

A Discipline-Spanning Overview of Action Research and Its Implications for Technology and Innovation Management

Matthias Guertler, Nathalie Sick, and Anton Kriz

“ *If you want truly to understand something, try to change it.* ”

Kurt Lewin

Psychologist, considered the founder of social psychology

The iterative and learning character of action research is particularly beneficial for exploring complex socio-technical problems in technology and innovation management (TIM). In this respect, action research allows both rigorous and relevant research due to parallel solving of real-world problems, capability building, and gaining scientific insights. However, the use of action research within TIM research is surprisingly limited. Action research also is not a homogeneous research methodology since each research discipline, such as education and organizational science, has its own action research streams, which are often only loosely linked. A systematic overview of those action research traditions and specific best practices is still missing, which complicates a systematic transfer and use of action research in TIM. This article addresses this essential gap by building a cross-disciplinary overview of action research streams based on a bibliometric analysis using Scopus. The analysis includes relevant disciplines with action research traditions, their development over time, and the most influential journals, authors, institutions, and countries. Along with this discipline-spanning analysis, the article investigates particular TIM benefits and challenges of action research. The two key contributions of this article are: 1) a discipline-spanning overview of action research and its evolution and 2) an analysis of its implications for TIM research. These contributions build the basis for strengthening the use of action research in TIM. In the medium-term, action research has the capacity to link academia and industry more closely and, in doing so, assists important endeavours of translating more of our research outcomes into practice.

Introduction

This study provides a discipline-spanning overview of action research and its implications for technology and innovation management (TIM). TIM is characterized by complex socio-technical problems which include the involvement of a large variety of different stakeholders across the entire lifecycle of a product-service system (Kralisch et al., 2018). Moreover, innovation is multi-faceted and can be an outcome, a process, and a capability (D'Alvino & Hidalgo, 2012; Hauschildt & Salomo, 2007; Hidalgo & Albors, 2008). Due to the socio-technical complexity and novelty of innovations, innovation management also faces high levels of uncertainty (D'Alvino & Hidalgo, 2012).

The iterative learning and human-centred character of action research is particularly beneficial for exploring the complex socio-technical problems in TIM. Understanding the complex systems of technical and social elements, their relationships, and their dynamics can benefit from applied approaches such as action research (Benner & Tushman, 2015; Ottosson, 2003). In this respect, action research allows both rigorous and relevant research due to parallel resolving of real-world problems, capability building, and gaining scientific insights (Brydon-Miller et al., 2003). However, despite these benefits and successful applications in other disciplines such as education (Hult & Lennung, 1980), sociology, and experimental psychology (Burnes, 2004), the use of action research within TIM

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research is surprisingly limited. A Scopus search in November 2018, using the terms “action research” and “innovation management” linked to title, abstract, and keywords (before 2018), yielded only 19 journal articles. Action research itself is also not methodologically homogeneous since each research discipline, such as education and organizational science, has their own action research streams, which are often only loosely linked. A systematic overview of those action research streams and specific best practices is still missing, which complicates a systematic transfer and use of action research in TIM.

To allow a successful application of action research in TIM and a systematic transfer of approaches from other disciplines, it is important to build a detailed understanding about the “where” and “why” of action research for TIM as well as “which” and “how” cross-disciplinary approaches can be transferred and adapted. This article contributes to this overarching goal by focusing on the following fundamental questions: Which disciplines have successfully applied action research to date? Which benefits can action research provide to TIM but also which potential barriers might it face?

The present article addresses this essential gap by building a discipline-spanning overview of action research streams based on a bibliometric analysis using Scopus. The analysis includes relevant disciplines with action research traditions, their development over time, and the most influential journals, authors, institutions, and countries. Along with this discipline-spanning analysis, the article investigates and reviews important benefits and challenges of action research for TIM.

The key contributions of this article are twofold. First, the discipline-spanning overview of action research and its evolution provide insights into different disciplinary streams of action research as a basis to deepen and stretch the thinking between TIM and other disciplines applying action research. Second, opportunities and pathways to further discuss and establish the use of action research within the TIM discipline are identified based on the analysis of benefits and challenges for TIM research. In the medium-term, this enables greater academic and industry linkage for more rigorous research and in so doing helps strengthen the translation of research outcomes into practice.

The remainder of this article is structured as follows. The next section provides an overview of the bibliometric analysis including data collection and measures

used. Next, findings of the bibliometric analysis are presented, followed by a discussion of the benefits and challenges of action research for technology and innovation management. The study closes with a summary of the main insights and limitations and an outlook on further research.

Research Method

In order to map the research landscape of action research, a bibliometric analysis of discipline-spanning contributions to the field of action research has been conducted. Bibliometrics as a quantitative statistical analysis originated in library and information science (Broadus, 1987; Pritchard, 1969). The method is now increasingly used in other research areas to map a certain field from a macro-perspective (Zhang et al., 2010).

The bibliometric analysis is based on Scopus, provided by Elsevier B.V., a global database with more than 71 million records, which is a well-established data source for bibliometric analyses (Harzing & Alakangas, 2016). To cover a broad and particularly discipline-spanning range of contributions, the search term “action research” was used for title, abstract, and keywords. As different disciplines show varying patterns of publishing research results, particularly concerning journal articles, conference proceedings, and books, no limitations were implemented in terms of document types. The search was conducted in November 2018 with results including all material up until the end of 2017. The search resulted in 16,946 documents related to action research. Medicine was excluded as a discipline of analysis due to the high number of false positives, such as “action research arm”, “action research aim”, and other topics around genetics and stroke therapy. This reduced the sample to 13,727 documents.

In a first step, the disciplines involved in action research were analyzed as well as their respective publication outlets, more specifically peer-reviewed articles and reviews as well as conferences and books or book chapters. In a second step, the sample was reduced to peer-reviewed articles (i.e., articles, articles in press, reviews, editorials, and notes). These articles were analyzed in terms of the most influential journals, authors, contributions, as well as institutions and countries, while providing additional disciplinary insights. Measures used in this study, and established as well as widespread in bibliometrics, are contributions and citations as well as h-index (Hirsch, 2005; Merigó et al., 2015). Using the total number of contributions in combination with citations and h-index captures the extent as well as

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the outreach and influence of contributions in the field (Ding et al., 2014).

In addition to the quantitative bibliometric analysis, qualitative insights are added to complete the discipline-spanning review of action research with a discussion of benefits and challenges particularly to TIM.

