Using an ICT tool to stimulate multi-disciplinary innovation teams in establishing responsible research and innovation practices in industry

Flipse, Steven

Delft University of Technology

Corresponding Author: Steven Flipse, S.M.Flipse@TUDelft.nl

Abstract: This case study demonstrates that industry researchers can productively work with experts from the social sciences / humanities to integrate principles of Responsible Research and Innovation (RRI) into actual, on-going industrial innovation projects. The case presents the first example of collaborative, interdisciplinary and integrated innovation project management that is supported by an ICT tool with the aim of stimulating RRI. It is also the first case that presents both qualitative and quantitative data demonstrating enhanced socially responsible innovation with combined attention to technical, economic and social aspects.

The tool, in the form of an online innovation project support dashboard, helps researchers understand and appreciate 'soft' project aspects regarding communication and socio-ethical context as well as relevance, by measuring and visualising the impact of such aspects in relation to innovation project success. As such, the tool can be used to enable researchers to develop into more 'reflective practitioners' who take responsible innovation as a starting point rather than an add-on to technical innovation.

In addition, the tool is adaptable to different industrial innovation contexts. For this case study, the tool was used in a contract research organisation leading many innovation projects. The benchmark element is based on innovation project assessment of earlier projects within the organisation. That means that in each

organisation, also within different innovation fields, context specific key innovation quality and performance indicators (KPIs), and their interrelations, can be identified, ensuring the tool's relevance and usability within other organisations.

The results and considerations presented in the case study can therefore help inspire researchers from the fields of natural and social sciences to set up and participate in collaborative research and innovation practices to further support and enhance RRI.

Keywords: Innovation, RRI, organizations

Citation: The full citation information will be inserted here once the paper is accepted.

Field of Research or Industry

At NIZO Food Research BV in Ede, the Netherlands, commercial industrial contract research is conducted on food and animal feed, with a main focus on healthy, sustainable food/feed composition and production. The research organisation's primary customer base consists of food and animal feed manufacturers who wish to optimise their production processes, or develop products that are healthier or have improved shelf life. Similar to other scientific organisations, NIZO's innovation project leaders' work has a strong foundation in science and technology.

In recent times, policy makers, social scientists and corporate managers have been advocating responsible research and innovation (RRI) practices, through which companies can further embody corporate social responsibility. These practices include active reflection on – and integration of – socio-economic and socio-ethical aspects by innovators on the research and development working floor, in addition to technological and scientific aspects. However, innovators are frequently not used to doing this. In fact, social scientific research has shown that researchers and engineers are often preoccupied with their technological work, and therefore tend to focus less on the socio-ethical and socio-economic context (cf. Brunner & Asher 1992). Some innovators have even indicated that they are discouraged to focus on anything else but the science and technology (cf. Fisher & Miller 2009). Even where innovators are aware of the social and ethical aspects relevant to their scientific or technological fields, they may fail to think about the implications of their own daily work (cf. Patra 2011).

In the case study presented here, the innovation project leaders proved to be neither unwilling nor unable to take socio-ethical and socio-economic considerations into account. At the same time, such considerations remained 'blind spots' to them, as long as the underlying aspects and issues were not made explicit in relation to their daily practices and on-going (laboratory) activities. The tool presented in this case study enables innovators to shine some light on these blind spots. Reflection and integration of broader contexts was reached by collaborating with an external researcher from the social sciences/humanities. This 'critical outsider' helped the innovation project leaders reflect on their daily practices from a more social and economic perspective, in a way that did not compromise potential innovation project quality and success.

Event or Activity

Study overview

In this study, a 'collaborative space' was set up in which innovators worked together with a critical outsider, on their own innovation projects (ranging from basic research to proof of concept to product development and production development), at their own innovation sites. In this space, they interpreted results from an ICT-based innovation project evaluation tool together, and considered how RRI-related aspects can be included in innovation projects.

During the preparation of this case study, the possibility and utility of socio-ethical aspect integration through such collaboration was identified as a possible first step in the process of establishing RRI in practice (Flipse et al. 2013a). It was found that innovators not only appreciated such collaborations, but could also integrate the external perspectives constructively in their on-going work. They highlighted that they now explored more research options than they would have done otherwise, and that such collaboration enabled them to better select which research options to explore further, making their innovation practices more efficient. However, more tangible evidence of the link between innovation project success and the consideration of broader socio-ethical and socio-economic questions was desirable.

