



# Implementing RRI in a Research and Innovation Ecosystem

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**Abstract.** New organizational forms are emerging today at all levels of society, and more and more research is conducted in dynamic collaborative networks or ecosystems. Unlike traditional research centers, these new types of organization are very dynamic, with fluid boundaries, and volatile in terms of membership. This characteristic requires that more attention be paid to research ethics and RRI. This work reports on an implementation process carried out in a research and innovation ecosystem according to the principles and guidelines proposed by the ETHNA project. The process, its barriers and drivers are described, and finally, learned lessons and recommendations are presented.

**Keywords:** Responsible Research and Innovation · Research Ethics · Research and Innovation Ecosystem · Living Lab · Ethical governance

## 1 Introduction

In recent years, there is a growing concern about the multiple dimensions of research ethics and responsible research and innovation (RRI) [1, 2] among various stakeholders such as funding agencies, publishers, research centers, scientific societies, and the research community at large. However, the level of awareness of the available principles and mechanisms is not homogeneous across all fields. For instance, while these issues have been at the center of attention of communities involved in health-related or biomedical research for a long time, the situation in engineering research is somewhat different and has only more recently begun to be discussed. The exception is perhaps the case of the technology management, environment engineering, and innovation sub-fields which have included the topic of RRI in their agendas for some time now [3]. The fact that a substantial amount of the RRI literature produced by social and health-related scientists is seen by engineering researchers as too theoretical and even using a hermetic language also contributes to this difference. Nevertheless, even in engineering and technology development fields the situation is changing, at least as a result of the pressure from research funding agencies [1, 4] and publishers. Often research programs require a link to the sustainability dimension, e.g., by addressing the UN Agenda 2030 for sustainable development [5]. For instance, the various sub-items of Goal 9 of this

agenda, “*Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation*” clearly relate to a perspective of RRI in manufacturing. The growing maturity of Artificial Intelligence and its fast adoption in novel technological developments is also motivating extensive discussion on ethics and technology [6]. Furthermore, the growing societal demand for accountability, particularly when research is supported by public funds, and the impact of widespread Internet/social networks reporting cases of plagiarism, fabrication, and other forms of research misconduct, including the emergence of “criminal science publishing gangs”, are acting as a wake-up call to the entire research community [3, 7]. The growing importance of “data science” also raises the need to understand the responsibility of data management and develop proper data governance mechanisms [8].

On the other hand, in recent decades, new forms of organizing research have emerged, notably leveraging different forms of collaborative networks [9–11]. Compared to traditional organizations with very precise “boundaries”, such as universities, research institutes and research centers, the more fluid, and dynamic networked organizations such as research and innovation ecosystems [12, 13] bring a new level of complexity that, at the same time, makes the establishment of appropriate RRI principles and mechanisms more crucial for a healthy collaboration and sustainability of those organizational forms.

This chapter focuses on the implementation of research ethics and RRI dimensions in a collaborative research and innovation ecosystem in Portugal. It thus discusses the experience gained from adopting the ETHNA system and guidelines. The lessons learned are likely to benefit similar research and innovation ecosystems and research networks in general.

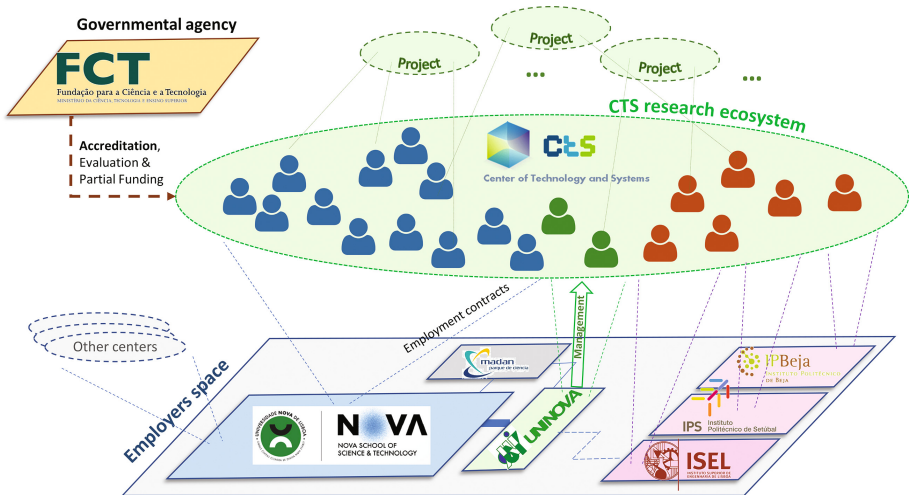
## 2 Research and Innovation Ecosystem Structure

When trying to increase the acceptance of RRI it is important to understand and take into account the organizational context and how to “manoeuvre inside the organization” in order to succeed and overcome resistance [14]. The RRI implementation case here reported was carried out during 2022 at the Center of Technology and Systems (CTS) of UNINOVA (<https://cts.uninova.pt/>), hereafter referred to as UNINOVA-CTS, which is a research center recognized by the Portuguese government agency for science and technology (FCT – “Fundação para a Ciência e Tecnologia”).

### 2.1 Ecosystem Structure

UNINOVA-CTS, like many other research centers in Portugal, is a kind of research and innovation ecosystem, including researchers who have an employment contract with one of the following entities: NOVA School of Science and Technology (a faculty of the NOVA University of Lisbon, to which most members are connected), ISEL/Polytechnic Institute of Lisbon, Polytechnic Institute of Setubal, and Polytechnic Institute of Beja. Most of these members are part of the academic staff of the mentioned institutions, where they teach, but carry out their research activities in the context of UNINOVA-CTS as a result of a cooperation agreement. This includes a total of about 75 researchers with a

PhD. In addition, this ecosystem also includes about 80–100 PhD students who carry out their research work for their theses at this center. From an administrative point of view, CTS is hosted and managed by UNINOVA, a legal, not-for-profit entity, also part of the “periphery” of NOVA University of Lisbon (Fig. 1).



**Fig. 1.** The CTS Research and Innovation Ecosystem

Research at UNINOVA-CTS is organized in projects, which are typically funded by international (e.g., European Commission and European Space Agency) and national programs. These projects are typically carried out in consortia involving academic and industrial partners. Some researchers may be involved in the creation of spinoffs to exploit research results. These spinoffs are typically hosted, at a preliminary phase, in the Madam Park incubator, also located in the vicinity of our campus.

