suppliers for positive practices, share social and environmental issues to be addressed with suppliers			CSR, Management	Supply chain suppliers	Medium
Put in place procedures for investigating reports of concerns or misconduct (e.g. whistleblowing)			All	Internal R&D, R&I partners, supply chain suppliers, end-users and consumers	Medium
Ensure non-discriminatory recruitment processes			HR, CSR	Internal to the company	Short
Adaptive risk management			Management, R&D, quality	Internal to the company	Medium
Embedded ethicists in the R&I process	- Compliance with qualified norms and standards	All	CSR, R&D	Internal to the company	Medium
Establishment of an ethical, social and legal monitoring board	- Facilitate the access to financial support	All	R&D, Management	R&I partner, supplier, policy makers, end-users	Long
Include ELSI criteria in internal procedures for R&D project quality monitoring (check-list, guidance)		Applied research, Engineering and testing	R&D, Management	Internal to the company	Short
Ensure ethical management of research data and FAIR data management ⁶		R&I, CSR	R&I, CSR	R&I partners, internal to the company	Medium
Perform regular ethical review and get ethical certification (by independent bodies)		Engineering and testing, Go to market	CSR, quality	Certification bodies,	Long

⁶ FAIR data principles: Findable, Accessible, Interoperable, re-usable- See <https://www.go-fair.org/fair-principles/>

				regulators and authorities	
Social accountability and quality certification at company and supply chain level			CSR, quality	Certification bodies, regulators and authorities, investors	Long
Post-marketing monitoring of ELSI impacts			R&D, quality	Regulators and authorities	Long
Explicitly include ELSI of R&D and Innovation products in the CSR/sustainability reporting		Go to market	CSR, Marketing	All	Long
Support and invest in sustainable supply chains		Go to market	Management	Suppliers	Long
Select funding mechanisms based on ethics/responsibility requirements		All	R&D, management	Funding bodies, investors	Short

Table 6: Focus on the embedded ethicist approach

Description	Opportunities and barriers
Embedded ethicists aim at what has been described as “co-operative co-shaping” of technology. It can be understood as involving iterations of the following steps, as put forward by Gorp and S. van der Molen: • Gathering of data about the project to help identify ethical issues • Reflecting on these issues and searching for relevant ideas in literature • Preparing the discussions on the ethical issues and decisions that would have to be made • Having a discussion with the team or some researchers and taking a decision • Reporting about the ethical issues and decisions made	This approach has the potential downside that it may be yet more demanding upon the technologists’ time, and the potential advantage that it facilitates more dynamic and deeper reflection on the issues that are raised. On the positive side, the interaction with the technologists on particular problems is a very effective way of accelerating understanding of the issues within the company, and willingness to engage frequently with ethics is a good measure of the seriousness of the company with respect to ethics. The fact that this is time-consuming for ethicists is outweighed by the accelerated understanding they get of the technology issues.

Table 7: Selection of tools to support implementation of RRI actions included in Table 3, Table 4 and Table 5
(based on data in the PRISMA RRI toolkit - www.rri-prisma.eu/toolkit)

Name	AR*	IN*	RE*	Organization
Matter Principles for Responsible Innovation	✓			MATTER (UK)
Responsible innovation- quick-scan assessment matrix	✓	✓		Karim project (EU)
B-Impact: social and environmental impact benchmarking	✓	✓	✓	B Corp.org
Gendered innovations in research and innovation		✓		European Commission
Stakeholder maps		✓		Transnational Network for Social Innovation Incubation (EU)
Stakeholder engagement: Rethinking your strategy for stakeholder engagement	✓	✓	✓	BSR.org
Synthetic Biology deliberation aid	✓			Forum for the future .org
Designing for values: a reflection tool to embed values in your product				TUDELFT (NL)
Techno-moral vignettes/scenarios: Exploring moral aspects of future technologies	✓			Rathenau Instituut (NL)
Gender equality, toolkit to improve gender equality in the organization strategy			✓	Australian government
Stage-gate model	✓		✓	Stage Gate Int
Sustainability method selection tool	✓			RIVM (NL)
Safe Innovation Approach: balancing risks, benefits and costs of nanomaterials	✓		✓	NanoReg 2 Project
Licara NanoScan: Integrating risk assessment and life-cycle analysis for nanomaterials	✓			LICARA project (EU)
Trusted environment: creating a safe (technical) environment for sharing information and data	✓			Public Impact company