A method was therefore developed to identify innovation project Key Performance Indicators (KPIs), based not only on technological aspects but also on social and economic aspects (Flipse et al. 2013b). Based on a statistical analysis of the performance of recently completed innovation processes, KPIs were distilled that clarified why some innovation projects are more successful than others. Such KPIs concerned scientific / technological project characteristics (e.g. regarding health effects, available materials and machines), financial and economic factors (resources, customer's strategic goals), as well as social characteristics (teamwork, collaboration, societal relevance). This resulted in a digital benchmark model, which could be used to assess running projects. The benchmark

is therefore based on a statistical analysis of projects run at the organisation itself, making the identified KPIs and their interrelations highly relevant and targeted.

As a next step, this concept was developed further into a preliminary software-based support tool that helps researchers reflect on their practices and explore possibilities for improvement on social, economic and technical levels. With this pilot tool, innovators could then monitor the quality of their running projects, and easily assess where improvements are possible (see activity component 1, below). After the projects are scored, they are evaluated in the collaborative space (see activity component 2, hereafter).

RRI activity component 1: Interaction with a digital support tool

The first step in establishing RRI in industrial project practice at NIZO, was learning which RRI aspects are relevant to consider in relation to project success. To do this, the innovators score their projects using the pilot version of the software tool. This allows them to compare their running innovation projects with the benchmarks of the earlier projects (Flipse et al. 2014). Since the comparison is based on similar projects, from the same organization in the same sector and context, the tool can be expected to provide relevant input for the organization for which the tool was developed. The pilot tool produces a graphical representation of project performance, which also presents information on many 'blind spots' that researchers might have, e.g. regarding socio-economic relevance and impact. This is visualised in Figure 1.

The pilot tool displays performance on various KPIs (green lines) and the overall project (blue line) in relation to successful and less successful previous projects[1]. When zooming in on one specific KPI, the dashboard displays the scores of various elements from which the KPI is constructed. E.g. the KPI 'Customer Insight' consists of 5 elements that can all be visually represented. This way, the user gets information on e.g. which KPI-specific elements of this KPI to improve on. Additionally, the tool can display scores on a single KPI by various different project team members. This way, if two team members disagree

1 Industrial projects usually distinguish two main success evaluators for projects. First, projects can be considered successful if the client is satisfied with the procedure followed (and possibly also the outcomes, but not necessarily so). This is mainly important for contract research organizations and non-profit research activities. Second, projects can be successful if they generate more money than they initially cost. This is mostly important for commercial organizations' internal R&D projects. In this case study, the first criterion for success is adhered to: projects are considered successful if the clients are satisfied afterwards. This was assessed using project evaluation forms.

on one particular KPI, they can more easily resolve differences, possibly complementing one another's viewpoints.