UNINOVA-CTS research addresses engineering systems with a cyber-physical dimension in the broad area of information and communication technologies, including modelling and design, development of support technologies and methods, proposition of adequate governance models, application, and assessment. The center covers a wide spectrum of knowledge areas in electrical and computer engineering and aims to further knowledge and technology development towards cognitive and collaborative cyber-physical systems, while pursuing interdisciplinary integration (Fig. 2).

The center is concerned with contributing to contemporary societal challenges, including a strong component of applied research in industry and services, guiding its action through the continuous search for excellence in research and effective value creation and valorization of research results. This aim also includes a strong commitment to the training of young researchers and early career researchers, and to having an active presence in international networks, contributing to strategic research agendas, and engaging with societal stakeholders. However, despite the mentioned objectives, the level of awareness and implementation of RRI at the begin of this initiative was relatively low.

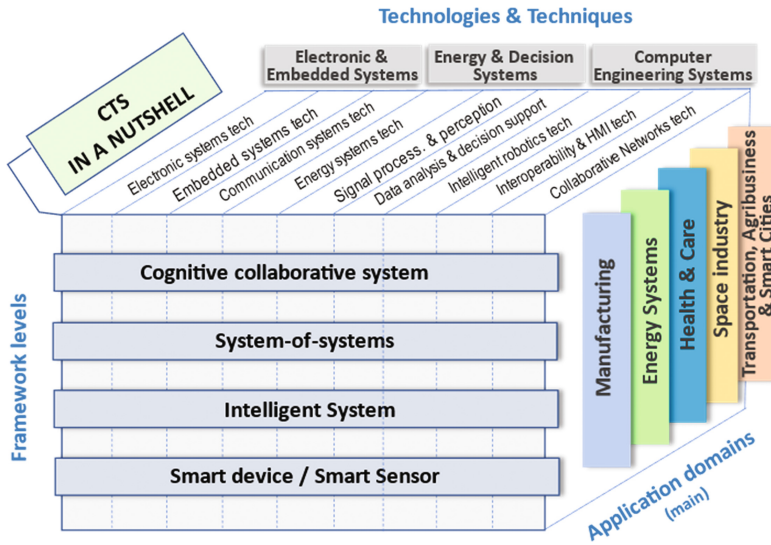


Fig. 2. UNINOVA-CTS scope

According to its mission, UNINOVA-CTS is committed to: (i) Planning and conducting high quality research on advanced engineering systems [excellence in research], (ii) Creating value and societal impact with research results [excellence in society engagement], (iii) training the future generation of researchers in the field [excellence in education]. The center pursues its objectives guided by the following values: (a) academic honesty and responsibility, (b) appreciation of excellence, (c) appraisal of creativity and entrepreneurial spirit, (d) respect for individual intellectual freedom, and (f) attention to societal concerns. Although the presence of ethics governance mechanisms was low at the beginning of this implementation, such announced values indicate a pre-disposition to implement RRI.

## 2.2 Complementarity Approach

Each researcher at UNINOVA-CTS is indeed subject to various “RRI spaces” (Fig. 3), namely:

- A. *Employer’s RRI space*: first, the researcher must comply with the code of ethics and other RRI principles of the employer which, nevertheless, are not always extensively disseminated.
- B. *CTS RRI space*: then he/she needs to comply with the RRI principles of the CTS research ecosystem.
- C. *Projects’ RRI space*: each time a researcher is involved in a project, he/she needs to comply, during the duration of the project, with the RRI principles defined by the funding agency for that specific project/program.
- D. *Scientific society code of ethics*: finally, most researchers are members of international and national scientific and technical societies (e.g., Institute of Electrical and

Electronic Engineers (IEEE), International Federation of Information Processing (IFIP), International Federation of Automatic Control (IFAC), Society of Collaborative Networks (Socolnet), National Engineers Association) and as such they need to comply with the code of ethics of these societies.

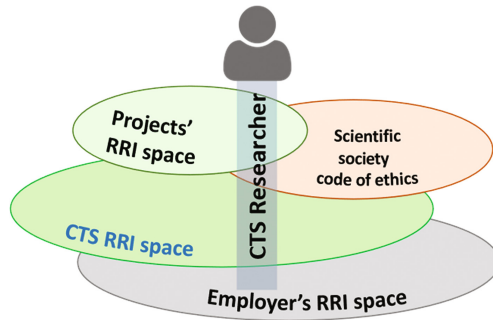


Fig. 3. Coping with multiple RRI spaces

More specifically, regarding each “space”:

- A) All mentioned (academic) employers are public institutions and as such follow general rules of public entities, including gender equality, conflicts of interest, rules against plagiarism, etc., but such principles should deserve more structured dissemination. In terms of organizational units: NOVA University of Lisbon has an *Ethics Council* that acts as an advisory body to the rector, but so far with limited interaction with the research community. Some seminars on *responsible data management* have also been organized for the directors of research centers. ISEL/Polytechnic Institute of Lisbon has no specific RRI committee or rules; at Polytechnic Institute of Setubal due to the existence of a health school, there is an ethics committee dedicated to health, but no general RRI principles for the entire institute; Polytechnic Institute of Beja has an *Ethics Committee* that acts as an advisory body with the mission to promote high standards of integrity, honesty, and best practices but most researchers are not well acquainted with it.
- B) In its agreement with the accreditation agency (FCT – Foundation for Science and Technology), UNINOVA-CTS has stated that the center is committed to carry out its activities under the widely accepted principles of Research Ethics and Responsible Research. To prevent misconduct and bad practices, the “**European Charter for Researchers**” [15] was identified as a useful guide, namely along the principles and recommendations concerning: Research Freedom, Ethical Principles, Professional Responsibility, Professional Attitude, Contractual and Legal Obligations, Accountability, Good Practices in Research, Dissemination and Exploitation of Results, Public Engagement, Relationship with Supervisors, Supervision and Managerial Duties, Continuing Professional Development.

These principles are conveyed to PhD students and early-stage researchers through training actions. The IEEE authorship principles [16] have been promoted and frequently reminded to all researchers. At the start of this project, there were no specific organizational units devoted to RRI, being these issues dealt with at the management board level.

- C) Some research funding programs impose general and specific ethical principles, such as the case of European Commission's programs in Horizon 2020 and Horizon Europe [17, 18], and national funding programs.
- D) The mentioned societies usually have a code of ethics. One example: IEEE Code of Ethics, but in practice most researchers are not well acquainted with it.

Based on this context, Table 1 summarizes what we could identify as existing resources per RRI key.