Discipline-Spanning Bibliometric Overview of Action Research Literature

General overview

As of November 2018, 13,727 documents on action research have been published. Peer-reviewed articles hold the biggest share with 79%, followed by conference papers with 14% and books, as well as book chapters with 7%. Table 1 provides an overview of the most relevant disciplines with more than 500 publications on action research. A disciplinary analysis reveals that social science is the dominant discipline,

contributing 58% of all publications. Business, management, and accounting – including TIM – follows with 21%, while computer science and engineering account for 15% and 9%, respectively. As publication structure and strategies can vary across disciplines, a detailed analysis of three key outlets of scientific research is given: 1) peer-reviewed articles (i.e., articles, articles in press, reviews, editorials, and notes), 2) conference papers, and 3) books and book chapters. Unsurprisingly, peer-reviewed articles are the key outlet for most disciplines, ranging from 64% in decision science to 98% in nursing with an overall average of 79%. Exceptions, as Table 1 highlights, are computer science and engineering, with conference papers the dominant or at least equal outlet for research publication. This might be due to a more prominent role of conferences in these disciplines, which might mean that conference papers need to be considered when analyzing these disciplines, but this requires further research.

Table 1. Overview of central disciplines in action research

	Total	Peer-Reviewed Articles	Conference Papers	Books & Book Chapters
Total	13,727	10,792 78.6%	1,905 13.9%	953 6.9%
Social Science	7,924 57.7%	6,789 85.7%	493 6.2%	624 7.9%
Business, Management, and Accounting	2,829 20.6%	2,481 87.7%	182 6.4%	152 5.4%
Computer Science	2,085 15.2%	865 41.5%	1,114 53.4%	71 3.4%
Engineering	1,288 9.4%	651 50.5%	548 42.5%	67 5.2%
Art and Humanities	1,280 9.3%	1,152 90.0%	15 1.2%	110 8.6%
Psychology	1,051 7.7%	924 87.9%	74 7.0%	52 4.9%
Nursing	897 6.5%	880 98.1%	4 0.4%	12 1.3%
Decision Science	682 5.0%	434 63.6%	230 33.7%	3 0.4%
Environmental Science	673 4.9%	599 89.0%	30 4.5%	42 6.2%

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Evolution of action research in different disciplines

Analyzing the year-by-year evolution of action research articles published in each discipline reveals a long “incubation phase” between the first publication and an increased publication momentum (Figure 1). The start of a publication stream is considered as two consecutive publications with no more than three gap years. The seminal paper on action research by Kurt Lewin dates back to 1946. This social sciences action research article is seen as the start of all publication streams (Burnes, 2004) and is still seen as seminal in today’s action research landscape. In the following five years, the disciplines of business, management, and accounting; arts and humanities; psychology; as well as nursing started publication activities on action research. However, it was not until around the beginning of the 1970s that action research led to a continuous publication stream and began to develop additional intensity. In 1974, decision science published the first action research art-

icles with consecutive contributions. Later disciplines are computer science and engineering with smaller gaps of eight and 12 years, with action research only gaining real momentum from the early 80s. The most recent discipline in our analysis is environmental science starting in 1980.

Figure 1 highlights a marked incline in publications in social sciences from the 1980s with this catapulting after 2004. A more general incline across respective disciplines is observed with the turn of the millennium. The growth factor of the annual publication rates from 2000 until 2017 ranges from 1.0 for nursing and 2.5 for psychology up to 32.0 for engineering. Decision science and business, management, and accounting represent the lower middle field with a growth factor of 3.5 and 4.2 respectively. The upper middle field is formed by social science (7.4), computer science (7.7), environmental science (8.8), and arts and humanities (9.6).