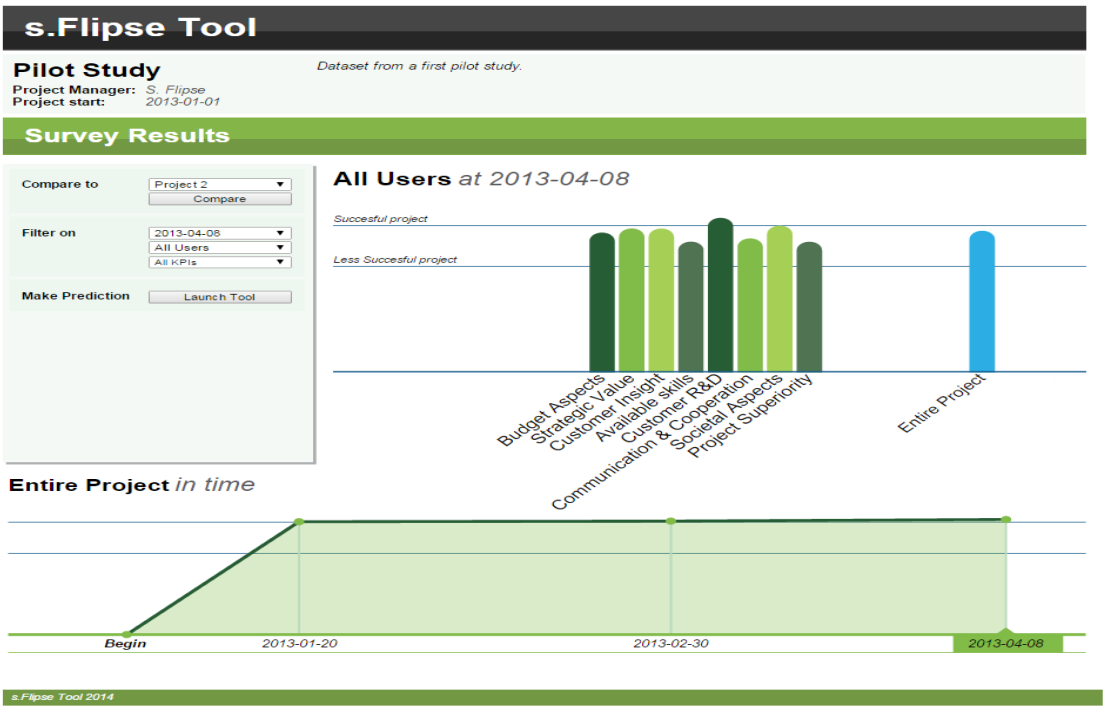

Figure 1: **Element of ICT-tool that presents virtual KPI scores for a virtual project. In this example, all project related KPIs are relatively high: they show more similarities with the benchmark of successful projects (top line) than with the less successful projects (bottom line). Still, some elements can be improved, which are those elements with the lowest scores.**

RRI activity component 2: Interaction between innovation experts and critical outsiders, using the tool

Once the KPI scores are known, the innovators know which elements are going well and which elements can be improved on. Yet the relation with RRI needs to be made explicit. The active inclusion of socio-ethical and socio-economic considerations in innovation projects can be realised with a method called 'Midstream Modulation' (MM[2]). In MM a

2 In MM, the 'midstream' refers to the processes taking place between 'upstream' funding and 'downstream' adoption of R&D in society (i.e. actual R&D activities). The value of MM lies in allowing researchers to further understand their motivations for technical decisions and broadening those decisions with contextual insights, during the actual phase where innovations take shape, i.e. the innovation sites' laboratory floors.

critical outsider (usually a scholar from the social sciences / humanities) interacts regularly with innovators at their own innovation sites for a period of 12 weeks, to incrementally 'broaden' research decisions with social and ethical considerations.

MM starts with a pre-interview in week 1 and a post- interview in week 12 in the form of a semi-structured questionnaire. The differences in answers to the questions given in the pre- and post-interview by the researchers provide insights into changes of awareness on the social and ethical dimensions of their work. During the weekly interviews (see Figure 2 and Footnote 3) in between these pre- and post-interviews the outsider and the innovator discuss research decisions with regard to research opportunities, considerations, alternatives and outcomes (i.e. 'modulation' of decisions), based on the outcomes of the evaluation tool[3]. This makes decision-making processes more visible, allowing the identification of possibilities for enriching these decisions with socio-ethical and socio-economic contexts.

3 See https://cns.asu.edu/research/stir for more information on the procedures of this method.

Figure 2: Images illustrating various roles critical outsiders might adopt in laboratories. These images are stills from a MM-movie (see link in Footnote 3). Top left shows a caricature of a critical outsider in the lab, as an example of how engagement should not work. The bottom left shows a critical outsider who actually participates in on-going laboratory research. The right shows an outsider who observes and asks questions in the lab, taking notes.

Example of engagement activity

Through the collaboration with an outsider and with support from the pilot ICT tool, innovators reflect on their on-going practices, and together explore possibilities to expand research considerations beyond usual socio-technical context. Below, an example is given of how societal context and an RRI perspective can be of relevance to researchers. In one innovator's post-interview, the critical outsider asked if there were any social goals for his project. The innovator answered[4].

4 For the sake of confidentiality, no specific product names and technological process descriptions can be mentioned here.

> *At first, I thought there weren't any. But I think that consuming this [product, SF] can have societal benefits. Such [processed] [products] are less sensitive to spoilage. That can be especially useful for the consumer in warmer countries. […] Additionally, socially, there is the communication with [the client]. That's maybe the most social aspect of this project.*

This quote illustrates that before the 12 weeks of interaction with the tool and outsider, the innovator had not thought of any societal consequences, and had not considered communication with the client as particularly important. This innovator mentioned in an earlier interview that the client came to him with a particular question, which he would just do research on, without initially fully understanding the client's rationale for even starting this project. The outcome of the tool illustrated in an early project phase that the scores for the quality of communication and strategic goals were initially low.

Taking these scores as starting points, the outsider and innovator started discussing how communication quality could be increased. The possibility was discussed that the innovator did not know enough about the client's targets to address its issues properly. Hereafter, he started to ask the client more questions, which helped both him and the client to identify separate economic, technological and also societal goals. Spoilage and waste generation became increasingly important topics.