**Table 1.** Pre-existing RRI resources for UNINOVA-CTS

<b>RRI key</b>	<b>RRI Space</b>	<b>Existing resources before starting the implementation process</b>
<b>Research integrity</b>	<i>Employers</i>	Ethics committee, but not widely known; DPO-GDPR sub-contracted
	<i>Uninova-CTS</i>	Some promotion of good research practices but lacking a formalized model and wider adoption; Ethical Code of IEEE regarding authorship is amply disseminated among researchers; Some promotion of RRI among PhD students
	<i>Projects</i>	Follow the general principles of Research Ethics; RRI is explicitly enforced by the funding organizations
	<i>Scientific societies</i>	Code of ethics of IEEE; Code of ethics of IFIP; Code of ethics of national engineers' association, but not widely disseminated
<b>Gender perspective</b>	<i>Employers</i>	General rules/laws of Portuguese Government
	<i>Uninova-CTS</i>	The center depends on the rules followed by the institutions that employ CTS researchers. Current gender distribution is not balanced but this is not the result of any discrimination, rather a reflection of the gender (un)balance in this scientific field
	<i>Projects</i>	Compliance with rules of funding programs
	<i>Scientific societies</i>	Some initiatives to encourage women in engineering (e.g., IEEE)

(continued)

**Table 1.** (continued)

<b>RRI key</b>	<b>RRI Space</b>	<b>Existing resources before starting the implementation process</b>
<b>Public engagement</b>	<i>Employers</i>	Office for Innovation Research and Impact Strategy (IRIS), a recent initiative at NOVA; Vice-dean for S&T dissemination
	<i>Uninova-CTS</i>	Involved in technology transfer and results exploitation actions; A good number of spin-offs (average of 1 per year in the last decade) originated from CTS members; Many dissemination events (ad-hoc) but not uniform in all areas of activity of the center
	<i>Projects</i>	Many projects require involvement of end-users
	<i>Scientific societies</i>	Use of existing channels in scientific societies to reach a wider engagement with society
<b>Open access</b>	<i>Employers</i>	Some repositories: PURE repository; IPL repository + open access journal
	<i>Uninova-CTS</i>	Promotion of knowledge sharing and publication in open access channels (but constrained by the high and fast increasing financial costs of open access publications)
	<i>Projects</i>	Open access required by funding organizations e.g., EC, FCT
	<i>Scientific societies</i>	Open access journals (e.g., IEEE)

These resources, which are disperse and of which the researchers are not fully aware were essential in determining the position of CTS with respect to RRI implementation needs and were used as the basis for reaching the level of commitment regarding the implementation of the ETHNA system [19] through the identification of the main goals and priorities.

It should also be noted that participation of researchers in UNINOVA-CTS is voluntary. The employment institutions encourage or demand that staff get involved in a research center, but researchers can choose the center/ecosystem they join and can move from one center to another. As a result, there is some volatility of membership regarding PhD holders. Regarding PhD (and MSc) students, they remain associated with the center for the duration of their studies and naturally leave after their graduation. Since the population of PhD students represents a little over half of the total membership of UNINOVA-CTS, this strongly contributes to a high volatility of the research population, requiring continued attention to the endogenization of RRI principles and practices.

### 2.3 Needs, Challenges and Opportunities

Considering the described characterization of UNINOVA-CTS, the following main needs were identified for research ethics and RRI implementation:

- Development of better structured information repositories/navigation map on RRI principles and tools.
- Adoption/establishment of straightforward implementation guidelines.
- Organization of a repository of templates/models/exemplary cases with particular focus on:
  - Ethical principles of authorship;
  - Conflicts of interest, namely in the context of creation of spinoffs and exploitation of results in interaction with industry;
  - Research data management;
  - Relationships between supervisors and PhD students;
  - Clear identification of added **value** of RRI for engineering researchers (of utmost importance);
  - Very flexible governance approaches. In a research ecosystem like UNINOVA-CTS (which is a kind of collaborative network), the creation of dedicated “organizational structures” for RRI would be an extra overhead, extremely difficult to implement. As such, the governance models proposed by ETHNA sound a bit “too bureaucratic” and require funds that are not available.

Since the organizational structure of UNINOVA-CTS (a collaborative and distributed research ecosystem) is common to many centers in Portugal, results from ETHNA with the above characteristics could be replicable to those centers.

As the Director of the center was engaged, from the beginning, in this implementation process, the departing situation points to a strong leadership. In what concerns the base, RRI norms and practices have not been effectively implemented at the institutional level. They are fragmented by each RRI space. As such, CTS-UNINOVA fits into the “strong leadership/weak base” quadrant of the ETHNA classification (Fig. 4).

Furthermore:

- The UNINOVA-CTS research center, due to its mission to promote excellent research and innovation practices and the commitments assumed with the Portuguese research funding agency, has already some awareness regarding RRI in all its key areas. However, making RRI awareness widespread and materialized in concrete rules and mechanisms used by all researchers still need a considerable effort.
- In this line, some initiatives have already started before ETHNA implementation, namely regarding research ethics and integrity, such as some promotion of research good practices or RRI awareness among PhD students. However, it is expected a long way to go because there is a lack of formalized models matching our context and the RRI norms and practices are not yet fully adopted by most of the CTS research members.



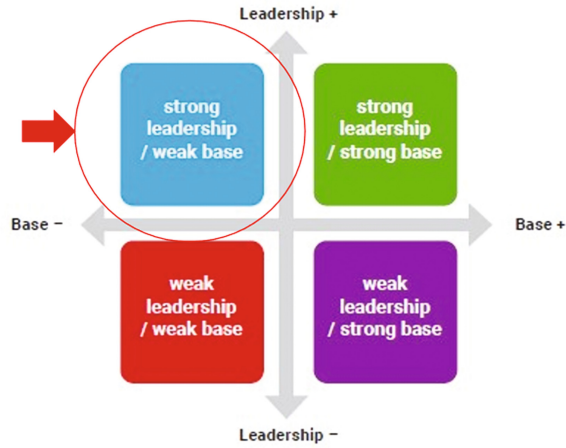


Fig. 4. ETHNA RRI institutionalization Quadrants and UNINOVA-CTS

- It is also noticeable that although there is good awareness of the RRI importance at the management board level, CTS researchers are quite busy with their own research and with acquiring new funded projects, and thus not motivated to play a proactive role or spend time with RRI implementation.

Based on the identified situation, it was decided to pursue a Level 2 implementation of the ETHNA system [19] (see Fig. 5). However, regarding pillar 2 (Ethics Committee & Ethics Line), due to the lack of specific funds, it was decided to follow a minimalist approach, just creating a RRI task force.

