The EPSRC's responsible innovation framework: to what extent does it influence research practice?



Project report

Citation: Rose, D. C., Schillings, J., Shortland, F., Smith, R. (2023) The EPSRC's responsible innovation framework: to what extent does it influence research practice?. February 2023. Cranfield University.

Funding: British Academy/Leverhulme Small Research Grant: SRG20\200074, acknowledging research support provided at the University of Reading (where grant was originally won).

Image: Brett Jordan (Unsplash)

Copyright: © 2023 by the authors. This report is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1 Introduction

This report outlines results from a small pilot project conducted as part of the British Academy/Leverhulme Small Grant scheme. Commencing in 2020 and delayed due to COVID-19 delays, this report discusses our findings in the context of other related external research conducted since the project start date. The motivation for our small project was to understand whether the Engineering and Physical Sciences Research Council's (EPSRC, UK Research Council) Responsible Innovation framework is making an impact on the research practice of its grantholders. To provide brief background on the framework, the concept of responsible innovation has gathered pace over the last decade with the work of Stilgoe *et al.* (2013), Owen (2014), and others influencing the policy of the EPSRC. Although definitions and terms vary, 'responsible innovation' (sometimes known as 'responsible research and innovation') is taken here as a guiding concept to ensure that society is 'taking care of the future through collective stewardship of science and innovation in the present' (Stilgoe *et al.*, 2013, 1570). Opening-up research and innovation at an upstream stage may help to set trajectories that are both more acceptable and better aligned to society and also make unintended negative consequences less likely to occur, as they sometimes have in the past (Murphy *et al.*, 2016). Operationalisations of the concept vary, but Stilgoe *et al.* (2013) outlined four key tenets:

1. Anticipation: foresighting the consequences of science and innovation, both good and bad, easily and uneasily foreseen, as well as how they are distributed across society.
2. Inclusion: ensuring that stakeholders affected by science and innovation are given the chance to share their views.
3. Reflexivity: ensuring that stakeholder views are taken into account which can mean changing the intended original trajectory of science and innovation processes.
4. Responsiveness: having systems in place to respond to consequences caused by science and innovation.

This operationalisation was embedded into the EPSRC's policies for grant recipients in 2013 via the AREA framework (anticipate, reflect, engage, act), which is a variation on the same four tenets as above. EPSRC's move to embrace responsible innovation principles has been welcomed since national funding bodies play a key role in setting the norms and conditions within which researchers and innovators operate (Schoisswohl *et al.*, 2023). Although institutionalisation of responsible innovation within research and innovation settings can occur via a bottom-up process, the top-down role of funding bodies is often vital (Randles *et al.*, 2016; Ten Holter *et al.*, 2022).

The introduction of the AREA framework by the EPSRC to shape the activities of its grant recipients is, however, only a first step. Responsible innovation, or the good stewardship of science and innovation in the present (Stilgoe *et al.*, 2013), only occurs in practice if words are translated into actions. For responsible innovation frameworks to be effective, they have to change research practices rather than promote business-as-usual (Pansera *et al.*, 2020). Awareness of responsible innovation is the next step and previous research has suggested that scientists may not be familiar with the latest policy drives (Glerup *et al.*, 2017). Next, key actors, including funders and researchers, need to be 'willing and able to actively practice RRI-aligned activities in their day-to-day roles' (Regan, 2021, 30). Ten Holter *et al.* (2022) argue that responsible innovation should be 'built in' to funding calls, rather than simply being 'bolted on'. Several pieces of research, which our project contributes to, have begun to explore the impact of the EPSRC's AREA framework (or other responsible innovation policies) in practice, though all acknowledge the difficulty of assessing what 'success' or 'influence' looks like for a concept where

impacts are often diffuse and slow-moving (Stilgoe *et al.*, 2013; Pansera *et al.*, 2020; Owen et al, 2021). There is evidence of some impact on the activities of grant recipients, including wider stakeholder engagement, openness, and public outreach, described as a shift away from narrow 'public understanding of science' approaches to two-way dialogue and deliberation (Pansera *et al.*, 2020). Owen *et al.* (2021) describe various phases of the EPSRC's journey to institutionalise responsible innovation. Referring to the early period between 2013 and 2017, they write:

> "…while there was evidence of some RI institutionalisation between 2013 and 2017 at EPSRC and the communities it funds, particularly in a small number of key themes, overall this had been limited in both scope and reach during the four years since publication of the RI policy." (Owen *et al.*, 2021, 8)

They argued that only a few Centres for Doctoral Training (CDTs) funded by the EPSRC had embedded responsible innovation training, but overall uptake and implementation was patchy and uncertain. Owen *et al.* (2021), however, argue that post early 2018 saw a new phase of activity around responsible innovation from the EPSRC, including stronger mandates for CDTs and researchers to commit to responsible innovation. They conclude (page 9) by stating that "[i]n a small number of cases RI appears to have been embraced in a substantive way…[a]t the other end of the spectrum there is evidence of outright resistance." Whilst the aforementioned studies have increased our knowledge of impact, it is fair to say that we still have limited information about whether responsible innovation is being translated into institutional practice; and if it is, whether it is symbolic or substantive (Pansera *et al.*, 2021; Ten Holter *et al.*, 2022). Our project is particularly interested in whether the EPSRC's AREA framework has changed business-as-usual across UK universities, focusing on individual researchers and PhD students within institutional contexts.

These previous studies have explored the barriers to implementing the AREA framework (or similar responsible innovation policy) in practice. Barriers listed below are taken from Glerup *et al.* (2017), Pansera and Owen (2018), Carrier and Gartzlaff (2020), Pansera *et al.* (2020), Kuzma and Cummings (2021), Owen *et al.* (2021), Regan (2021), Stahl *et al.* (2021), Ten Holter *et al.* (2022) and Jakku *et al.* (2023). Many are interlinked:

1. *Lack of clear definition*– in some ways, responsible innovation as a concept thrives on interpretive flexibility and ambiguity, allowing it to be considered in different research and innovation contexts (Pansera *et al.*, 2020). However, researchers have reported that the lack of clarity can make it difficult to know how to implement it in practice.
2. *Institutional inertia* – universities can be resistant to change for many reasons.
3. *Difficulty of measuring progress* – policies that are hard to measure can be difficult to support and enact.
4. *Clash with disciplinary norms and personal attitudes* – most researchers funded by the EPSRC are not social scientists. Responsible innovation approaches (e.g. stakeholder engagement) require knowledge. Studies have found that the AREA framework has been best incorporated, for example, into CDTs where a select group of 'champion' individuals have the knowledge and interest to embed it (Ten Holter *et al.*, 2022). Kuzma and Cummings (2021) found significant relationships between "stronger egalitarian cultural-beliefs", "higher levels of experience", "positive attitudes" and responsible innovation. Personal attitudes alone, however, may not translate into actions. Amongst publicly funded researchers in Ireland, Regan (2021) reported that some scientists expressed positive attitudes towards responsible innovation, but few could offer practical examples of actions being taken. Other disciplinary

concerns include worries over stakeholder bias, a lack of public understanding of science (Carrier and Gartzlaff, 2020), and the difficulty of anticipating consequences associated within an uncertain and serendipitous innovation environment.

5. *Lack of training and knowledge* – following on from the above, some researchers found responsible innovation difficult to do without training and knowledge.
6. *Lack of reward structures plus workloads* – high workloads and lack of rewards for partaking in responsible innovation activities can mean that training or actions are not taken up by individual researchers (Jakku *et al.*, 2023). Lack of time for extra responsibility is a key concern (Glerup *et al.*, 2017).
7. *Lack of resources* – engaging the public and undertaking other responsible innovation approaches takes time and requires resources which scientists do not always have (Carrier and Gartzlaff, 2020).
8. *Clash with external policy environment* – studies have found that governments can push a pro-science and innovation agenda (or academic capitalism) to raise productivity and some researchers may see this 'at odds' with responsible innovation (Glerup *et al.*, 2017; Owen *et al.*, 2021).
9. *A negative attitude towards top-down pressure* – one study reported that some individuals may not respond well to top-down pressure to the implementation of responsible innovation. This may create a feeling of 'hostility' amongst scientists (Pansera *et al.*, 2020) who may think the policy is overly alarmist or cautious (Regan, 2021). Co-designing policies on responsible innovation with researchers is important not least so it is framed in the right language (Glerup *et al.*, 2017).
10. *Loss of autonomy* – some researchers have expressed caution about loss of autonomy and freedom of research (Carrier and Gartzlaff, 2020; Regan, 2021).

Institutionalisation of responsible innovation takes time and requires 'systemic and organisational changes to research and development practices across multiple levels' (Jakku *et al.*, 2023, 2).

The overall objective of our study, which was carried out contemporaneously with some of the studies mentioned above, is to understand the impact of the EPSRC's AREA framework on research practice in UK universities. Whilst there is overlap with previous literature, our mixed methods approach of in-depth interviews with EPSRC-funded researchers and a survey of EPSRC-funded researchers and PhD students adds additional insights. Whilst the thoughts of CDT leads have been sought by previous research, little research has heard directly from PhD students within Centres that are mandated to embed responsible innovation. We focus deliberately on the period from 2018-2022 as Owen *et al.* (2021) reported that the EPSRC put a renewed effort into institutionalising responsible innovation from 2018 onwards.

2 Methodology

We were interested in the period from 2018 onwards, which meant that we included researchers and PhD students in our study if they had been in receipt of funding from the EPSRC since then. Participants did not have to be currently funded (at the time of involvement) by the EPSRC and were included if they were still in receipt of money after the start of 2018, but the project had started beforehand. Our study was a small, pilot project spending only around £5,000 on short-term researcher support and

thus we set our expectations (and those of the reader) accordingly. The purpose was to gain useful insights to plan a possible larger piece of work, as well as to provide interim findings to the EPSRC, although during the course of delivery, it was apparent that other studies were also ongoing in this area. Our team have maintained contact with these research teams in the hope of a potential future collaboration. Delivering this project alongside other activities during the COVID-19 pandemic was challenging, not least because it required the involvement of UK researchers and PhD students who were themselves overburdened during difficult and stressful times. The project was thus delivered in two main phases of activity, in the early months of 2021 and the final months of 2022. The research was approved by an ethics committee at the University of Reading (where grant originally held).

