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Chen, J., Nichele, E., Ellerby, Z. et al. (2022) Responsible research and innovation in practice: driving both the 'how' and the 'what' to research. *Journal of Responsible Technology*, 11. 100042. ISSN: 2666-6596

<https://doi.org/10.1016/j.jrt.2022.100042>

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Responsible research and innovation in practice: Driving both the ‘How’ and the ‘What’ to research

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ARTICLE INFO

Keywords:

Responsible research and innovation
Trustworthy autonomous systems
Interval-valued data capture
Researcher-RRI interaction

ABSTRACT

There have been ongoing discussions in research communities, including the field of trustworthy autonomous systems (TAS), on how researchers may meaningfully engage with responsible research and innovation (RRI). By critically reflecting on the RRI aspects of an ongoing research project focusing on the efficient capture of richer quantitative human response data (e.g., from consumer surveys), this paper offers a case study on how research development can be ethically driven. The role of RRI in the project is unpicked against the broader considerations of its possible interactions with researchers in a typology we developed: as a research *safeguard*, research *subject*, and research *driver*. Going beyond the more common practice of using RRI simply to safeguard *how* research should be conducted, it is demonstrated that it can also serve as a positive driving force to explore *what* should be researched. Experiences and challenges are elaborated within the main stages of research development, potentially applicable to a wider range of future projects in the field.

1. Introduction

Responsible Research and Innovation (RRI), sometimes known simply as responsible innovation, is playing an increasingly important role in a wide range of research disciplines and areas, including the emerging field of trusted autonomous systems (TAS) (He et al., 2021; Hesketh, 2021; Martínez-Fernández, Franch, Jedlitschka, Oriol & Trendowicz, 2020). RRI is particularly relevant in this field because the trust, or trustworthiness, in an autonomous system (AS) stems not only from the system itself, but also from the research and development process leading to the advent of the technology.

Establishing a universally accepted definition of RRI remains a challenge, explored by many (Hellström, 2003; Stilgoe, Owen & Macnaghten, 2013; UKRI, 2021). However, innovators—in many cases researchers and research institutions—are often considered to have a particularly important role to play (Stahl, 2019). This paper aims to contribute to the ongoing academic dialogue on how RRI practices can support the development of research plans, through a practical vignette of an ongoing research project, which we believe can inform future practices. It discusses implications of RRI not just in terms of *how* research should be conducted (e.g., in ensuring ethical treatment of study participants, and appropriate data protection measures), but also

in terms of *what* research questions should be covered. The latter point involves considering not only the avoidance of potential harms, but making efforts to identify opportunities to maximise societal benefits from research outcomes, and to encourage their equitable distribution. In addressing these two approaches we will first introduce the concept of RRI as a research *driver*—in addition to as a research *safeguard* (Section 2)—before explaining how this can be implemented in practice with the case study of our research project (Section 3), and discussing the experiences and reflections that could be relevant for future research activities (Section 4).

2. What does RRI mean to researchers? A researcher-RRI interaction analysis

Depending on the research theme and methodology, researchers often need to consider what to invest in practising RRI, and what benefits they can avail themselves out of the process. Here, we loosely categorise potential relationships between researchers and RRI, based on the main function of RRI in relation to their research activities. We refer to this analytical approach as researcher-RRI interaction, as summarised in Table 1 below.

The first category of researcher-RRI interaction, and we would argue

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<https://doi.org/10.1016/j.jrt.2022.100042>

Table 1
A researcher-RRI interaction typology.

Category	Role of RRI	Major objective	Typical activities
How?	As a research safeguard	To improve compliance with research ethics standards	Planning and implementing required, recommended or best RRI practices
Why?	As a research subject	To generate knowledge about RRI	Investigating the theories and practices of RRI
What?	As a research driver	To articulate new research needs	Developing research themes and activities based on RRI considerations—which would otherwise not have been developed

the most common, can be summarised as *RRI as a research safeguard*. Researchers in this case engage with RRI primarily as a means to ensure their research activities comply with any applicable research ethics requirements, or any higher ethical standards or objectives they see appropriate for their research. Engelhard et al. (2014) reviewed the RRI policies of seven major research funders in the world, and compliance with ethical rules was found to be required by all those funders, especially around ethical acceptability and sustainability.