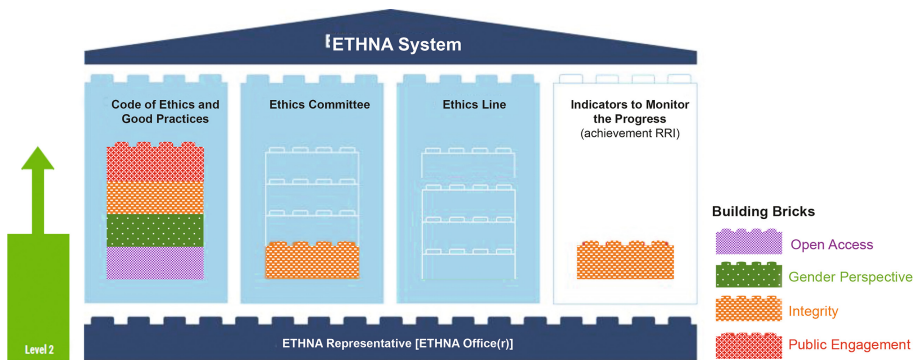
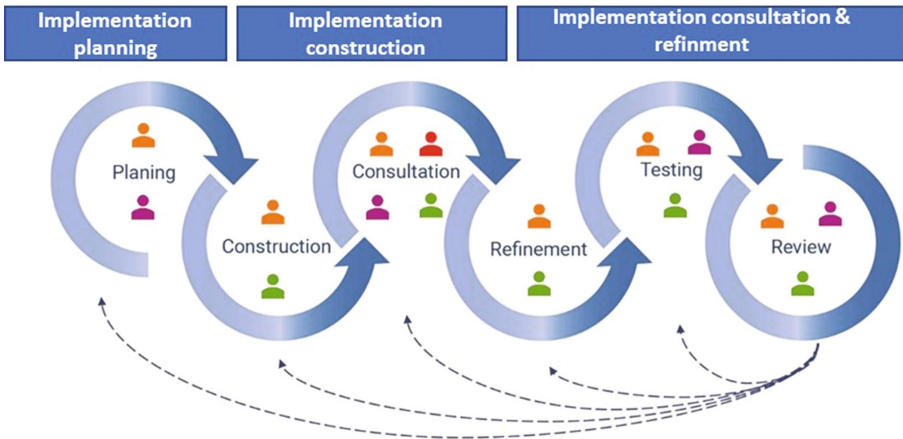


Fig. 5. UNINOVA-CTS Level of implementation commitment

### 3 The Implementation Process

The implementation of the ETHNA System is an iterative process (living lab) that consists of three main phases decomposed into six consecutive sub-phases as depicted in Fig. 6.



**Fig. 6.** ETHNA System implementation process

#### 3.1 Phases of the Process

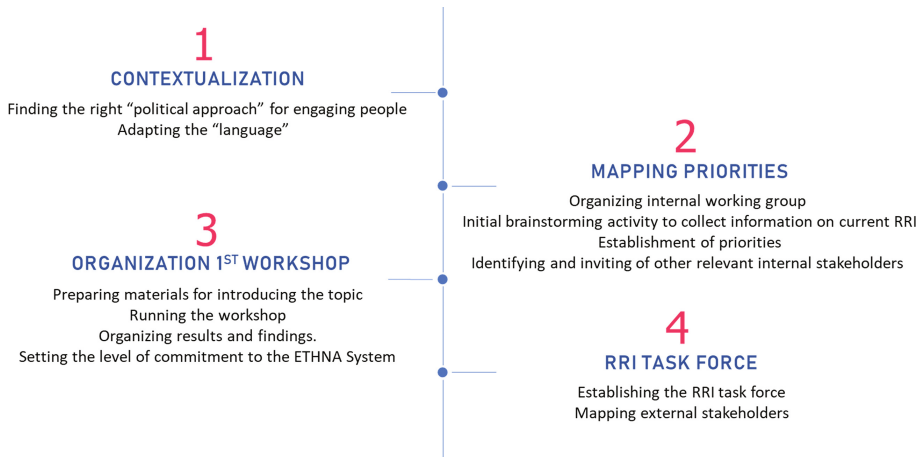
Although taking these ETHNA System guidelines as a general approach, it was necessary to make some simplification/adaptation of the process. This simplification was needed mainly motivated by the following reasons:

- Researchers are quite busy with their own work and they are not “RRI researchers” (i.e., they do not do research on RRI itself). Thus, it is not realistic to expect the involvement of researchers in too many meetings/workshops for RRI implementation.
- The process started during COVID-19 confinement period, which also limited interactions among researchers and other stakeholders.

Therefore, the main (adapted) steps were the following:

**Implementation Planning.** The main objective of this phase is to prepare and initiate the implementation process. The ETHNA System guide was slightly modified and adapted to the UNINOVA-CTS case, resulting in 4 main steps as depicted in Fig. 7:

- *Step 1: Contextualization.* Since members of UNINOVA-CTS are extremely focused on their own research activities it was necessary to find the right “political approach” for engaging people and adapting the ETHNA’s “language” to a more contextualized and general discourse to motivate participants.



**Fig. 7.** Adapted phases of the implementation steps

- *Step 2: Mapping priorities.* The initial information on current RRI status at CTS was collected with the help of an internal working group through brainstorming. It was useful on one hand to understand the CTS-UNINOVA situation regarding the different RRI keys, and on the other hand to establish the goals and corresponding implementation priorities considering the available resources, the capabilities, and identified objectives. In this step it became evident that one of the first priorities was the organization of the RRI knowledge repository and the creation of a RRI taskforce. During this phase, other relevant internal stakeholders were also identified and invited to join the implementation activities.
- *Step 3: Organization of the 1st internal workshop.* This phase comprised the preparation of the materials for introducing the ETHNA System to the CTS members, on running the workshop and organizing the results and findings. As a result of this workshop, some adjustments were made to the priorities established by the internal working group. For instance, besides the issues of gender perspective, it was decided to consider a more general scope of inclusion. This was motivated by the diversity of nationalities and cultural/religious backgrounds of CTS members. It was also defined the CTS's level of commitment to the ETHNA System as illustrated by the blocks highlighted in Fig. 5.
- *Step 4: Establishing RRI task force.* Consisted of the identification and establishment of the RRI task force that is composed of 5 CTS senior researchers including the director of the center and one member of the board. At this stage a mapping of the external stakeholders was also elaborated.