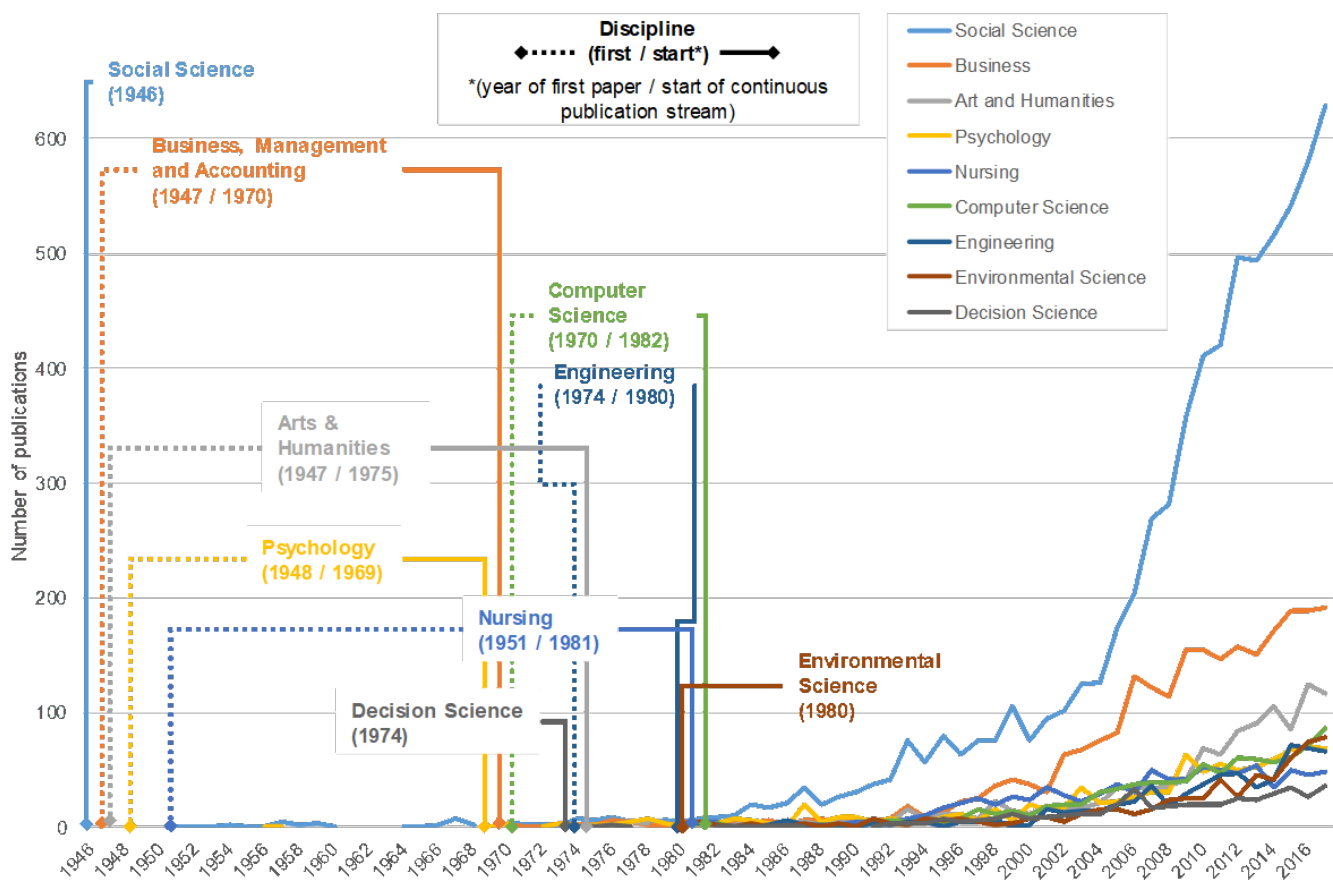


Figure 1. Evolution of new action research publications in the key disciplines

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The most influential journals

Another key aspect of a bibliometric overview of action research is *where* studies on or involving action research are published, particularly concerning the focus and disciplines. It is striking that the most productive action research journals are specifically dedicated to action research as a research method, for example, *Educational Action Research* (445 articles), *Action Research* (298 articles), *Systemic Practice and Action Research* (221 articles), and the *International Journal of Action Research* (76 articles) (Table 2). The aforementioned journals are either associated with social science or business, management, and accounting, the two major disciplines in action research (Table 1).

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Table 2. Most productive and influential journals publishing action research

	Journal	Total Papers (TP)	Total Citations (TC)	TC/TP	5-years IF (Thomson Reuters)	Social Science	Business, Management, and Accounting	Computer Science	Engineering	Art and Humanities	Psychology	Nursing	Environmental Science	Decision Science	Health Professions
1	<i>Educational Action Research</i>	445	3136	7.0	N/A	x									
2	<i>Action Research</i>	298	3627	12.2	0.83	x	x								
3	<i>Systemic Practice and Action Research</i>	221	1876	8.5	0.88		x								
4	<i>Journal of Advanced Nursing</i>	102	3137	30.8	2.76							x			
5	<i>Journal of Clinical Nursing</i>	84	1317	15.7	1.98							x			
6	<i>International Journal of Action Research</i>	76	235	3.1	N/A	x	x								
7	<i>Teaching and Teacher Education</i>	52	1749	33.6	3.34	x									
8	<i>Nurse Education Today</i>	47	480	10.2	2.43	x						x			
9	<i>Journal of Applied Behavioral Science</i>	41	954	23.3	2.18						x				
10	<i>Human Relations</i>	40	2486	62.2	4.35	x	x			x					
11	<i>Espacios</i>	36	16	0.4	N/A		x								
12	<i>Learning Organization</i>	34	651	19.1	N/A	x	x								
13	<i>AI and Society</i>	33	71	2.2	N/A			x		x					
14	<i>British Educational Research Journal</i>	33	718	21.8	2.29	x									
15	<i>Journal of Social Issues</i>	32	2689	84.0	3.26	x									
16	<i>Social Science and Medicine</i>	32	2071	64.7	3.84	x				x					
17	<i>International Journal of Operations and Production Management</i>	31	1921	62.0	4.37		x							x	
18	<i>International Journal of Learning</i>	30	19	0.6	N/A	x									
19	<i>Management Learning</i>	30	780	26.0	2.46		x							x	
20	<i>British Journal of Occupational Therapy</i>	29	209	7.2	0.97										x

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Notably, these more dedicated action research journals are not amongst the most influential journals in terms of citations and impact factor. The highest number of citations per paper (number of total citations “TC” divided by number of total papers “TP”) is held by the *Journal of Social Issues* (84 TC/TP) with the seminal paper by Kurt Lewin from 1946 with 1796 citations, followed by *Social Science and Medicine* (65 TC/TP), *Human Relations* (62 TC/TP), and the *International Journal of Operations and Production Management* (62 TC/TP). Similar to the most productive journals, the most influential ones are attached to social science and business, management, and accounting, but also to arts and humanities and decision science. Underlining the interdisciplinary nature of action research, many journals show affiliations to more than one discipline.

However, no TIM journal can be found amongst the most productive or influential journals. Two findings need to be highlighted in this context: On the one hand, there are very productive dedicated action research journals that focus on action research as a research method. On the other hand, highly influential discipline-specific journals are identified without a particular focus on action research. Despite the inferiority in numbers, it seems that a discussion on the application as well as advantages and challenges of action research is happening on a discipline-specific level. One reason might be that the discussion on when and how to apply action research needs to consider the characteristics and boundary conditions of each discipline, which require and are crucial for discipline-specific action research models.

The most influential articles

Sorted by average annual citations, Table 3 presents the most influential articles on action research. The work of Israel and co-authors (1998) on community-based research to improve public health is a standout with the highest number of annual citations (125 TC/year). What is striking about the remainder of the articles is the high representation of management and, more specifically, TIM-related topics. In light of the fact that no TIM journal was found amongst the most productive outlets for action research, TIM-related topics and authors seem to be active but are publishing in different domains. “Action Design Research” by Sein and co-authors (2011) is a seminal work published in *MIS Quarterly* in the management information systems domain. Kaplan’s (1999) “Innovation Action Research” is distributed through the *Journal of Management Accounting Research* in the accounting domain while Linder and Williander’s (2017) “Circular Business Model Innovation” is published in

Business Strategy and the Environment in the strategic management domain. More distantly related examples from general management are the study by Kieser and Leiner (2009) on “Why the rigor-relevance in management gap in is unbridgeable” in the *Journal of Management Studies* or Luescher and Lewis (2008) on “Organizational change and managerial sense making” in the *Academy of Management Journal*. This dispersion of TIM-related action research articles across non-TIM outlets reinforces the need for a discipline-spanning analysis of action research, in order to build a deep understanding of a successful application and the benefits and challenges of action research for TIM.