* AR: Anticipation & Reflection; IN: Inclusiveness; RE: Responsiveness

SWOT analysis for RRI implementation in companies

Based on PRISMA experience and reflection provided so far, an attempt to provide a summary of Strengths, Weaknesses, Opportunities and Threats (SWOT) of RRI implementation in industry is provided in Table 8. Further details are provided in PRISMA deliverable 5.1.

Table 8: SWOT analysis for RRI implementation

	Helpful to achieve the objective	Harmful to achieve the objective
	STRENGTHS	WEAKNESSES
Internal origin	• Create value • Motivate workers • Offer competitive advantage • Strengthen relations with all stakeholders • Increase trust among stakeholders • Increase the social value/impact of R&D • Strengthen quality of innovation at industrial level • Ensure compliance with qualified norms and standards • Identify new market needs • Potential to communicate benefits and risks of products • Increase transparency in product development	• Limited awareness and skills on the RRI concept • Additional bureaucratic burden, lack of resources (particularly for SMEs) • Low perception of tangible impact on product development • Lack of integration of RRI across the company functions • Internal boycott from some functions in the company • Difficulties in measuring associated costs • Adding excessive extra costs to product development • Intellectual Property Rights • Misuse of the concept (checkbox exercise)
	OPPORTUNITIES	THREATS
External origin	• Improve product quality, desirability and acceptability • Improve product sustainability, safety and reliability • Increase customer satisfaction • Improve effect on quality of life and health of customers – by addressing existing social needs • Improve efficiency (e.g. use of resources, decision-making process) and cost reduction on a medium/long term • build corporate image and reputation • Improve market penetration, profit • Facilitate the access to financial support	• Difficulties in engaging with stakeholders • Possible slowdown or even premature stop of innovation • Few practical examples available from industry (case studies, applications) • Lack of engagement along the value and supply chain • Lack of endorsement by partners and suppliers • Seen by stakeholders as a “window dressing” exercise • Lack of incentives (at policy and regulatory level)

Criteria for impact analysis of RRI actions

A model of questionnaire for the self-assessment of the impact of the RRI actions is proposed in Table 9. It is structured in a set of five questions, based on lines of evidence (LoE), plus a sixth question related to the direct costs of the RRI actions. Each of the five questions is detailed by a set of sub-questions (criteria). Note that Q5 refer to economic criteria related to the product development (e.g. time to market), while Q6 refer to the costs of performing the RRI action (e.g. doing stakeholder engagement activities, establishing an ethical and social advisory board, etc.).

For each RRI action, the product/project manager should evaluate the impact of each criterion. A three-score scale (“positive, neutral/irrelevant, negative” for the questions 1 to 5; “low, medium, high” for question 6 on costs of the RRI action) is used, that could be visualized using emoticons (as in “sentiment analysis” techniques⁷). An example of what could be the outcome of the method is provided in the self-assessment matrix in Table 10 (based on a generic set of three actions A1,2,3). The methodology is further described in PRISMA deliverable 5.1..

Table 9: Description of the questions and sub-questions (criteria) proposed for the self-assessment of the impacts (benefits, barriers, costs) of the uptake of RRI actions