**Implementation Construction.** This phase consisted of a comprehensive working activity on the implementation of the Code of Ethics and Good Practices in R&I for ETHNA's building blocks (Research Integrity, Open Access, Public Engagement and Gender Perspective). This activity was mainly conducted by the RRI task force and complemented with a second workshop with experts and internal stakeholders.

The recruitment of the external stakeholders for the next Consultation phase was also performed.

**Implementation Consultation and Refinement.** This step consisted in a workshop with internal and external stakeholders from research and education, business and industry, and civil society. The main objective of this workshop was to present the implementation status of Code of Ethics and Good Practices in R&I, create a discussion session and collect inputs from the different perspectives. After this consultation workshop a refinement phase was initiated aiming at refining the developed components of the CTS ETHNA System until a collective agreement on the content of those key documents was reached. For this stage, online feedback collection modality was used. The agreement was reached on the assumption that these are “live documents” that need to go through continuous improvement. For instance, the guidelines on open access are likely to evolve as the “open access market/channels” also evolves.

### 3.2 Main Outcomes

Considering the specific nature of the research center, in which most researchers are employees of other institutions (Universities and Polytechnic Institutes) and thus already subject to different ethical systems, the implementation of ETHNA system focused mainly on complementarities. As such, a number of key documents on various RRI aspects (Code of Ethics and Good Practices in Research and Innovation, Open Access Guidelines, Gender and Inclusion Equality Plan), illustrated in Figs. 8, 9 and 10, were elaborated. The included items and the level of detail in each document resulted from the identified priorities and considering the mentioned perspective of “complementarity”.

A particularly useful instrument is the Open Access Guidelines. On one hand, all researchers feel the pressure from funding agencies to publish in open access (often a mandatory requirement) and to pursue principles of open science. But on the other hand, they have to face contradictory challenges, namely:

- The cost of open access publications, which puts an added pressure on researchers to acquire further resources.
- The fact that open access publications are still less prestigious than publications in “traditional” channels. The proliferation of predatory open access journals does not help. As a result, a considerable number of researchers do not value publications for which the authors have to pay to publish (the prevalent model behind open access) and this can even have a negative impact when researchers are evaluated. Having some practical guidance on how to deal with such “confusing situation” is perceived by all CTS researchers as a critical need.

Another outcome was the creation of awareness among the UNINOVA-CTS community by creating a specific section on RRI in the organization’s web site and organizing some internal dissemination seminars.

Additionally, considering that all members of the center are mostly focused on their own research activities and no resources are available to create additional organizational



Fig. 8. Scope of the Code of Ethics and Good Practices document

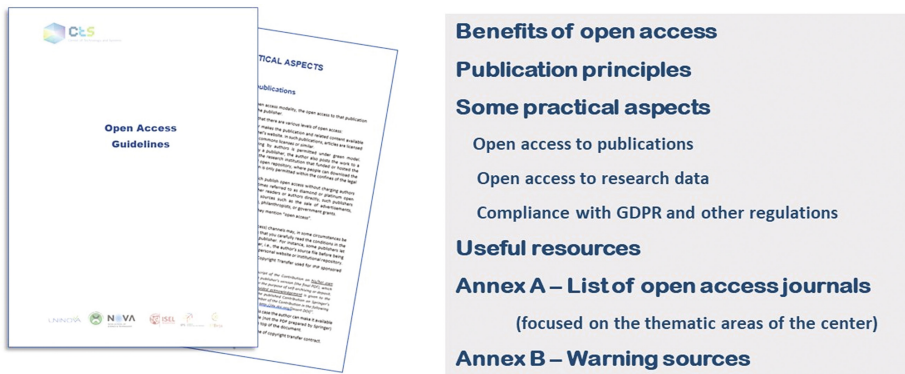


Fig. 9. Scope of the Open Access Guidelines document

structures, the organizational changes were limited to launching an RRI Task Force instead of a very formal RRI committee.

Finally, another result of this implementation has been the strengthening of training sessions for young researchers/PhD students. All our PhD students have an initial course on Scientific Research Methodologies and Techniques, which includes a specific unit on Research Ethics (Fig. 11, Unit 10). Beyond this specific unit, RRI principles and practices are emphasized in all other units. For example, when discussing Publication of Results (Unit 4), students are amply warned of unacceptable practices and behaviors in publishing and motivated for the benefits of conducting research according to proper standards. Even in the Introduction unit, RRI is present e.g., when discussing the relationship between the supervisor and the student.

Furthermore, we usually include some invited talks on research ethics and RRI in the annual DoCEIS conference that is organized for doctoral students [20].

Progress and performance indicators are included in the Table 2. A more extensive list of indicators can be found in [21].