The most productive and influential authors (peer-reviewed)

Nineteen authors with more than ten publications can be found in the action research arena, with David Coghlan the most productive with 44 papers (Table 4). Beyond being productive, he is one of the authors of “Action research for operations management”, and in doing so laid the foundation for using action research in operations management (Table 3). Chris Huxham, with a total of 11 contributions, is the most cited and influential author with 112 citations per paper. Reviewing the disciplines associated with the authors’ publications in Scopus, it is striking that all authors are linked to social science, the originating and dominant discipline shaping action research. Moreover, most authors have published in a wider variety of disciplines, including medicine; business management, and accounting; arts and humanities; as well as psychology. In contrast, only two authors – John Elliott and Karen Goognough – show a discipline-specific profile with their respective focus on social science and psychology.

The most productive and influential institutions and countries

The analysis of the most productive and influential institutions and countries reveals that Australia and the UK show strong streams of action research with eight and respectively six institutions in the TOP 20 (Table 5). Major contributions are also available from Brazil, Canada, Denmark, Ireland, and Sweden. Compared to other areas, the country profile seems to be quite specific, with powerful streams of action research in a small number of countries. Interestingly, the research output does not show a high variety between 72 contributions for first ranked Monash University in Australia compared to 51 contributions of Goteborgs Universitet in Sweden on rank 20. While citations per paper are also rather equally distributed, the University of

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Table 3. Overview of most influential articles

#	Authors	Year	Title	Cited By	Avg. Annual Citations	Journal
1	Israel, B.A., Schulz, A.J., Parker, E.A., Becker, A.B.	1998	Review of community-based research: Assessing partnership approaches to improve public health	2507	125.4	<i>Annual Review of Public Health</i>
2	Sein, M.K., Henfridsson, O., Purao, S., Rossi, M., Lindgren, R.	2011	Action design research	555	79.3	<i>MIS Quarterly: Management Information Systems</i>
3	Montero, I., León, O.G.	2007	A guide for naming research studies in Psychology	582	52.9	<i>International Journal of Clinical and Health Psychology</i>
4	Linder, M., Willander, M.	2017	Circular business model innovation: Inherent uncertainties	47	47.0	<i>Business Strategy and the Environment</i>
5	Shirk, J.L., Ballard, H.L., Wilderman, C.C., Phillips, T., et al.	2012	Public participation in scientific research: A framework for deliberate design	261	43.5	<i>Ecology and Society</i>
6	Bock, G.W., Kim, Y.-G.	2002	Breaking the myths of rewards: An exploratory study of attitudes about knowledge sharing	681	42.6	<i>Information Resources Management Journal (IRMJ)</i>
7	Catalani, C., Minkler, M.	2010	Photovoice: A review of the literature in health and public health	310	38.8	<i>Health Education and Behavior</i>
8	Jagosh, J., MacAulay, A.C., Pluye, P., Salsberg, J., et al.	2012	Uncovering the benefits of participatory research: Implications of a realist review for health research and practice	216	36.0	<i>Milbank Quarterly</i>
9	Geels, F.W., Berkhout, F., Van Vuuren, D.P.	2016	Bridging analytical approaches for low-carbon transitions	71	35.5	<i>Nature Climate Change</i>
10	Cornwall, A., Jewkes, R.	1995	What is participatory research?	809	35.2	<i>Social Science and Medicine</i>
11	Coughlan, P., Coghlan, D.	2002	Action research for operations management	537	33.6	<i>International Journal of Operations and Production Management</i>
12	*Kaplan, R. S.	1998	Innovation action research: creating new management theory and practice	668*	33.4	<i>Journal of Management Accounting Research</i>
13	Myers, M.D.	1997	Qualitative research in information systems	688	32.8	<i>MIS Quarterly: Management Information Systems</i>
14	Lüscher, L.S., Lewis, M.W.	2008	Organizational change and managerial sensemaking: Working through paradox	326	32.6	<i>Academy of Management Journal</i>
15	Kurtz, C.F., Snowden, D.J.	2003	The new dynamics of strategy: Sense-making in a complex and complicated world	489	32.6	<i>IBM Systems Journal</i>
16	Straub, D.W., Welke, R.J.	1998	Coping with systems risk: Security planning models for management decision making	614	30.7	<i>MIS Quarterly: Management Information Systems</i>

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Table 3 (continued). Overview of most influential articles

#	Authors	Year	Title	Cited By	Avg. Annual Citations	Journal
17	Avison, D.E., Lau, F., Myers, M.D., Nielsen, P.A.	1999	Action research	581	30.6	<i>Communications of the ACM</i>
18	Sedlmair, M., Meyer, M., Munzner, T.	2012	Design study methodology: Reflections from the trenches and the stacks	177	29.5	<i>IEEE Transactions on Visualization and Computer Graphics</i>
19	Chatti, M.A., Dyckhoff, A.L., Schroeder, U., Thüs, H.	2012	A reference model for learning analytics	173	28.8	<i>International Journal of Technology Enhanced Learning</i>
20	Puhakainen, P., Siponen, M.	2010	Improving employees' compliance through information systems security training: An action research study	216	27.0	<i>MIS Quarterly: Management Information Systems</i>
21	Jacobs, S., Dendoncker, N., Martín-López, B., Barton, D.N., Gomez-Baggethun, E., et al.	2016	A new valuation school: Integrating diverse values of nature in resource and land use decisions	52	26.0	<i>Ecosystem Services</i>
22	Sebanz, N., Knoblich, G.	2009	Prediction in joint action: What, when, and where	231	25.7	<i>Topics in Cognitive Science</i>
23	Baum, F., MacDougall, C., Smith, D.	2006	Participatory action research	303	25.3	<i>Journal of Epidemiology and Community Health</i>
24	Shannon, K., Kerr, T., Allinott, S., Chettiar, J., Shoveller, J., Tyndall, M.W.	2008	Social and structural violence and power relations in mitigating HIV risk of drug-using women in survival sex work	252	25.2	<i>Social Science and Medicine</i>
25	Baskerville, R.L., Wood-Harper, A.T.	1996	A critical perspective on action research as a method for information systems research	550	25.0	<i>Journal of Information Technology</i>
26	Lewin, K.	1946	Action research and minority problems	1792	24.9	<i>Journal of Social Issues</i>
27	Wang, C.C.	1999	Photovoice: A participatory action research strategy applied to women's health	469	24.7	<i>Journal of Women's Health</i>
28	Case, J.M., Light, G.	2011	Emerging methodologies in engineering education research	172	24.6	<i>Journal of Engineering Education</i>
29	Davison, R.M., Martinsons, M.G., Kock, N.	2004	Principles of canonical action research	344	24.6	<i>Information Systems Journal</i>
30	Kohler, T., Fueller, J., Matzler, K., Stieger, D.	2011	Co-creation in virtual worlds: The design of the user experience	165	23.6	<i>MIS Quarterly: Management Information Systems</i>
31	Kieser, A., Leiner, L.	2009	Why the rigour-relevance gap in management research is unbridgeable	212	23.6	<i>Journal of Management Studies</i>

