A Roadmap for Responsible Innovation in Industries
Incorporating ethical and societal values

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A Roadmap for Responsible Innovation in Industries: Incorporating ethical and societal values

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1. Introduction

When it comes to innovation, companies need to think of the impact of their innovation on direct users, indirect stakeholders and even society at large. How can companies innovate responsibly? More specifically, how can companies align societal and ethical values with commercial interests as part of their innovation strategy? What does this mean for their corporate social responsibility (CSR) strategy?

The above questions are the focus of this 'best practice paper'. We will describe a roadmap (strategic process) that companies can follow to integrate 'Responsible (Research and) Innovation (RRI)' into their CSR policies and business strategy. We will also highlight key performance indicators (KPIs) for monitoring these objectives. The expected outcome of adopting RRI is that companies may gain numerous benefits, among others:

- Strengthening links with consumers and end-users;
- Enhancing the company's reputation (trust);
- Decreasing business risks and unintended consequences;
- Strengthening public trust in the safety of products;
- Adopting and environmentally profile;
- Medium-term competiveness.

This paper is fully based on the results of EU- Horizon 2020 project titled 'PRISMA' (promoting responsible innovation in industry) (see: https://www.rri-prisma.eu/). The overall goal of the PRISMA project was the development of an RRI roadmap to support industrial companies in integrating RRI into their research and innovation (R&I) strategies and activities by integrating technical, ethical, social, environmental and economic issues into R&I practices, by improving the ethical and social impacts of their outcomes. Figure 1 and Figure 2 show, respectively, the project in a nutshell and the consortium of the project.

Figure 1: PRISMA project in a nutshell

Figure 2: PRISMA-consortium

The project (2016- 2019) included eight industrial projects (pilots) developing new technologies in different sectors. The eight pilots vary among a number of dimensions that enable a comparative analysis among the pilots. The relevant differences are shown Table 1.

	Pilot company	Type of company	Relation consortium partner – pilot	Technology field	Technology development stage	Country
1	Colorobbia	SME, Private	External support	Nano-technology	Emerging	Italy
2	Archa Srl	SME, Private	External support	Nano-technology	Emerging	Italy
3	Spectro	SME, Private	External support	Internet of Things	Emerging/existing	The Netherlands
4	Aerialtronics	SME, Private	External support	Drones	Emerging/existing	The Netherlands
5	Evolva	SME, Private	External support	Synthetic biology	Emerging	Switzerland
6	Bisigodos	EU-financed project	Embedded ethicists	Bio-technology / chemistry	Emerging/existing	UK
7	WMG: Hub of All Things	Start-up, PPP	Embedded ethicists	Internet of Things	Emerging	UK
8	WMG: RDM	Start-up, PPP	Embedded ethicists	Autonomous vehicles	Emerging	UK

Table 1: List of pilots in the PRISMA project

The diversity of the pilots highlighted the realities, challenges and constraints in which industrial companies operate. In addition, during the project, stakeholder meetings with industry, standardization bodies and the academic community were organized. The meetings were positively received by stakeholders involved, as indicated by the following testimony:

Testimonial PRISMA/Pilot *Colorobbia Consulting Research Centre (Italy, nanotechnology):*
'With PRISMA we learned the importance of focusing on the ethical and social impacts of NanoMed since the early phases of the development, to become responsive and trustworthy toward needs and requests from users and society. This experience has convinced us of the strategic value of RRI for NanoMed and our organization'.

This paper is structured as follows. The next section gives a short introduction to RRI. Subsequently, we describe a six-step roadmap (strategic process) for companies to integrate RRI into their CSR policies. We then highlight KPIs that may help companies measure the impact of the resulting policies. This is followed by highlighting some lessons learned based on the eight pilots. Finally, we discuss the status of the roadmap in terms of an upcoming new industrial standard for RRI.

2. Responsible Research and Innovation (RRI)

When science and technology are not devised responsibly, they may create new risks and ethical dilemmas, fail in solving the problems they are meant to, and spur controversy. This is why we need RRI.

