Charting a Course of Action: An Insider-Outsider Approach

Paul Woodfield, Katharina Ruckstuhl and Rafaela C.C. Rabello

> *"Give me six hours to chop down a tree and I will spend the first four sharpening the axe."*
>
> Abraham Lincoln
> 16th president of the United States (1861 to 1865)

We explore an alternative approach to action research that can be implemented throughout the lifespan of a science and technology research programme. We do this by examining the emergence and development of a participant-observer research approach - where a researcher is also part of the same community of practice as those being observed - in the technology and innovation management context. Our motivation stems from the need to understand innovation processes and management over a long period. Typically, consultants are employed for a given period to carry out action research. We present a case where social scientists, as opposed to action research consultants, carried out action research after a history of relationship building and becoming embedded within a longitudinal science and technology research programme. This allowed the social science researchers to build trust and rigor with those being observed before engaging an action research approach. We present our case as a narrative of experiences, events and turning points, reporting on what was observed and experienced by these social scientists. Our study extends current knowledge by mapping the research journey toward action research through three phases: navigation, iteration, and reflection phases. We argue that richer insights are generated when participant-observers engage early, and that their insights lead to action research that is more informed.

Introduction

Recent research discusses the merits and reasons to engage action research in the technology and innovation management context (McPhee et al., 2019a, 2019b; Guertler et al., 2020; Ollila & Yström, 2020). With a foundation in earlier action research conversations in management and organization (Israel et al., 1992; Huxham & Vangen, 2003; Ottosson, 2003), a good argument exists for introducing action research into innovation management projects to generate rich insights that support rigorous qualitative research and change in practice (Ollila & Yström, 2020). We depart from recent innovation management studies focused on action research models, by 1) focussing on a large research programme rather than a single industry or research project, and 2) concentrating on phases that in our experience are precursory to action research frameworks. There is a vast difference between innovation management in an industry context where social scientists are employed to carry out research for a defined period, and a research programme where the social science research is carried out in real-time. In our case, the real-time feature was integral to the innovation management environment across numerous projects within a research programme.

Innovation management, as a social science discipline, sits outside the natural sciences and technology disciplines. However the interaction between social sciences, natural sciences, and technology is increasingly a feature of global discussion (Bastow et al., 2014a). Put another way, convergence occurs between disciplines, which calls into question "the artificial gulf

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between the 'social' and the 'technical' —and thus between the social sciences and natural science and engineering" (Williams & Edge, 1996). Despite the increasing recognition of social science as a key contributor to interdisciplinary natural science and technology contexts (Lutzenhiser & Shove, 1999), social science is still a marginal player, with social researchers often being incorporated only late in the process, and without clear frameworks or guidelines of how to integrate social and natural sciences (Sievanen et al., 2012).

However, a further need is present for social scientists to integrate with natural science and technology disciplines, as the latter "require building many strong relationships, which in turn, means real engagement and mutual understanding of different concepts and cultures" (Jones, 2012). Given that major publicly funded research projects typically focus on natural sciences and technology, along with the sociological and economic aspects of innovation (Chanal, 2012), we believe that innovation management research needs to create evidenced pathways between social sciences, natural sciences and technology in innovation projects to promote successful interdisciplinarity.

In this paper, we propose a structured methodological process for social scientists tracking early upstream research and development (R&D). This is when science aims and pathways are still unclear, and knowledge of a phenomenon has yet to be revealed. We discuss the journey from the perspective of a social science team exploring a complex mission-orientated (Mazzucato, 2018) natural science and technology programme that has a mission to grow a high-tech New Zealand economy through mission-led physical science and engineering research.

Ultimately, we are guided by two broad research questions: *"In what ways can researchers engage early to build relationships with respondents before conducting action research?"* and *"Can richer insights be generated by mapping a research pathway toward action research?"* In answering these questions, our contribution maps a pathway toward action research that can be sustainable and recursive. This contrasts with typical engagements involving an external consultant or researcher that facilitates action research without prior and in-depth knowledge of the science and technology research team which they are studying. We therefore do not aim to replicate the typical action research process. Instead, we contribute toward elucidating the precursory phases prior to conducting action research. In other words, we nudge the experience of a more transactional action research approach, by stepping back and speaking to the journey that leads up to carrying out authentic and meaningful action research built on trust and rigour.