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Table 4. The most productive and influential authors

	Author	Total Papers (TP)	Total Citations (TC)	TC/TP	h	Organization	Social Science	Medicine	Business, Management, and Accounting	Computer Science	Engineering	Art and Humanities	Psychology	Nursing	Environmental Sci.	Decision Science	Health Professions
1	Coghlan, David	44	1462	33.2	19	Trinity College Dublin, Ireland	x		x	x	x	x	x	x	x	x	
2	Flood, Robert Louis	23	157	6.8	15	Norges Teknisk-Naturvitenskapelige Universitet, Norway	x		x	x	x	x				x	
3	Kock, Ned Florencio	20	831	41.6	30	Texas A and M International University, USA	x	x	x	x	x	x	x		x	x	
4	Eilks, Ingo	17	326	19.2	17	University of Bremen, Germany	x	x	x		x	x			x		
5	Zuber-Skerritt, Ortrun	17	403	23.7	13	Griffith University, Australia	x		x			x	x			x	
6	Koch, Tina	16	454	28.4	28	University of Newcastle, Australia	x	x	x			x		x			
7	Elliott, John	13	316	24.3	16	University of East Anglia, UK	x					x					
8	Mathiassen, Lars	13	487	37.5	29	Georgia State University, USA	x	x	x	x	x	x	x			x	
9	Robinson, Andrew Lyle	13	150	11.5	18	University of Tasmania, Australia	x	x		x	x	x	x	x	x	x	x
10	Dick, Bob	12	241	20.1	8	Southern Cross University, Australia	x	x	x			x	x				
11	Lykes, M. Brinton M.	12	213	17.8	15	Boston College, USA	x	x	x			x	x				
12	Wood, Lesley A.	13	36	2.8	6	North-West University, South Africa	x	x	x			x	x				
13	Brydon-Miller, Mary L.	11	458	41.6	8	University of Louisville, USA	x		x				x		x		
14	Fine, Michelle	11	232	21.1	32	The Doctorate-Granting Institution of the City University of New York, USA	x	x	x			x	x				
15	Goodnough, Karen	11	127	11.5	8	Memorial University of Newfoundland, Canada	x						x				
16	Haslett, Tim	11	94	8.5	8	University of Technology Sydney, Australia	x		x		x		x			x	
17	Huxham, Chris	11	1227	111.5	23	University of Strathclyde, UK	x		x	x	x	x	x		x	x	
18	Reason, Peter	11	458	41.6	14	University of Bath, UK	x	x	x				x	x		x	x
19	Spirig, Rebecca	11	47	4.3	14	UniversitätsSpital Zurich, Switzerland	x	x						x		x	x

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Table 5. Overview of institutions and countries

University / Institution		TP	TC	TC/TP	Country	Country		TP
1	Monash University	72	1449	20.1	Australia	1	USA	2339
2	The University of British Columbia	71	1542	21.7	Canada	2	UK	2203
3	Queensland University of Technology	71	830	11.7	Australia	3	Australia	1168
4	Griffith University	67	990	14.8	Australia	4	Canada	656
5	University of Manchester	65	1651	25.4	UK	5	Brazil	340
6	University of Queensland	63	868	13.8	Australia	6	Sweden	306
7	University of South Australia	60	580	9.7	Australia	7	Spain	291
8	Universidade de Sao Paulo	58	281	4.8	Brazil	8	South Africa	282
9	University of Sheffield	57	990	17.4	UK	9	Netherlands	267
10	University of Toronto	57	1225	21.5	Canada	10	New Zealand	244
11	University of Technology Sydney	56	512	9.1	Australia	11	Finland	227
12	Aalborg Universitet	54	811	15.0	Denmark	12	Italy	205
13	University of Melbourne	54	797	14.8	Australia	13	Norway	194
14	Curtin University	54	291	5.4	Australia	14	Germany	191
15	Trinity College Dublin	53	1531	28.9	Ireland	15	Ireland	179
16	University of Leeds	53	996	18.8	UK	16	France	172
17	University of Salford	52	2164	41.6	UK	17	Denmark	165
18	Loughborough University	51	917	18.0	UK	18	Thailand	125
19	Open University	51	781	15.3	UK	19	Taiwan	124
20	Goteborgs Universitet	51	1028	20.2	Sweden	20	China	118

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Salford in the UK is the most influential institution with 42 citations per paper followed by Trinity College Dublin, Ireland, with 29. Although the USA show the highest number of articles per country (2339 articles), no US university/institution is amongst the TOP 20 universities. From a country perspective, the TOP 3 countries show a big lead to all following countries of the TOP 20.

The most productive and influential institutions and countries

Figure 2 presents the key institutions in the highlighted most active countries along with their most dominant disciplines. Social science and business, management, and accounting are well represented in the most active countries. Nursing, as well as arts and humanities, follow in the UK, Australia, and Canada, with the UK focusing on computer science in contrast to psychology in Australia and Canada. Action research in the US is positioned stronger in psychology, arts and humanities, and computer science. Brazil, in contrast, shows a slightly different profile. While social sciences and busi-

ness, management, and accounting are less dominant, action research is also robust in engineering and decision science.