Main questions (Q)	Criteria (C)	Impact of RRI action (s)
Q1: Scientific & Technological Line of Evidence	- Q1.1: Inspire technological innovation - Q1.2: Feasibility of the technology solution - Q1.3: Degree of technological innovation - Q1.4: Product quality (performance/efficiency) - Q1.5: Product reliability - Q1.6: Extend the product life cycle	- Positive - Irrelevant - Negative
Q2: Ethical & Societal LoE	- Q2.1: Product acceptability - Q2.2: Product safety - Q2.3: Product environmental sustainability - Q2.4: Effect on quality of life and health of customers - Q2.5: Product related services and guidance (e.g. ethical protocols) - Q2.6: Address user’s needs and rights’ (e.g. privacy, data ownership, etc.) - Q2.7: Trust with/avoid conflicts with business partners, suppliers and end-users	- Positive - Irrelevant - Negative
Q3: Strategic LoE	- Q3.1: Competitive advantage - Q3.2: Corporate image - Q3.3: Transparency on product qualities - Q3.4: Customer satisfaction, meeting new consumers’ needs or requests - Q3.5: Building legitimacy and gain consumer loyalty on the product - Q3.6: Improve relationships with partners, suppliers and sub-suppliers - Q3.7: Fulfil ethical and social requirements (e.g. for access to funding)	- Positive - Irrelevant - Negative
Q4: Organizational LoE	- Q4.1: Allocation and deployment of resources (e.g. human resources) - Q4.2: Team cooperation and motivation for product development - Q4.3: Address regulatory barriers - Q4.4: Safety at the workplace - Q4.5: Risk management - Q4.6: Gender and diversity contribution to product development - Q4.7: Avoid irresponsible behavior	- Positive - Irrelevant - Negative

⁷ The “sentiment analysis” aims to determine the attitude of a subject with respect to a specific topic or the emotional reaction to a document or an event. The attitude could be an emotional state but also a judgment or evaluation

Q5: Economic LoE	- Q5.1: Product cost - Q5.2: Time to market - Q5.3: Market penetration - Q5.4: Market size - Q5.5: (Favored) access to financial support - Q5.6: Profit - Q5.7: Human Resources	- Positive - Irrelevant - Negative
Q6: RRI action costs	- Direct costs to perform the RRI action	- Low - Medium - High

Table 10: Example of a matrix for the self-assessment of the overall impact of RRI actions, based on specific criteria for product development. Assessment is done using emoticons, as in sentiment analysis

IMPACT OF RRI ACTIONS ON CRITERIA	IMPACT OF RRI A1	IMPACT OF RRI A2	IMPACT OF RRI A3
Q1: Scientific & Technological Line of Evidence			
Q2: Ethical & Societal LoE			
Q3: Strategic LoE			
Q4: Organizational LoE			
Q5: Economic LoE			
Q6: Direct costs of the RRI action			

Tools for materiality and stakeholder analysis

Different studies and projects developed tools supporting materiality and stakeholder analysis.

Some of them are useful to identify the most relevant issues or the business areas that could benefit the most from the application of RRI practices, or to what extent a company practices are aligned with RRI principles and how to move the innovation process ore responsible.

This is the case, for example, of the RRI self-check tool developed by the Compass project, that allows to analyze the company innovation process from different perspectives (the management, the idea generation and research, the development and testing and the market and impact) and find the most relevant issues from the RRI point of view⁸.

Other tools can be useful to visualize the different issues and help in analyzing them. This is the case of the materiality matrix (see Figure 4), where for each issue the relevance to both the stakeholders and the organization has to be estimated, based on the impact it could have⁹.