By definition, Von Schomberg (2011, p. 9) defines RRI as:
'*Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on 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).*' Hence, the key aspect of RRI is that it aims *at developing safe and ethically acceptable products and processes, responding to the needs and expectations of people and society.*

In general, most research and development (R&D) practices are expected to already pay attention to societal challenges such as sustainability or privacy. However, RRI aims at providing a holistic approach to incorporate societal values from a broad perspective (safety, transparency, trust, inclusiveness, accessibility, sustainability) and to deal with conflicting values (for example, privacy versus security). RRI is based on the following principles (Stilgoe et al., 2013):

- *Reflection and Anticipation*
  Integrate analysis of the ethical, legal and social impacts (ELSI) of R&I since the early stages of product development, to prevent undesirable events, to shape desirable futures and organize activities and resources towards them.
- *Inclusiveness*
  Perform stakeholder engagement to inform all phases of product development. Reflexivity, anticipation and responsiveness can be improved by a broad participation of different stakeholders.
- *Responsiveness*
  Integrate monitoring, learning and adaptive mechanisms to address stakeholder, public and social values and normative principles in product development, and to react to changing circumstances and knowledge.

These principles are also embedded in the roadmap as we will see in Chapter 3.

The need for RRI in industry
Although several companies, mainly large ones, have assumed responsibility for many parts of their operations through Corporate Social Responsibility (CSR), they have only, to a limited extent, done so for the R&D and innovation processes within their company. *Figure 3* shows the different phases of the product development and life cycle.
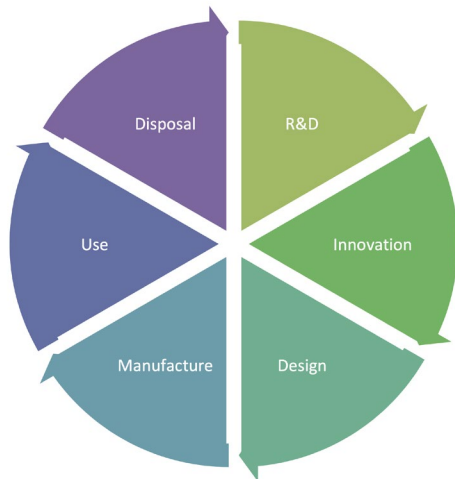
Figure 3: Different phases of the product development and life cycle

Current CSR efforts that relate to this product development and life cycle usually focus on the <u>latter</u> phases, like manufacturing, use, and disposal of products.
RRI aims at also addressing the <u>earlier phases</u> of R&D, innovation and design. This is important also for industry because many of the later possibilities, limitations and effects of products are decided in these earlier phases. Also, the costs of changing the product usually increase over the development and life cycle.

To integrate RRI into R&D and innovation processes in industry, the key solution can be the development and testing of a roadmap that helps industries to implement RRI in their innovation processes as part of their CSR policy in order to deal with uncertain and sometimes partly unknown risks and ethical concerns of transformative technologies. PRISMA co-designed and co-developed such a roadmap with eight pilot companies during the project.

3. A Roadmap for Companies to Develop Strategic RRI Policies

Companies work in different technologies which raise different RRI issues. Depending on the firm size, companies have different resources.
However, as part of the PRISMA project, despite the above differences, we defined a roadmap that actually help companies to make their own tailor-made RRI-plan. This roadmap is a methodology or strategic process in order to embed RRI in the CSR policies of a company.
In this section, we will describe this methodology which consists of six steps. We first summarize them (see next table) and then explain them in more detail.
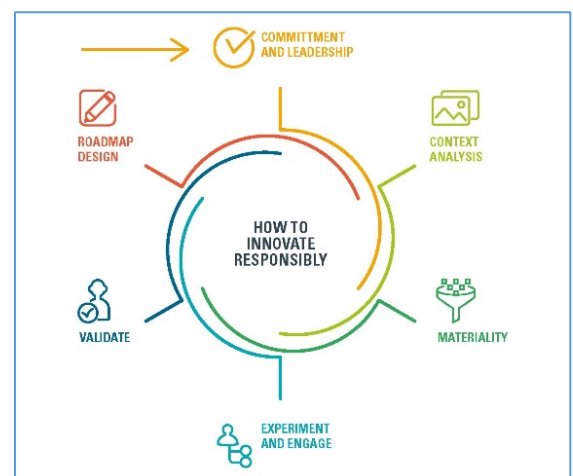