Even though these discussions did not technologically change the outcome of the project significantly, it did provide more focus on which research avenues to pursue. Because of the framing of product use in warm countries, various processing and packaging options would be less useful than others. Without communication between the innovator and the client, solutions might have been proposed that were not viable in the situation in which they should be used. As such, the interaction increased the speed of this project, and made sure that resources were spent more appropriately.

The technological focus of innovators who wish to explore all possible options for research, is a valuable asset for innovating companies. It might seem strange that such social and societal considerations as mentioned above are not highlighted upfront. As was mentioned above, innovators might be too preoccupied with their technological work, and these societal considerations may be considered irrelevant. In this case, the tool and discussions with the critical outsider further helped clarify the significance of these aspects, making the project more successful in the long run than it might have been without the tool and discussions. At least, that's what the innovators claim in this case study and what the project scorings indicate, as is mentioned below.

Impact achieved

In this case study, all NIZO's researchers demonstrated increased reflective awareness of the socio-ethical context of their work and also integrated this context in their decisions, thereby making their research more responsive to societal considerations. Simultaneously they reported improvements with regard to the technical and economic context. In contrast, projects in which the pilot tool was not used, did not report such improvements. It can therefore be hypothesized that researchers and the critical outsider were able to identify possible project problems and barriers more quickly and easily by using the tool. As such, the tool helped enhance and speed up RRI practices in the field of healthy and sustainable food/ feed products and processes.

The narrative and project KPI scoring illustrate the empirical possibility to functionally integrate such context deliberations in industrial R&D practice using critical reflection based on Midstream Modulation and an ICT based tool. It indicates that participants can usefully deploy such aspects in their work, and that doing so improves project quality. The KPIs are acknowledged by project leaders to contain relevant context elements, which are important to their on-going daily work. These aspects can be actively managed by the project leaders in their communication and cooperation within the company and with the customer.

Moreover, the pilot tool provides a way for RRI aspects to be continuously represented as a crucial part of good RRI project management, in which a range of aspects is considered beyond scientific, technological and economic ones. This way, RRI aspects can more readily find their way into on-going innovation work on the laboratory floor as an integrated part of daily innovation practice. This allows innovators to be more easily responsive to RRI-relevant aspects.

Why does it fall under Responsible Research and Innovation (RRI)?

RRI practices, following EU policy guidelines and Stilgoe et al. (2013), entail several elements that can be translated into industrial innovator actions. Four distinct features of RRI include, *anticipation* of societal effects (insofar as possible), *reflexivity* of involved stakeholders on socio-ethical and socio-economic dimensions of (new and emerging) innovations, *inclusion* of considerations on these dimensions in scientific and technological development processes, and *responsiveness* of involved stakeholders to change the shape or direction of developments in response to stakeholder and/or public values and changing circumstances. More specifically, Stilgoe et al. (2013) state that, *"responsible innovation can be seen as a way of* ***embedding deliberation*** *on these [four elements, emphasis added, SF] within the innovation process"* (p. 1570).

One can also follow the EU-policy reasoning lines, in which RRI is considered an inclusive approach to research and innovation that ensures that societal actors work together during the whole research and innovation process, aiming to better align both the process and outcomes of research and innovation with the values, needs and expectations of European society. In general terms, RRI then implies anticipating and assessing potential implications and societal expectations with regard to research and innovation (also see Appendix on RRI relevance in terms of EU H2020 action lines).

Within this case study, we focused on the midstream, i.e. the phase where research and development actions are carried out, and actual innovations are shaped. More specifically, we focused on responsiveness towards socio-ethical and socio-economic aspects, an essential prerequisite for RRI to take shape (cf. Stilgoe et al. 2012). From an RRI perspective, being responsive on the midstream includes more than taking anticipation, reflexivity, and inclusion into consideration. 'Consideration' in fact could mean that things are debated, but not actually used to develop new innovative ideas – hence the contrast between consideration and responsiveness.

In this case study, such responsiveness is embedded in innovation practices through explicit deliberation of socio-ethical and socio-economic context – including anticipation of effects, increasing reflexive awareness on broader context, and inclusion of stakeholder viewpoints through such explicit deliberations with a critical outsider. In our view, in order to make RRI elements a constructive and integrated part of innovation management, continuous and repeated consideration of such elements is crucial. By combining technical, economic and social KPIs, all the potential 'blind spots' of project management are covered in one overview. This way, RRI-relevant elements such as societal context and use implications can never be omitted.