Research Programme Context

This study is centred on New Zealand's National Science Challenge: *Science for Technological Innovation - Kia kotahi mai - Te Ao Pūtaiao me Te Ao Hangarau* (To come together, to join as one, the world of Science, the world of Innovation), herein referred to as SfTI. As one of 11 mission-led national science challenges, SfTI has received USD65 million over a 10 year period to deliver research that enables the New Zealand Government to implement a more strategic approach to public science investment (Daellenbach et al., 2017). The SfTI mission is designed to "enhance the capacity of New Zealand to use physical sciences and engineering for economic growth" (Hazel, 2017). SfTI is a community of practice (CoP) that involves researchers in all universities across New Zealand, Crown Research Institutes and private research institutes, industry, and Māori (indigenous people of New Zealand). In this virtual organization context, researchers were encouraged to investigate "stretch-science" that addresses industry challenges and issues 5 to 10 years in the future. In doing so, the objective is to target novel technologies.

To achieve its mission, SfTI is organized into 5-8-year programmes (also known as "spearheads") and shorter "seed" projects (1-3 years). One of the spearheads is called "Building New Zealand's Innovation Capacity" (BNZIC), which comprises a team of social scientists positioned to examine national physical science spearhead projects. Having a social science research team like BNZIC in a National Science Challenge (NSC) is unique across all of New Zealand's NSCs. Within SfTI, innovation activity that develops *"technical capacity"* is mandated for the other spearhead projects that are natural science and technology-led. However the BNZIC spearhead addresses two perceived weaknesses in the New Zealand innovation system: *"human capacity"* (skills and attributes that enable and drive researchers to be entrepreneurial), and *"relational capacity"* (industry networking, engagement capabilities and experience) (Science for Technological Innovation, 2018). Importantly, the BNZIC spearhead is driven by the

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assumption that New Zealand science teams typically promote a closed model of R&D, which can be an impediment to maximising the benefits of physical science and engineering for enterprises and communities (Science for Technological Innovation, 2016). A more "open innovation" approach, whereby enterprises create value by acquiring, assimilating, and exploiting knowledge from both internal and external sources (Chesbrough, 2003; Gassmann et al., 2010), may help develop pathways to shift "stretch science" in ways that achieve economic growth. BNZIC's research to this end aims to provide theoretical insights into open innovation processes.

Research Method

To answer the two research questions we draw on primary data and employ a narrative approach (see Creswell, 2018) to investigate ways researchers engage early to build relationships with respondents before conducting action research. We had open access to participants and the ability to collect data early in an upstream innovation programme. This enabled us to conduct interviews with respondents and attend their team workshops and meetings. Ultimately, this meant as social scientists we became "insider-outsiders", that is, we were part of the SfTI community of practice, but outside the research projects or spearheads being investigated. As highlighted through this section, we were in a fortunate position to be able to develop our approach by being reflexive over a long period. In so doing, we generated rich insights that contributed toward mapping a research pathway toward action research.

We draw on data derived from longitudinal social-science research of two separate cross-organizational science team spearhead research programmes (hereon collectively referred to as "spearheads"). One involved research on additive manufacturing and 3D and/or 4D printing of bio-composites (hereon in "Additive Manufacturing"), and the other adaptive learning robots to complement the human workforce (hereon in "Robotics") (Science for Technological Innovation, 2019).

We employ a narrative approach (Polkinghorne, 1995; Elliott, 2005; Gubrium & Holstein, 2008; Savin-Baden & Major, 2013; Creswell, 2018), which is a well-recognized qualitative method useful for organising and giving meaning to experiences (Elliott, 2005; Creswell, 2018). The narrative approach also allows us to make sense of unusual events or issues by creating and constructing stories of experiences and their meanings (Savin-Baden & Major, 2013). Of the many ways to undertake narrative approaches, we adopt a researcher and participant co-constructed approach to capture meanings and "conceive, capture and convey the stories and experiences of individuals" (Savin-Baden & Major, 2013).

Data that inform our narrative approach were derived from a longitudinal research approach over four years since their inception to investigate the management processes of the Additive Manufacturing and Robotics spearheads. Data included observation of both spearheads' workshops and meetings, including a cross-disciplinary workshop attended by both the Additive Manufacturing and Robotics spearheads, which facilitated an ideation process across the teams. We conducted semi-structured interviews with the researchers of both spearheads. Subject to ethical guidelines under the SfTI umbrella, all interviews were recorded and transcribed, then organized and managed through NVivo, a qualitative research software (refer to Table 1).

Each of the authors of this paper was involved in both collection and participation of the research carried out. This involvement means as researchers we recognize that we were not outside of the subject or process, but rather integral and integrated parts of the research (Savin-Baden & Major, 2013). This position allowed us to document an "episode" of our social science teams' experience from both the experience of the ones being "researched" (through interviews and observations) and as researchers (through reflexivity) (Finlay, 2002; Hibbert et al., 2010).

Findings and Discussion

The BNZIC team took a guided (that is, with research objectives) exploratory approach to their research. Derived from their experiences, Table 2 identifies the research phases the team went through, the rationale for each stage, and who in the overall research programme influenced each phase.