We used the EPSRC's Grants on Web system to identify a list of researchers or leads of Centres of Doctoral Training funded since 2018, which was confirmed by everyone taking part. Sampling was purposeful and adopted a key informant perspective, trying to speak to grant recipients from a variety of disciplines and institutions. We undertook 12 in-depth interviews with UK researchers funded by the EPSRC at 11 institutions between February and July 2021. Disciplines covered were synthetic biology, biotechnology, pharmacy, computer science, robotics, statistics, economics, remote sensing, environmental engineering, and social science. Nine researchers were male and three were female. In addition, 24 other people were approached for interview but either declined or did not respond. Interviews were semi-structured with the topic guide shown in Appendix A. The interviews were conducted online by three separate researchers (JS, RS, FS) and transcribed by an external organisation. They were thematically analysed manually by one researcher (DCR).

We also undertook an online Qualtrics survey of UK EPSRC-funded researchers and PhD students between September and November 2022. The survey was circulated via social media, by emailing interviewees, and by contacting CDT/DTP leads or administrators. Questions are shown in Appendix B. We received 138 responses (103 PhD students, 35 researchers/academics). In total, 30 institutions were represented in the responses with the top five institutions accounting for 76 responses and no more than 20 responses from any one single institution. At least 43[1] disciplines were covered. The gender response split was 87 Male, 43 Female, 2 Non-binary/non-conforming, with 6 preferring not to say or selecting other (no further detail provided). Descriptive statistics are provided for close-ended questions and open-ended answers were thematically coded. Respondent numbers in the survey vary for each question as not all questions were mandatory.

[1] Taking the first discipline given, as described by respondents (136 gave responses): Aeronautical engineering (1), Aerosol science (1), AI (2), Atmospheric Science (1), Automotive Engineering (1), Behavioural Science (1), Biochemical engineering (5), Biology (2), Biomaterials Science (1), Biomedical Science (4), Chemical Biology (1), Chemical Engineering (1), Chemistry (12), Computational Materials Modelling (1), Computer Science (13), Computing (5), Cybersecurity (2), Data Science (1), Economics (1), Electronic Engineering (3), Engineering (10), Environmental Science (1), Geography (1), Geospatial engineering (1), HCI (2), Health technology (2), Immunology (2), International relations (1), Machine Learning (3), Materials Science (6), Mathematical sciences (1), Mathematics (11), Mechanical engineering (2), Medical imaging (1), Neuroscience (3), Pharmaceutical Sciences (2), Physics (8), Psychology (9), Risk Analysis (1), Robotics (5), Social sciences (1), Sociology (1), Statistics (3).

3 Results

3.1 Awareness

We asked the twelve interviewees whether they were aware of the concept of responsible innovation and the EPSRC's AREA framework. In total, 11 out of 12 respondents were aware of responsible innovation and 9 out of 12 knew about the AREA framework. The person who had not heard of the term said *"I don't know whether it's a defined term. I've heard the two words used separately"* (interview 3). It is particularly interesting to understand where their awareness of the concept comes from; largely it was as a result of disciplinary background. Several respondents noted that their disciplines(e.g., synthetic biology), had a long-standing focus on ethics within which the principles of responsible innovation were widely known.

> *"it's been part of the synthetic biology landscape, shall we say, since very early days, and early inception. From the very inception of the field, it's taken a very strong stand in terms of making sure that that is done in a responsible way and that people are thinking through the implications of the science that they do." (Interview 1)*

> *"it's so long ago that I can't even remember….I consider that I am very strongly supportive of Responsible Research and Innovation and would probably bring it in before they worried about me not doing so. I'm a bit proactive in that area because I'm involved in the area of synthetic biology, the Responsible Research and Innovation AREA agenda, as it was sometimes referred to, is very much encompassed in the whole research theme of synthetic biology, so it's not separate. So that was why I wanted to be interviewed and make sure you got really quite a positive story about engagement with it." (Interview 6)*

Some of our interviewees were social scientists who knew about, and taught sessions on, responsible innovation.

Others had come across responsible innovation through collaboration with social scientists:

> *"So actually, I came across and started working with social scientists in the space of responsible innovation prior to the EPSRC obviously creating their AREA framework." (Interview 1)*

> *"The specifics around Responsible Innovation I probably have heard about since we employed our research fellow. So, I'd say having a resident social scientist really helps." (Interview 2)*

> *"I've come across it because it is explicitly in use in many funding remits that I have applied for and I've, yeah, I've had to take some of these into account in various ways. I've also, so my projects are usually interdisciplinary and a good friend of mine is an ethicist." (Interview 9)*

Others had heard of the concept because they had taken a leadership role within a bid for a Centre for Doctoral Training (CDT) which mandated training in responsible innovation:

"it's something that was pointed out by our funder that that's something that we need to address in this CDT, so my primary source of information is the EPSRC." Interview 4)

One interviewee had heard of responsible innovation, but preferred the Innovate UK PAS440 framework[2], arguing that it was more tangible and useful in practice:

"for me as an engineer it granulated down to, well what do I actually do? Because I think every human being, oh you know I want to do responsible innovation, I don't want to do irresponsible innovation, this is the right thing to do it's great, but how to do it? And that's where I saw the difference between the EPSRC and the Innovate one." (Interview 8)

The survey also asked about awareness of 'responsible innovation' and specifically the AREA framework. Respondent numbers vary for each question as some were optional. Separating out responses from PhD students (Figures 1 and 2) and academic researchers (Figures 3 and 4), awareness was generally good of the term 'responsible research and innovation', but awareness of the AREA framework was lower:

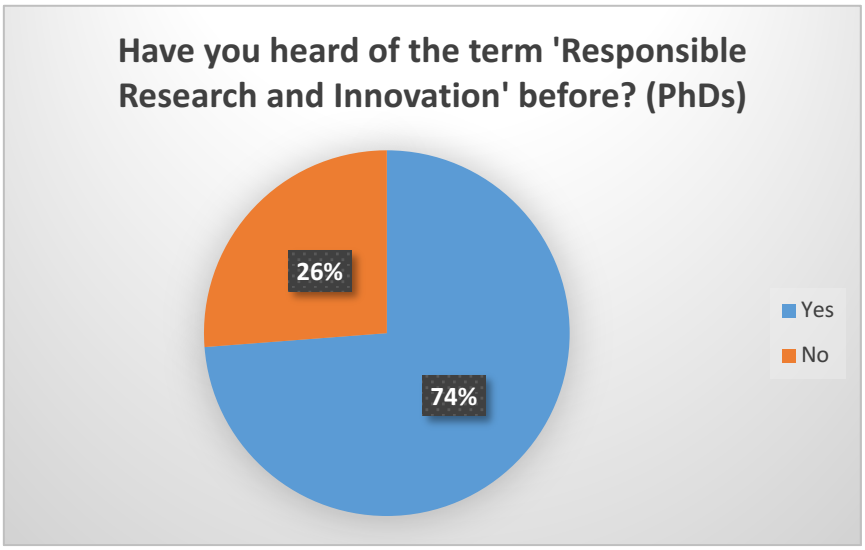


Figure 1: PhD student awareness of RRI (% count, n=103)

[2] https://pages.bsigroup.com/l/35972/2020-03-17/2cgcnc1?utm_source=pardot&utm_medium=email&utm_campaign=SM-STAN-LAU-PAS-PAS440-2003

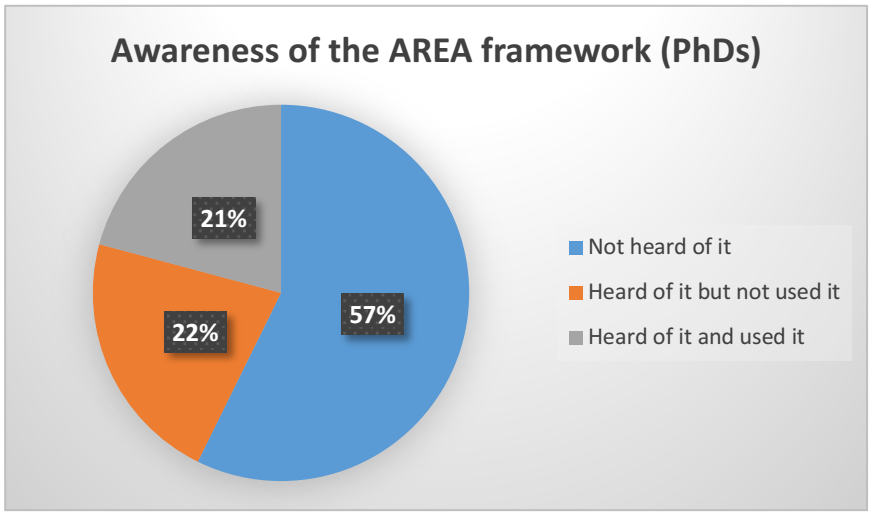


Figure 2: PhD student awareness and use of the AREA framework (% count, n=96)