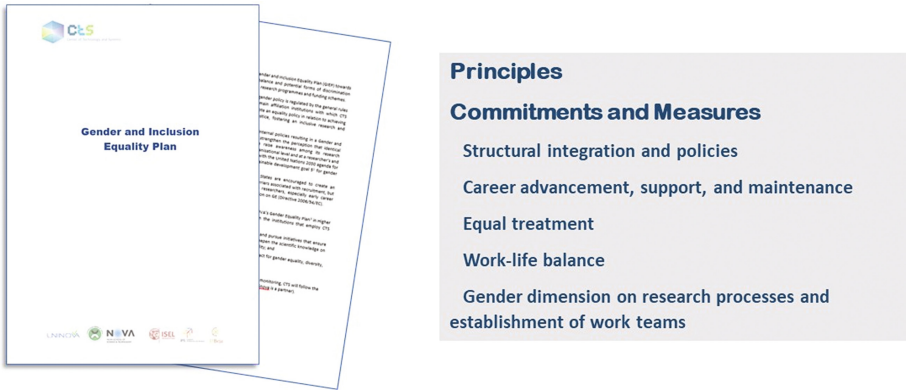


Fig. 10. Scope of the Gender and Inclusion Equality Plan document

- Unit 1: INTRODUCTION**  
Objectives for a PhD, base concepts, types of research, relationship with supervisor
- Unit 2: SCIENTIFIC METHOD**  
Overview of research methods, steps of the scientific method, engineering research and design science research method
- Unit 3: LITERATURE REVISION**  
Information sources, information search, special sources, synthesis and critics
- Unit 4: PUBLICATION OF RESULTS**  
Writing scientific papers, publication channels, evaluation procedures, citations
- Unit 5: THESIS ORGANIZATION AND VALIDATION**  
Structure, research question, thesis contribution, validation of results
- Unit 6: RESEARCH IN COLLABORATION**  
Types of projects and partnerships, requirements, collaboration spirit and constraints
- Unit 7: PROJECT PROPOSAL PREPARATION**  
General structure of a proposal, typical example
- Unit 8: RESEARCH PROJECT MANAGEMENT**  
Management structure, management principles, tools, risks, reporting
- Unit 9: ASSESSMENT OF RESEARCH RESULTS**  
Phases of research and outcomes, research performance indicators
- Unit 10: RESEARCH ETHICS**  
Ethical issues and behavior, responsible conduct, scientific practices and violation
- Unit 11: INTELLECTUAL PROPERTY RIGHTS**  
Concepts, types, protection mechanisms, rights identification, rights transfer
- Unit 12: ROADMAPPING AND FUTURE PLANNING (1)**  
Future planning objectives and approaches, concept of roadmapping
- Unit 13: ROADMAPPING AND FUTURE PLANNING (2)**  
Roadmapping methodology
- Unit 14: PROJECT PROPOSAL PREPARATION - EXAMPLES**  
Examples in different programs – H2020, ESA
- Unit 15: PANEL – PROPOSALS NEGOTIATION EXERCISE**

Fig. 11. Scientific Research Methodologies and Techniques course

**Table 2.** List of progress and performance indicators for the UNINOVA-CTS implementation

<b>Progress Indicators</b>	<b>Achievement</b>
Creation of RRI working group to elaborate CEGP	Fully
Decision of the coverage of CEGP	Fully
Launch a participatory process with stakeholders to discuss the first draft of the CEGP	Fully
2nd draft of the CEGP reflecting the relevant aspects from the participatory process with stakeholders	Fully
Actions to promote RRI key Integrity	Partially
Actions to publicize the idea of ethical governance of R&I in line with the ETHNA System	Partially (needs continued effort)
Actions to raise internal awareness concerning the Code of Ethics and Good Practices	Partially (needs continued effort)
Actions to promote RRI Training for ESR	Partially (needs continued effort)
Designation of RRI Officer	Not achieved
Established the core duties of RRI Office	Partially
Action Plan for the implementation of the RRI Office	Partially
Actions to promote RRI key Gender	Fully
Actions to issue reports and make recommendations on principles related to conflicts of interest	Partially
Actions to promote RRI key Open Access	Fully (although needing continuous update)

<b>Performance Indicator</b>	<b>Quantification (if applicable)</b>
The level of commitment to ETHNA System determined	Level 2
Tackle the RRI keys: Research Integrity, Gender Perspective, Open Access and Public engagement	Public engagement was achieved only in a limited way
Actions aimed at reflecting, reporting, and making recommendations on principles related to R&I ethics and professional ethics	Multiple actions taken (e.g., interviews + workshops + internal sessions)
Actions to monitor the level of compliance by professionals and by the organization with the CEGP values, principles, and behaviors	Only achieved to a limited extent. Further development needed
Actions implemented to generate internal awareness of the ETHNA System	Dissemination through digital channels + Multiple Internal meetings
Actions implemented to generate internal awareness of the contents of the CEGP and its benefits	
Actions CTS has taken to promote the CEGP	
Actions to promote RRI Training	Multiple education actions
Meetings for the creation of RRI task force	Multiple internal meetings
Establishment of the RRI core duties and Action Plan	
Actions taken to promote gender balance	Specific EU project Proposal + Conference paper + Gender and Inclusion Equality Plan + Internal dissemination
Meetings for the creation of the code of conflicts of interest	Multiple internal meetings
Actions taken to promote RRI key Open Access	

## 4 Implementation Barriers and Drivers

During the implementation process, the following main barriers and drivers were identified:

**Barriers.** Some of the main barriers found along the implementation are:

- The living lab process proposed by ETHNA was perceived as a bit too bureaucratic/complex, giving implementors the feeling of doing things “just because ...”. In fact, the method was like a “one way” approach, leaving little room for adaptation to each context. A co-creation approach [17] would better suit the needs, and as such we had to make several changes to the process.
- A major difficulty was identifying external stakeholders and finding ways to involve them. Broadening the conversations on RRI to include wider stakeholder groups typically “conflicts” with more traditional views of scientific research [22]. The situation was made even more difficult due to the COVID-19’s confinement period.
- The design of the ETHNA System was, to some extent, based on the assumption that “stakeholders are eager to adopt these ideas and get involved.” This is not really the case, as researchers are busy with their own projects and are not so thirsty to spend time on other activities. In this context, one of the main challenges is to find ways to motivate them and design mechanisms that can lead to a “change in culture”. The initial ETHNA’s guidelines were not very helpful in this change process.

**Drivers.** On the other hand, a number of factors played a driving role:

- Implementation was greatly facilitated by the fact that the Director of UNINOVA-CTS was involved in the process from the beginning and is the coordinator of the RRI task force.
- The identified actions were considered to contribute to the fulfilment of UNINOVA-CTS’ commitments to the Portuguese research funding agency regarding the implementation of a RRI model. Since the outcome of such commitments must be demonstrated during the evaluation of all national centers by that agency, this led to a strong additional motivation.
- The fact that most employers of UNINOVA-CTS researchers (e.g., NOVA University of Lisbon, Polytechnic Institutes, etc.) have already established some level of awareness on some aspects related to RRI, having included in their governance structures ethics committees and mechanisms for promoting good research and innovation practices, gender and inclusion plans, etc., facilitated the initial dialogue.
- Most UNINOVA-CTS researchers are members of international and national scientific and technical societies (e.g., IEEE, IFIP, IFAC, Socolnet, National Engineers Association) and, as such, they are asked to comply with the code of ethics of such associations. Nevertheless, in practice, many of them do not pay much attention to those codes.
- The proposed ETHNA System implementation methodology, which is carefully designed, well detailed, documented and explained, despite the lack of co-creation mechanisms as mentioned above, was useful in giving a broad overview of the process.



Based on the acquired experience, some changes to the general ETHNA System guidelines could be perceived as good practices:

- Starting with an additional action to prepare first drafts of key documents by RRI task force, rather than multiplying the number of workshops that require the involvement of the various stakeholders. Only after these draft documents are produced should we proceed with consultation and refinement by involving all relevant stakeholders in the organization as a way to engage them in a participatory process.
- Making an effort to adapt the “jargon” of the ETHNA System to the internal reality and constraints of the center. This also requires extra effort from the RRI task force but contributes to better acceptance by the stakeholders.
- Establishing a strong and clear link between the RRI implementation process and the internal preparation for the center’s evaluation by the national funding agency (which calms potential internal “political” barriers).