Our research questions are answered below in succession as we discuss the phases. First, we answer the question relating to ways researchers engage early by discussing our journey through the Navigation and

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Table 1. Participant Summary

Spearhead/ Pseudonym	Role	Discipline	Time with SfTI	Career length
Building New Zealand's Innovation Capacity (BNZIC) spearhead				
BNZIC-PO1	Participant-observer (PO)	*Social Scientist*	*6 years*	*20-30*
BNZIC-PO2	Participant-observer	*Social Scientist*	*5 years*	*10-20*
BNZIC-PO3	Participant-observer	*Social Scientist*	*2 years*	*0-10*
BNZIC-PO4	Participant-observer	*Social Scientist*	*3 years*	*0-10*
Additive Manufacturing (AM) spearhead				
AM-TL1	Team Leader (TL)	*Natural Scientist*	*5 years*	*20-30*
AM-TL2	Team Leader	*Natural Scientist*	*5 years*	*10-20*
AM-TL3	Team Leader	*Natural Scientist*	*5 years*	*20-30*
AM-R1	Researcher (R)	*Natural Scientist*	*5 years*	*20-30*
AM-R2	Researcher	*Natural Scientist*	*5 years*	*10-20*
AM-R3	Researcher	*Natural Scientist*	*5 years*	*20-30*
AM-R4	Researcher	*Engineer*	*5 years*	*10-20*
AM-R5	Researcher	*Designer*	*5 years*	*20-30*
AM-R6	Researcher	*Designer*	*5 years*	*20-30*
AM-R7	Researcher	*Natural Scientist*	*3 years*	*20-30*
AM-R8	Researcher	*Natural Scientist*	*<1 year*	*20-30*
AM-R9	Researcher	*Natural Scientist*	*5 years*	*20-30*
AM-R10	Researcher	*Natural Scientist*	*5 years*	*20-30*
AM-R11	Researcher	*Natural Scientist*	*5 years*	*10-20*
AM-R12	Researcher	*Natural Scientist*	*2 years*	*0-10*
AM-R13	Researcher	*Natural Scientist*	*<1 year*	*20-30*
AM-R14	Researcher	*Natural Scientist*	*<1 year*	*20-30*

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Table 1. Participant Summary (cont'd)

Robotics (ROB) spearhead				
ROB-TL1	Team Leader (TL)	*Engineer*	*3 years*	*10-20*
ROB-TL2	Team Leader	*Engineer*	*3 years*	*20-30*
ROB-TL3	Team Leader	*Engineer*	*3 years*	*30-40*
ROB-TC2	Team Coordinator (TC)	*Project Manager*	*3 years*	20-30
ROB-R1	Researcher (R)	*Engineer*	*2 years*	*10-20*
ROB-R2	Researcher	*Engineer*	*2 years*	*30-40*
ROB-R3	Researcher	*Engineer*	*2 years*	*10-20*
ROB-R4	Researcher	*Engineer*	*2 years*	*10-20*
ROB-R5	Researcher	*Natural Scientist*	*2 years*	*30-40*
ROB-R6	Researcher	*Engineer*	*2 years*	*30-40*
ROB-R7	Researcher	*Engineer*	*2 years*	*30-40*
ROB-R8	Researcher	*Engineer*	*2 years*	*0-10*
ROB-R9	Researcher	*Engineer*	*2 years*	*0-10*

Table 2. Reserach design approach in an innovation management context

	Navigation phase	***Iteration phase***	***Reflection phase***
Research design	Exploratory 'grounded' approach - Interviews - Observations - Relationship building	Participant-observer approach - Interviews - Observations - Ethnographic	Action research approach - Ethnographic - Innovation processes recognized - Action research engaged
Rationale	Allowed methodologies to emerge and brought social science, natural science and technology researchers together	Embedding the social science team as *'insider outsiders'* to build a collaborative, knowledge-sharing environment between social science, natural science and technology researchers	Research intervention providing a feedback loop throughout the community of practice
Influence	Senior management team and advisors; international assessment panel	BNZIC team guided by senior management team and advisors	BNZIC team guided by senior management team and advisors, industry 'Mission Lab'
Stage	Research design	Data gathering and organization	Reflection and action
RQ answered	RQ1: "In what ways can researchers engage early to build relationships with respondents before conducting action research?"		RQ2: "Can richer insights be generated by mapping a research pathway toward action research?"

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Iteration phases. To this end, we establish ways researchers engage by developing relationships, trust, and rigor, by first taking an exploratory approach then a more embedded participant-observer approach as "insider-outsiders". This leads to answering the second question relating to whether richer insights can be generated by mapping a research pathway toward action research. Thus, the Reflection phase discusses the emergent action research design that reflects richer insights informing this approach. As the next sections will make clear, the research process responded to the activities of the project participants and their research as they emerged in real-time.