Synthesis of findings

The bibliometric analysis revealed that action research is applied in a variety of disciplines, with social science clearly the strongest and business, management, and accounting (including TIM) following in second. The first and seminal publication by Lewin (1946) started the action research journey with publication activity often exhibiting long incubation phases. Publications on action research gained real momentum after the turn of the millennium with the steepest increases in engineering. In addition to disciplinary streams, action research also shows particular strength in specific countries such as the USA, the UK, and Australia – although it might be interesting to investigate the influence of different cultural publication traditions onto these numbers. It is striking that the most productive journals (total number of articles) publishing action research are

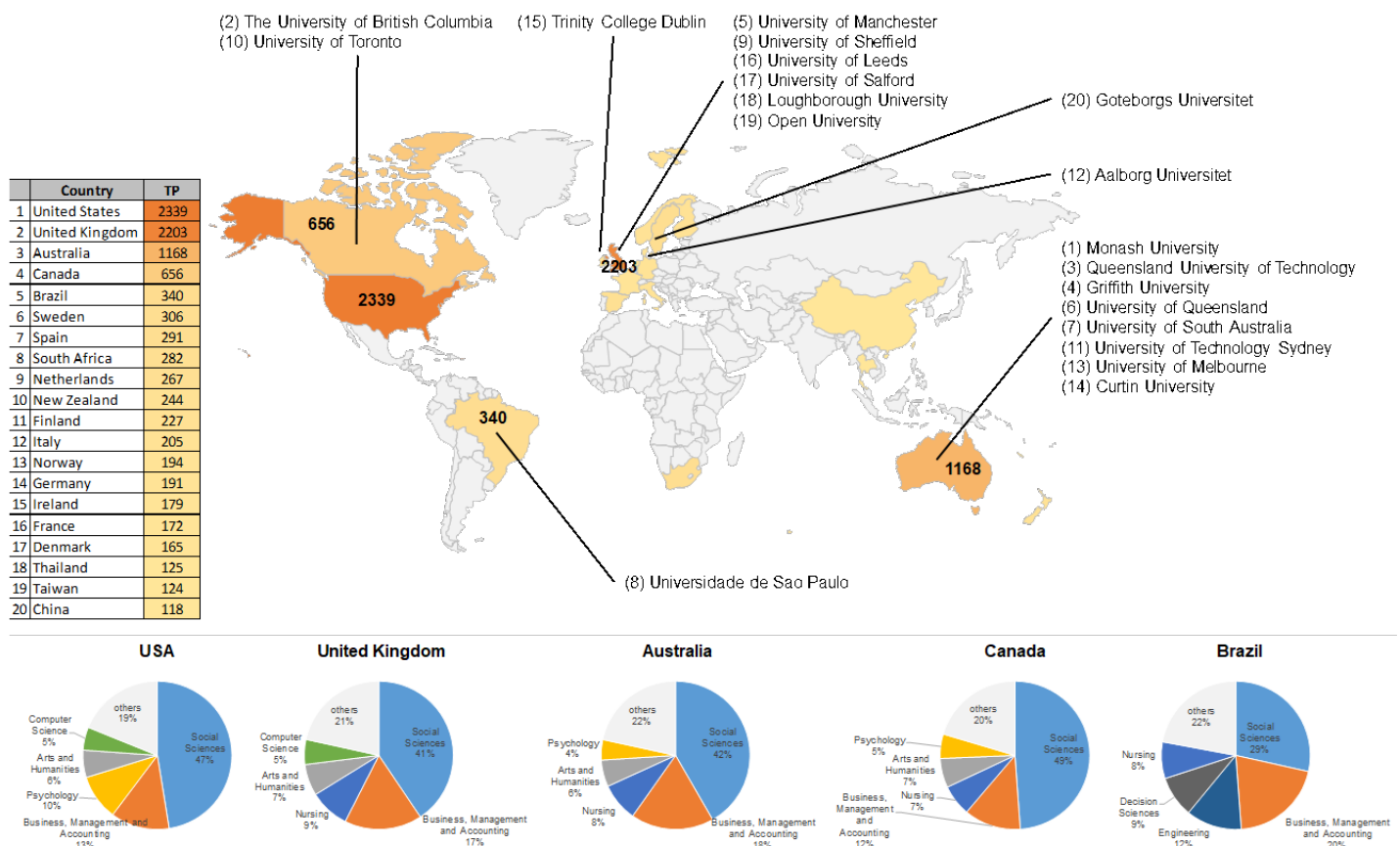


Figure 2. Global overview of most productive and influential institutions and authors

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discipline-spanning and action research specific, while the most influential journals as well as articles (impact factor, citations per article) are published in discipline-specific journals. Although TIM journals are not represented among the most productive or influential journals, TIM-related topics hold a fair share of the most influential articles in the action research domain. Most of these articles were published in journals from other disciplines, which aligns with the small number of 19 dedicated action research articles in TIM or innovation management in general. This might indicate that researchers interested in publishing action research articles aim for journals in disciplines, where action research is more accepted. This stresses the need for a discipline-spanning analysis to understand the benefits and challenges of action research in TIM for a successful application. A subsequent qualitative analysis of action research literature reveals the benefits and challenges of action research for TIM.

Action Research Benefits and Challenges for Technology and Innovation Management

Following on from the bibliometric analysis, it became clear that action research approaches are scattered throughout a wide variety of disciplines, from which a TIM-specific model is yet to emerge. The specific developments of action research streams in different disciplines also highlighted the need for tailored approaches to account for the varying boundary conditions and requirements in each discipline. The following qualitative literature analysis aims to take an initial step towards a TIM-specific action research approach by discussing the benefits and challenges of action research highlighted in the different disciplinary streams from a TIM perspective (Table 6). For this purpose, the central elements of TIM mentioned in the introduction are related to the respective benefits and challenges of action research:

- Socio-technical character of innovation problems and systems
- Multi-faceted character of innovations and innovators
- Variety of innovation management stakeholders
- High levels of uncertainty around innovations

This discussion can serve as a foundation for developing a TIM-tailored action research approach based on insights and learnings from a variety of other disciplines.

Benefits of action research

Action research has an interdisciplinary character, which helps to overcome established discipline structures and “silos”. This is necessary to deeply understand socio-technical innovation systems and different dimensions of innovators (Levin, 2012), which are characteristic of TIM. In this respect, the non-linear but iterative action research process spiraling around inherent learning and knowledge development (Herr & Anderson, 2005; Lewin, 1946) helps to explore TIM problems with a high level of technological and human uncertainty and ambiguity.

Action research allows for the advancement of theory while solving real-world problems, as does TIM (Hult & Lennung, 1980; Levin, 2012; Mumford, 2001; Ottosson, 2003). A central advantage is the capability of combining rigour and relevance as complementary rather than antitheses (Flyvbjerg & Sampson, 2011; Levin, 2012; Mumford, 2001) with validity, depth, and a holistic research understanding identified as not necessarily compromising rigour (Eikeland, 2006). This overcomes the risk of basic or applied research being isolated and irrelevant (Flyvbjerg & Sampson, 2011; Levin, 2012; Ottosson, 2003) including direct evaluation of research results and theories as well as in-depth insights around TIM-related company processes and structures (Susman & Evered, 1978).