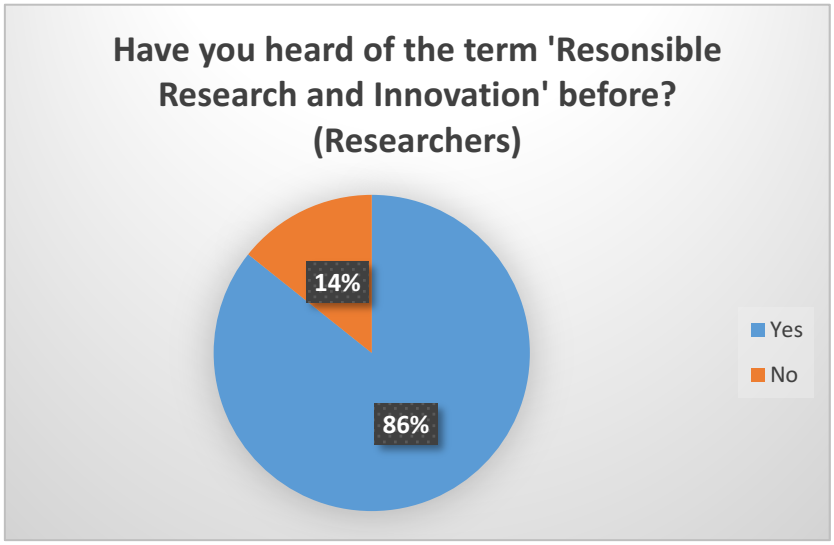


Figure 3: Researcher awareness of RRI (% count, n=35)

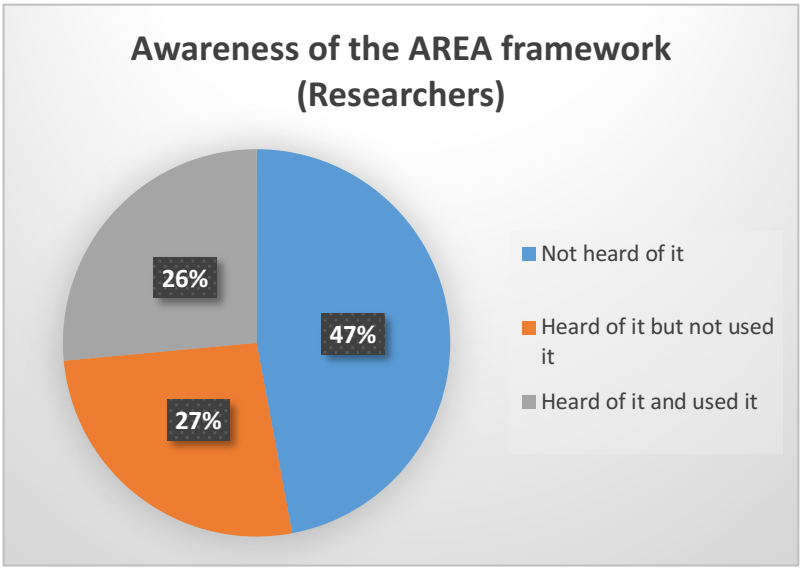


Figure 4: Researcher awareness of the AREA framework (% count, n=34)

3.2 Definitions and attitudes

We were also interested in how interviewees defined responsible innovation and the research practices associated with it. A number of themes emerged. Some respondents thought it was partially about communicating better with the public in the context of public acceptance of innovation or about enabling the innovation to have a legacy:

> *"…what is the likely public acceptance of those things? So that's something that we're concerned about." (Interview 2)*

> *"So actually, Responsible Innovation here is about designing something which has a local supply chain…the expertise and the knowledge locally to maintain things, such that when the project ends, it can run, it's sustainable long term in country." (Interview 7)*

For others, it was about better engagement with the public, but not necessarily just for public acceptance, rather a more holistic sense of the public good.

> *"I would argue that all science overlaps with society. It's funded by society, right? So, at the very least you have a responsibility to explain what you're doing and why you're doing it. It's not just about necessarily engaging…if your perceived end user of your technology is, say, industrial biotech, then you should be engaging with industrial biotech companies or start-ups, or investors, or whatever, right? Because if your technology is actually going to have a life beyond the lab, from it being just a, an academic endeavour, then if you don't engage then it, you won't fulfil your objectives." (Interview 1)*

> *"… it involves thinking about innovation more than the mocking up of the harms, if you like, the risks, so rather than just assuming that innovation will do good, it's about thinking more concretely about how to enable that good, and that means in some ways making the innovation more challenge led. It also means about it being more inclusive and delivering a broader set of values than simply economic values, so thinking about what the innovation's actually trying to do from the start." (Interview 5)*

> *"There's the long-term implications in terms of we believe that what we're developing is essential to society for the greater good… I think it comes under that umbrella heading of responsible innovation." (Interview 3)*

> *"…for me it's being able to create more sustainable solutions." (Interview 6)*

> *"I research and other people in my team try to look into how the outcomes of our research can benefit lives of people, especially disadvantaged groups." (Interview 10)*

Reflexivity was also mentioned:

> *"we are not simply chasing data and research results for the sake of it, that the people that we hire, we give them the space and time to be reflective and self-critical about what they're doing and why they're doing it…So actually it's about being thoughtful and critical about what you're doing, and asking yourself why you're doing it, and what are the consequences of what you're doing? That does involve a little bit of future gazing but the, not to the extent that you can look into the future and see the consequences, but at least*

being aware that there are unintended consequences to the things that you do…I suppose, a broader philosophical understanding about what innovation is and what it means to society, and how it integrates as part of society." (Interview 2)

Reflection from some interviewees specifically considered possible winners and losers from innovation:

"…you need to think about who will win, who might win and who might lose from this intervention, and then how would you change your intervention to ensure that ideally, as far as possible, everyone benefits, because if you have people who are being compromised in their ability to earn money or whatever from your intervention, you really need to address that somehow. if you introduce some piece of technology, and you don't consider how that impacts on people, that's not appropriate. I think really just, almost flagging to researchers, you must consider the implications beyond just whether this device works and how many dollars it might save per year." (Interview 7)

"…it is as a future looking way of scaffolding research and by that I mean, sure we want to do, we want to innovate, we want to develop new things, but we also need to foresee the consequences of what we do and we have to think about ways to make sure there is no adverse consequences." (Interview 9)

A social scientist gave their own view about the balance between science communication and more reflexive forms of public engagement:

"…engagement could be simply around outreach and telling the public about the awesome science they're doing, whereas if, for some it was really about a more citizen science led approach or a stakeholder engagement approach where they were listening and trying to understand perhaps the challenge they were facing, for their science was going to solve but from a stakeholder or public point of view." (Interview 5)

Inclusiveness and diversity in research was also mentioned:

"…an aspect of Responsible Innovation, which is to be inclusive, to be diverse." (Interview 4)

One person argued that researchers could interpret responsible innovation differently:

"It's whatever people want it to be, but it is not just, to my mind, it's not just that picking out what is a potential commercial opportunity, it's more than that. It's how, if you're innovating responsibly, you should be selecting products and processes that could, that maybe could support a more circular economy." (Interview 6)

In this vein, one respondent felt that the AREA framework was vague and open to interpretation:

"…it's very vague. It's qualitative and vague. And subject to different type of interpretations. So as a researcher I feel that there is a lot of scope of improving it in terms of clearly modifying in some way, or giving more qualitative guidance to, so that people can focus on how their research can be turned into responsible innovation in any subject area, in any research." (Interview 10)

Survey responses gave similar views about the definition of responsible innovation with 71 comments being made by PhD students and 26 by researchers. PhD students mainly defined responsible research and innovation as a process to consider the wider implications and impact of their research on society (seeing the bigger picture), ensuring they are positive and not negative. For some, this meant engaging with stakeholders whilst for others it was more about public acceptability of science. Some responses used the common Stilgoe *et al.* year? definition. For some, it was '*rebranded ethics'* but that meant considering negative impacts on society and taking steps to overcome them. Very few definitions implied scepticism towards the concept with only one person saying '*no idea*' and one other saying '*corporate BS that the uni says to look good/get funding*'. Survey responses from academic researchers showed little difference.

The survey also gauged attitudes towards the purpose of responsible innovation. Figure 5 shows the response of 101 PhD students about the importance of considering societal implications and expectations of their research and innovation. Figure 6 shows the response of researchers:

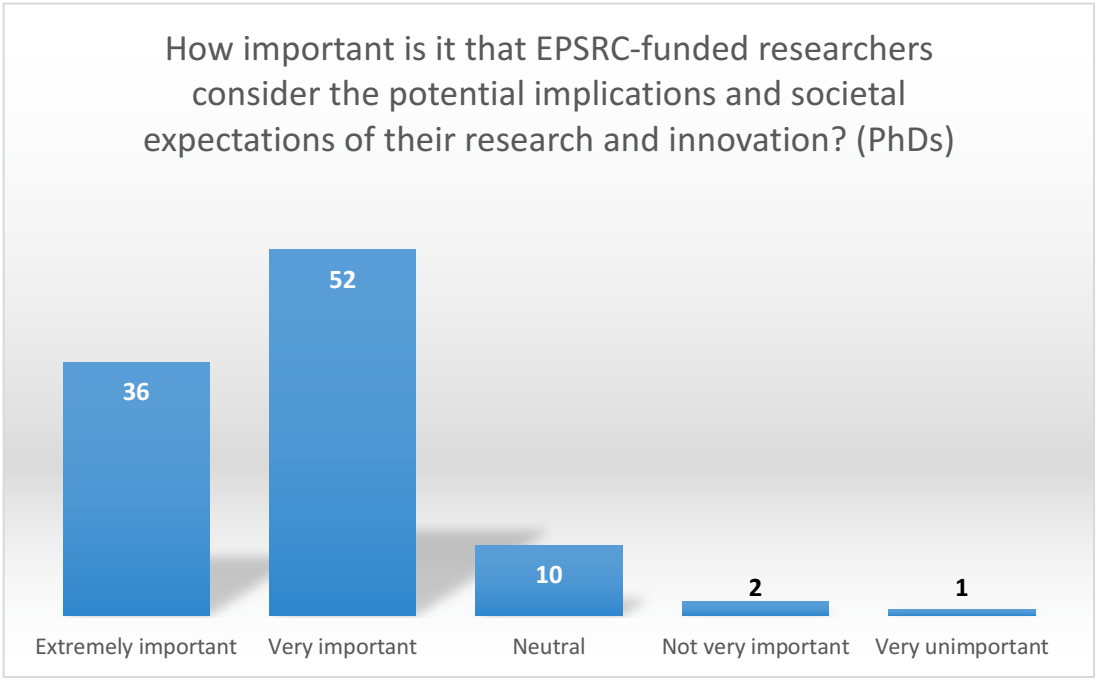


Figure 5: Importance of considering implications of research, PhD students, raw count, n=101.