Navigation phase

With experience and knowledge on their side, SfTI management could safely explore what might - or might not - work when bringing a social science lens to a natural science and technology forum. The navigation phase was the time for BNZIC leaders to experience ambiguity and uncertainty in the knowledge that their pursuit would shape and enhance innovation processes and performance. In doing so, the BNZIC researchers found themselves in two types of researcher roles. On the one hand, they were "participants" as part of the SfTI community of practice, while on the other being an "observer" in their data-gathering role. This "participant-observation" approach (Merriam & Tisdell, 2016) within SfTI has advantages and disadvantages, albeit the approach became central to identifying ways R&D moves from closed to open innovation processes. Participant-observation research carried out, aims to enable researchers to observe how people behave and interact in their natural environment. As an ethnographic research method, participant-observation is a process where the observer is part of the social situation in order to carry out an investigation, as well as being part of the research context observed, that is, they can modify and influence this context by their own behaviour (Schwartz & Schwartz, 1955).

In our case, participant-observation was most appropriate given (1) it provided participants with time and space to get used to the social scientists, and (2) the actors observed had little knowledge of certain phenomenon, such as innovation processes, and (3) they were unaware of when knowledge is obscured from outsiders, or that sometimes there is monopolistic or privileged access to knowledge (Merton, 1972). We also utilized participant-observation when the problems under scrutiny were complex and not easily studied by direct observation or case study. For example, collaboration in teams and between teams and stakeholders, where participant-observation facilitates "sense-making" of underlying structures and mechanisms (Weick, 1995).

The "here and now" time factor plays a major part in participant-observation. It delimits where the research begins by defining and redefining issues or problems, while aiming to provide practical and theoretical explanations for each situation. As such, practical decisions can be made based on the concepts, generalisations, and interpretations stimulated through participant-observation (Jorgensen, 1989), for example, identifying capacity development needed in spearheads.

Given the complex character of each spearhead and that they were largely developed from scratch, the BNZIC team likewise grounded its methodology in observing what was being experienced by the science and technology participants. This approach is constructionist in that the researchers were not "detached" from the participants they were studying (Miles & Huberman, 1994). This allowed them to construct meaning in various given situations (Creswell, 2009), in turn enabling both objectivity and subjectivity without promoting one over the other in terms of being valid or true (Crotty, 1998). As such, the researchers needed to remain balanced in both their subjective and objective roles, while being tasked with understanding how the technical, human, and relational capacities of the participants relate to each other, along with navigating the innovation outcomes. This was supported by using active methods such as interviewing, or through more passive direct observations (Jorgensen, 1989; Creswell, 2018).

There were several advantages when, for example, observation criteria and ethical considerations for gathering information was needed. A distinguishing and advantageous feature of integrating participant-observation from the outset is SfTI's inclusive culture of knowledge sharing across projects, and its all-researcher workshops, including all spearheads, BNZIC researchers, senior leadership, the SfTI advisory group and Board.

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> *"Initially, the way they [SfTI] have managed it is they have put really big emphasis on meeting each other, which I think was key for success, because we are such a big group and we didn't really - I mean, we knew a little bit of each other, and we have worked in past programs, but not everyone. I think by spending more time and having this organized meeting where we have to see each other was really important to take the next step". (AM-R2)*

> *"I think there's mutual respect, even though you come from different disciplines, and you work in slightly different ways. I think there's mutual respect between the actual group as to what [those] benefits the individuals could actually bring to the table". (AM-R6)*

Through SfTI workshops and their research contracts, the BNZIC team was given access to all research teams, for the most part via interviews, workshops, and meetings.

However, two disadvantages of observations include time constraints, and situations where events may proceed differently because they are being observed (Yin, 2003). Firstly, with research teams spread across the country, a lot of time was spent travelling to and from meetings, workshops, and interviews, making participant-observation somewhat time-consuming and costly. However, sufficient resources were allocated to carry out the research within a reasonable timeline provided. That said, researchers who have been given the time and resources to work on the project still needed to refine and sensitize themselves to insure greater validity of the collected data (Schwartz & Schwartz, 1955). Secondly, when only interviews were carried out, there can be some variance in the interview format, for example, by phone or videoconferencing. Although some basic observations can be made through these mediums, we required *in loco* presence in our attempt to capture the interactions between team members, industry, and other stakeholders. The following "iteration stage" provides examples of how the BNZIC team balanced the insider and outsider roles as the navigation phase happened.