## 5 Lessons Learned

From the experience acquired with this implementation exercise, a number of learned lessons can be mentioned:

**On the Sustainability of Institutional Changes.** An important aspect in any RRI implementation project is how to make the initiated actions sustainable in the long term. Although it is too early to make an assessment of such sustainability, some points can be mentioned:

- Considering the reality of the center, it was understood that the most important and long-lasting measure is the change of culture. This is rather difficult to achieve with older/senior researchers who have their own habits and autonomy. Senior researchers are also too busy with their own research and management activities. Therefore, the emphasis is put on the training young researchers. The center hosts about 100 PhD students and they all receive specific training on research ethics and RRI, which is expected to be an effective mechanism for changing the culture. But this needs to be a continued effort, as we receive new students every year.
- On a more “political level”, the tools provided by the ETHNA System greatly helped UNINOVA-CTS to fulfil its contractual obligations to the national research funding agency, which would otherwise require too long a process with long discussions and too many “political” hurdles.

**On the Wider Potential of Institutional Changes at the Organization.** Beyond the internal impacts of an RRI implementation, namely in terms of mechanisms and change of behaviour, it is also relevant to consider the wider impact in terms of relationships with external stakeholders:

- Prior to the implementation of ETHNA, the center had no experience or even awareness of discussing RRI with external stakeholders. As a result of the implementation

exercise, several contacts and working sessions took place with external stakeholders. The overall reaction was quite positive and good feedback was obtained to improve our key RRI documents/plans.

- These interactions opened some initial directions for further collaboration with those external entities (new project proposal, joint conference paper, etc.). In fact, this is also in line with the growing awareness of the social responsibility of research institutions regarding technology transfer [2]. An increased perception of the role of co-creation [17] also results from these interactions.

**On What Worked Well.** Several aspects of the implementation process proved to be particularly adequate for a networked ecosystem like our center. Among these we can highlight:

- Adopting a “complementarity” perspective, i.e., focusing only on aspects deemed important to the center (understood as a federated ecosystem of researchers), and assuming that other general ethical principles are already covered by the ethical codes of the different employing institutions with which our researchers have a contractual link, is an effective approach.
- Avoiding the creation of complex bureaucratic organizational structures. Since there are no funds for such structures, having only a task force was manageable at this stage. However, it is still too early to assess whether it works in the long term.
- Rather than attempting to elaborate the key documents through a large number of discussion workshops (as suggested in the initial living lab methodology), we created a small team that did substantial preparatory work and drafted preliminary versions of these documents. Then the internal workshops were minimized and focused on discussing these drafts and collecting feedback, which proved to be an effective approach.

**On What was Difficult.** In addition to the effort to smooth internal “political barriers” and to interact with external stakeholders, other aspects of the process proved particularly difficult. Among these we can highlight:

- As mentioned before, adopting the “living lab guidelines” of ETHNA appeared a bit too “bureaucratic” for our reality. The implementation process and corresponding guidelines should be a co-creation process, rather than having to follow a top-down prescription. The model recommended in the project was too “unidirectional”, from “designers to implementers”, which is very wrong and against the very essence of a living lab where co-creation should be nurtured.
- Another thing that perhaps happens with projects focused on RRI implementation, is that at the beginning, part of the consortium had the assumption that “Stakeholders are eager to adopt these ideas and get engaged”. This is not really the case, as researchers in our institutions are busy with their own projects and while they may see RRI as important, they are not available to spend much time on a complex implementation process or to accept more bureaucratic procedures.
- As also mentioned above, the most important thing is to “change the culture” and the current living lab methodology needs further refinements to support this.

**Recommendations.** Although this work is based on a single implementation experience, we believe that some recommendations might be useful for similar research ecosystems:

- When starting any RRI implementation process, it is necessary to make a good demonstration of the importance of RRI and the potential benefits (added value) to all participants. This can be challenging since we are competing for the time and attention of researchers (and other stakeholders) that are focused on their own activities.
- Organize a small RRI team that takes the ETHNA System tools and examples and makes an adaptation to the reality of the organization. This adaptation will make the process much more effective than starting from scratch.
- It is crucial to involve the organization’s leadership in the process.
- If possible, link closely to strategic commitments between the organization and its relationship with national funding agencies. As such, participants feel the pressure from outside rather than from an internal taskforce.
- Whenever possible, establish a link with training programs for young researchers in order to create a new culture. This seems to be in line with some emerging trends for teaching RRI in higher education institutions [23, 24].
- Considering the current ETHNA System living lab guidelines, it is necessary to simplify and adapt them to the reality of each organization.

Naturally the implementation of the ETHNA System [19] is not a “one shot” process, especially in the context of a dynamic (and volatile) research and innovation ecosystem. The process needs continuous attention and monitoring [21] as societal demands evolve and, in the case of an ecosystem like UNINOVA-CTS, there is a continuous flow of people in/out.

## 6 Conclusions

Effectively introducing RRI dimensions and key mechanisms into engineering and technology-oriented research ecosystems is not easy, because there is less awareness in these communities of the importance of the principles at stake compared to other communities, such as health and biomedical research. Researchers in engineering and technology development are often too busy with their own projects and attracting new funded projects, being difficult to engage them in discussing other issues. Therefore, raising awareness and implementing mechanisms for culture change are major challenges. However, the adoption of a systematic method as proposed by ETHNA and using a collection of examples and templates greatly facilitates the process.

In the case of a research and innovation ecosystem, it is important to adopt a “complementarity-based” approach, as participants are subject to various “RRI spaces”, each one with specific requirements. This is particularly relevant as more and more research is carried out by dynamic networked communities.

As the number of researchers focused on RRI increases, namely in the area of social sciences, and new focused projects are launched, the area consolidates, particularly in

terms of concepts, mechanisms, and procedures, but there is a risk that this “new community” becomes too separated from the “other researchers” for whom these developments are made. Thus, there is a need for a continuous effort of co-creation and adaptation to the reality of each organization.

This work reflects an initial implementation process, lacking the long-term feedback. Continuous monitoring and adjustments are necessary as societal perspectives and demands on RRI evolve.