A second way in which researchers may engage with RRI is to treat *RRI as a research subject*. In this case, RRI is seen as a social phenomenon to be studied. The need to develop knowledge about RRI stems from the power dynamics and implications involved in the course of research and innovation. Stilgoe (2013, p. xii) argues that ‘[o]nce we lift the lid on innovation to reveal its politics, we can start to see that, for all of the good intentions of individual researchers, innovation can be a form of what Ulrich Beck calls “organized irresponsibility.”’ As such, RRI emerged as a research interest originally from the field of science and technology studies (STS) (Özdemir, 2019).

However, for researchers whose primary interests lie outside RRI, its consideration may often be perceived as a ‘speed bump’ rather than an ‘engine’ for research. It is in this regard that we see the importance of embedding RRI in research in a third way, not necessarily studying RRI theories and practices as such, but at the same time not limiting researcher-RRI interaction to safeguarding research activities. In this case, we consider *RRI as a research driver*. Fundamentally, researchers taking this approach embrace RRI as an opportunity to discover new research themes and activities. In technical terms, RRI can be viewed as an additional constraint to the research process—and just as additional constraints can foster innovation, RRI can become an active catalyst for shaping research.

As an example, privacy considerations—which are an important part of a typical RRI framework (Stahl, 2013)—have driven a new wave of innovation known as privacy-enhancing technologies (PETs) (European Parliament, 2012). Contrary to a common belief that privacy and data protection would stifle innovation (see e.g. Bovenberg, Peloquin, Bierer, Barnes & Knoppers, 2020), Cohen (2000, p. 1427) argues that privacy is the cornerstone of digital innovation, a true sense of which ‘require[s] the ability to think outside or around existing, predictable technological and social patterns’ that goes beyond the common practice of exploiting personal data. We will explain below how we followed a similar paradigm in developing our own research. This, we believe, echoes the research agenda shared within the TAS research community, as the classic ‘business model’ of monetising personal data may impact trust by users (see Ausloos, Heyman, Bertels, Pierson & Valcke, 2018; Nilsson, Crabtree, Fischer & Koleva, 2019). As will be shown below, involving RRI conversations early on in the development of a project, while core research questions are still taking shape, as opposed to only after those questions have been finalised, has the advantage of supporting researchers to see alternative possibilities regarding the nature and scope of their research initiatives.

We intentionally took advantage of RRI discussions as a research

driver for our project, but do not claim to be the first research team to do so. Yet, it is the collective, intellectual reflection on this practice and the theorisation as well as classification of related activities that we consider the contribution of our work here. It should be noted that the three types of researcher-RRI interaction do not have to be mutually exclusive and can indeed co-exist in the same research project. In the next section, we explain, in a reflective manner, how we have engaged with RRI both as a research safeguard and a research driver in a recent research project.

3. RRI-driven research development in practice: a case study

This paper explores the case study of an interdisciplinary research project that aimed to improve the capture of quantitative responses from individuals, in the context of consumer preferences. At its most basic, the investigated data capture technique underpins a quantitative questionnaire approach, where participants answer questions by circling their response on a continuous scale, as opposed to choosing an option from a list, cf. an ordinal scale. Doing so, each response is captured as a continuous interval, capturing both response position and associated range, uncertainty, or flexibility—through the size of the interval provided. Beyond this, complementary modelling and analysis approaches are being developed and evaluated, such as the Interval Agreement Approach (IAA—example shown at the bottom of Fig. 1), which generates a group-level model of the data without outlier-removal and with minimal model assumptions. We verified the capability of this methodology to capture richer consumer preference information and explored its perceived utility to businesses, by conducting empirical research with both consumers and decision-makers, recruited through an online participant recruitment service as well as our industry partners.

We see the possibility of this approach being applied to an AS that makes decisions based on quantitative consumer preference data. The main stakeholders we engage with in this project include consumers and decision-makers in the industry. The RRI discussions emerged organically in the early days of the formation of the research team, and were carried through all three main stages of our research that determine: (1) the research questions; (2) the research work plan; and (3) the research activities. We consider this whole process ethically-driven, as ethical/RRI considerations have played a key role in each of the stages through which the design of the research takes shape.