Iteration phase

As an ethnographic method, participation often requires the researcher to adopt an outlook and acclimatize to those being observed (Malinowski, 1922; Denzin & Lincoln, 2011), and tailor the role according to the setting (Schwartz & Schwartz, 1955; Creswell, 2013). In our case we were not acclimatising as an outsider coming in, but rather as an "insider-outsider" (Headland et al., 1990; Bartunek & Louis, 1996; Dwyer & Buckle, 2009; Colville et al., 2014). As argued by some, insider-outsiders are located on a continuum (Hellawell, 2006), meaning they are neither inside nor outside the community of practice, but rather "in-between" (Breen, 2007; Dwyer & Buckle, 2009).

When approaching participant-observer research, the researcher's impact on the participants should be established, along with the extent to which the researcher is culturally embedded in the research (Butcher, 2013). As outlined earlier, some assert that a perspective where the researcher is not part of the research's cultural group is best. The fear here is that an insider approach would make it difficult for a researcher to distinguish values, practices, or behaviours that are typically part of everyday life (Morse & Richards, 2002).

The insider-outsider issue is one that BNZIC researchers had to acknowledge for two reasons. The first is that while the researchers were outside the professions or industries of those being observed, they were still part of the same SfTI research programme and tasked with achieving its goals. The issues that this raised included a need to acclimatize to jargon being used, or at least being able to discern enough to understand the conversations during meetings, interviews, and the like. For example:

> *"It just – the lead times – it takes – you've got a lot of different people from different disciplines – to find a common language, shared interest – all that sort of stuff; it just takes a while". (AM-R5)*

> *"Yeah, and that's why I keep trying to use the language midstream, but it doesn't seem to have quite connected yet". (BNZIC-PO1)*

> *"I guess one of the key things of bringing a new team together, and particularly when they're coming from really diverse disciplinary areas, is how do you get them all into working in the same way? People come with their own language and their own expectations. Most people, when you use a term like 'stretch science', everybody's got their own take on what it means from a disciplinary perspective". (BNZIC-PO2)*

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Linked to the insider-outsider concept, a notable challenge as participant-observer for our team was balancing rapport so that there is no lack of engagement, or too much rapport with a loss of objectivity (Miller, 1952; Brayboy & Deyhle, 2000). In other words, establishing rapport with effective engagement works alongside not having so much familiarity and risking a loss of objectivity. For example, maintaining a closer relationship with the leaders of the spearheads to maintain good access to their teams, while maintaining some distance from forging close relationships with team members so there is an over-familiarity resulting in loss of objectivity.

The BNZIC social science team was able to reflect on their experience through a sense-making process in organizational learning across the SfTI Challenge (Weick, 1995; Vince & Elkjaer, 2009; Colville et al., 2014). This sense-making helped the team to conclude that there was actionable knowledge being produced (Argyris, 2005; Antonacopoulou, 2009), that:

> *"[I]llustrates the impact that management scholarship can have by connecting theory and practice, knowledge and action, promoting the power of connectivity and the significance of judgement in defining intentions, actions and the outcomes sought could be implemented". (Antonacopoulou, 2009)*

Through both the navigation and iteration phases, the BNZIC researchers developed relationships, trust, and rigour, to the extent that there a call arose to position social science as a "call to action". Table 3 displays examples of relationship building and establishing embeddedness through interactions between social science, natural science, and technology researchers via navigation and iteration phases.

In answering the first research question, social science researchers engaged early by entering the field of research to explore phenomenon through interviews and observations. As a longitudinal programme, this approach made way for methodologies to emerge that brought social science, natural science, and technology researchers together. Then as participant-observers the approach required the BNZIC team to become "insider-outsiders". This took them beyond building relationships with the natural science and technology researchers, and toward building a collaborative, knowledge sharing environment founded on mutual respect, that could to some extent support a common language across disciplines. With these factors in mind, a firm foundation for conducting action research was established. The following "reflection" phase plots out how action research design emerged and transitioned from the precursive navigation and iteration phases.

Reflection phase

As the BNZIC spearhead progressed through the precursive navigation and iteration phases, an action research design emerged. Action research was considered an appropriate intervention to "improve collaborative leadership and [for] trialling new approaches to organizing and funding science" (Daellenbach et al., 2017). What distinguishes action research from other research designs is that it is an "enquiry with people rather than research on people" (Altrichter et al., 2002). It is also a design that requires the researcher to be reflexive (Willig, 2001) and, when actively embedded in research, to continuously and systematically improve the research objectives and research process (Kemmis et al., 2014; Ruckstuhl et al., 2019).