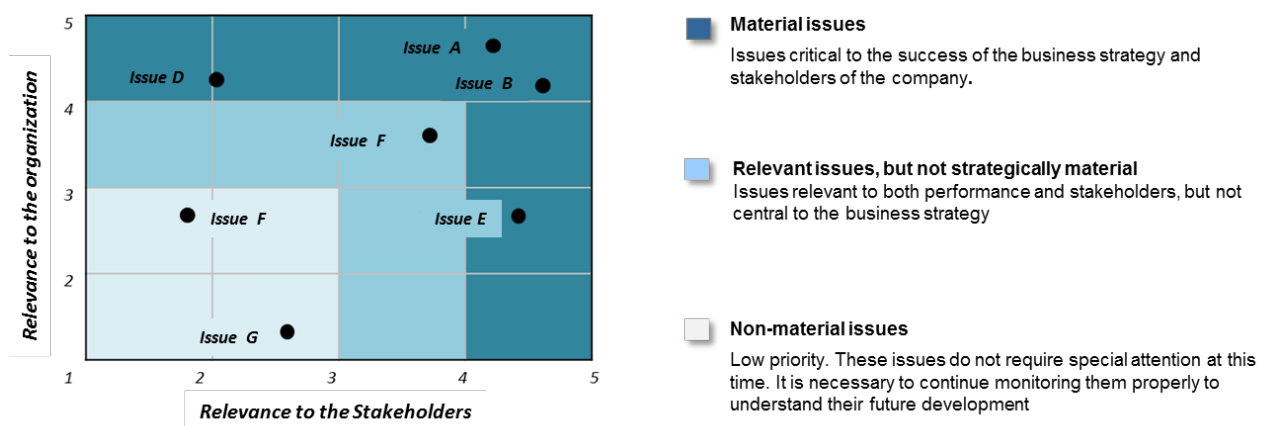


Figure 4: Example of a materiality matrix

Use a range from 1 to 5

1 - Not significant: the topic has no impact on the organization or on the decision-making process of Stakeholders

2 – Little significance: the topic has little impact on the organization or on the decision-making process of Stakeholders

3 - Significant: the topic has an impact on the organization or on the decision-making process of Stakeholders

4 - Very significant: the topic has a significant impact on the organization or on the decision-making process of Stakeholders

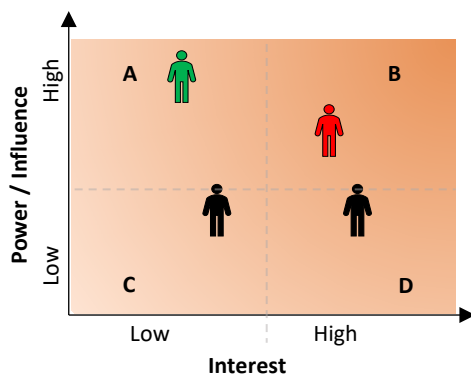
5 - Priority: the topic has a strong impact on the organization or on the decision-making process of Stakeholders

When it comes to stakeholder analysis, several steps can be taken. One of these steps is stakeholder mapping, which is a visual exercise and analysis tool that can be used to further determine which stakeholders are most useful to engage with. Stakeholder maps can be visualized based on several criteria, for instance: the level of influence against willingness to engage, type of stakeholder against level of influence, or capacity to engage and knowledge of issues against expectations. It is important to clearly set the criteria for mapping stakeholders in accordance to what is the aim of the engagement. Other criteria can be represented through dimensions and/or colors.

A practical example is presented in Figure 5, using a matrix tool

⁸ Compass project - <https://innovation-compass.eu/self-check/>

⁹ UNI/PdR 18 Social responsibility in organizations - Guidance to the application of UNI ISO 26000



Categorize stakeholders according to their potential interest in and influence on the goal, and place them on the grid accordingly (according to a realistic assessment and not based on your personal assessment of where they should be). When plotting positions on the grid, consider marking stakeholders who you see as advocating or supporting your initiative in green, and those whom you expect to block or criticize your initiative in red.

Figure 5: Example of the Interest/ Influence grid

A: If important to engage, raise their interest: High-power. Low-interest stakeholders: at least these stakeholders should be kept informed. Important to build a good relationship if there is no need to involve them directly. How actively these stakeholders should be pursued needs to be driven by the importance of having them involved in the dialogue.

B: Engage: High-influence, high-interest stakeholders: these are the stakeholders that efforts need to be made in order to engage fully

C: Do not engage (at least, not at the beginning): Low-influence, low-interest stakeholders: Do not involve them in the stakeholder event, but review this approach periodically, because their status can change.

D: If important to engage, strengthen their capacity to get heard: Low-influence, but interested stakeholders: If these stakeholder's interest is high, there must be a reason. Often these stakeholders have important information, perspectives or experiences. But they may lack the capacity to make their voices heard, so they need support in doing so. Stakeholders in this quadrant can become important supporters of the Stakeholders event. Engage them, support them and keep them adequately informed to keep their level of interest high.