Figure 4: The roadmap-methodology

Step	Action	Elucidation
1	*Top management commitment and Leadership.*	Ensure endorsement of the organization toward RRI values and approach
2	*Context analysis*	Analyse 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.
3	*Materiality*	Identify and prioritize: drivers and challenges for RRI; risks and barriers to overcome; stakeholders to work with; significant RRI actions to pursue
4	*Experiment and engage*	Perform exploratory/pilot RRI actions, engage stakeholders to participate in the RRI roadmap design
5	*Validate*	Evaluate impact of the roadmap on both the product development and the organization through Key Performance Indicators (KPIs)
6	*Roadmap design*	Consolidate and visualize the long-term RRI strategy, covering all the R&I value chain (time to market) and product life-cycle

Table 2: Summary of the six steps that form part of the roadmap/methodology.

Note that the formulation of the RRI roadmap is a flexible and iterative process.
Below we describe each step in more detail.

Step 1: *Top management commitment and leadership.*
A prerequisite for RRI implementation is top level management commitment. One aspect of this commitment is raising the awareness that the adoption of RRI can have many beneficial effects on companies as discussed in the introduction.

The economic and organizational burden sometimes associated with RRI implementation is to be considered not solely as a cost, but as an investment.

Top level management can demonstrate leadership and commitment to RRI by:
- Ensuring that an RRI roadmap, related actions, objectives and vision are shared at the top level and are in line with values and identity of the key-stakeholders.
- Ensuring that RRI principles are integrated and kept alive in the organization's management systems and governance.
- Making available the resources needed for the roadmap design and its future implementation.

Without top management commitment, all the actions envisaged to design an RRI roadmap and its adoption will be less effective.

Step 2: *Context analysis*
The RRI roadmap must be geared to the realities and the constraints in which the organization operates.

During step 2, the following should be identified:
- The specific technologies and products, and related R&I projects, on which to focus the RRI roadmap de sign ('RRI product');
- The ethical, legal and societal impacts, as well as the technical, strategic, organizational, economic impacts concerning the RRI product. This analysis is expected to influence the selection of all roadmap elements and the setting of vision;

- Time frame or the development stages of the RRI product, from the start to the expected time to market of the product;
- The stakeholders interested/involved in the development of the RRI product throughout the innovation eco-sys-tem, including an initial understanding of their needs and perspectives.

The SWOT (strength, weaknesses, opportunities, and threats) and PESTLE (political, economic, socio-cultural and technological, legal and environmental factors) analyses can be used to evaluate internal and external issues.
Based on the identification and analysis of internal and external issues, the organization can map relevant stakeholders and understand their needs and expectations, highlighting those who are relevant for RRI implementation and linked to the organization innovation ecosystem.

Step 3: Materiality analysis
The term 'materiality' is often used in CSR. Materiality means analysing which issues are the most important of being addressed by businesses.

In the context of the roadmap, the materiality analysis aims to understand which issues are relevant in terms of RRI with respect to the context in which the organization finds itself and operates.

The goals of this phase are thus the following:
- Identifying relevant ethical, social and legal impacts of the RRI product, and describing them in terms of drivers (creation of value, positive impacts) and organizational challenges (achieving impacts).
- Identifying the risks and barriers (uncertainties) to address. Scientific, technical, strategical, organizational, economic, ethical and social aspects should be considered in determining such risks and barriers
- Selecting stakeholders to engage with, within the innovation ecosystem of the RRI product
- Selecting RRI actions that can contribute to achieve impacts and as well address risks and barriers.