According to Piggot-Irvine (2009), action research is defined by some as collaborative work to address problems that are of group concern, or as the participatory process that seeks to bring together practice, theory, and reflexivity in order to develop practical solutions to social research problems (Reason & Bradbury, 2001). Moreover, action research is "practice-changing-practice" (Kemmis, 2009) as a result of a systematic inquiry of social practice, through a collaborative process that employs self-reflection during the research project (Sandretto, 2007).

The fundamental purposes of doing action research are to determine what is actually occurring, to change what is not working, and to test a hypothesis (Sagor, 2010). Sagor (2010) suggests that the best way to identify action research is to ask three questions: Is the focus on your professional action? Are you empowered to adjust future actions based on the results? Is improvement possible? In the context of the SfTI Challenge, the BNZIC team can answer these questions positively.

From the outset, the BNZIC team planned to conduct action research, although the phase and timing of this were uncertain. As a longitudinal programme, the BNZIC team was fortunate to have been able to explore,

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Table 3. Examples of trasitioning from the Navigation phase to the Iteration phase

Phase	Context	Quote	Observation
Navigation	Science and Technology (S&T) researcher shared their concern about academic researchers' engagement in the challenge with participant-observer (PO); PO responded they were going to look deeper into that issue.	AM-TL1: And that tension gives you all of the cost tensions, the 'how involved are the university people, or do they just sit out' … are they committed into it, or do they have a student in there … and they're sitting on the top type of thing? **BNZIC-PO1: And that's something I am going to be interested to watch because … it is the same inside the university.**	Science and Technology (S&T) researcher **sharing concern** with participant-observer (PO); PO willing to let **social science work be influenced by active concern** ⇨ Shows social researchers took on board a concern from the participant (relationship building)
Navigation	S&T researcher asked for advice on how to structure a thoughtful knowledge exchange with Māori; PO happily suggested, drawing on her expert Māori knowledge; S&T researcher took on board the suggestion	AM-TL2: It's probably the offer – how would we structure a course [that enables thoughtful knowledge exchange]? **BNZIC-PO2: What about if it was perhaps something with for example, at the Māori arts and crafts – a sort of an understanding that presenting – like a stakeholder engagement – that's your stakeholder.** AM-TL2: It could be done … maybe bring in aligned programmes – we bring in some of their knowledge, and then presenting to us, kind of thing. It could be done, yeah.	S&T researcher tried to **tap into PO's Māori expert insider knowledge**; PO willingly **offered advice**; S&T researcher and PO **jointly mapping out** potential intervention; PO's suggestion was then taken on board ⇨ Shows an emergence of trust through the advice provided by PO (relationship building)
Navigation	S&T researcher asked PO to explain Māori worldview (i.e. to close a gap in understanding of a core concept in the science challenge); PO willing to answer, but hesitant due to own non- Māori background	ROB-R1: You'll need to explain to me what the Māori worldview is. **BNZIC-PO4: Well, I mean examples – I wouldn't know explicitly, because I'm not Māori myself, but at the same time, some of the concepts would be around sustainability, longevity, the community side; science that's been around for them for many years.**	S&T team member seeking an explanation from PO on SfTI core concept; **PO not an expert** in the field with an implicit acknowledgement that they too could learn more about the Māori worldview ⇨ Shows an emergence of sharing knowledge through concepts provided by the PO (relationship building)
Iteration	S&T researcher noted they didn't know if their research was benefitting Māori communities and that they hadn't managed to gain	AM-R4: I don't quite understand if I benefit [an industry or organization], does it really get back to the Māori community? Is it going to be that one family around – or that one iwi around [an industry or organization], that is going to benefit? Is it going to be of	S&T researcher shared wish to learn more about Māori communities and their economy with expert insider PO; PO open to taking action to satisfy desire to learn more

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Table 3. Examples of trasitioning from the Navigation phase to the Iteration phase (cont'd)