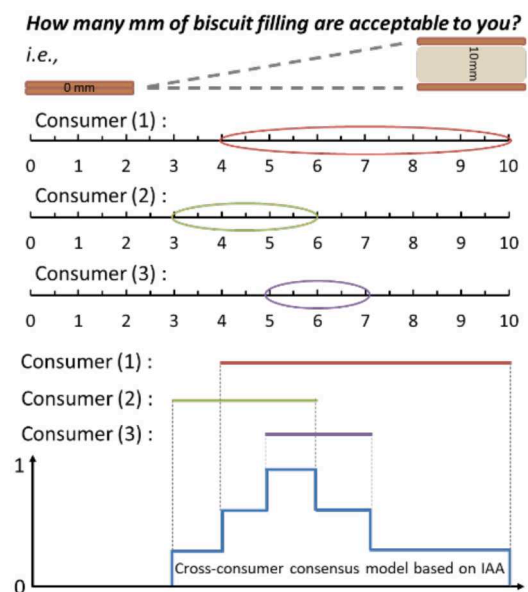


Fig. 1. Example of proposed technique (for the underlying research, see Ellerby et al. (2020); Ellerby et al. (2021); Wagner et al. (2015)).

3.1. Exploring the nature of research

The technique to capture consumer preferences envisaged in the research proposal built upon previous work in which some of the team members were involved (Ellerby, Miles, McCulloch & Wagner, 2020, 2021; Wagner, Miller, Garibaldi, Anderson & Havens, 2015). Once the idea of developing a follow-on project was agreed between the team members, the discussions about the overarching research theme began to evolve around how the project could be grounded on a robust ethical basis, largely prompted by the fact that the research funder particularly emphasised the importance of RRI, and asked applicants to specify their RRI considerations at the grant proposal stage. In the research proposal, we specify such a prospect as:

“We will focus on how this method may offer ethical improvements in research and innovation, by comparison with existing quantitative and qualitative data collection methods. As a method which functions through active (and inherently consensual) engagement with consumers, this could offer substantive benefits in RRI—it may also potentially increase trust in resulting products, by re-enfranchising consumers in the design process.”

This is an example of how we embedded RRI as a research driver as early as in the stage of research question design, where we envisaged how the proposed technical approach could promote social equitability and inclusivity. We considered both potential risks and benefits concerning consumer privacy—technically, this approach has the capacity to capture ‘richer’ (and therefore, more) data concerning individual consumer preferences, compared to traditional point-response alternatives. On the other hand, it also permits respondents to tailor the specificity of their response to a degree that they are comfortable with (e.g. providing their age with a more narrow or broader interval), offering a less invasive approach compared to other forms of data currently used to predict consumer preferences (e.g., ‘passive’ data such as past purchases, internet searches, and website visits—for which consumers may have only given tacit, or less than fully informed consent for their use). The primary research questions were adjusted accordingly to reflect this RRI-driven way of thinking about what the research project could lead to.

3.2. Scoping research work programme

Once the main research questions were agreed on, the work programme of the project was divided into three work packages (WPs).

WP1, headed ‘giving decision-makers what they need’, investigated:

- (1) Potential benefits of capturing consumer preference uncertainty and flexibility, including impact on market segmentation and product design.
- (2) Potential barriers to adoption of capturing consumer preference uncertainty and flexibility.
- (3) Best practices in effective communication of richer ‘uncertainty-aware’ data.

Two methodological approaches were proposed:

- (1) A survey, conducted via the online platform Prolific (see Palan & Schitter, 2018), and targeted specifically at those in decision-making positions (e.g., managers, consultants or business partners with managerial experience and/or leadership responsibilities).
- (2) Focus groups, with employees from an industry partner of the project. Latter sessions were designed as a hybrid between focus groups and workshops, giving participants the chance to use the proposed methodology, view and interpret outputs in respect to real-world scenarios.

WP2, ‘giving consumers what they want’, focused on establishing capacity to achieve impact in practice by empirically evaluating a core set of hypotheses about the proposed approach. Specifically, WP2 set out to establish whether the proposed technique could quantify degrees of real-world flexibility in consumer preferences, informing the range of properties—and therefore products—that are suitable for a given consumer, or indeed, a given set of consumers.

