Journey Towards Agility: Three Decades of Research on Agile Information Systems Development

Completed Research Paper

Phil Diegmann
University of Cologne
Albertus-Magnus-Platz,
50923 Cologne, Germany
diegmann@wiso.uni-koeln.de

Tim Dreesen
University of Cologne
Albertus-Magnus-Platz,
50923 Cologne, Germany
dreesen@wiso.uni-koeln.de

Björn Binzer
University of Cologne
Albertus-Magnus-Platz,
50923 Cologne, Germany
binzer@wiso.uni-koeln.de

Christoph Rosenkranz
University of Cologne
Albertus-Magnus-Platz,
50923 Cologne, Germany
rosenkranz@wiso.uni-koeln.de

Abstract

After more than 15 years since the Agile Manifesto and extensive research on agile information systems development for nearly three decades, a comprehensive body of knowledge is available and is constantly growing. Agile information systems development is considered an effective way for managing information systems development projects in environments characterized by rapidly changing requirements. This study aims to shed light on the existing knowledge on agile information systems development by applying a structured literature review and computer aided analysis consisting of distinct text mining techniques. We analyzed a sample of 775 papers and provide results from articles among the Senior Scholars' Basket, selected information systems conferences, and selected journals from management and computer science. Based on our approach, we are able to (1) evaluate key articles and journals, (2) analyze the development of agile information systems development research in the last three decades and, most importantly, (3) identify research foci of the past as well as gaps in our knowledge on agile information systems development for further research.

Keywords: Agile, Software Development, Computer Aided Analysis, Information Systems Development, Literature Review, Text Mining, Topic Modelling

Introduction

Interest in *agile information systems development* (AISD) methodologies has increased in recent years in both research and industry (Conboy 2009; Dybå and Dingsøyr 2008; Fitzgerald et al. 2006a; Lee and Xia 2010). Based upon the principles of the Agile Manifesto (Beck et al. 2001), different implementations of AISD methodologies, such as Scrum or eXtreme Programming (XP), have emerged and motivated a variety of research.

AISD has been applied to a wide range of projects: from small teams, situated in co-located offices (e.g., Cao et al. 2009b) to large scale, distributed, or outsourced projects (e.g., Sarker and Sarker 2009). In this context, AISD methodologies and practices have been implemented successfully but also unsuccessfully

(Lee and Xia 2010). Research also has investigated the customization and configuration of agile approaches, the so-called method tailoring (e.g., Fitzgerald et al. 2006a; Karlsson and Ågerfalk 2009; Wang et al. 2012). Due to the wide variety of topics covered by AISD research, ranging from rather technical aspects (e.g., Balijepally et al. 2009) to sociological or psychological factors (e.g., Maruping et al. 2015), and from an individual level to an organizational level (e.g., Zheng et al. 2011), a clear categorization of existing streams of research is difficult to recognize. Additional difficulties arise as the concept of AISD, its exact definition and conceptualization, and its applicability are debated (Conboy 2009).

Motivated by this, our study's objective is twofold. First, we ask what topics of AISD research have been in the past and are currently investigated. Second, we want to identify topics that are not covered in current research and therefore still remain under-explored in extant literature. Consequently, the central research questions guiding our study are: *(1) What research topics have been addressed within the last three decades by AISD research, and (2) how do these topics differ in terms of available publications and their distribution over time?*

To answer our research questions, we conducted a structured and comparative literature review as described by the guidelines of Levy and Ellis (2006) and Webster and Watson (2002), followed by computer-aided topic modeling (Aggarwal and Zhai 2012; Debortoli et al. 2016) on the extant body of knowledge of AISD.

The remainder of this paper is structured as follows. We give an overview about related work, targeting research on the field of AISD. Next, we describe our research design being used for data collection and analysis. Following, we present and discuss our findings. Finally, we provide an outlook for future research directions.

Related Work and Background

Agile Information Systems Development

In practice, approaches for developing information systems range from sequential approaches (Royce 1970) to more cyclic, iterative approaches (Boehm 1988). During the last two decades, AISD methodologies such as eXtreme programming, rapid application development, or rapid prototyping complemented the iterative approach. Additionally, new management concepts associated with AISD, such as Scrum and Lean Software Management, have been proposed.

The four basic principles of the Agile Manifesto (Beck et al. 2001) can be found in most AISD methodologies. According to the Agile Manifesto, AISD should value individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan (Beck et al. 2001). Each of these principles have been subject to research in some sort: for instance, in regard to individuals and interactions, research has investigated the effects of communication in AISD teams (Hummel et al. 2013), in regard to working software, extant literature investigated the influence of pair programming on software quality (Balijepally et al. 2009), in regard to customer collaboration, the funding process has been studied (Cao et al. 2013), and the ability to respond to change has been subject of studies as well (Fitzgerald et al. 2006a; Lee and Xia 2010).

Moreover, next to the methodologies themselves, extant research so far has studied individual or organizational phenomena, such as the use and effects of specific agile practices (Balijepally et al. 2009; Maruping et al. 2009; Recker et al. 2017), and effects regarding whole projects or organizations, such as the introduction of AISD methodologies to teams (e.g., Cao et al. 2009b). Furthermore, the use of hybrid methodologies or the tailoring of agile methodologies to a team's specific needs is covered (Karlsson and Ågerfalk 2009; Lee and Xia 2010; Wang et al. 2012). Literature investigating the success and failure of AISD mostly focuses on specific methodologies such as Scrum or XP (Fruhling and de Vreede 2006), or specific practices, for instance pair programming (Cao et al. 2013). Extant research focusing on success and failure of AISD in general exists, but is rare (Lee and Xia 2010; Recker et al. 2017).