	further insights into Māori economy; PO seemed willing to take action in response to that.	societal benefit? I've got no real feel for that. **BNZIC-PO2: That might be the same with any of these projects though, mightn't it?** AM-R4: Absolutely. So, I don't really have a feel for that because I just don't know. One of the things that I wanted out of this challenge that I haven't quite received or haven't engaged enough, is I wanted to learn about Māori people and the Māori economy. I ticked that on one of the boxes on day one, two years ago, and I'm still not there. **BNZIC-PO2: Okay, so let's see if we can do something about that.**	⇨ Shows an emerging 'insider-outsider' interaction that could benefit the wider SfTI Challenge (establishing embeddedness)
Iteration	S&T researcher complained to the PO about team leaders not doing much research themselves, but rather delegating the work to PhD students and post-docs; the PO explained the rationale for the system and responded why the set up may make sense the way it was.	ROB-R8: It also makes me wonder why all these researchers are managing the project, but then hiring someone to manage and do the project. It's like, why are you managing the project, if you're not actually going to manage the project? Does that not mean you're on too many projects, and you should delegate them out? **BNZIC-PO4: Well, I think part of that comes into – so, people that are like professors and so-on, have very long-term relationships in the science system, in industry and so-on … and it's almost like they're a lynchpin for other things to happen, like being able to get a post-doc."**	S&T team member used PO to **vent his frustration** about the team leaders' (lack of) engagement in the research; PO responded with a justification for the current system by **sharing insider knowledge** into SfTI challenge ⇨ Shows an emerging 'insider-outsider' interaction by responding to concerns (establishing embeddedness)
Iteration	S&T team member complained to PO about how the researchers' voices do not get heard; PO suggested opportunities did exist and shared insights into the process/mechanism to hear researchers' voices/suggestion; S&T researcher noted that they actually had the chance, but did not take up the chance to engage.	ROB-R3: Yeah, is anybody ever asking the researchers what would be the best way of doing things? That doesn't seem to happen. **BNZIC-PO4: We've got a new [national] chief science advisor, and I know that [they have] done the rounds, and also, [they have] concentrated on, obviously, the sciences. … So, I think we do see a bit of that. Have you had any engagement with…** ROB-R3: [Chief Science Advisor]? **BNZIC-PO4: [Chief Science Advisor] … what was her role, as well, and –** ROB-R3: Yeah, I was going to go along to one of her talks, but – she came down and gave a talk, but I didn't end up doing that. I don't know why; other things to do, I expect. So, yeah, I haven't really engaged very much in what she's doing.	PO able challenge a S&T researcher with **a probing question that revealed information** about not engaging with the Chief Science Advisor ⇨ PO found out info only because they had knowledge of how researchers could voice their views through a process/mechanism that exists in the wider national science system (establishing embeddedness)

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observe, participate in, and then reflect on how to best enhance scientists' professional action to improve innovation outcomes in a community. This only happened after a three-year process whereby the first action research "intervention" took place with two of the spearhead teams. This intervention involved facilitated workshops that aimed at accelerating radical innovation with new natural science teams.

Finally, the research process shifted from a formative navigation phase to a normalized research process through the iteration and reflection phases. With the BNZIC team becoming normalized within the SfTI framework, the navigation phase would become redundant, except perhaps where tranche funding required a need to regroup, pivot, or address capabilities in the team. In this scenario, the navigation phase might be restricted to the inclusion of new research aims, or where new spearhead projects begin. However, the navigation stage would be informed by research already carried out and, although exploratory, is likely to be less organic with an established framework in place. Thus, an external consultant may need to start from the beginning each time they are engaged.

Beyond the research process, our findings concur with Bastow et al.'s (2014a) suggestion of three areas that provide a compelling rationale for social scientists being more embedded in natural science and technology projects. First, as natural science and technology disciplines are typically better funded, including social science in well-funded natural science and technology projects can encourage and improve future funding for social science projects (see also, Bastow et al., 2014b). Second, with natural science and technology subjects reflecting better citation and review practices, social scientists that work closely with natural science and technology disciplines can expect increases in citation rates. Third, with social impact gaining ground and incentives growing to improve social, political, and economic problems, an impetus exists for cross-disciplinary group cooperation with the involvement of social scientists. Ultimately, we found that investing time to create a greater connection between disciplines, led to disrupting "business-as-usual" with action research.

In summary, we can answer the second research question by recognizing that richer insights were generated by mapping a research pathway toward action research. Social science researchers on our team were able to determine what was occurring in real time, and then reflect on how to best enhance processes to improve innovation outcomes. Moreover, these insights informed the action research interventions that provided a feedback loop throughout the community of practice.

Conclusions

This article showed ways researchers can engage early to build relationships with respondents before conducting action research. Through our insights we answered two research questions: *"In what ways can researchers engage early to build relationships with respondents before conducting action research?"* and "*Can richer insights be generated by mapping a research pathway toward action research?"* We demonstrated how richer insights can be generated when social science research is included earlier in a natural science and technology-led research programme. Thus, we were able to map a research pathway toward action research over a long period.

We further reflected upon why action research was not employed from the outset. From an initiative that promoted social science to understand human and relational capacity, the "Building New Zealand's Innovation Capacity" (BNZIC) team moved toward an interventionist approach, using an action research methodology to change research (and researcher) behaviour. By exploring and communicating this process of navigation, iteration and reflection phases, we framed a way for researchers in the innovation management field - and wider management discipline - to adopt the ethnographic techniques outlined in this research. We believe it serves as a rich and rigorous foundation from which a bank of data could be drawn from to contribute to the action research process.

