

How the Analytic Hierarchy/Network Process Supports More Responsible and Committed Research and Innovation

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1. Introduction

Research Performing and Funding Organizations worldwide are increasingly calling for better Research and Innovation (R&I), societal integration with the grand challenges facing society and the creation of sustainable economic growth. In this context, Responsible Research and Innovation (RRI) emerged in the previous decade. RRI refers to a process of research, development and innovation that takes into account the effects and potential impacts on the environment and society (Stilgoe et al., 2013; Von Schomberg, 2013). Furthermore, RRI is part of a broader set of ideas and initiatives that address socially accountable and responsible innovation. In effect, several studies show an increasing interest by researchers to align their innovative work with their own values and societal interests (Mu & Pereyra-Rojas, 2015; Pereyra-Rojas et al., 2017).

The RRI concept has been studied from various disciplinary perspectives (Wiarda et al., 2021), and has gained traction mainly due to its inclusion in European science policies since 2010, which have been an undeniable driving force. The political will to better align research with societal needs and concerns is leading to ambitious policies and processes to transform the R&I system, including RRI. To accomplish these goals, it is necessary to use managerial tools that facilitate the engagement process of the different RRI stakeholders, and this is where the Analytic Hierarchy/Network Process (AHP/ANP), developed by Saaty (1980, 2001), can play an important role.

2. Responsible Research Innovation approach

The RRI approach has gained increasing attention since it first appeared. It has been incorporated into the European Union's Framework Programmes, of which it is still part, and has taken form through scientific publications, books, manuals, conferences, and mainly projects. More than 200 projects have been financed by the EU since the approach was incorporated into the framework¹. The quick and mainstreamed eruption of RRI onto the European scientific agenda caused a reaction from the scientific community, which reflects on how it might be articulated and put into practice, how to measure efforts in this context, and how to integrate the efforts made in other areas of knowledge.

However, this process is at a stage where RRI as such has not yet been systematically defined or integrated into many of the policies that promote R&I (Research and

¹ Among the projects financed, these stand out: [GREAT Project](#) (2013), [ResAGorA](#) (2013), [PARRISE](#) (2014), [Responsible-Industry](#) (2014), [MoRRI](#) (2015) and [Super-MoRRI](#) (2018), [RRI-Tools](#) (2016), [MULTI-ACT's](#) (2019), [YOUCOUNT](#) (2021), and many others.

Innovation) at the country or regional level. The term RRI is unknown to the general public, to many people working in the fields of science, technology and innovation, and even more unknown beyond the EU's borders. Current publications in RRI predominantly originate from European countries and are funded by European institutions or agencies.

RRI involves the following six key areas (Strand et al., 2015):

1. **Ethics:** The ethics dimension in the RRI framework addresses the need to ensure the social relevance and ethical acceptability of science and innovation results. It considers what “in order to adequately respond to societal challenges, research and innovation must respect fundamental rights and the highest ethical standards” means.
2. **Public engagement:** This area seeks to promote greater interaction and two-way dialogue between diverse actors about science and innovation related issues. It is the “engagement of all the societal actors (research, industry, policy-makers, and civil society) and their joint participation in the research and innovation process”.
3. **Gender equality:** This area promotes an “all actors (women and men) are on board” ideal. It seeks a greater effective presence of women, but also a greater global openness to people who challenge traditional gender stereotypes.
4. **Open access:** This is defined as access to bibliographic information and data, as well as research methods and results. It means “giving free online access to the results of publicly-funded research (publications and data)”.
5. **Science education:** This refers to all activities that are aimed at facilitating greater interaction among citizens, researchers and other social actors. It seeks to promote interest in science and scientific vocations.
6. **Governance:** This refers to any form or coordination designed to foster and mainstream RRI within an organization or in the interaction with other stakeholders. It is a key umbrella area that states that policy-makers “have a responsibility to prevent harmful or unethical developments in research and innovation”.

Some authors also propose the inclusion of the following areas:

7. **Social justice:** This can be defined as the promotion by science and technology of an ideal condition in which all citizens have equal rights, opportunities and access to social resources.
8. **Environmental sustainability:** This involves the diagnosis and management of environmental impacts, both positive and negative. It addresses the relationship between nature and R&I, and how to incorporate it into responsible R&I.

As has been clearly expressed, articulating RRI requires that societal actors (researchers, citizens, policymakers, business, third sector organizations, etc.) work together during the whole research and innovation process in order to better align the process and its outcomes with the values, needs and expectations of society (Strand et al., 2015).