The ultimate result is a visual representation of which issues should be prioritized according to their importance to the company's success and stakeholders' expectations. Obviously, anticipation is key (see Chapter 2).

A materiality analysis *early in the innovation process* is essential to anticipate impact and thus to adapt the process. It thus needs to be linked to the product Technology Readiness Level (TRL) and time to market.

Step 4: Experiment and engage
The aim of this step is to ascertain the appropriateness and the feasibility of the RRI roadmap, in particular through stakeholder engagement. The outcomes of this phase will make possible to refine the *materiality analysis (see step 3)*, in terms of significant ethical, social and legal impacts to address, and the stakeholders that are part of the innovation ecosystem.

However, stakeholder analysis is not an easy process and requires quit some resources. Some conditions for success are (*van de Riet, 2003; Hermans, 2005*):

- Clearly Identify purpose of actor analysis in relation to the roadmap and that it will result in useful knowledge. Ensure that it forms the basis for analysing and evaluating the feasibility of different options;
- Ensure that stakeholder-engagement take place early in the innovation process (so that it still can have an impact);
- Take a broad scope and multi-actor viewpoint. This means that the problem is explored from different perspectives and not just from a single pint if view.

- Identity possibly irreconcilable differences;
- Last but not least: ensure that the process is trustworthy, for example, make your analysis accessible for all stakeholders.

Step 5: Validation

In this phase, the organization evaluates and validates the added value of the roadmap in terms of its impact on both the product development and the company, based on the selected criteria. This process is needed to evaluate the feasibility of the roadmap, and, if necessary, to refine it. It could also help to provide documented information to the organization during the implementation of the road- map actions as evidence of the results.

Thus, in this phase the following aspects should be addressed:
- *Identify* what needs to be measured and monitored and how to do it;
- *Measure* (at least qualitatively) the impacts of the RRI actions defined in the roadmap, focusing on the added values both tangible and intangible, based on the selected criteria;
- *Explore* whether and to what extent the roadmap could be embedded in the usual practices of the organization (innovation, risk, quality, social responsibility practices).

For this validation, set of Key Performance Indicators (KPIs) have been developed as part of the PRISMA project. These KPIs could be used as starting point to develop more specific KPIs tailored to the specific needs of a company. *We will elaborate on this in Chapter 4 .*

Step 6: Roadmap design

The aim of the roadmap is to *consolidate and visualize* the long-term RRI strategy. It covers the R&I value chain and product life-cycle, integrating technical, ethical, social, strategic and economic aspects.