Highlighted below are key insights from the navigation and iteration phases:

- **Navigation Phase**
  - The project timeline needs to provide the participant-observer time and space to build trust with the participants.
  - Having open access to participants is preferred (for example, to interview, attend workshops and meetings, etc.), especially when the problems under examination are complex and not easily studied by direct observation or case study.

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- To observe interactions between team members, industry, and other stakeholders it is preferable to be present *in loco*.
- Ultimately, the navigation phase focussed on relationship building.

• Iteration Phase

- By building trust in the navigation phase, participant-observers in the iteration phase were no longer acclimatising as an outsider coming into a new environment. Instead researchers became "insider-outsiders" where they were neither inside nor outside the community of practice, but in-between.
- With trust having been built, researchers were perceived and accepted as an insider, however the tension of being "in-between" needed to be managed, for example, in balancing rapport so there was no under-rapport, and thus a lack of engagement.
- Maintaining a close relationship with spearhead leaders supported good access to their team. This needed to be done while balancing over-familiarity and blurring of boundaries, which sometimes results in a loss of objectivity.
- Ultimately, the iteration phase focussed on establishing embeddedness.

By building on the navigation phase, participant-observers through the iteration phase continued to develop relationships, trust, and rigor, which were embedded in that environment. These phases generated rich insights that led to increased confidence in mapping a research pathway toward action research that included the reflection phase:

• Reflection Phase

- With relationships developed and embeddedness established, the research team used insights they gathered to intervene from an informed position.
- Leading into an action research approach with precursory phases, a more comprehensive and rigorous understanding of innovation processes was revealed.
- With the researchers' role now being as insider-outsiders, they were able to be empathetic, reflexive, and objective, which ultimately led to actionable interventions that may have far reaching implications and be long-lasting.
- Ultimately, an embedded research team with established relationships can gain richer insights that support the implementation of a robust action research approach.

Contribution and implications

The paper makes two prominent contributions. First, through the navigation, iteration, and reflection phases, we identified that giving time to the social science process (for example, engage earlier rather than later) can have an incremental impact on social scientists' sense of insiderness, building trust and relationships, and respect from those being observed, before suggesting actionable improvements. We propose that embedding social science early in an upstream innovation programme can lead to a better understanding of the best action and intervention to address an innovation mission. An alternative view might be to engage an external consultant (Davison et al., 2004; Davison & Martinsons, 2007; Nosek, 2007) - without building the rapport an 'insider-outsider' can build - who is less empowered to have an impact on adjusting future actions (Sagor, 2010).

Second, our study showed that action research consultants may find themselves in a vulnerable position of not having enough knowledge, or may be following techniques and styles that do not suit the myriad of circumstances as required (Davison et al., 2004). Our approach aligns with Nosek's (2007) findings that it may be difficult for outside consultants/researchers to gain sufficient trust or organizational knowledge to establish the true story known only to insiders. In this paper, we have gone beyond that, and have contributed by providing a structured methodology that prepares the ground for implementing a robust action research approach. In this approach, social scientists can "step back", analyse a situation, and intervene to modify the direction of decision-making processes or unproductive patterns of behavior. As such, we propose moving away from

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"employing" action researchers toward *"being"* action researchers, as social scientists alongside the natural science and technology researchers. That is, engaging social scientists early to build rapport and to generate insights that will ultimately inform action research.

Implications and future research

Treading lightly and keeping loose boundaries at the outset meant a bespoke methodology could emerge, serving the needs of our team's complex research programme. Naturally, this "open agenda" was supported by the long timeframe and incredible access afforded to the social scientist team. Our findings could influence the way longitudinal research programmes are designed through the navigation, iteration, and reflection phases, toward action research, where actionable feedback can be provided. Furthermore, we have presented a scenario that challenges the norms and increases our overall understanding of how innovation management research can be improved. By addressing the ways social science can become embedded in a natural science and technology research environment, we can see how gradual convergence of social science, natural science, and technology research will enhance the quality of research from all sides. We thus found that being an "insider-outsider" brought challenges, but was overall advantageous in mapping toward an action research framework (Colville et al., 2014).

Finally, future research could draw attention to specific ways our phased "insider outsider" approach to action research differs from current applications of the action research process. While the broader management discipline has adopted action research frameworks, the question is whether these are transferable or generalisable to the innovation management context. Do they represent or mirror the added complexity of concepts in the innovation and entrepreneurship space? Are there ways to better conduct social science research in closed vs. open innovation contexts? We hope in some small way this paper will encourage authors toward a trajectory of research designs, methods, and approaches that are rigorous and support the advancement of cross-disciplinary research (Conn & Ritala, 2019). In doing so we envisage research being generated that is relevant to practice and provides a basis for research translation and communicating results outside academia.

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