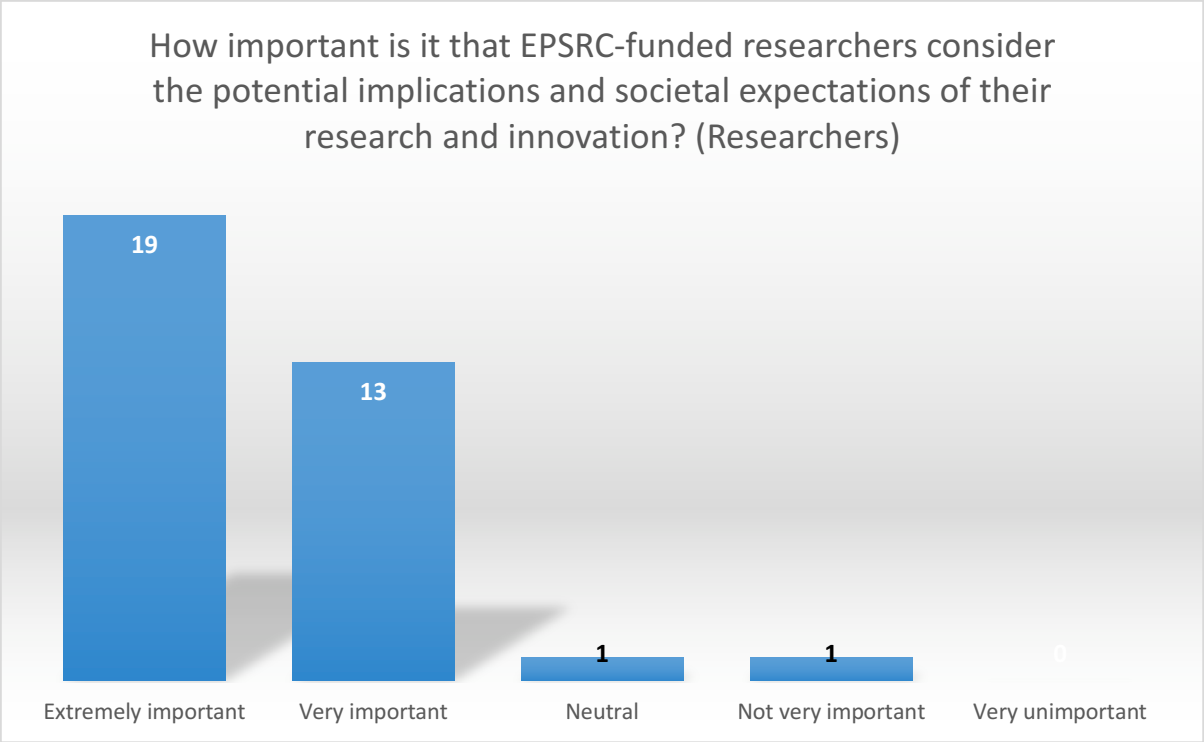


Figure 6: Importance of considering implications of research, Researchers, raw count, n=34.

When asked specifically to comment on whether EPSRC-funded researchers should consider responsible research and innovation students in their work, 70 PhD students said 'Yes', 26 thought it depended on their topic, and none said 'No'. For researchers, 28 said 'Yes', 4 thought it depended on their topic, and none said 'No'.

3.3 Training

We were also interested in the type of training received by researchers or offered to students in a CDT. Researchers in interviews generally thought that there were many training opportunities and that it was up to their institution to help provide it to themselves and students, rather than the funder:

> *"…the EPSRC's job is to mandate it and to provide the frame…and to require it and hopefully…to ensure that it's been done, so as, at the midpoint, mid review point and at the end, final review point…it should be a requirement for continuation of funding that responsible innovation has been taught successfully. But I don't think they should be, in the same way they wouldn't be stepping in and telling the PIs how to do the science, I don't think it's their role to step in and tell the CDT how to teach". (Interview 5)*

> *"…the thing is I believe that there's so much, there's so many training opportunities for innovation activities that I don't think there's any shortage of that." (Interview 3)*

Interviewees who represented CDTs generally thought students received good provision:

> *"They've been really, really good...it's not a generic, off the peg, RRI package from some sort of external trainer. It's the people who work very much in the field, so it's very*

relevant to the work that's going on in the CDT. And I think that really helps. I've been really impressed actually how engaged the students have been with it." (Interview 1)

A social scientist argued in an interview that responsible innovation had to be taught be experts:

"Responsible Innovation has to be taught by people who are experts in Responsible Innovation. It's a social science topic and it needs to be taught by social scientists." (Interview 5)

Ideally, it also has to be integrated throughout the PhD process according to the same interview:

"So, it needs to be integrated throughout the PhD process, not just in the first year with a course, and that I think is the tell-tale, I think that measure of success of these CDTs in five, ten years will be in whether those students have incorporated Responsible Innovation in their PhD proposal, in their PhDs, in their dissertations, but also that they've been asked to do so." (Interview 5)

In the survey, we asked 100 PhD students if they had been trained on responsible innovation, noting that they were likely to be at different stages (and, therefore, an answer of 'no' does not mean they will not receive training over the course of their studies) – 61 said 'Yes', and 39 said 'No'. When asked who they thought should be responsible for ensuring PhD students are trained in responsible innovation, 95 students gave their views (Figure 7), with responsibility seen to lie primarily on the university, but also on the funding body and the researcher themselves.

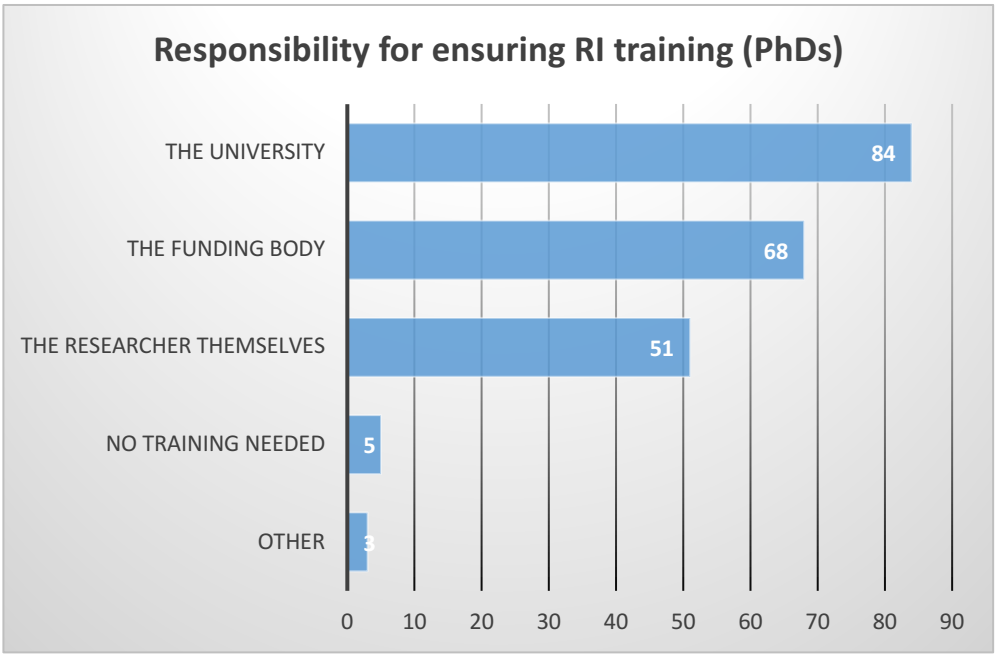


Figure 7: Responsibility for ensuring RI training, PhD students, n=95.

The survey asked PhD students what sort of training (if any) they had received on responsible innovation, again noting that some may be at an early stage of their degree with training to come in the future. Of the 51 comments, training had been received largely as a result of their CDT in the form of workshops, mandatory modules, or coursework. Others attended an ethical hackathon or received online training. Academic survey responses indicated that those who had been trained had accessed

information through online courses or webinars, university training sessions or seminars, or working with more experienced researchers.

Researchers were asked the same question – 15 had received training in responsible innovation, but 18 had not. Figure 8 shows their views on who should be responsible for ensuring that researchers are trained in responsible innovation, again with the primary responsibility falling on the university:

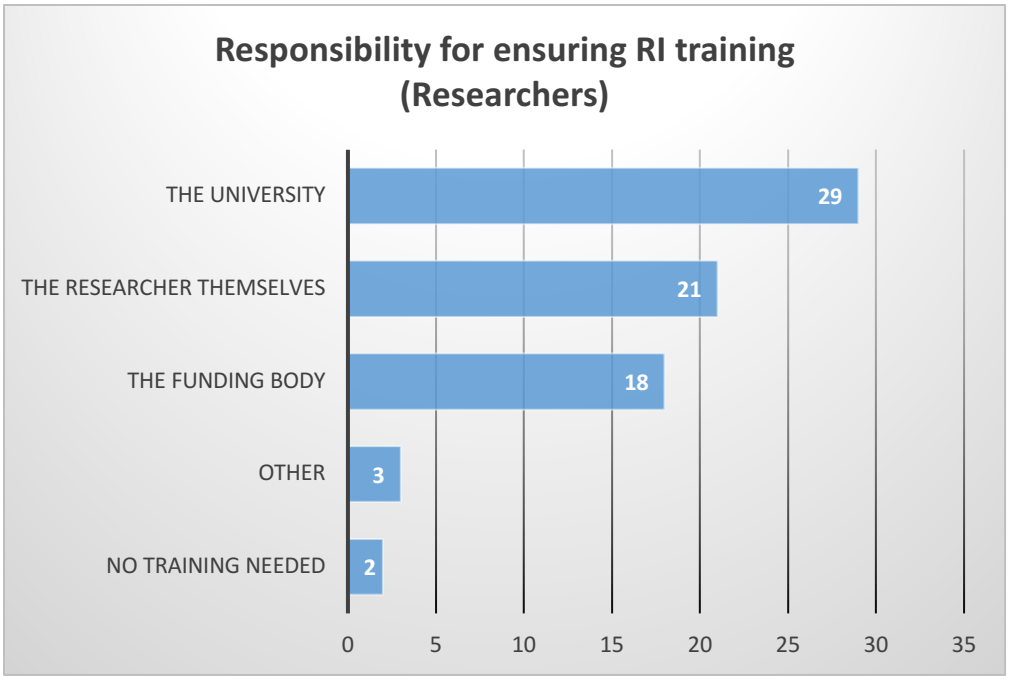


Figure 8: Responsibility for ensuring RI training, researchers, raw count, n=33.