WP3, ‘doing what is right’, focused on anticipating, fostering positive, and mitigating potential negative or inequitable impacts, i.e. whether the envisaged technique would improve or deteriorate data collection in terms of the:

- (1) Protection of consumer privacy (especially with regard to the identifiability and intrusiveness of data collected).
- (2) Wider impact on certain sections of the society.
- (3) Acceptability of data collection by consumers.

We hypothesised one potential impact of this technique being ‘tolerance penalisation’, where more tolerant demographic groups might be more likely to end up with products further away from their most optimal option. For example, if evidence for men giving narrower confidence intervals (see Soll & Klayman, 2004) is replicated in the provision of preference intervals. In a conscious way, we specifically drew on RRI considerations to inform our decisions on what research topics to cover (‘as a driver’) and how to answer the research questions (‘as a safeguard’).

WP3 was implemented in close alignment with the work conducted in WPs 1 and 2, with the aim of collating perceptions on these issues from both decision-makers and consumers, respectively. WP3 was also specifically tasked with supporting the other two WPs to plan for the proposed focus groups and surveys in a way that adheres to a high ethical standard, which we will further elaborate in the next sub-section.

3.3. Planning for research activities

As soon as the proposed research was funded, the research team began to plan for an ethics session to facilitate constructive reflection on how our research activities may achieve better RRI performance. We invited another research team to join the session to allow for further external, reciprocal inputs into both teams’ design of research. The session was run online with assistance of an online collaborative platform, Miro. As part of the session, we also made use of a digital copy of the Moral-IT cards, a deck of ideation cards designed to prompt reflection on normative aspects of technology development (Urquhart & Craigon, 2021).

The research team participated in two exercises, one identifying the short-term risks, long-term risks, and benefits of the technology to be developed, and the other identifying the short-term and long-term safeguards. The discussions covered both the short-term risks directly associated with research activities and the long-term impact of the envisaged data capture technique being applied to large-scale future systems.

As a result, certain additional measures were taken. In WP1, for example, taking into consideration concerns that participants may have revealed or commented on strategic choices they implement professionally (e.g., regarding privacy and intellectual property matters) we decided to follow Chatham House Rule, with reference only to the sector and professional role of the participants. Recordings were kept only for transcription purposes and deleted as soon as these were completed. Transcripts were shared with partners or participants, who were given the opportunity to correct, redact and check anonymisation of the transcript—removing any data that could be a cause of concern for their company. Moreover, in terms of inclusivity, equality, and privacy implications, a set of questions were devised to solicit their privileged insights from within the industry, specifically concerning potential risks to (or inequitable impacts on) consumers that may arise from adoption of

this new methodology.

Regarding WP2, we made several RRI-driven decisions concerning study design. First, we chose to sample through the commercial ‘Prolific’ online recruitment platform (Palan & Schitter, 2018), which facilitated ensuring our sample was representative of the broader UK population on age (with all participants over 18 years old), gender, and ethnicity. Second, we made the choice to document the design of the study in an online open-access archive (Ellerby, 2021), to safeguard against biases in interpretation of results (see Nosek et al., 2019; Nosek, Ebersole, DeHaven & Mellor, 2018). Third, to expand upon preceding research evaluating user experience and potential demographic differences concerning the response method (Ellerby & Wagner, 2021), we incorporated four additional user feedback questions designed to specifically address potential risks identified around data privacy (e.g., identifiability, and intrusiveness), and to complement those asked to industry professionals in WP1, but from the consumer perspective. We also pre-registered our intentions to investigate various potential demographic differences in use, acceptance, or user experience concerning the interval preference specification method. The aim here was to identify potential areas requiring future research concerning risks of inequitable impacts between societal groups in (semi-)autonomous product design.

4. Promises and limitations in respect to future projects

In this section, we summarise some of the lessons learnt from our experience of practising RRI-driven research development through our research project, and then briefly discuss the extent to which these lessons can apply to future research projects, especially those in the TAS research community. As part of the reflection on our positive experience below, we provide some actionable recommendations while acknowledging they might not be applicable to all research projects.