Existing Literature Reviews

By conducting a systematic literature review, we assessed the current state of research regarding summarizing and aggregating literature reviews. We searched for articles containing "literature" and

"review" as well as a synonym for AISD (i.e., agil*, scrum, xp) in the title, abstract, or keywords. The search revealed 15 results, of which none did a historic-holistic approach, but instead focused on a specific field of interest, such as software engineering for ubiquitous systems (e.g., Guinea et al. 2016), individual acceptance, tailoring, or use of agile methods and practices (e.g. Campanelli and Parreiras 2015; Inayat et al. 2015), general practices and challenges in agile requirements engineering (e.g., Inayat et al. 2015), geographically distributed, large scale AISD and agility (e.g., Dikert et al. 2016), or communication in AISD (e.g., Hummel et al. 2013).

We can therefore conclude that few summarizing or aggregating literature reviews on the field of AISD research exist, and that those articles are oftentimes specialized and limited in scope. For instance, AISD has been included in a summary for information systems offshoring (Strasser and Westner 2015). Other aggregating or summarizing literature focuses on the concept of agility itself (Conboy 2009), but only few provide an overview about existing studies (e.g., Dingsøyr et al. 2012; Dybå and Dingsøyr 2008). In sum, a clear categorization of existing streams of research is difficult to recognize.

Research Method

First Phase: Structured Literature Review

The approach of a structured literature review is chosen because of the low number of review articles that are being published in the information systems field (Rowe 2014; Webster and Watson 2002) as well as the lack of summarizing reviews so far. Reviews are often a means to expose emerging issues to potential theoretical foundations, and because AISD itself is still a continuously emerging topic, this review aims at analyzing the extant research literature to summarize what has already been researched and what is left to be examined. To provide a comprehensive overview on current AISD topics and those topics that still have to be investigated, the existing literature will be thoroughly examined using a structured approach by following the guidelines of Levy and Ellis (2006) and Vom Brocke et al. (2015).

Initially, our data collection process started by performing an extensive keyword search within leading journals in order to find relevant research articles as suggested by Webster and Watson (2002). We set a focus on primarily high quality, peer-reviewed literature, published in journals of the "Senior Scholars' Basket of Journals" and the AIS Toplist[1] (including leading journals not only from IS but also Management and Computer Science). Additionally, we included articles of five prominent IS conferences (i.e., AMCIS, ECIS, HICSS, ICIS, PACIS). We defined a single search string for our keyword search to identify relevant articles in different databases:

> *TIKEAB:(software OR "information system") AND TIKEAB:(development OR engineering OR maintenance OR method* OR practic*) AND (TIKEAB:(agil* OR SCRUM OR XP OR "Extreme Programming") NOT TIKE:(manufac*))*

with TIKEAB searching in title, keywords, and abstract and TIKE searching in title and keywords.

As we aimed for an as broad and holistic overview as possible, we only applied minimal include and exclude criteria. We excluded those publications, which were either difficult to automatically analyze via text mining (e.g., non-English language or with no full text available) or which were not research-focused (e.g., an opinion or commentary). We decided to use a restriction for the publishing year of the articles, thus, articles that were published between January 1st, 1985 and December 31th, 2016 were included. January 1st, 1985 was chosen because the first article we found was from 1985 and all data was collected in January 2017, which is why we chose December 31st, 2016 as cap. All search results were examined regarding title, abstract, and keywords. Within the resulting set of papers, we further identified relevant articles for our project purpose (i.e., investigating AISD) and dropped the others (i.e., not investigating AISD).

In total, after manually removing duplicates and those studies which did not examine AISD but, for instance, organizational agility, our final set of articles consists of 569 articles matching our search indicators for AISD in journals and 206 articles in conference proceedings, totaling up to 775 articles. Table 1 gives further information concerning the distribution of the results.

[1] As the official website is no longer available, the list is archived here:
https://web.archive.org/web/20161007113451/http://aisnet.org/?JournalRankings

Second Phase: Computer Aided Analysis

Following to the data collection, we analyzed all articles with the help of the computer-aided analysis and text mining tool *Scikit-learn* (Pedregosa et al. 2011). From within the Scikit-learn suite of machine learning tools, we specifically applied *topic modelling* (Aggarwal and Zhai 2012; Debortoli et al. 2016), which uncovers topics shared by different articles. We use this technique to easily discover topics shared across research and therefore to help in answering our research questions. Research found text mining and especially topic modelling to be helpful in discovering hidden topics by classifying, summarizing, and clustering of text (Maowen et al. 2012; Srivastava and Sahami 2009) and topic trends over time (Alghamdi and Alfalqi 2015). This semi-automated approach is especially helpful in analyzing large amounts of text (Maowen et al. 2012; Srivastava and Sahami 2009).

In order to analyze the extracted data, we first had to convert the articles into a compatible format by extracting text where available or by applying optical character recognition where no text was directly accessible. Furthermore, we annotated the extracted text with additional information, such as author, year, title, and outlet to enable further-reaching analyses.

Following the data preparation, we utilized *Latent Dirichlet Allocation* (LDA; Blei et al. 2003) as implemented in Scikit-learn as a specific topic modeling approach. Within LDA, each document is seen as a mixture of different topics and each topic has certain probabilities of generating keywords. Keywords are allowed to occur in more than one topic. LDA has been used in various research studies (Chen et al. 2016; Lukins et al. 2010) and has been suggested as a suitable and helpful tool for IS research (Debortoli et al. 2016).

A too high number of topics to extract might lead to an excessive number of meaningless topics and a too low number might constrain the results unnecessarily; thus, the number of topics to be extracted is the most crucial parameter of the analysis (Debortoli et al. 2016). All authors individually and independently tested the number of topics parameter with 5 to 75 and rated each result set regarding the meaningfulness of the identified topics. Additionally, we used four different algorithms (Arun et al. 2010; Cao et al. 2009a; Griffiths and Steyvers 2004; Mimno et al. 2011) aimed at evaluating the quality of topic models to decide which number of topics leads to the optimal topic model. After testing and evaluating different numbers of topics, we settled on 50 topics, as it provided differentiated topics. Of these 50 topics, all which covered less than 0.1% of all tokens (i.e., text) were discarded, resulting in a final set of 25 topics. Furthermore, we decided against the use of lemmatization or stemming to avoid misleading keywords (e.g., "agil" instead of "agility" or "agile"). We opted to use n-grams (i.e., creation of consecutive words such as "agile software development"; in this setting, we decided to use 3-grams) to reduce the number of words with identical meanings but different lexical representations. To further refine the results, we used a list of stop words, which consisted of frequently found words, which added no meaning, such as "et al." or "journal". A complete list of all stop words used within our analysis is available from the authors on request.