Also, 99 PhD students were asked where they would go if they had a query about responsible innovation with Figure 9 showing that most would discuss with a supervisor or CDT lead, with others referring to the EPSRC framework, university ethics policy, or perform an internet search. Researchers (33) were also asked the same question, with the EPSRC's framework being the top answer, following by the university's ethics policy, discussing with colleagues, or an internet search (Figure 10).

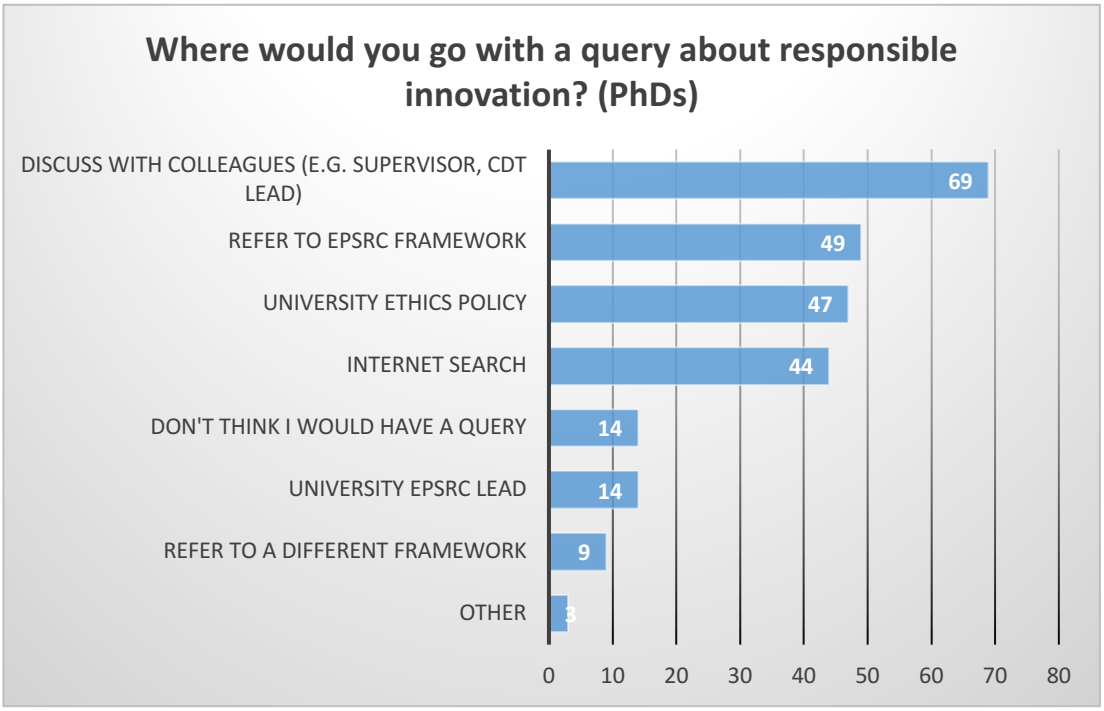


Figure 9: Sources of information about responsible innovation, PhD students, raw count, n=99.

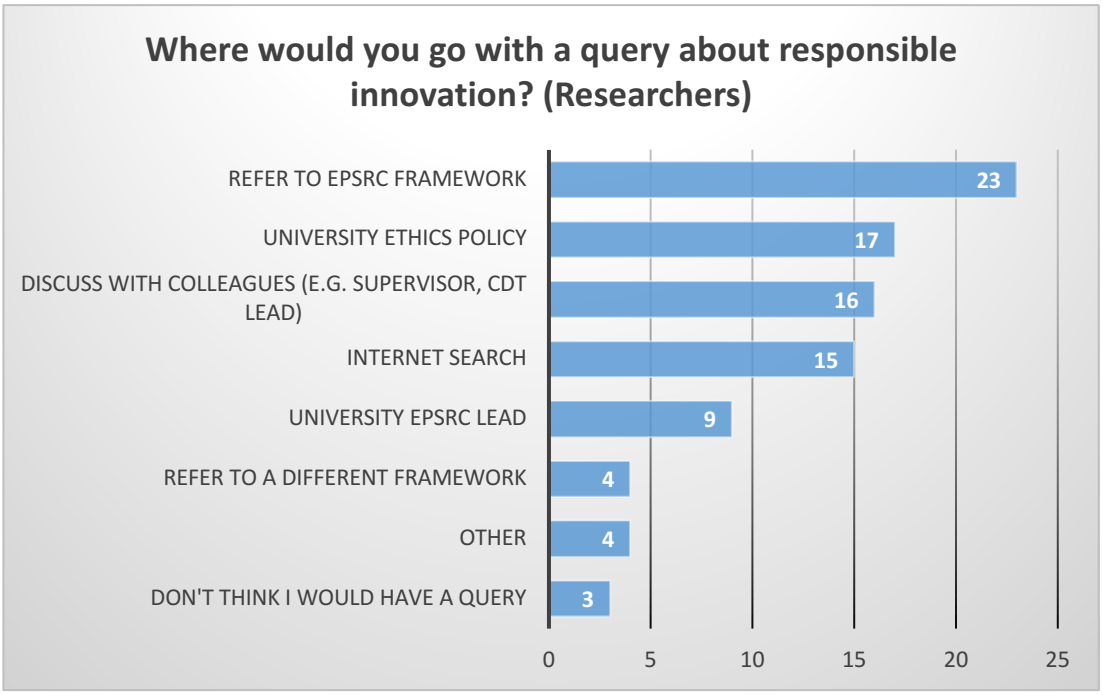


Figure 10: Sources of information about responsible innovation, researchers, raw count, n=33.

3.4 Impact on research practice

A key objective of this report was to understand whether the EPSRC's responsible innovation framework (or the concept itself) is having an impact on the research practice of grant recipients. It should be noted that it can be difficult to measure influence, a point noted in previous literature. One interviewee said for CDT students:

"Hard to measure I think that's hard to judge at this stage in the process, when they're only x years in. I expect that, I think it's good background training just for all scientists to be made aware that they should stop and think about what they're doing." (Interview 1)

One interviewee implied that responsible innovation had a profound effect on their research activities:

"…it's [responsible innovation] not an add on in the projects, right? Because the project is meant to look at these things, so whenever we would have a meeting, it is only thing that we speak about. So, we, the project just started. We have a project, a consortium meeting every month, we also have more regular meetings depending on the tasks at hand. I'm the leader for one work package and we have work package meetings several times a month and usually we speak about these things, yeah, the whole meeting." (Interview 9)

Some other interviewees, particularly the engineer, social scientist, and synthetic biologists said responsible innovation had an impact on their research, but in rather general terms without specific examples. In terms of impact, improved science communication and public engagement were mentioned:

"So, there was quite a lot of public engagement with that and there were some interesting social media around it as well." (Interview 2)

"The research plan that we have at the moment, for that particular grant, involves users of IoT devices, and smart devices". (Interview 9)

However, one of the same interviewees and others wondered what tangible impact the responsible innovation framework had made on their projects:

"I don't know that we've had as much chance to reflect on it as I would like…in terms of its implementation, how do you make sure that your work packages speak to the framework? That has been a little bit more challenging, and I think it tends to lead to a way of working where you stick in the token ethics work package or the token Responsible Innovation work package to show that it's in there but it becomes a bit of a tick box in the exercise rather than something that's integrated into your project process." (Interview 2)

"I have to confess that I haven't really put a lot of effort in going beyond that and then, beyond the common-sense element of, yeah, you think about it ahead of time, then you do some more thinking, which is the reflect, then you really engage with what you're trying to do and then you act on it." (Interview 4)

When asked if they had done anything different in the innovation process as a result of stakeholder engagement, one interviewee (2) said *"no, not really*".