The use of this grid is particularly helpful in determining what type of engagement process is required. The exercise can also be done using Power/Interest on the axes for instance.

Another type of tool is the ring stakeholder map (see example in Figure 6) This diagram generally starts on the micro-level, for instance with the identification of the primary stakeholders (e.g., investors, shareholders, customers, directors, employees, suppliers) and scales up to a meso and macro-level where secondary (e.g., government, media, local communities, activists) and contextual stakeholders (e.g., natural resources, past/future generations).

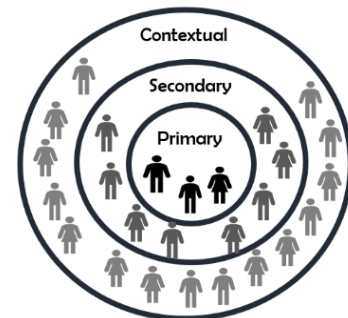


Figure 6: The ring stakeholder map

Other tools and recommendations can be found in the PRISMA project RRI tool-kit¹⁰ and in PRISMA deliverables D4.1 and D4.2.

¹⁰ <http://www.rri-prisma.eu/toolkit/stakeholder-maps/>

Methods for stakeholder engagement

There are different methods for stakeholder engagement depending on the issue that has to be discussed, the group or stakeholder to be engaged, the level of engagement (Inform, Consult, Involve, Collaborate) the desired outcomes and, in some cases, the topic itself.

Based on PRISMA experience (deliverables 4.1, 4.2) and analysis, in Table 11 some examples of methods for stakeholder engagement are provided, together with a brief description of the level of engagement, the methodology and the expected outcomes.

Table 11: Methods for stakeholder engagement

Methods	Level of engagement	Description	Expected Outcomes
Conferences and presentations with selected stakeholders	- Inform - Involve	- A formal meeting of people with a shared interest where experts provide information to a specific target (even large) audience.	- Stimulate dialogue
Focus groups	- Consult - Involve	- Discussion in a small (4 to 12 members) group of stakeholders facilitated by a skilled moderator	- Obtain a range of insights (people's attitudes, beliefs, desires, reaction) in a relaxed, non-threatening environment
Workshops	- Consult - Involve - Collaborate	- Single, short event designed to introduce or teach participants practical skills, techniques, or ideas which they can then use in their work or their daily lives. Generally small groups, allowing everyone some personal attention and the chance to be heard.	- Obtain feedback from participants - Collect opinions, values, needs, concerns about the topic and related issues - Generate new ideas and ways to improve the material introduced
World Café	- Consult - Involve - Collaborate	- Discussion in few small groups and multiple rounds. Host introduces the process and the "Café etiquette". - After the first round, people are free to change the table for the next round - Each round starts with a question designed for the specific context and purpose - At the end, results of single groups are shared in a plenary discussion.	- Generate new ideas, joint decision making, key strategic issues, new ways for collaboration, etc. - Reflect on implications of a complex issue - Identify specific steps for further exploration and implementation - Graphic recording of people's ideas and expressions in words, images and colours, to be shared as a framework or guide
Fish Bowl exercise	- Involve - Collaborate	- Form of dialog to discuss specific topics in large groups. Few chairs are arranged in an inner circle (the fishbowl). Few participants are selected to start the conversation, sitting in the fishbowl, while the others are sitting outside (all around). The moderator introduces the topic and who is in the fishbowl discusses, while who	- Collect opinions, values, needs, concerns about the topic and related issues - Reflect on implications about a complex issue - Generate new ideas, joint decision making, key strategic issues, new ways for collaboration, etc.