Third Phase: Coding

Following Saldaña (2016), we applied different coding strategies as an exploratory problem-solving technique and to link our keywords to patterns, resulting in meaningful topic descriptions. At the core is the task of conceptualization, that is, "the process of grouping similar items according to some defined properties and giving the items a name that stands for that common link" (Strauss and Corbin 1998, p. 121). As coding can be seen as "cyclical act" (Saldaña 2016), our coding process therefore can be distinguished between a first cycle coding and second cycle coding phase.

During the *first cycle coding* we started with "descriptive coding". Descriptive coding is one approach to analyze the data's basic topics to assist with answering questions as "What is going on here?" (Saldaña 2016). It leads primarily to a categorized summary of the data's contents and is essentially the groundwork for second cycle coding and further analysis and interpretation (Wolcott 1994, p. 55). Following Miles and Huberman (1994), descriptive codes may even be assigned "subcodes" to increase the amount of detail. All authors independently and individually made use of descriptive coding with subcodes, and compared all resulting topics against each other by comparing the included keywords per topic. Based on the keywords, a summarizing phrase was suggested. In case of matching topic phrases, no further action was needed. In case of differing topic phrases, the reasoning for each phrase was compared and alternatives were discussed. Subsequently, descriptive coding for differing phrases was repeated and consensus was reached.

The coding process can be illustrated with the example of the topic "Pair Programming". We started the process by independently searching for patterns in the top 30 most frequent keywords of all keywords in this topic. In the case of this topic, the top five keywords were "software", "group", "programming", "total", "pair". While these already painted a rather clear picture, we additionally had a look at the top 30 relatively most salient keywords, that is those that have the largest frequency in this topic compared to all other topics. For this example, "pairs" was the top salient keyword and "pair programming" the eighth most salient keyword. Further, "pair programming" was not found to be more salient in any other topic. In addition to the mere ranking of these keywords, we compared the keywords in the topic at hand with all other keywords and the occurrence of each keyword in other topics. Due to the nature of the LDA algorithm, a keyword can occur in multiple topics. For instance, "software", the most frequent keyword in the topic "Pair Programming" occurs even more frequently in the topics "Project-, Team-, Knowledge Management & Leadership" and "User Involvement & Software Evolution". Therefore, the context and the keywords as a whole are important factors for deciding on a label. As a third source of evidence, we looked at the most covering publications (in terms of the LDA model). These were dominated by publications, which were explicitly looking at pair programming as a phenomenon, for instance, Parrish et al. (2004) or Balijepally et al. (2009). Based on these sources of evidence the different labels and descriptions were then compared and discussed by all authors. In this example, all authors labeled this topic identically, which is why no additional cycles of coding were needed for this topic. If no consensus would have been easily reached, another round of coding for this topic would have been conducted. All other topics were processed similarly to this exemplary approach.

We then applied "pattern coding" as a *second cycle coding method*. Pattern coding is appropriate for the development of major themes from data (Miles and Huberman 1994; Saldaña 2016). These codes are capable to "identify an emergent theme" and therefore are helpful for "grouping those summaries into a smaller number of sets, themes, or constructs" (Miles and Huberman 1994, p. 69). Similar to first cycle coding, we then tried to group our descriptive codes into meaningful pattern codes – again first individually, followed by a discussion where needed. Again, pattern coding was conducted twice until consensus was reached.

We completed the coding process with a final step, in which we did some post-coding activities such as fine-tuning of the wording and alphabetical order of the results. The outcome of the coding process is a final set of 25 topics and eight topic groups.

Results

Figure 1 displays the total number of articles published per year, as well as the number of articles published each year in the Senior Scholars' Basket. Table 1 shows the number of papers found for each outlet with at least five publications. Conferences and journals are displayed separately, but each are ranked by the number of publications in descending order.

Table 2 lists our identified topics, the topic groups, the keywords contained in each topic, and the rank in terms of distribution of the individual topics over the tokens (i.e., words and word groups) in our data set. As can be seen from Table 2, we identified several topic groups because of the different foci of the topics themselves: while some topics comprise more general information such as concepts, principles, or methodologies related to AISD (see topic group "Agile Methodology & Practice Usage"), others focus on an organizational perspective and link agile principles such as flexibility or agility to different contexts (see topic group "IT Capability & Agility"); still others focus on managerial implications (see topic group "Project, Team, & Knowledge Management") or put emphasis on certain aspects such as social aspects and requirements engineering (see topic groups "Social Interactions & Behavior" or "Stakeholders & Requirements Engineering") or risks and success factors (see topic group "Risk, Control & Success Factors in Agile"). Furthermore, we identified topic groups containing research regarding the current state of agile research (see topic group "State of the Research in Agile") or technological aspects (see topic group "Technologies & Applications").