Like other research techniques, action research requires systematic fact finding, but it has particular strengths in aiding and supporting goal-directed actions for specific organizational contexts (Hult & Lennung, 1980; Kaplan, 1998; Theodorakopoulos et al., 2012). Socio-technical systems (Levin, 2012), including organizational culture and behaviour as well as broad ranges of interdisciplinary stakeholders (Sérór, 1996), demand rigour but also need to be reflective of the changing and ongoing realities. In a complex socio-technical TIM context with different dimensions of innovators, action research, with its human-centered and client-empowering approach, enables deeper access and utilizes not only explicit but also implicit stakeholder knowledge and feedback on new approaches, interpretation of data, and identified research “anomalies”, meaning unexpected findings (Eikeland, 2006; Flyvbjerg & Sampson, 2011; Hult & Lennung, 1980; Swann, 2002). These “anomalies” are common in highly uncertain TIM systems. Their systematic investigation sometimes might create better questions and lead to better research. This can reveal underlying cause-effect chains of phenomena and is the basis of improved understanding of TIM theory and models (Susman & Evered, 1978).

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Lewin (1946) and Arens-Fischer and colleagues (2010) noted the importance of more applied theory when human agency is involved. This potentially generates new theory through practice but also incorporates “active evaluation” of both the “researched” and “researchers” (Brydon-Miller et al., 2003). Closely working with clients also allows for a better understanding of organizational group dynamics and underlying power structures, interests, and interdependencies (cf. Arieli et al., 2009; Flyvbjerg & Sampson, 2011; Ottosson, 2003). Competence building is a real advantage of action research in TIM since clients are often beneficiaries of training insights – sometimes direct or alternatively through osmosis – while also engaging in the problem-solving process. This has spill-over advantages with potential to increase client commitment. Building trust sets the basis for more sustaining cooperative efforts between academia and clients and inevitably helps transition TIM knowledge and approaches into practice (Kaplan, 1998).

Challenges of action research

Action research has potential for “shining a light” on real-world and real-time business and industry nuances, yet it still has important challenges. A pertinent issue hampering such a method relates to limited precision in interventions including sub-optimal or non-existent research and research design quality (cf. van Aken, 2004) with increased relevance not sufficient in compensating for poor research design (Eden & Huxham, 1996; Levin, 2012). Applied TIM research projects often bear the risk of focusing too strongly on a technology development part and neglecting an overarching methodological perspective. Like commensurate methods and designs, action research requires deep expertise and adequate verification and justification of empirical efforts. An inordinate focus around “action”, particularly of practitioners consulting in “the field” (e.g. McNiff & Whitehead, 2003; Starkey et al., 2009), without proper regard to “research” is arguably action research’s most contentious challenge.

Another challenge with this form of application-oriented research is a need for researchers to have skilled facilitation, problem solving, and communicative capacity beyond less invasive TIM research methods such as surveys or interviews (cf. Hult & Lennung, 1980; McGivern & Fineman, 1983) with such expertise notably not easily acquired (Snoeren et al., 2012). Aligning interests of clients and researchers is a key challenge and is far from trivial. Action researchers exploring socio-technical TIM problems with high levels of uncertainty

also need to be aware and open to unforeseen events and unanticipated findings, which might contradict their prior experience (Hodgkinson & Rousseau, 2009). This requires appropriate adjustments with trial and error and added time and potential additional resources (Burnes, 2004). Changing course requires researcher resilience due to a lack of a “neat step-by-step approach” (Herr & Anderson, 2005) and loss of control over variables (McGivern & Fineman, 1983). Interdependencies within socio-technical innovation systems are a crucial challenge that concomitantly makes prediction and specificity difficult (Burnes, 2004; Lewin, 1947; McGivern & Fineman, 1983).

Effort, time, and cost of embedding researchers into a socio-technical innovation system with various innovators and stakeholders is a major challenge. Levin (2012) argues that this, along with a usually interdisciplinary character, adds to the complexity of a project. There is also a risk of getting lost in the problem-solving process (Hult & Lennung, 1980) and getting too close to clients and stakeholders (Snoeren et al., 2012). Awareness of interests, power, and political games becomes critical where researchers are variously involved or embedded in these systems (Mumford, 2001). The variety of innovators and stakeholders requires a careful but challenging selection of willing and suitable project partners and definition of appropriate levels of involvement (Hult & Lennung, 1980). Fincham and Clark (2009) subsequently argue “research” and “practice” are two distinctive domains with closeness often compromising independence with thorough research techniques actually the responsibility of academics, not practitioners.

Clearly, specialist social exchange competences such as building trust and avoiding controversies require experience and adequate capability (Arieli et al., 2009; Snoeren et al., 2012; Wicks & Reason, 2009). Nurturing researchers with action research curiosity and capacity with skills in problem solving as well as methodical and social competences is important. It may mean, like anthropologists and ethnographers, TIM researchers need to be willing to “live in the field” (Levin, 2012: 134; McGivern & Fineman, 1983; Susman & Evered, 1978). Systematically reflecting on and challenging one’s own research and context dependencies to avoid biases are crucial but also fundamental (Levin, 2012; Snoeren et al., 2012; Starkey et al., 2009). Action research also requires the communication of research findings to different communities and TIM stakeholders. Although it is essential, it requires additional effort and experience about how to purposefully present these findings to

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each community (Eikeland, 2006; Hult & Lennung, 1980; Levin, 2012). In terms of academic publications, action research papers often struggle with word restrictions of journals as a detailed and transparent description of the study and its research design can be quite lengthy. Table 6 summarizes the key arguments above based on a substantive analysis and synthesis of the action research literature in relationship to TIM.