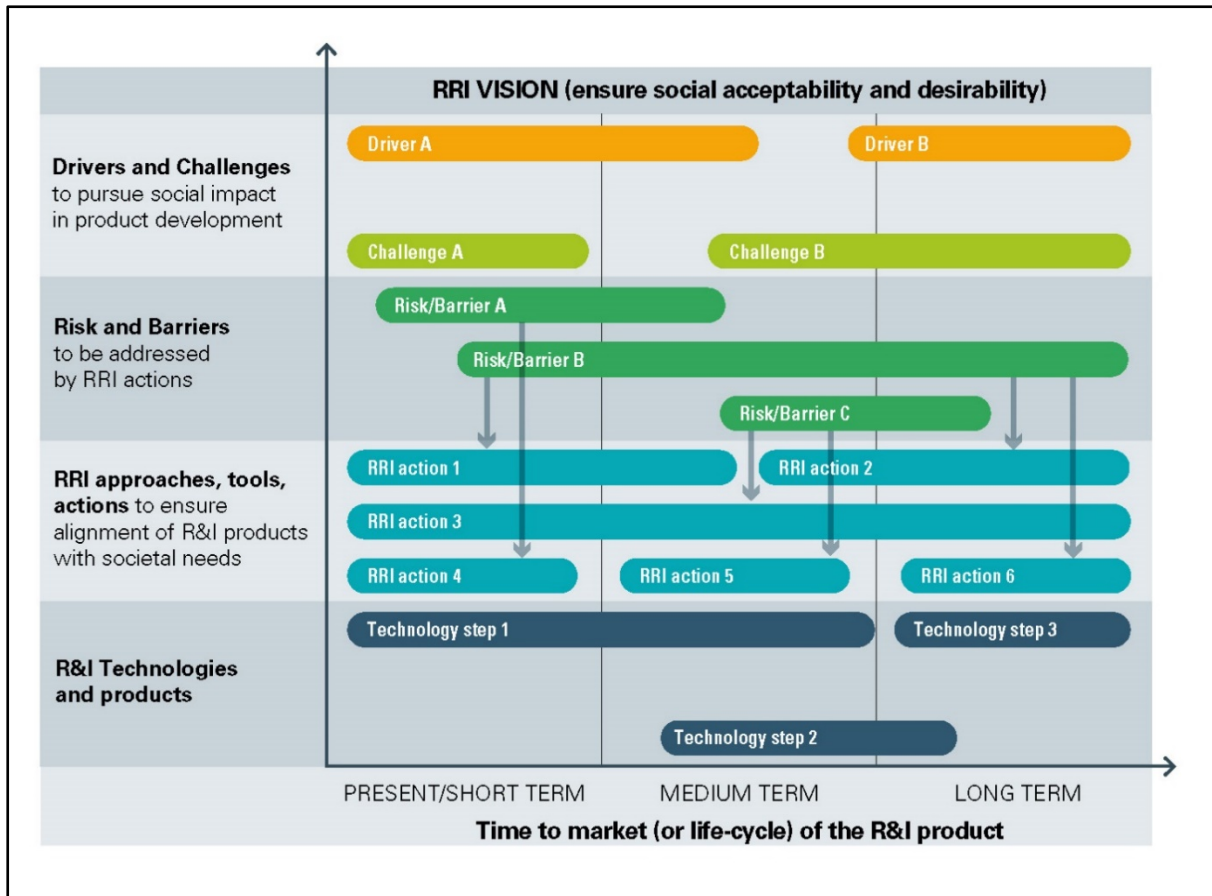Figure 5 shows a visual presentation of a RR- roadmap (template) for a company:

Figure 5: Roadmap template

The X-axis of the roadmap indicates the expected duration of the research and product development is indicated, 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).

On the Y-axis—you will find:
- 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;
- Identification of the risks and barriers addressed by the RRI actions;
- Identification of an action plan to implement RRI all along the steps for product development, core part of the roadmap;
- Identification of the innovative technologies that enable to address the objectives of the research and innovation (RRI product).

4. KPIs for RRI

As we have seen in Chapter 3 (Step 1), RRI requires ownership at company level in a broad way. As such, to embed RRI into business strategies of companies, it is of crucial importance to engage all relevant internal stakeholders. First, you need the commitment of CEOs to get things on the agenda. Next, you should also focus on engagement from other internal key actors and the workforce.

An effective approach to kick off the discussions is to review the existing Key Performance Indicators (KPIs) of the company. *How can they be linked to indicators for RRI?*

Example of linking KPI's

For example, an organizational KPI could be:
- The monetary value of the (existing or potential) market for this project is large;
- Or ' Marketing and communication of the outcome of this project will emphasize heavily the societal benefits (health, sustainability) of the project.

These can be linked or integrated with KPIs for RRI like, for example:
- Societal values (privacy, safety, health, security, data ownership, etc.) are actively included in the design process of this project;
- Or: Within this project we apply risk identification and risk management strategies to adjust the product.

As part of the project, we developed a checklist of KPIs for innovation from both an organizational or business point of view and the RRI-perspective (Yaghmaei et al., 2019).
We ended up with ten key indicators. These should be considered as indicative, and a *starting point* to develop more specific KPIs tailored to the specific needs of a company.

The next table provides an overview of these key indicators.