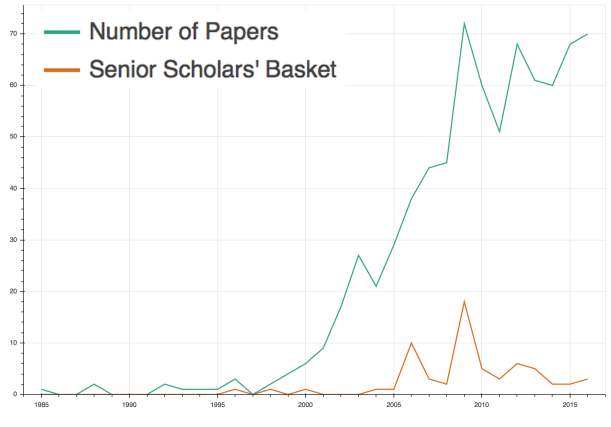

Figure 1: Number of Articles Found Per Year
Total number of articles and in Senior Scholars' Basket

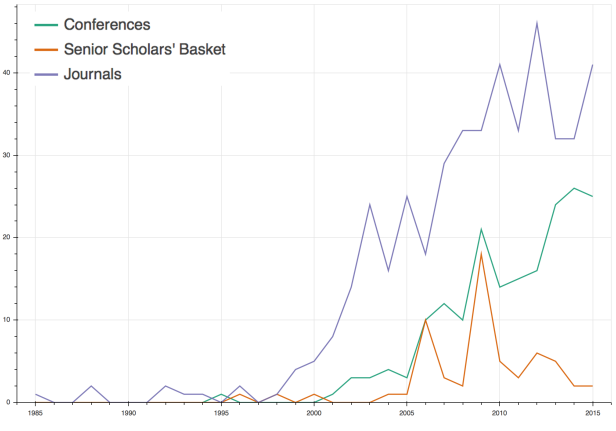

Figure 2: Articles in the Senior Scholars' Basket, Journals, and Conferences Per Year

Outlet	#
Conferences	
Hawaii International Conference on System Sciences	94
Americas Conference on Information Systems	47
European Conference on Information Systems	29
International Conference on Information Systems	21
Pacific Asia Conference on Information Systems	15
Journals	
IEEE Software	172
Journal of Systems and Software	78
Information and Software Technology	71
Computer	28
Communications of the ACM	23
IEEE Transactions on Software Engineering	21

Outlet	#
European Journal of Information Systems	18
Information Systems Journal	16
Information Systems Research	14
Communications of the AIS	9
International Journal of Information Management	8
Journal of Database Management	8
Computer Supported Cooperative Work	6
Computers in Human Behavior	6
Information Technology and Management	6
Journal of Management Information Systems	6
Expert Systems with Applications	5
Information Systems Frontiers	5
Management Information Systems Quarterly	5

Table 1: Distribution of Results Across Outlets with at Least Five Result
Outlets are sorted in descending order by their number of publications (see column "#")

Topic Group	Topic	Rank	Keywords
Agile Methodology & Practice Usage	Scrum	3	1) team 2) scrum 3) teams 4) product 5) work 6) sprint 7) stories 8) story 9) time 10) project
	Lean & Large Scale Agile	5	1) software 2) studies 3) development 4) research 5) practices 6) lean 7) quality 8) engineering 9) software development 10) challenges
	Extreme Programming	8	1) xp 2) risk 3) development 4) software 5) plan 6) driven 7) methods 8) process 9) project 10) management
	Pair Programming	9	1) software 2) group 3) programming 4) total 5) pair 6) face 7) mean 8) development 9) research 10) performance

Topic Group	Topic	Rank	Keywords
	Test-Driven Development	12	1) test 2) process 3) testing 4) software 5) tests 6) development 7) source 8) code 9) unit 10) integration
	Software Architecture in Agile	13	1) architecture 2) design 3) software 4) architectural 5) decisions 6) decision 7) architects 8) development 9) making 10) software architecture
	Code & Refactoring	22	1) code 2) line 3) lines 4) conf 5) class 6) design 7) refactoring 8) time 9) new 10) participants
	Agile Practice Usage	24	1) use 2) content 3) subject 4) terms 5) information 6) transactions 7) students 8) available 9) conditions 10) accepted
IT Capability & Agility	Organization, Capabilities & Fit	18	1) systems 2) information 3) research 4) function 5) information systems 6) theory 7) assessment 8) capability 9) process 10) organisations
	Agile Values & Culture, Tools	21	1) values 2) practices 3) tool 4) tools 5) value 6) goals 7) culture 8) project 9) practice 10) support
Project, Team, & Knowledge Management	Project-, Team-, Knowledge Management & Leadership	1	1) development 2) team 3) software 4) project 5) teams 6) software development 7) management 8) systems 9) information 10) methods
	Success Factors in Outsourced & Offshored Agile	11	1) project 2) client 3) management 4) projects 5) success 6) requirements 7) software 8) vendor 9) offshore 10) development
	Global Software Development	26	1) gsd 2) communication 3) offshore 4) distributed 5) global 6) cultural 7) socio 8) practices 9) mechanisms 10) software
	Open Source	27	1) network 2) social 3) source 4) open source 5) software 6) open 7) week 8) dependencies 9) structure 10) project
	Permission & Coordination in SD	28	1) permission 2) owner 3) software developers 4) industrial 5) academic 6) software 7) experiment 8) studies 9) students 10) development
Risk, Control & Success Factors in Agile	Features, Values & Costs	4	1) software 2) development 3) value 4) project 5) product 6) period 7) time 8) example 9) computer 10) business
	Documentation, Quality Metrics & Measurements in Agile	14	1) software 2) documentation 3) quality 4) cost 5) research 6) systems 7) attributes 8) process 9) related 10) number
	Control Mechanisms in Agile	15	1) control 2) systems 3) information 4) management 5) development 6) information systems 7) controls 8) organizations 9) research 10) process
	Control Alignment & Patterns in Agile	19	1) control 2) alignment 3) patterns 4) pattern 5) socio 6) mechanisms 7) organizational 8) process 9) new 10) environment
Social Interactions & Behavior	Communication & Social Interaction in (Virtual) Teams	10	1) information 2) research 3) communication 4) systems 5) information systems 6) social 7) knowledge 8) technology 9) theory 10) group
	Cognition, Task Complexity & Software Quality	16	1) task 2) performance 3) software 4) mental 5) programming 6) models 7) complexity 8) pair 9) cognitive 10) tasks
	Job Satisfaction & Perceptions in Agile	17	1) job 2) practices 3) work 4) satisfaction 5) development 6) team 7) software 8) use 9) pm 10) feedback
	Relationships & Behavior	30	1) relationships 2) personal 3) relationship 4) behavior 5) isd 6) developers 7) customer 8) types 9) monitoring 10) help
	User Involvement & Software Evolution	2	1) software 2) development 3) design 4) systems 5) process 6) software development 7) new 8) engineering 9) use 10) user