Reflective Conclusion

The study at hand contributes a quantitative discipline-spanning analysis of different action research streams across the globe as well as a qualitative analysis of benefits and challenges of action research for TIM. First, the close relationship between theory and practice in action research proves to be particularly beneficial to tackle socio-technical innovation problems and therefore bridge the rigour–relevance gap in TIM. However, in comparison to further TIM research methods, additional effort is required to prove the rigour and validity of the method. Second, the interdisciplinary nature of action research aligns well with the multi-faceted character of innovation and helps to span boundaries between disciplinary silos in TIM. On the other hand, TIM researchers need to be prepared and trained in how to take advantage of action research for boundary-spanning purposes. Third, the human-centred and client-empowering action research approach enables the inclusion of the TIM-specific wide variety of stakeholders and the continuous balancing of their interests and requirements. On the flip side, TIM researchers have the responsibility to ensure sufficient closeness between stakeholders and researchers, while maintaining independent research at the same time – which is less of an issue when using other TIM research methods. Fourth, the iterative action research process supports exploration in highly uncertain TIM environments, while the frequent pivots in action research projects are more likely to lead to more disruptive theory extensions. However, there is no TIM-specific action research methodology available that guides TIM researchers through the iterative steps of the action research process. In summary, these insights provide recommendations and avenues for further research on where, when, and how to purposefully use action research in TIM:

- The discipline-spanning bibliometric analysis in this study could be enlarged by using additional measures to identify linkages between TIM and other disciplines, such as co-citations or keyword analyses.
- A detailed qualitative analysis of TIM-specific contributions across journals from different disciplines could add to the current analysis and identify additional strengths and “white spots” of action research in TIM to date.
- Future research should further investigate the potential bidirectional dependencies between a limited acceptance of action research in TIM-related journals and the high number of TIM-related publications in journals from other disciplines. This also includes an analysis of if, where, and how actual action research articles might have been published under a different label. The analysis of the most productive and influential journals can also help researchers to select the most suitable outlet for their publications.
- The research design and study description of action research projects can often be quite lengthy and in conflict with word limitations of journals. The development of a standardized way of describing action research projects could help to save space while ensuring a transparent research description.
- Due to the combination of technological and social aspects of TIM, future studies could explore how action research can be used in interdisciplinary joint projects in combination with other research methodologies. An example might be the development of a product–service system, which brings together technical subject matter experts for developing the system and TIM as well as engineering design researchers exploring the overarching innovation processes.
- Another interesting field of research is how practitioners and their expertise can be utilized best to yield in-depth insights and co-create knowledge to advance the TIM body of knowledge. This deep research “in the field” requires further investigations into how rigour and relevance can be combined most efficiently in a TIM environment.
- In the context of the capability building through action research, the link and potential synergies to action learning should be explored in the future. This could benefit teaching and practitioner training of TIM approaches as well as training of action researchers themselves.
- Based on the insights from the abovementioned research endeavours, a TIM-specific action research methodology needs to be developed. Although existing

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Table 6. Technology and innovation management specific benefits and challenges of action research

Benefits	Challenges
<p>Socio-technical character of TIM problems and contexts</p> <ul style="list-style-type: none"> • Continuous alignment of theory and practice creates holistic understanding of innovation as a socio-technical system including its organizational culture and behaviour (Kaplan, 1998; Ottosson, 2003; Séror, 1996) • Combination of rigour and relevance allows for solving real-world TIM problems while advancing TIM theory (Levin, 2012; Mumford, 2001) • Better diffusion of new TIM approaches in practice to bridge the rigour–relevance gap in TIM (Kaplan, 1998; Theodorakopoulos et al., 2012; Yang & Hsiao, 2009) 	<ul style="list-style-type: none"> • Effort, time, and cost to embed TIM researchers into a socio-technical innovation system (Sørensen, Mattsson, & Sundbo, 2010) • TIM researchers need to be willing to live “in the field”, which might contradict prior experience (Levin, 2012; Susman & Evered, 1978) • Higher effort compared to further TIM research methods to ensure and prove validity and rigour of research (Coughlan & Coughlan, 2002; Eikeland, 2006)
<p>Multi-faceted character of TIM</p> <ul style="list-style-type: none"> • Interdisciplinary character of action research helps to overcome established discipline structures and “silos” often present when solving TIM problems (Levin, 2012) • Deeper understanding of group dynamics and their effects on TIM outcomes (cf. Arieli et al., 2009; Flyvbjerg & Sampson, 2011) 	<ul style="list-style-type: none"> • Slow acceptance and thus application of action research in TIM • TIM researchers need training and experience in how to span boundaries using action research, e.g., selecting suitable clients for the research project and assign them to appropriate roles (Arieli et al., 2009; Snoeren et al., 2012)
<p>Variety of TIM stakeholders</p> <ul style="list-style-type: none"> • Competence building for clients and researchers (technical and social) for future TIM projects (for details: Arieli et al., 2009; Burnes, 2004; Hult & Lennung, 1980) • Human-centred and client-empowering approach enables access to tacit knowledge of TIM stakeholders (Eikeland, 2006; Flyvbjerg & Sampson, 2011; Hult & Lennung, 1980) • Iterative and reflective action research approach allows for continuous balancing of TIM stakeholder needs 	<ul style="list-style-type: none"> • Need to analyze TIM stakeholder networks, interests, and power requires experience and knowledge about individual needs of each community (Mumford, 2001) • Requires purposeful processing and presentation for each TIM stakeholder community (Eikeland, 2006; Levin, 2012) • Managing closeness, but also independence of research and practice as a responsibility of TIM researchers (Fincham & Clark, 2009)
<p>High levels of uncertainty around TIM</p> <ul style="list-style-type: none"> • Iterative action research process helps to explore highly uncertain and ambiguous TIM problems (Herr & Anderson, 2005; Lewin, 1946) • Alignment of the iterative action research process with the effectuation process in entrepreneurship and TIM (cf. Frederiksen & Brem, 2017) • Pivoting in action research projects allows for more disruptive theory improvements in highly uncertain TIM environments 	<ul style="list-style-type: none"> • Iterative action research process and pivoting, including unexpected findings, might contradict TIM researchers’ prior experience • No TIM-specific action research methodology available providing a rigorous step-by-step process (Herr & Anderson, 2005) • A detailed description of a study’s action research design can be lengthy and conflict with word limitations of journals

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action research methodologies from other disciplines such as “design science research” and “education action research” cannot directly be adopted, they should be carefully analyzed to use their experience and adapt suitable elements.

A better understanding of the application of action research in TIM along with new TIM-specific research methodologies has the potential to enhance academic standing in industry and strengthen the translation of research outcomes into practice. In general, it is crucial to avoid seeing and marketing action research as “the” new research paradigm for TIM. Instead, action research will be a valuable enhancement of the existing TIM research methodology toolbox.

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