The survey also probed about impact of responsible innovation on research practice. Figure 11 shows a mixed picture of impact based on the views of 101 PhD students, although each student is likely to be at a different stage of their project, whilst Figure 12 shows the responses for researchers:

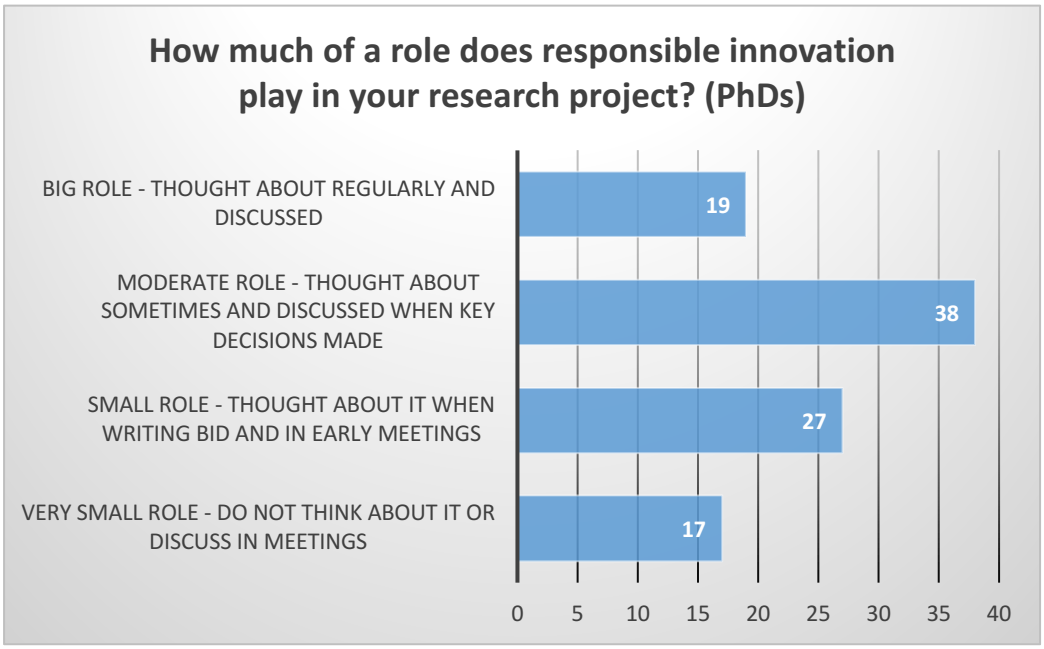


Figure 11: Role played by responsible innovation in research project, PhD students, raw count, n=101.

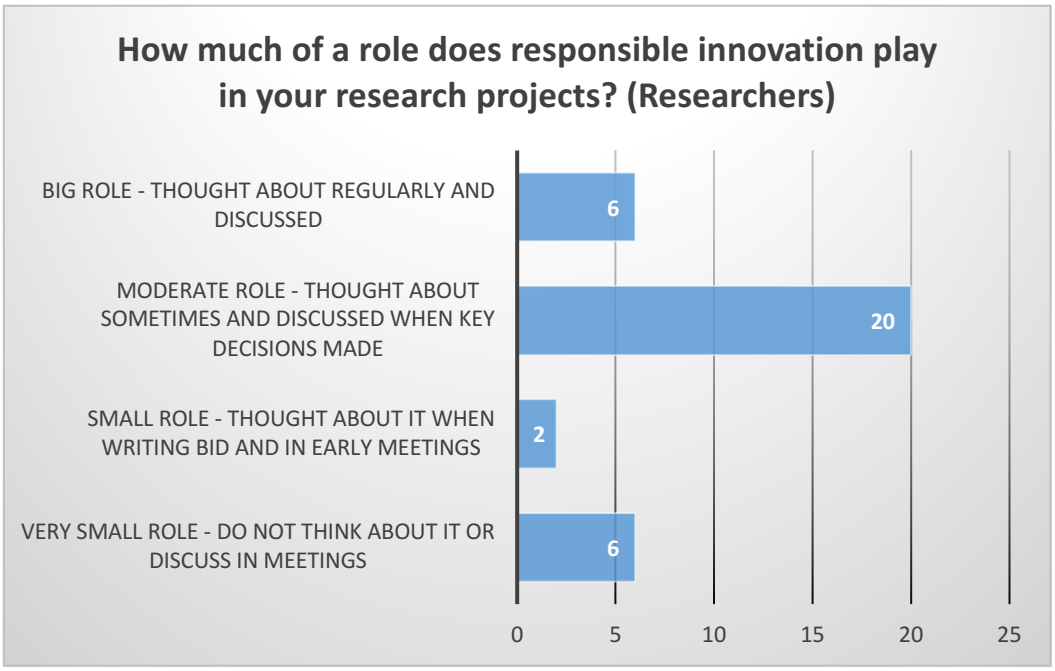


Figure 12: Role played by responsible innovation in research project, Researchers, raw count, n=34.

The survey asked for open-ended responses to the question of whether steps had been taken in research projects to incorporate principles of responsible innovation. 44 PhD students and 23 academic researchers gave a response with the following tangible impacts mentioned (it should be noted that one academic researcher was a specialist in RRI and therefore focused on it entirely). Quotes are from students unless stated:

1. Stakeholder engagement – the most commonly mentioned theme. This consisted of involving stakeholders directly in fieldwork or asking them how innovations would affect them; or in the views of one student '*putting myself in other's shoes'*. A selection of responses is included below:

   "Planning of co-creation workshops, ensuring that my project is driven by the needs of a vulnerable community rather than imposed upon them. Engagement and reflection on how my project could work and problematising any unintended consequences before they materialise."

   "Planned interviews with a wide range of stakeholders to gain insights from as many different perspectives as possible."

   "Outreach projects, for example New Scientist Live." (Academic)

2. Embedded throughout research project – several comments stated that the impacts of their research had been thought about from the proposal stage through to execution, including some who stated that it was a requirement of their CDT:

   "As a part of the CDT program, we have to introduce RRI plan in our PhD project, implement the key principles wherever possible, record and include it in our thesis."

   "RRI informed my research journey as I was aiming to identify and address power through the design of new technologies. I used the approach to structure a critical forward-thinking approach that anticipated and reflected on the consequences of my innovations."

3. Ethical approval – several students said that they followed institutional or disciplinary ethical standards and permission processes:

   "I've gone through the ethics committee approval and I engage in workshops about ethics in scientific research and technological development within my research group."

   "Seeking favourable ethical approach for a project, thinking about the wider implications of the project."

4. Conversations with supervisors or research group – some students mentioned that they had spoken with their supervisors or colleagues about responsible innovation:

   "Discussing work and its impact with my supervisor."

   "I engage in workshops about ethics in scientific research and technological development within my research group."

Other steps taken included following the Sustainable Development Goals, ensuring research was open access and reproducible, including a reflective chapter on impact in the thesis, ensuring money was spent evenly across different countries, running training courses for students (academic), and ensuring low environmental impact of their lab.

3.5 Barriers

Following on from previous literature, we explored the barriers to implementing responsible innovation principles in research practice. Several were raised in the interviews and are presented below (A-Z):

- **Attitudes** – the attitudes of individual researchers/students were seen as an important influence on whether responsible innovation principles would have an impact on research practice:

  "I don't think the AREA framework is likely to change those people's views. So, I think the AREA framework provides a useful framework for those who want to do it." (Interview 5)

  "There are people who are having personal motivation to do certain things [like responsible innovation]" (Interview 10)

  One interviewee thought that individuals could get defensive about the concept:

  "I think if you start by challenging them about their own project there's an impetus to get a bit defensive…so I think by starting by taking them away from that and asking them to think about how science is judged beyond the confines of the ivory tower…these are smart people and they're very aware as well…the current generation is obviously very media and social network savvy." (Interview 1)

  "With some of them, there's a bit of resistance, with some of them there's a bit of unfamiliarity, some of them really get it." (Interview 4)

- **Academic incentives (lack of) (within universities)** – this was the most widely talked about barrier to implementing responsible innovation. Many interviewees felt that too much pressure was placed on them and others to do other things, including a 'publish and perish' model or the quest to chase grants as a marker for promotion:

  "I think that one of the challenges within the academic context that we're working in, where we're chasing grants, we're postdoctoral students who are on short term contracts and need to get data out and need to be able to publish in order to get their tenure track positions, or whatever it is that they're looking for, is that there is not enough space for that reflection and that consideration to be given to what they do." (Interview 2)

  "…basically, unless there's money at the end of something a lot of times it doesn't hit the people, they don't notice it." (Interview 11)

  Or that universities did not give enough support to some people in grant writing to include additional elements like responsible innovation:

  "So, the more reviewing I do for the EPSRC the more I realise that the universities are inconsistent in how they're treating people. So, I can see that some universities

are probably just on other stuff…I can read an application and I can see, well, actually this person didn't get a lot of support on this." (Interview 11)

Whether or not responsible innovation was valued by board members at the university could also make a difference:

"Institutional values I think with these things the challenge is not in the teaching but in the way in which the teaching is valued by the other management board members It's always the last thing on the agenda…whoever's responsible for Responsible Innovation must be on the bid to start with and must be on the management board, no question for me on that." (Interview 5)

- **Academic incentives (from the funder) –** lack of incentives from the funder to integrate responsible innovation within proposals was raised as a hindrance. One interviewee felt that the EPSRC placed the emphasis on scoring for the quality of the science, not whether it is responsible or not, whilst another said it must be a part of CDT assessments:

  "Most researchers are looking at EPSRC funding because it's cutting-edge science and technology. And that's for the main thing, EPSRC is saying that you have to be excellent or outstanding in your research and innovation. They're not saying whether it has to be responsible or not." (Interview 10)

  "…the final assessment of one of the projects will be on responsible innovation. Unless you have that assessment, it's not seen to be valued by the students." (Interview 5)

- **Disciplinary norms** – the quotes listed in section 3.1 indicate that some individuals found it easier to incorporate responsible innovation into their research because of disciplinary norms, experience, and training.