Topic Group	Topic	Rank	Keywords
Stakeholders and Requirements Engineering	Stakeholders & Requirements Engineering in Agile	7	1) requirements 2) project 3) team 4) software 5) process 6) requirement 7) management 8) self 9) manager 10) case
	Usability & Designers	23	1) usability 2) designers 3) project 4) integration 5) activities 6) scrum 7) users 8) user 9) end 10) inter
	Goals & Expectations Management	29	1) goal 2) goals 3) project 4) methodology 5) implementation 6) single 7) systems 8) projects 9) organization 10) process
State of the Research in Agile	Surveys in Agile Research Studies	20	1) team 2) surveys 3) teams 4) questions 5) survey 6) software 7) results 8) different 9) customer 10) answer
	Literature Reviews & Conversants in Agile Research	25	1) cao 2) wang 3) beck 4) conboy 5) face 6) pm 7) methods 8) reference 9) cross 10) collaboration
Technologies & Applications	Cloud & Security	6	1) service 2) process 3) business 4) services 5) data 6) security 7) modeling 8) systems 9) level 10) order

Table 2: Identified Topics, Including the Rank Regarding Distribution & Top 10 Keywords
Topic groups are sorted alphabetically, topics are sorted by their rank, and keywords are sorted by frequency

Research Foci Over the Last Decades

Although at first glance our topics presented in Table 2 seem to randomly comprise a lot of different and wide spread themes, further investigation and analysis of our results reveal distinct and meaningful patterns. The resulting topics, consisting of specific keywords, are overlapping but each one of them has its "raison d'être", as they represent themes that have been addressed in AISD research within the last decades.

As can be seen from Table 2, the first topic group, "Agile Methodology & Practice Usage", summarizes the "basics" of AISD. The keywords are centered around AISD methods, concepts, practices, management, and tasks. The second topic group, "IT Capability & Agility", relates to a broader view on agile, namely organizational agility and IT capabilities. The third topic group "Project, Team, & Knowledge Management", is focused more on project management activities. Similarly, "Risk, Control & Success Factors in Agile" entails risk assessment, quality and success factors, as well as control related content. The following topic group, "Social Interactions & Behavior", is on a higher level of abstraction, as it includes topics with some relation to social interactions, such as communication, behaviors, job perceptions, and relationships. "Stakeholders & Requirements Engineering" entails topics centered around different stakeholders, the process of requirements engineering, and generally speaking the involvement of users in the software development process. The next topic group, "State of the Research in Agile" is again of a higher level of abstraction, as it investigates research of AISD itself and entails a topic related to literature reviews, authors, and well-known conversants in AISD research. The last topic group "Technologies & Applications" relates to some technical and application-oriented facets, namely cloud technologies and security in AISD. What is striking about the last topic group is that it currently consists of only one topic. However, we believe that grouping makes sense, as we expect additional - and for this group relevant- topics in the expansion of the database.

Looking at the rankings of the topics and overall distribution of each topic group (see Figure 3), "Social Interaction & Behavior" seems to be covered less by AISD research, with the highest ranking of 10 and an overall distribution of 6.73%. While there are interrelations between this topic group and other common topic groups (e.g., "Stakeholders & Requirements Engineering" or "Project, Team, & Knowledge Management"), the more specific nuances (i.e., individual-level aspects, such as job satisfaction, and team-level aspects, such as relationships) are not discussed in these more frequent topic groups. Another possibly surprising detail is the low representation of "IT Capability & Agility" with only 1.93%. This is due to our focus on AISD specifically and not agility in general, as most of the studies including agility in terms of a capability perspective do not deal with AISD directly.

Key Outlets and Articles

Based on the number of publications per outlet displayed in Table 1, we clearly see that the Hawaii International Conference on System Sciences dominates the conferences with exactly double the number of publications (94) as the second most published-in conference (47), Americas Conference on Information Systems. The most prestigious IS conference, the International Conference on Information Systems, shows up second to last with 21 publications. This might hint at the more technical and less IS-typical orientation of extant AISD research. However, this proposition needs a closer investigation and a deeper discussion is provided within our section "Implications".

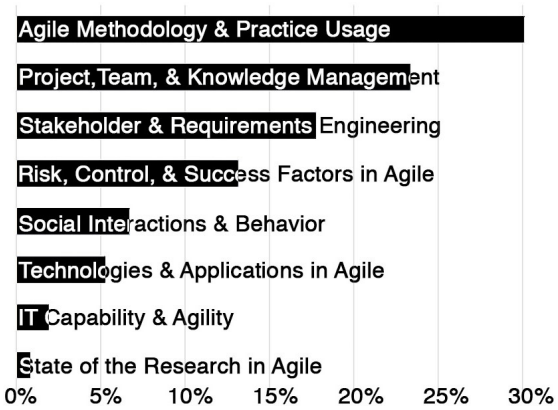

Figure 3: Topic Group Distribution
Distribution in percent of tokens (Σ = 99.9%)