Articulating RRI requires a combination of different strategies and methods, the involvement of different actors (Stilgoe et al., 2013) and consideration of the realities of each context (Mejlgaard et al., 2018). Thus, RRI imposes greater complexity for R&I practitioners and policymakers. Establishing scientific policies that address RRI in a

comprehensive way is necessary in order to be able to analyze the specific characteristics of the different R&I systems at different levels of analysis (macro, meso and micro). Hence, the operationalization of RRI practices is currently a hot issue. Some authors advocate larger and more comprehensive studies to test specific RRI theories. This is especially valid in light of the broad, diverse, and still explorative nature of contemporary RRI (Wiarda et al., 2021).

3. AHP/ANP support of more responsible research and innovation

Using RRI as a new paradigm requires a different approach to the design, monitoring and evaluation of research agendas and policies. To establish and implement RRI, several metrics or evaluation approaches have been generated. Different discourses from different perspectives have taken place to address the practices of industries, governments, and public research institutes.

As previously mentioned, case studies are vital to identify potential propositions that, using larger and more comprehensive studies, can lead to the testing of specific RRI theories (Wiarda et al., 2021). Some recent examples of helpful exploratory case studies constitute a magnificent example of the use of the AHP/ANP approach to address some complex decisions with regard to monitoring and promoting RRI.

The AHP/ANP are useful tools for prioritizing and defining which metrics contribute the most to RRI monitoring and evaluation at different levels. These methods also have the important advantage of allowing the inclusion of the different RRI actors in the decision-making process even if they are not familiar with the technical intricacies of the actual process. There are some experiences where the AHP/ANP has made it possible to contribute to the body of knowledge applied to RRI monitoring at different levels.

At the national level, in Spain, the INPERRI Project (2016-2019) proposed concise lists of RRI indicators to monitor Spain's science and innovation policies in the eight RRI areas or perspectives (Gonzalez-Urango, García-Melón et al., 2020; Monsonís-Payá et al., 2017; Otero-Hermida & García-Melón, 2018). INPERRI focused on the co-creation of indicators aimed at identifying specific demands in the Spanish research and innovation context. The results assist Spanish policymakers and Research Funding Organizations in monitoring their policies in accordance with RRI principles.

The development of these lists was mainly based on the analysis of existing projects and literature, as well as the participation of different experts in participatory sessions organized for each of the RRI areas. For science education, a Social Network Analysis was carried out, following the methodology proposed by Gonzalez-Urango (2020), to detect the most relevant actors within the field of science education in Spain. Participatory group sessions were conducted to produce the lists of indicators, which were then prioritized using the AHP (Vinagre Fernandez, 2019). For public engagement, qualitative content analysis techniques were used for the in-depth study of the deliberative process and the generation of indicators, and the AHP was used for the prioritization of the indicators that were developed (García-Melón et al., forthcoming).

Another particular study in the gender area has been developed into a tool for monitoring and assessing the gender gap at academic events (Corona-Sobrino et al., 2020). The study is based on a combination of qualitative analysis, AHP and AHP Sort (Ishizaka et al., 2012) to design specific lists of performance indicators and the thresholds required to sort the results with a traffic light signal. These techniques have allowed the indicators to be weighted as well as the generation of some composite indicators.

Finally, at the micro level (project), Ligardo-Herrera et al.(2019) assess the stakeholders' influence in a research project within the context of responsible research and innovation. The ANP method allowed ranking and ordering the project's stakeholders based on their influence on the anticipation of the responsibility of the project and its possible outcomes. The purpose of this assessment was to help a research team more efficiently devote their limited resources to stakeholder management.

All these experiences have involved a typical AHP/ANP prioritization process. The findings have been concrete results that can be used to implement and promote RRI. They have all involved the active participation of different actors and can therefore be applied at national policy levels, and at the project, institutional and/or individual level, allowing for a wide variety of uses.

4. Conclusion

Rather than being an exhaustive explanation of RRI, the intention of this essay is to briefly present an interesting framework that the European Union has been building around science that is more aware of global challenges. A second intention is to highlight the usefulness of the AHP/ANP as valuable tools to handle the complexities derived from the implementation of a multidimensional concept such as RRI.

The proposed AHP/ANP applications are useful in the context of evaluation, learning or comparison. All the experiences emphasize the importance of including different techniques to collect and analyze the opinions of stakeholders (content analysis of documents, interviews and focus groups; participatory sessions, or Social Network Analysis (SNA)). These combinations are useful in studies that seek to tackle complex and sometimes controversial and difficult problems. However, they require a high degree of participation of stakeholders. Beyond the traditional identification of stakeholders, the ideal objective is to achieve their effective inclusion. This means the highest level of involvement, according to the stakeholder engagement levels proposed by Gonzalez-Urango et. al (2022), in such a way that they can contribute valuable knowledge that complements scientific expertise and enriches the knowledge base.

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