- **Lack of interest from industry** – the lack of interest from industry partners about responsible innovation was raised by one interviewee, which could challenge implementation within a research project:

  "…our experience is that the manufacturers of devices do not care whatsoever about these risks, and they will do the minimum, if at all, to prevent bad situations to occur for users. And so that also drove us to want to do more on these things because there is clearly a need for this sort of projects, and so the barriers, yes, would be that the manufacturers don't necessarily, are not necessarily forthcoming with a few things. They don't necessarily want to be constrained by us and so interacting with manufacturers hasn't been the easiest." (Interview 9)

- **Time and pressure** – partially linked toa lack of academic incentives, interviewees spoke about the many pressures on researchers and students, a context within which extra training or activity around responsible innovation must sit:

  "everyone's time is very pressured, and the reality is that I'm not, it's unlikely I'm going to go looking on the EPSRC website for more training, to be honest." (Interview 7)

- **Unclear definitions** – one interviewee wondered whether the lack of clear definition negatively impacted implementation:

  "It seems to be somewhat used by social scientists as a tool to bat each other over the head with a peer review. That is a little bit difficult. it's a little bit misused in the assessment of grants because it is still, it's like any research area, it is contentious and there are different approaches…And then there's also social scientists whose approach is very much of, OK we're going to get involved from day one and change things." (Interview 6)

The survey asked 96 PhD students and 34 researchers about the barriers to doing responsible innovation. Figure 13 shows the results for PhD students, with the 15 'other' responses relating to lack of awareness, lack of interest from management or supervisors, laziness, university bureaucracy, lack of relevance, lack of incentive, and the pressure to publish. Figure 14 shows the results for researchers, with the six 'other' answers relating to lack of academic incentives, political interference, and changing policy/funder environments. With hindsight, we should have included academic incentives as an option in the survey given it was a strong outcome in the interviews (was an oversight), but this may be part of the 'lack of support' category.

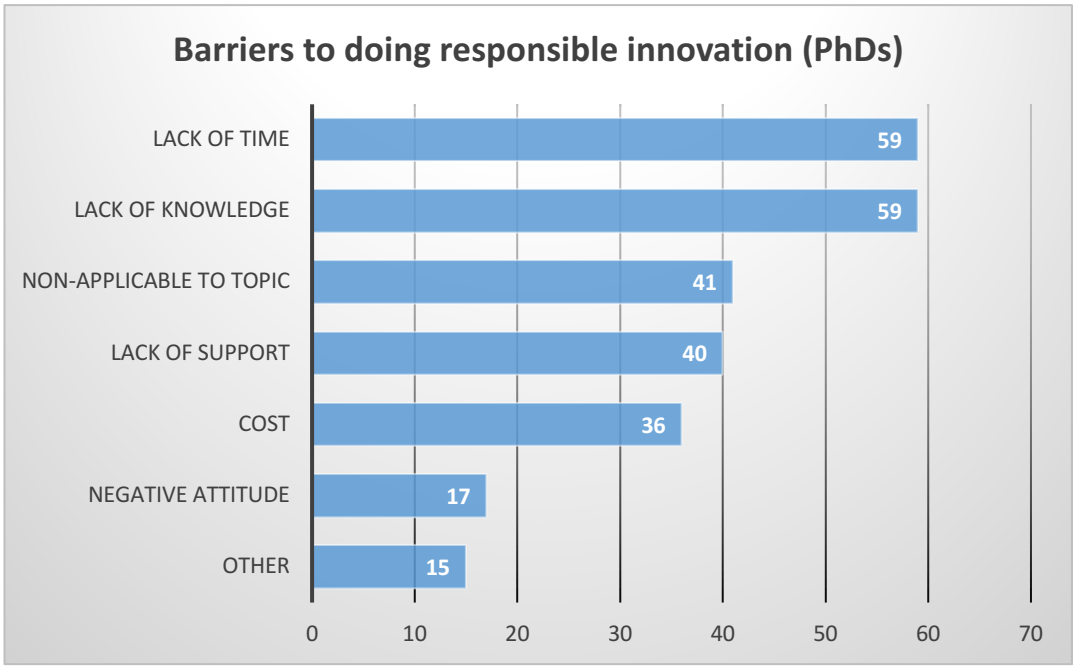


Figure 13: Barriers to doing responsible innovation, PhD students, raw count, n=96.

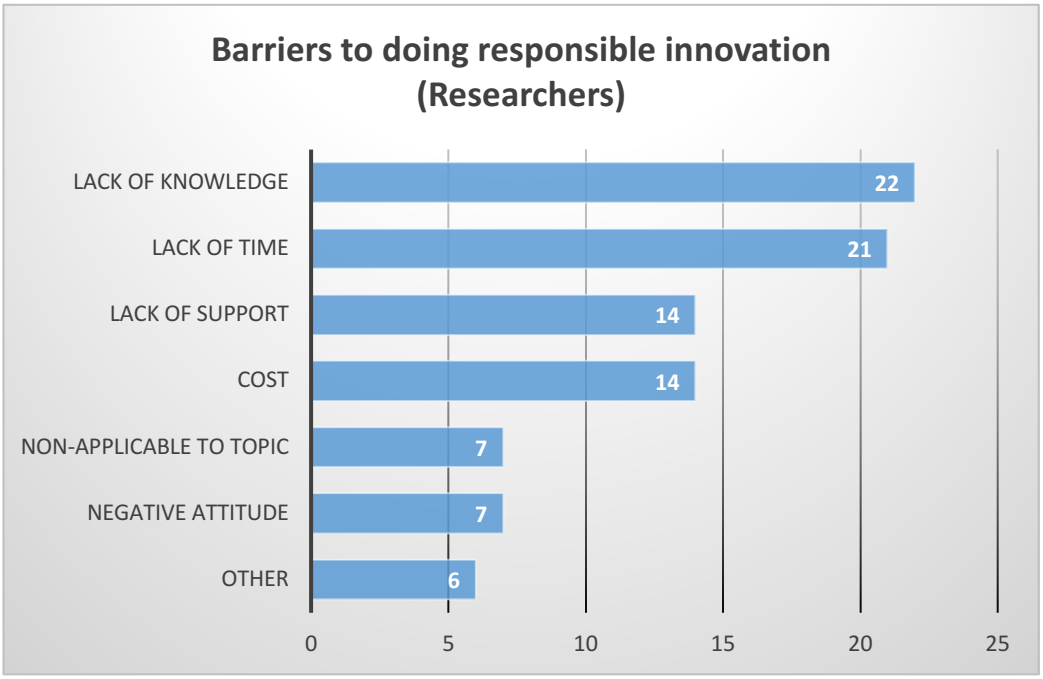


Figure 14: Barriers to doing responsible innovation, Researchers, raw count, n=33.

Some open-ended comments at the end of the survey reflected on barriers. These related to:

1. The nature of the research topic with some not being seen as morally controversial.
2. The lack of interest from some researchers in responsible innovation.
3. The potential to cause friction with sponsors of research.
4. Lack of support from the supervisor.
5. The concept being too broad and difficult to apply.
6. The danger of politics interfering with science.

4 Conclusion

Our results tally with the broad thrust of literature on the practice of responsible innovation in research settings. Previous studies have indicated that researchers generally want to pick research topics that are of relevance and benefit to society and recognise the need to consider wider societal implications (Carrier and Gartzlaff, 2020). In our study, awareness of the concept of responsible innovation was high amongst EPSRC-funded PhD students and researchers, although recognition of the EPSRC's AREA framework was lower.

The literature has raised concerns about whether responsible innovation is 'bolted onto' rather than 'built into' research practice (Ten Holter *et al.*, 2022) and this may limit tangible impact (Glerup *et al.*, 2017). Owen *et al.* (2021) raised similar concerns but argued that the EPSRC had committed to the further institutionalisation of responsible innovation post-2018. Our study contains some evidence that institutionalisation has occurred given that EPSRC-funded PhD students were largely aware of the concept and described the mandatory training that they had received in the respective CDTs. CDT training, as well as the involvement of supervisors and experienced social science colleagues, are clearly important for enhancing knowledge about responsible innovation and some universities may be better placed to access in-house specialists than others (Ten Holter *et al.*, 2022).

Yet, tangible impact of awareness and training on responsible innovation was more difficult to pin down (Pansera *et al.*, 2020). This is illustrated by both the breadth of definitions and examples of tangible impact received in our study. Definitions of responsible innovation varied, some at the more superficial end of including stakeholders to enhance public acceptability, and others taking a more reflexive approach and substantively including society in considering the wider social and ethical implications of their research. Likewise, impact of responsible innovation on research practice ranged from the superficial to the more profound. For some researchers and students, they could provide evidence of enhanced stakeholder engagement to enable wider reflection and co-creation, whilst others relied on institutional ethical approval and conversations with supervisors. Where the CDT mandated responsible innovation, there was more evidence that it was embedded into proposals, fieldwork, and execution, sometimes with associated coursework or Masters modules recommended.

Our results concur with previous literature about the barriers preventing the implementation of responsible innovation principles. Implementation in everyday practice was partially a function of disciplinary norms and knowledge, with certain disciplines demanding more of a focus on ethics and some seeing responsible innovation as less relevant for their topic, or they lacked in knowledge of how to do it. Inter-disciplinary working, particularly with social scientists, was seen as an important way of enhancing knowledge and interest. Where attitudes were more positive towards implementation, there are a number of other constraints. This included university and academic incentives to publish over engaging with stakeholders, as well as a perceived funder focus on scientific quality rather than responsible innovation. Time pressure, lack of collaborator interest, and unclarity of the definition were also identified as barriers.

In briefly summarising the research, we return to the analogy of Ten Holter *et al.* (2022) that responsible innovation needs to be 'built into' rather than 'bolted on' in research settings. The emphasis on responsible innovation in CDTs, mandated by the EPSRC, seems to be making a difference, although universities need support in accessing the specialists needed to deliver this training and in encouraging students (and researchers) to follow through with the right support and incentive structures. Some disciplines need more support than others if they do not have a history of responsible innovation and ethics. Involvement of social scientists and stakeholders in EPSRC grants also appears to be important in embedding responsible innovation from the start.

5 References

Carrier, M., Gartzlaff, M. (2020). Responsible research and innovation: hopes and fears in the scientific community in Europe. *Journal of Responsible Innovation*, 7(2), 149-169.

Glerup, C., Davies, S. R., Horst, M. (2017). 'Nothing really responsible goes on here': scientists' experience and practice of responsibility. *Journal of Responsible Innovation*, 4(3), 319-336.