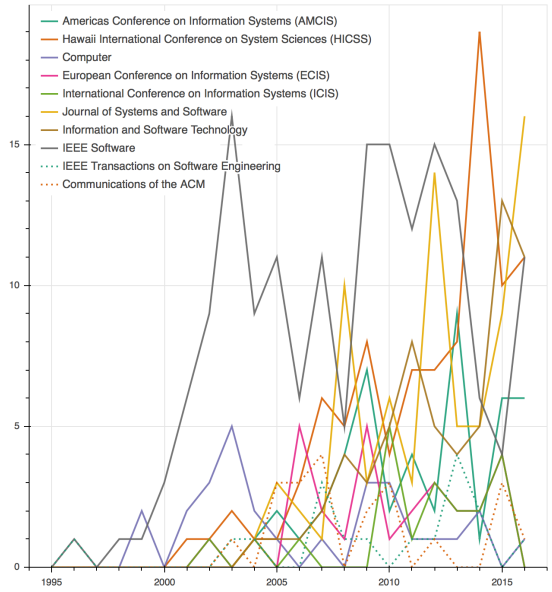

Figure 4: Top 10 Most Published-in Outlets Over Time

Regarding the journal-based publications, the field is dominated by IEEE Software with 172 publications, followed by the Journal of Systems and Software (78) and Information and Software Technology (71). The most published-in journal of the Senior Scholars' Basket is the European Journal of Information Systems with 18 publications, ranked seventh.

Looking at the history of the most published-in outlets (see Figure 4), one can identify different trends. While some outlets have been publishing AISD research early on (e.g., IEEE Software, Computer, or the Hawaii International Conference on System Sciences), some started out later (e.g., European Conference on Information Systems, Journal of Systems and Software, or Information and Software Technology). While IEEE Software has been early on a very important outlet for AISD research, it shows a downward trend since 2010 – but for the last year of our observation in which an increase is to be seen.

Looking at more recent publication statistics, especially the Hawaii International Conference on System Sciences, Information and Software Technology, and the Journal of Systems and Software appear to be the most up-and-coming outlets for AISD research.

Topic	Top 2 Most Covering Papers
Scrum	*Eloranta et al. (2016), Gupta and Reddy (2016)*
Lean & Large Scale Agile	*Nurdiani et al. (2016), Smits (2007)*
Extreme Programming	*Cao et al. (2009b)*, Fitzgerald et al. (2006a)
Pair Programming	*Parrish et al. (2004), Domino et al. (2007)*
Test-Driven Development	*Pyhajarvi et al. (2003), Crispin (2006)*

Software Architecture in Agile	*Kazman et al. (2006)*, *Woods (2015)*
Code & Refactoring	*Vodde and Koskela (2007)*, Mossige et al. (2015)
Agile Practice Usage	*Fruhling and Vreede (2006)*, *Sarker and Sarker (2009)*
Organization, Capabilities & Fit	*Hobbs and Scheepers (2010)*, *Hobbs and Scheepers (2009)*
Agile Values & Culture, Tools	*Krzanik et al. (2010)*, *Lawrence and Rodriguez (2012)*
Project-, Team-, Knowledge Management & Leadership	*Conboy and Wang (2009)*, *Xu and Shen (2016)*
Success Factors in Outsourced & Offshored Agile	*Jørgensen (2016)*, Strasser and Westner (2015)
Global Software Development	*Bannerman et al. (2012)*, *Alzoubi and Gill (2014)*
Open Source	*Rothenberg et al. (2014)*, *Feller et al. (2008)*
Permission & Coordination in SD	*Turk et al. (2005)*, *Andrade and Fiadeiro (2002)*
Features, Values & Costs	*Denne and Cleland-Huang (2004)*, *Nejmeh and Thomas (2002)*
Documentation, Quality Metrics & Measurements in Agile	*Zhi et al. (2015)*, *Basili et al. (1996)*
Control Mechanisms in Agile	*Cram and Brohman (2010)*, *Gregory et al. (2013)*
Control Alignment & Patterns in Agile	*Cram et al. (2016)*, *Cram and Newell (2016)*
Communication & Social Interaction in (Virtual) Teams	*Salovaara and Tuunainen (2013)*, *Read et al. (2012)*
Cognition, Task Complexity & Software Quality	*Balijepally et al. (2015)*, Balijepally et al. (2009)
Job Satisfaction & Perceptions in Agile	*Tripp and Riemenschneider (2014)*, *Tripp et al. (2016)*
Relationships & Behavior	*Choi et al. (2008)*, *Madsen and Matook (2010)*
User Involvement & Software Evolution	*Hansson et al. (2006)*, *Rajlich (2006)*
Stakeholders & Requirements Engineering in Agile	*Jain et al. (2015)*, *Da Silva et al. (2014)*
Usability & Designers	*Wale-Kolade (2015)*, *da Silva et al. (2015)*
Goals & Expectations Management	*Venugopal (2005)*, *Rajagopalan et al. (2016)*
Surveys in Agile Research Studies	*Laanti (2013)*, *Jalali et al. (2014)*
Literature Reviews & Conversants in Agile Research	*Inayat et al. (2015)*, *Behutiye et al. (2017)*
Cloud & Security	*Coria et al. (2014)*, *Aulkemeier et al. (2016)*

Table 3: Topics and Top Two Most Covering Papers

Table 3 gives an insight into the articles covering each topic the most. It is important to note that this does not mean that these articles are the most influential or most important ones for this topic but rather are covering the topic most precisely in terms of the LDA model. From Table 3 we also see that some topics are driven by a few authors repeatedly (e.g., "Job Satisfaction & Perceptions in Agile" by Tripp and Riemenschneider or "Extreme Programming" by Cao).

Discussion

Trends

By further investigation of our timeline regarding the distribution of published articles (see Figure 1 and Figure 2) and distribution of topics (see Figure 5), we recognize several interesting findings. First, AISD seems to strongly draw the interest of the research community starting around the turn of the century, plateauing first at around 2003. Since then, there is a significant increasing slope of the graph, indicating that more articles have been published in the following years. Popular works published within this year are, for example, Williams and Cockburn's article "Agile Software Development: It's about Feedback and Change" (Williams and Cockburn 2003) and, unsurprisingly. the "Agile Manifesto" (Beck et al. 2001). All publications have in common that they deal with the topic of AISD from a methodology perspective, putting emphasis on concepts, principles, or detailed information concerning a specific approach. Some other

articles published in the year 2003 deal with the topic of "virtual teams" (e.g., Edwards and Sridhar 2003). This is not surprising, since the concept of virtual teams is seen as an important antecedent for "doing agile" in organizations (Bergiel et al. 2008; Bowen and Maurer 2002).