First, starting RRI discussions in the initial stages of research development can help to take full advantage of different possible project directions. The fact that some of those conversations took place even before we settled on the key research questions pointed towards a research agenda (in our case, the equitability issues of our approach) that would have been overlooked if the theme of the project were locked in too early. This is a major distinction of our approach here, engaging with RRI not simply as an afterthought of how to answer the research question in an ethical way, but indeed as an early intervention in terms of what ethical questions to ask in the first place. We therefore recommend that researchers refer to the relevant RRI literature and guidance before discussing the research topic, and take into account how RRI considerations could be in scope for their new projects during the discussion.

Second, having a dedicated part of the project, and experts in the team, to shape and guide the research with a specific focus on RRI-related issues, can be an effective way of engaging with RRI. Having a researcher from an RRI-related background leading a separate WP serves a dual objective: On the one hand, it implements *RRI as a research driver* by steering the scope of the more specific research questions across all three WPs towards a more ethical direction. On the other hand, it also implements *RRI as a research safeguard* by offering additional inputs into the ethical planning of the empirical research activities. From a cost-efficiency point of view, and as a practical recommendation for similar research projects, this may be an effective way of concentrating resources in supporting RRI compliance, as opposed to leaving that entirely to individual WPs.

Third, a formal RRI exercise with whole-team participation can boost collective thinking on improving existing practices. This proves to be particularly helpful if a reflective structure or framework is available to assist the comprehensive reflection on different aspects of the RRI considerations. Apart from the RRI frameworks and ideation cards mentioned above, researchers may also consider other interactive forms of reflective aids, such as serious games (Konstantinidis, Petsani & Bamidis, 2021). Almost for any research projects that involve human

participants and personal data, we would recommend this as an actionable exercise to prompt group reflection and discussion.

We see scope in applying the positive experiences to future research initiatives, especially within the TAS research community, where the importance of public trust is recognised as promotable through effective RRI engagement. Researchers can consider how the inception of a research idea about an AS technology can benefit from considering different RRI indicators.

That said, we experienced several challenges in our attempt to embed RRI as both a research driver and safeguard. First, meaningful engagement with RRI comes at a cost of limited time and resources—this is not always affordable or justifiable, especially for smaller-scale projects. For instance, preparation for and participation in the ethics sessions, while sparking discussions on new research directions and measures to mitigate risks, came at the cost of a substantial amount of project time from the whole team. Representative sampling, as another example, incurred substantial financial costs, being largely out-of-reach without engaging with commercial sample providers. Second, it is not always straightforward to strike a balance between minimising risks and maximising benefits. For example, we deliberately decided to offer participants from industry partners opportunities to redact their transcripts as far as they desired, running the risk of losing valuable data for further analysis, which was not an easy decision to make. This was a more stringent requirement on us than we had proposed in our ethics approval application, but we decided the trust resulting from this deviation would outweigh the impact on the reusability of the data. Third, and despite an evaluation framework recently developed by Reichmann et al. (2021), we note that the impact of RRI on the trustworthiness of research activities and research outputs in the long term is hard to measure. While we hypothesise that the firm commitment from industrial participants to discussing with us openly was encouraged by our strong data safeguarding measures, this is difficult to verify, which may in turn make the additional efforts harder to justify. Perhaps more fundamentally, we also acknowledge that adopting RRI as a research *driver* is not always possible, especially for projects that are more theoretical in nature. Nevertheless, we see strong potential for leveraging RRI as a research *driver*, as well as its more conventional role as a research *safeguard*, across a wide range of projects, not least those within the broadly-defined field of TAS.

5. Conclusion

We have discussed how research projects may benefit from RRI engagement in different ways. With the case study of a recent research project, we demonstrated how RRI can (and we would argue—should) be not just a research safeguard, but also a research driver; it is not just about how to conduct research in an ethically responsible way, but also about what research topics to cover to ensure technologies are developed in a socially responsible way. Specific suggestions were given as part of the reflection on our intellectual journey putting RRI to practice, which we believe can be beneficial to the wider research community.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This work was supported by the Engineering and Physical Sciences Research Council [grant numbers EP/M02315X/1, EP/T022493/1, EP/P011918/1]. The authors would like to thank the two anonymous reviewers for their comments on a previous version of this article.

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