Jakku, E., Fleming, A., Espig, M., Fielke, S., Finlay-Smits, S. C., Turner, J. A. (2023). Disruption disrupted? Reflecting on the relationship between responsible innovation and digital agriculture research and development at multiple levels in Australia and Aotearoa New Zealand. *Agricultural Systems*, 204, 103555.

Kuzma J., Cummings C. L (2021) Cultural Beliefs and Stakeholder Affiliation Influence Attitudes Towards Responsible Research and Innovation Among United States Stakeholders Involved in Biotechnology and Gene Editing. *Frontiers in Political Science*. 3:677003

Murphy, J., Parry, S., Walls, J. (2016) The EPSRC's policy of responsible innovation from a trading zones perspective, *Minerva*, 54 (2), 151–174.

Owen, R. (2014) The UK Engineering and Physical Sciences Research Council's commitment to a framework for responsible innovation, *Journal of Responsible Innovation*, 1:1, 113-117.

Owen, R., Pansera, M., Macnaghten, P., Randles, S. (2021). Organisational institutionalistion of responsible innovation. *Research Policy*, 50, 104132.

Pansera, M., Owen, R. (2018). RRI-Practice National Case Study Report UK. RRI-Practice deliverable. Grant Agreement no 709637. https://www.rri-practice.eu/wp-content/uploads/2018/11/RRI-Practice_National_Case_Study_Report_UNITED-KINGDOM.pdf

Pansera, M., Owen, R., Meacham, D., Kuh, V. (2020) Embedding responsible innovation within synthetic biology research and innovation: insights from a UK multi-disciplinary research centre, *Journal of Responsible Innovation*, 7:3, 384-409.

Randles, S., Laredo, P., Loconto, A., Walhout, B., Lindner, R. (2016). Framings and frameworks: six grand narratives of de facto RRI. In Navigating Towards Shared Responsibility in Research and Innovation: Approach, Process and Results of the Res-AGorA Project. 31-36. Retrieved from https://hal.archives-ouvertes.fr/hal-01320462

Regan, Á. (2021). Exploring the readiness of publicly funded researchers to practice responsible research and innovation in digital agriculture. *Journal of Responsible Innovation*, 8(1), 28-47.

Schoisswohl, U., Wunderle, U., Studený, L., van Kessenich, L. M., Weinlinger, P. (2023) Joining Forces – Staying Unique: Adapting RRI to Different Research and Innovation Funding Agency Contexts. In Blok, V. Putting Responsible Research and Innovation into Practice: A Multi-Stakeholder Approach. Springer.

Stahl, B. C. *et al.* (2021) From Responsible Research and Innovation to responsibility by design. *Journal of Responsible Innovation*, 8:2, 175-198

Stilgoe, J., Owen, R., Macnaghten, P. (2013) Developing a framework for responsible innovation. *Research Policy*, 42, 1568-1580.

Ten Holter, C., Stahl, B. Jirotka, M. (2022) Built in, not bolted on: responsible innovation in UK Centres for Doctoral Training – the new normal?, *The Learning Organization*, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/TLO-09-2021-0117

Appendix A – Interview topic guide

- Please briefly described the project funded by the EPSRC on x.
- Which other institutions and partners are involved in this project (if any)?
- For the EPSRC-grant you hold on x, have you received any training on research ethics during the course of the project?

- If so, what did this involved and who provided the training?
- If so, what impact did this training have on your project activities?
- If no, would you have liked to have received some training on research ethics?
- Have you heard of the term 'responsible innovation' before?
- If so, where have you come across the term?
- How would you define the term 'responsible innovation' or 'responsible research and innovation'?
- In what ways, if at all, have you considered the implications and societal expectations of your research during your EPSRC-funded grant?
- Should EPSRC-funded researchers consider the implications and societal expectations of their research during the project?
- What are the barriers, if any, to you and your team considering implications and societal expectations as part of your EPSRC-funded grant?
- Have you heard of EPSRC's 'AREA' (spell out too) framework before?
- If so, when and where did you come across this framework?
- The EPSRC's AREA framework asks researchers to anticipate the consequences of their research, reflect on whether to do things differently, engage stakeholders and listen to their opinions, and act on their views.
- What are your thoughts on this framework and what it is asking funded researchers to do?
- In what ways, if at all, have you anticipated the consequences of your EPSRC-funded research during the project?
- In what ways have you engaged stakeholders?
- If you have engaged stakeholder communities, have you acted on their feedback? What did you do differently?
- Have you received any training or resources on responsible innovation or EPSRC's AREA framework during the course of your EPSRC funded project?
- Do you have anything further to add?

Appendix B – Survey questions

Are you an EPSRC-funded researcher (post-doc upwards) or PhD student?

○ Researcher/academic (1)

○ PhD student (2)

Have you been in receipt of EPSRC funding from 2018 onwards? (it does not matter if you are not currently funded by them)

○ Yes (1)

○ No (2)

What is your gender?

- ○ Male (1)
- ○ Female (2)
- ○ Transgender (3)
- ○ Non-binary/non-conforming (4)
- ○ Other (if you wish to describe yourself in another way) (5)
  _____
- ○ Prefer not to respond (6)

What discipline do you primarily associate with?

_____

Have you heard of the term 'Responsible Research and Innovation' before?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Have you heard of the term 'Responsible Research and Innovation' before? = Yes

How would you define ‘Responsible Research and Innovation’?

_____

How important do you think it is that EPSRC-funded researchers/students consider the potential implications and societal expectations of their research and innovation during their projects?

- ○ Extremely important (1)
- ○ Very important (2)

○ Neutral (3)

○ Not very important (4)

○ Very unimportant (5)

In your opinion, how much of a role does responsible innovation play in the day-to-day management of your research project?

○ It plays a big role - e.g., I think about it regularly and discuss with my supervisor/project team when making decisions (1)

○ It plays a moderate role - e.g., I think about it sometimes and discuss with my supervisor/project team when making key decisions (2)

○ It pays a small role - e.g., I thought about it when writing the bid/applying for the project and perhaps in early meetings (3)

○ It plays a very small role/no role - e.g., I do not think about it or discuss with my supervisor/project team (4)

Display This Question:

If In your opinion, how much of a role does responsible innovation play in the day-to-day management... = It plays a big role - e.g., I think about it regularly and discuss with my supervisor/project team when making decisions

Or In your opinion, how much of a role does responsible innovation play in the day-to-day management... = It plays a moderate role - e.g., I think about it sometimes and discuss with my supervisor/project team when making key decisions

What are some of the steps you've taken to bring responsible innovation into your research project?

_____

If you had a query about responsible innovation in the context of your own research, where would you go to find your answer? Please select all that apply.

☐ Refer to the EPSRC (or UKRI) responsible innovation framework (1)

☐ Refer to a framework provided by someone else (please specify) (2)

_____

☐ Search on the internet (3)

☐ Refer to my university's ethics policy or committee (4)

☐ Discuss with my university's EPSRC lead (5)

☐ Discuss with colleagues who have experience in this area (includes supervisor or CDT/DTP lead) (6)

☐ Don't think I would have a query about it (7)

☐ Other (please specify) (8) _____

Have you ever received any training on responsible innovation?

○ Yes (1)

○ No (2)

Display This Question:

If Have you ever received any training on responsible innovation? = Yes

What did the training involve and who led it?

_____

Who do you think should be responsible for ensuring researchers are trained in responsible innovation? Tick all that apply

☐ The researcher themselves (1)

☐ The funding body (2)

☐ The university that the researcher is affiliated to (3)

☐ No training is needed (4)

☐ Someone else (please state) (5)
_____

Do you think EPSRC researchers should consider responsible research and innovation in their work?

○ Yes (1)

○ It depends on their research topic (2)

○ No (3)

What do you think some of the barriers are to taking steps in your research to consider, and act on, the potential implications and societal expectations of your research and innovation? Tick all that apply

☐ Knowledge of how to do it (1)

☐ Lack of support to do it (2)

☐ Time to do it (3)

☐ Cost of doing it (4)

☐ Not being applicable to the research topic (5)

☐ Negative attitude to doing it (6)

☐ Other (please state) (7) _____

The EPSRC has a framework for responsible innovation called AREA. This acronym refers to 'anticipating, reflecting, engaging, and acting'. How familiar are you with this framework?

- ○ I have not heard of this framework before (1)
- ○ I have heard of this framework but have not used it before (2)
- ○ I have heard of this framework and have used it before (3)

How useful do you think the AREA framework is for your specific research project?

For information, the AREA framework is:

Anticipate
Describe and analyse the impacts, intended or otherwise, that might arise. Do not seek to predict but rather support the exploration of possible impacts (such as economic, social and environmental) and implications that may otherwise remain uncovered and little discussed.

Reflect
Reflect on the purposes of, motivations for and potential implications of the research, together with the associated uncertainties, areas of ignorance, assumptions, framings, questions, dilemmas and social transformations these may bring.

Engage
Open up such visions, impacts and questioning to broader deliberation, dialogue, engagement and debate in an inclusive way.

Act
Use these processes to influence the direction and trajectory of the research and innovation process itself.

For more information on the framework, click here.

- ○ Extremely useful (1)
- ○ Very useful (2)
- ○ Neutral (3)
- ○ Not very useful (4)
- ○ Not at all useful (5)

Do you have any further comments to make on the issue of responsible research and innovation in your research practice?

_____

Which university/ies have you been at since 2018 whilst holding an EPSRC grant?

○ _____



https://dspace.org/

The EPSRC's responsible innovation framework: to what extent does it influence research practice?

Rose, David Christian; Shortland, Faye; Smith, Rachel; Schillings, Juliette

2023-02-22

https://dspace.lib.cranfield.ac.uk/handle/1826/19227

Downloaded from a DSpace repository. https://dspace.org/