Second, we identified a peak in our timeline. In 2009, we see the highest number of articles published within our predefined restriction of years. One explanation for this may be the call for papers for special issue themes, such as "flexible and distributed ISD" in Information Systems Research (ISR) journal (Fitzgerald et al. 2006b) or previous works, which inspired further research, such as Larman's "Agile and Iterative Development: A Manager's Guide" (Larman 2003) or Poppendieck and Poppendieck's "Lean Software Development: An Agile Toolkit" (Poppendieck and Poppendieck 2003). The ISR special issue was intended to build on the success of a previous special section of Communications of the ACM (Ågerfalk and Fitzgerald 2006a) and mini-track at the 39th Hawaii International Conference on System Sciences (HICSS) in 2006 (Ågerfalk and Fitzgerald 2006b). Ågerfalk and Fitzgerald argued that "it became clear from these efforts that as a very active emerging area of research, there was an imminent need for a forum that allowed for the development and dissemination of full-research papers of the highest quality" (Ågerfalk et al. 2009, p. 318). Similarly, a special issue of the European Journal of Information Systems was published in 2009 (Abrahamsson et al. 2009). It aimed at improving the understanding of various phenomena in AISD.

Third, we recognize a short flattening or decrease in new publications after 2003 and 2009. One reason for this decrease might be an incomplete coverage of scientific outlets in our current sample and a move from some authors to publish their research (temporarily) elsewhere. Another explanation might be the special issues mentioned beforehand. While special issues might result in a burst of publications in a given year, it might very well also lead to flattening in the following years as research projects might have been expedited to be included in the special issue and therefore would not be published in the following years.

Consolidating this description of the trend in publications of AISD research, we argue that AISD, while still being a highly important topic to industry and practice (Version One 2018), and despite a high and even growing number of publications, continues to lack coverage in the top journals of IS research, with only 63 out of 775 papers overall (see Figure 1 and Figure 2).

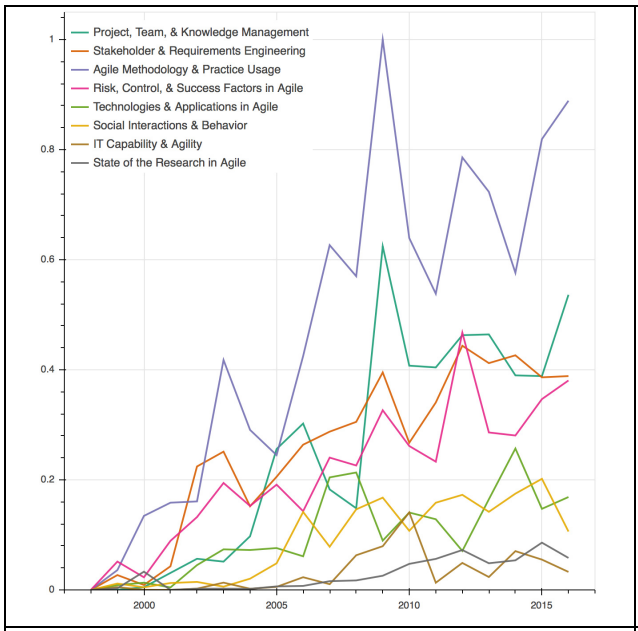

Figure 5: Total Normalized Topic Group Distributions Over Time (1998-2016)

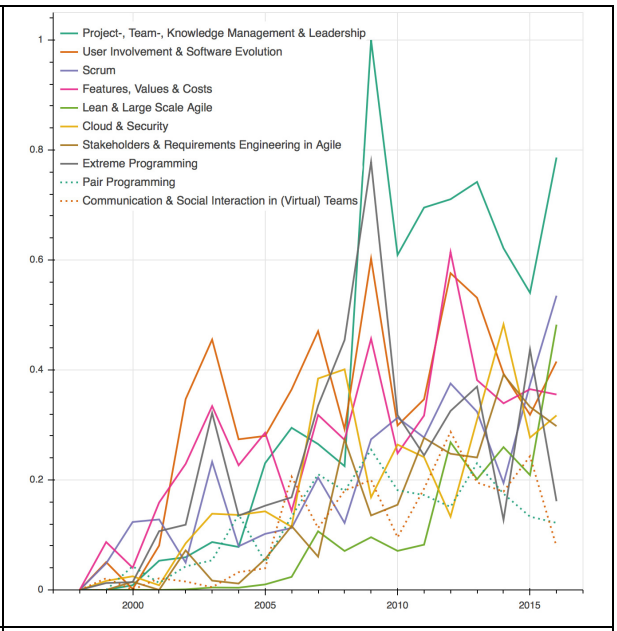

Figure 6: Total Normalized Top 10 Topic Distributions Over Time (1998-2016)

Implications

Combining the outlined descriptions and looking at the evolution of topics present in research (see Figure 5 and Figure 6), one might identify different trends in AISD research. "Project, Team, Knowledge

Management & Leadership" is overall losing traction since its peak in 2009. Similarly, "Extreme Programming" is following the same trend, indicating that both topics are becoming more and more saturated. In contrast to this trend, "Scrum" and "Cloud & Security" are overall showing a positive trend in topic distribution over time, indicating that these topics are not yet saturated. A less clear picture is drawn for the topic "Communication & Social Interaction in (Virtual) Teams" showing a more volatile behavior. Figure 5 further indicates that "Agile Methodology & Practice Usage" was and still is the most discussed topic group, with only temporary drops in its ascend. A similar trend can be observed for "Stakeholder & Requirements Engineering" and "Project, Team, & Knowledge Management", while these topic groups are generally less often discussed.