		is outside listens. Anyone is allowed to join the conversation by occupying an empty chair, or tapping the shoulder of the person (not talking) they want to replace. - At the end, the moderator closes the fishbowl and summarizes the discussion.	
Co-creation/co-design	- Involve - Collaborate	- Joint creation and evolution of value with stakeholders, intensified and enacted through platforms of engagement. - In order to be successful, the process needs to be transparent and stakeholders need to have access to the company data on the co-creation topic.	- Share specific and detailed information in order to allow a proactive creation - Identify values, needs, concerns, etc. - Generate new concepts and ideas - Joint value creation based on stakeholders' experiences - Collect, share and spread of ideas (e.g. design) - Unexplored ideas emerge because of open conversations
One-to-one interview	- Involve - Consult	- The list of issues to be addressed or questions to be asked can be presented in a structured or semi-structured way	- Collection of detailed information on a specific matter or sets of issues
Surveys	- Consult	- Data collection on a specific topic(s). Predominantly, data is collected by self-completion questionnaire or by (semi) structured interviews	- Collection of a data set that allows the identification of patterns of relationships between the topics

Examples of RRI Key Performance Indicators

Identification and measurement of indicators to monitor the level implementation of RRI principles and actions at company level could facilitate long-term adoption of RRI. In particular, it could help to align RRI activities with key business drivers and processes, stimulate continuous improvement of RRI “performances”, and allow consideration of RRI aspects in usual sustainability reporting at company level.

In PRISMA a set of 10 RRI Key Performance Indicators (KPIs) have been developed, selected and tested together with the pilot companies. The KPIs are based on literature review, interactive sessions with individual companies (pilots), on-field observation and auditing, monitoring of RRI-KPI within eight companies, meta-analysis of data, and self-reflection and auditing by internal and external reviewers before the pilot started and after the pilot ended.

These indicators should be considered as indicative, and a starting point to develop more specific KPIs tailored to the specific needs of a company. The table provides an overview of PRISMA RRI KPIs. Further details are provided in PRISMA deliverables D3.1, D3.2, and D3.3.

Table 12 Examples of quantitative indicators to monitor implementation of RRI principles at company level

	Item	RRI KPIs	Examples of quantitative parameters to measure KPIs
Anticipation & Reflection	1	Awareness of moral values	- Nr. of training sessions/meetings per year to learn and reflect on moral values connected to innovation strategy and core business
	2	Awareness of ethical issues of innovations	- Nr. of training sessions/meetings per year aiming to reflect on integration of social and ethical values into specific R&I/R&D projects
	3	Does the company embed moral values in its innovations?	- RRI principles formally integrated into the company’s mission and vision (e.g. ethical code of conduct) - Nr. of R&I/R&D projects per year where moral values are actively and included into innovation strategies and technological design
	4	Does the company (actively) anticipate social effects of its innovations?	- Nr. of R&I/R&D projects per year where internal/external stakeholders were involved from the early stages in product development - Nr. of consultancy initiatives with other innovators and external advisors to discuss and identify social impacts of R&I/R&D projects
Inclusiveness	5	Stakeholder engagement	- Nr. of stakeholder engagement initiatives organized per year by the company - Nr. of R&I/R&D projects per year where active stakeholder engagement is foreseen into R&I/R&D plans - Nr. of R&I/R&D projects per year where engagement with end-users has been performed
	6	Gender Diversity	- Percentage of men and women involved in R&I/R&D function/teams in the company

Responsiveness	7	Transparency and accountability about RRI-relevant choices	- Formal communication strategy established at company level to ensure most relevant RRI choices are explained in key company documents and/or the website
			- Nr. of patents per year aiming to integrate non-financial values
			- Nr. of open access publications
			- Nr. of events or webpages or channels in social media (or similar) disseminating project results to the general public
	8	Learning mechanisms to address public and social values in product development	- Nr. of user-centered approaches per year formally integrated into the company innovation model (e.g. user-centered design, co-creation)
			- Nr. of user experience tools per year carried-out to respond (new) societal demands and developments
	9	Capacity to align to societal goals	- Nr. of R&I/R&D projects per year addressing socially/ethically-oriented products/services
	10	Active monitoring of RRI impacts	- Percentage of R&I/R&D projects per year that apply impact analysis strategies (e.g. risk management, ethical/social impact analysis, etc.)
			- Formal external auditing procedures (at least yearly basis) in place to monitor non-financial values of the company

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