Lessons learned

The case study shows that the combined approach using both MM and the ICT based pilot tool can be functionally used to align business-relevant considerations through KPIs with the social and ethical sides of R&D. That NIZO was willing to contribute to this study by providing participating project leaders and allowing them to spend time on this study, further illustrates the significance of this research in industrial practice. Two things apparently worked well: a positive individual effect of the approach through collaboration and the pilot tool, and an institutional effect due to the introduction of the pilot tool. The combined approach facilitates not only insight into the KPIs of project management, but also insights in how to make projects more successful from an RRI perspective, early in innovation project development.

Actively incorporating socio-ethical and socio-economic context is essential for RRI to take shape. Also in terms of corporate social responsibility the alignment of such broader

contexts with innovation KPIs can be recommended. Innovators working on product design and development can be unaware of the social and ethical context of their work. This case study shows that RRI not only contributes to socially responsible innovation outcomes and practices, but can also play a significant role in actual project success when taken into account explicitly, as the example above illustrates. In contrast, if the tool is not used, such impacts on project management are not observed (also see Impact Achieved section). This is especially important in R&D activities that concern future and emerging technologies that influence our lives, e.g. in food innovation. The approach described here allows top-down corporate social responsibility efforts to become materialized in bottom-up project management. Hopefully the results and considerations presented in the case study can help inspire other researchers from the fields of natural and social sciences to set up and participate in collaborative research and innovation practices to further support and enhance RRI.

References

Brunner, R.D. & Ascher, W. (1992). Science and Social Responsibility. *Policy Science 25(3)*, 295-331.

Fisher, E. & Miller, C. (2009). Contextualizing the Engineering Laboratory. In (Eds. Christensen, S.H., Meganck, M. & Delahousse, B.) *Engineering in Context*, 369-381. Palo Alto: Academica Press.

Flipse, S.M., Van der Sanden, M.C.A. & Osseweijer, P. (2013a). Midstream Modulation in Biotechnology Industry – Redefining What is 'Part of the Job' of Researchers in Industry. *Science & Engineering Ethics 19*: 1141-1164.

Flipse, S.M., Van der Sanden, M.C.A., Van der Velden, T., Fortuin, F.T.J.M, Omta, S.W.F. & Osseweijer, P. (2013b). Identifying Key Performance Indicators in Food Technology Contract R&D. *J. Engineering & Technology Management 30(1)*: 72-94.

Flipse, S.M., Van der Sanden, M.C.A. & Osseweijer, P. (2014). Improving Industrial R&D Practices with Social and Ethical Aspects: Aligning Key Performance Indicators with Social and Ethical Aspects in Food Technology R&D. *Technological Forecasting & Social Change 85*: 185-197.

Patra, D. (2011). Responsible Development of Nanoscience and Nanotechnology: Contextualizing Socio-Technical Integration into the Nanofabrication Laboratories in the USA. *Nanoethics 5(2)*, 143-157.

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

Funding: This case study was conducted for the "Responsible Industry" project. The "Responsible Industry" project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 609817.

Acknowledgements: This case study was conducted for the EU-funded project "Responsible Industry" and was originally published on the project's website. A link to the page where the case study was published can be found here.

Appendix: Relevance to the five RRI Horizon 2020 actions lines (see above)

In general terms, RRI implies anticipating and assessing potential implications and societal expectations with regard to research and innovation. In practice, RRI consists of designing and implementing R&I policy that will: engage society more broadly in its research and innovation activities; increase access to scientific results; ensure gender equality in both the research process and research content; take into account the ethical dimension; and promote formal and informal science education.

Taking the above into consideration, the approaches used in this case study were explicitly designed for the purpose of engaging society (through assessing and anticipating potential implications and societal expectations through collaborations between critical outsiders and innovators, supported by an ICT tool) in research and innovation, and to take ethics into account (through focusing on socio-ethical issues for product production and development rather than only technical and economic ones). Still, this case study does not explicitly relate to RRI in increasing public access to scientific results and ensuring gender equality. On the point of promoting science education, this case study demonstrates another possibility, namely not science education to a general audience, but societal aspect education to scientific actors. Even though this is not an explicit goal for the H2020 agenda, such ‘education’ to scientists and engineers can be considered imperative for RRI to take shape. The results of the case study show that the tool can successfully be deployed in innovation practice to support and stimulate RRI, by making RRI an integral and constructive part of the innovation agenda.