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## References

1. Burget, M., Bardone, E., Pedaste, M.: Definitions and conceptual dimensions of responsible research and innovation: a literature review. *Sci. Eng. Ethics* **23**(1), 1–19 (2016). <https://doi.org/10.1007/s11948-016-9782-1>
2. Gwizdała, J., Śledzik, K.: Responsible research and innovation in the context of university technology transfer. *Folia Oeconomica Acta Universitas Lodzensis* **2**(328) (2017). <https://doi.org/10.18778/0208-6018.328.04>
3. Liu, J., Zhang, G., Lv, X., Li, J.: Discovering the landscape and evolution of responsible research and innovation (RRI): science mapping based on bibliometric analysis. *Sustainability* **14**, 8944 (2022). <https://doi.org/10.3390/su14148944>
4. Bouter, L.: What research institutions can do to foster research integrity. *Sci. Eng. Ethics* **26**(4), 2363–2369 (2020). <https://doi.org/10.1007/s11948-020-00178-5>
5. United Nations: Transforming our world: the 2030 agenda for sustainable development. Department of Economic and Social Affairs. <https://sdgs.un.org/2030agenda> (2015). Accessed 6 Apr 2021
6. Huang, C., Zhang, Z., Mao B. and Yao, X.: An overview of artificial intelligence ethics. *IEEE Trans. Artif. Intell.* (2022). <https://doi.org/10.1109/TAI.2022.3194503>
7. Sabel, B.A., Seifert, R.: How criminal science publishing gangs damage the genesis of knowledge and technology—a call to action to restore trust. *Naunyn Schmiedebergs Arch. Pharmacol.* **394**(11), 2147–2151 (2021). <https://doi.org/10.1007/s00210-021-02158-3>
8. Jiya, T.: Responsible data governance in projects: applying a responsible research and innovation (RRI) framework. *J. Technol. Manage. Innov.* **16**(1) (2021). <https://doi.org/10.4067/S0718-27242021000100031>
9. Camarinha-Matos, L.M., Afsarmanesh, H.: Collaborative networks: a new scientific discipline. *J. Intell. Manuf.* **16**(4–5), 439–452 (2005). <https://doi.org/10.1007/s10845-005-1656-3>
10. Graça, P., Camarinha-Matos, L.M.: Performance indicators for collaborative business ecosystems – literature review and trends. *Technol. Forecast. Soc. Change* **116**, 237–255 (2017). <https://doi.org/10.1016/j.techfore.2016.10.012>
11. Camarinha-Matos, L.M., Fornasiero, R., Ramezani, J., Ferrada, F.: Collaborative networks: a pillar of digital transformation. *Appl. Sci.* **9**(24), 5431 (2019). <https://doi.org/10.3390/app9245431>

12. Mehari, Y., Pekkola, E., Hjelt, J., Cai, Y., Stenvall, J., Ortega-Colomer, F.J.: Defining ‘responsible’ in responsible research and innovation: the case of quadruple helix innovation in the energy sector in the tampere region. In: Păunescu, C., Lepik, K.L., Spencer, N. (eds.) *Social Innovation in Higher Education. Innovation, Technology, and Knowledge Management*, pp. 199–225. Springer, Cham. (2022). [https://doi.org/10.1007/978-3-030-84044-0\\_10](https://doi.org/10.1007/978-3-030-84044-0_10)
13. Nieminen, M., Ikonen, V.: A future-oriented evaluation and development model for Responsible Research and Innovation. In: *Assessment of Responsible Innovation - Methods and Practices*, Taylor & Francis, New York (2021). <https://library.oapen.org/bitstream/handle/20.500.12657/42836/9781000292749.pdf?sequence=1#page=275>
14. Forsberg, E.M., Shelley-Egan, C., Ladikas, M., Owen, R.: Implementing Responsible Research and Innovation in Research Funding and Research Conducting Organisations—What Have We Learned so Far?. In: *Governance and Sustainability of Responsible Research and Innovation Processes*. SpringerBriefs in Research and Innovation Governance. Springer, Cham (2018)
15. EC: The European Charter for Researchers. European Commission, Directorate-General for Research (2005). [https://euraxess.ec.europa.eu/sites/default/files/am509774cee\\_en\\_e4.pdf](https://euraxess.ec.europa.eu/sites/default/files/am509774cee_en_e4.pdf). Accessed 28 Jan 2023
16. IEEE: Definition of authorship. <https://journals.ieeeauthorcenter.ieee.org/become-an-ieee-journal-author/publishing-ethics/ethical-requirements/>. Accessed 5 Jan 2023
17. Robinson, D.K.R., Simone, A., Mazzonetto, M.: RRI legacies: co-creation for responsible, equitable and fair innovation in Horizon Europe. *J. Respons. Innov.* **8**(2), 209–216 (2021). <https://doi.org/10.1080/23299460.2020.1842633>
18. Griessler, E., Braun, R., Wicher, M., Yorulmaz, M.: The drama of responsible research and innovation: the ups and downs of a policy concept. In: Blok, V. (ed.) *Putting Responsible Research and Innovation into Practice*. Library of Ethics and Applied Philosophy, vol. 40, pp. 11–34. Springer, Cham (2023). [https://doi.org/10.1007/978-3-031-14710-4\\_2](https://doi.org/10.1007/978-3-031-14710-4_2)
19. González-Esteban, E.: The ETHNA System and Support Tools. In: *Ethics and Responsible Research and Innovation in Practice*, LNCS, volume 13875, Springer, Cham (2023)
20. Camarinha-Matos, L. M., Goes, J., Gomes, L., Pereira, P.: Soft and transferable skills acquisition through organizing a doctoral conference. *Educ. Sci.* **10**(9), 235 (2020) <https://doi.org/10.3390/educsci10090235>
21. Monsonís-Payá, I., García-Melón, M., Lozano, J.-F.: Indicators for responsible research and innovation: a methodological proposal for context-based weighting. *Sustainability* **9**(12), 2168 (2017). <https://doi.org/10.3390/su9122168>
22. Stahl, B.C., Obach, M., Yaghmaei, E., Ikonen, V., Chatfield, K., Brem, A.: The responsible research and innovation (RRI) maturity model: linking theory and practice. *Sustainability* **9**(6), 1036 (2017). <https://doi.org/10.3390/su9061036>
23. Mejlggaard, N., et al.: Teaching responsible research and innovation: a phronetic perspective. *Sci. Eng. Ethics* **25**(2), 597–615 (2018). <https://doi.org/10.1007/s11948-018-0029-1>
24. Lukovics, M., Udvari, B., Nádas, N., Fisher, E.: Raising awareness of researchers-in-the-making toward responsible research and innovation. *J. Knowl. Econ.* **10**(4), 1558–1577 (2019). <https://doi.org/10.1007/s13132-019-00624-1>

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