	Key KPI	Examples of parameters
1	Awareness of moral values	Number 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	Number 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)
		Number 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?	Number of R&I/R&D projects per year where internal/external stakeholders were involved from the early stages in product development
		Number of consultancy initiatives with other innovators and external advisors to discuss and identify social impacts of R&I/R&D projects.
5	Stakeholder engagement	Number of stakeholder engagement initiatives organized per year by the company
		Number of R&I/R&D projects per year where active stakeholder engagement is foreseen into R&I/R&D plans.
		Number 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.
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.
		Number of patents per year aiming to integrate non- financial values.
		Number of open access publications
8	Learning mechanisms to address public and social values in product development	Number of user experience tools per year carried-out to respond (new) societal demands and developments.
		Number of user-centered approaches per year formally integrated into the company innovation model (e.g. user-centered design, co-creation).
9	Learning mechanisms to address public and social values in product development	Number of R&I/R&D projects per year addressing socially/ethically-oriented products/services.
10	Active ongoing monitoring 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.

Table 3: Key indicators for monitoring RRI

5. Key Lessons Learned

Below we will summarize some of the key lessons learned during the PRISMA project.

a. Stakeholder engagement
Stakeholder engagement is usually considered a very important strategy in RRI. What is key is
that stakeholder engagement already starts early on in the technology development process
and is done in a way that can influence research and development process.
But we found in the pilots that it is often difficult to do stakeholder engagement because: .

- The companies that we worked with (small companies), usually lack the resources the people
  or, the money to do stakeholder engagement;
- Sometimes there is a conflict with commercial interests. So companies might be working on
  innovation and they do not want to share that innovation with others which might make it
  harder to do stakeholder engagement;
- For technologies in which there's really a lot of controversy it's very hard to have constructive
  stakeholder engagement.

b. Trust and legitimacy
This is often seen as an important goal of RRI. Companies also want to trust because then people will
accept their products. Trust is also important because you want to have a dialogue about new
technologies. If you have a trusted environment it's much easier to do than if people don't trust each
other. But we also found that building trust can be quite hard, especially in controversial technologies.
Take for example, synthetic biology. Some NGOs really, really oppose synthetic biology. In such
circumstances, it's very hard to build trust. You cannot tell somebody. 'Well, trust me,'. You have to
build a relation.

c. Multiple values
One interesting thing that we found in the pilots that we did is that companies already do some form
of technology assessment of risk assessment, or they make a lifecycle analysis for sustainability or
they look at privacy. But often they only look at one value, so they only look at sustainability but *not*
at privacy. So it is important that they look at a broader range of values. Another thing that's
important in this respect to don't just listen take the opinion of experts but also to non-experts.

d. Conflicting values
Talking about values it is a very good starting point and way to discuss RRI with companies.
But often you have to deal with conflicting values. It is important that companies become aware of
these value conflicts and that they explain to the public how they deal with them. Because then it
becomes clear how they relate – and try to solve these values conflicts .

e. Lead users
We found that lead users in experimentation are important, especially for technologies that are not
used yet. You have to find out what the issues are and therefore you need to find lead uses that help
you to do so.

f. Certification
Certification is already something that most companies are doing or are confronted with. They
have to do certification of the safety of the systems or of certain sustainability requirements.
But what we also found is that it might be interesting to broaden certification and to look at
RRI-aspects of certification and develop guidelines for implementation,.

6. Way Forward

Roadmap and compliance with existing standards.
The roadmap was developed in collaboration with standardisation bodies and is thus consistent with existing management system standards and governance standards, such as the ISO 26000, ISO 31000, ISO 9001 and ISO 56000. Particular attention has been given to social responsibility (i.e. ISO 26000).

The roadmap is now a so-called pre-standard consensus document at EU level' (also known as 'CEN CWA'). The CWA will last until mind 2020 and is open to all interested parties.

Check out PRISMA-website
As part of the project we roadmap we published an extensive number of resources on our website
- The comprehensive roadmap;
- 8 best practices including testimonials and videos;
- Training materials (MOOC);
- KPI's (extensive list and shortlist);
- Last but not least a toolkit regarding, for example, stakeholder analysis, inclusiveness and the safe-by-design project.

Check out our website: https://www.rri-prisma.eu/.

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