The overall coverage of different topics, the rankings of the topics (see Table 2), topic group distributions (see Figure 3), and the distributions over time (see Figure 5), help us derive conclusions over gaps in the extant literature. While the top three topics are about team and project management, indicating no evident gap in literature, and nearly all topic groups having at least one topic in the top 10, indicating some degree of coverage, the topic groups "Social Interaction & Behavior" and "State of the Research in Agile" are outliers. While it is clear that the latter one is covered less often than the actual subject of this stream of research, the former is clearly part of the subject of interest. Topics focusing on social aspects of AISD are found first at rank 10, followed by ranks 16, 17, and 30, indicating a gap in current research. This lack is rather surprising with information systems constituting socio-technical systems, and the major problems of ISD projects being not so much technological as sociological in nature (DeMarco and Lister 1987, p. 4). While other topics might touch on social aspects as well (e.g., "Project-, Team-, Knowledge Management & Leadership"), these aspects are far less pronounced and of a more ancillary nature in these topics. As these aspects appear to be peripheral matter to extant research and in contrast to its peripheral appearance, research acknowledges the importance of not only technical but also social focus of AISD (Conboy et al. 2011; Maruping et al. 2015). Figure 3 paints a very similar image: "Social Interactions & Behavior" is the third to last topic group with only 6.73% coverage, lending further support to the call for more extensive research on the social and behavioral aspects of AISD.

In line with Dingsøyr et al. (2012) we observe a trend of increasing quantity and quality of AISD research and that some subfields (i.e., topics) in AISD research are more mature or saturated than others. Both, the findings from Dingsøyr et al. (2012) and the "top 10 burning questions" (Freudenberg and Sharp 2010) are reflected in our results: agile and lean, success factors, architecture in agile, or large scale agile are important topics, while pair programming and XP are becoming less important. Furthermore, Freudenberg and Sharp (2010) point out that sociological studies are important but currently too rare, which is clearly still the case and echoed by our results – a chance for IS researchers. This clearly shows that the calls for research from nearly a decade ago are still unanswered and need further investigation by AISD research.

To encourage AISD research to close these gaps, we propose the following research agenda. First, technologies and applications (see Topic Group "Technologies & Applications") as well as tool support (see Topic Group "IT Capability & Agility" and related topics) should be investigated further. The low rankings of the specific topics (see Table 2) and the low overall distribution (see Figure 3) paint a clear picture of an underrepresented research area. Studies on the effects of the use of tools such as versioning systems or coding tools would be valuable, as issues relating to, for instance, communication (e.g., Hummel et al. 2013) could be improved with improved understanding of the role of tools in AISD. Second, the "social" aspect of "socio-technical systems" needs to be embraced more by researchers. Similar to the first point of our research agenda, our data shows clearly a need for more research on this aspect of AISD. For example, studies on the effects of agile ISD on control or diversity could complement existing similar IS research streams (e.g., Lee and Xia 2010; Wiener et al. 2016). Third, we encourage AISD researchers to increase the amount of self-reflecting and reviewing literature. By reflecting upon the current stage of AISD research, gaps become more apparent and by replicating extant research, trust in existing findings can be improved. We believe that the AISD research community specifically and the IS community in general would benefit greatly from extensive research on these three main points of our proposed research agenda.

Conclusion and Outlook

Within this paper, we identified research topics on AISD covered by relevant IS journals and prestigious conferences on IS. A clear limitation of our study is the focus on IS-centric literature and only marginally

included computer science research. However, our findings provide an overview of topics, which attracted the attention of the research community dealing with AISD methodologies over the last three decades.

Based on the topic modeling conducted on this data set, we demonstrated the suitability of computer-aided topic clustering for outlining the current state of AISD research. With the help of computer-aided analysis, we were able to process large amounts of data and uncover hidden topics within these texts. Further processing of this data and the results, as well as qualitative analysis helped us gain deeper insights into the history of AISD research and uncover the topics in our body of knowledge regarding AISD research. Further, we waged an outlook into the future of AISD research by identifying less covered topics and looking for gaps in the topics covered by extant research. This might help other scholars in identifying new avenues and further extends the scientific community's knowledge about AISD.

We are confident that our study and results provide an appropriate degree of generalizability, completeness, and replicability. We described our procedure and sources to ensure replicability, while generalizability and completeness go together for this study. Due to the comprehensive literature basis provided by our structured literature review and the help of a computer-aided analysis, we are able to process extant research at large and discover hidden topics. This research design facilitates generalizability and completeness.

Future research might expand on this research by adding more outlets or updating the conclusions based on more recent publications to further extend the applicability and generalizability of our findings. We also call for replication of our study to improve the confidence in our results and our conclusions. A continued effort in keeping track of the developments in AISD research might help in keeping researchers focused and aware of trends, topics, and gaps.

Acknowledgements

The German Research Foundation (DFG) funded parts of this study under record no. RO 3650/8-1.

References

Abrahamsson, P., Conboy, K., and Wang, X. 2009. "'Lots Done, More to Do': The Current State of Agile Systems Development Research," *European Journal of Information Systems* (18), pp. 281-284.

Ågerfalk, P. J., and Fitzgerald, B. 2006a. "Flexible and Distributed Software Processes: Old Petunias in New Bowls," *Communications of the ACM*: Citeseer.

Ågerfalk, P. J., and Fitzgerald, B. 2006b. "Understanding Flexible and Distributed Software Development Processes," *HICSS 2006*: IEEE Computer Society Press Washington, DC, p. 1.

Ågerfalk, P. J., Fitzgerald, B., and Slaughter, S. A. 2009. "Flexible and Distributed Information Systems Development: State of the Art and Research Challenges," *Information Systems Research* (20:3), pp. 317-329.

Aggarwal, C. C., and Zhai, C. 2012. *Mining Text Data*. Springer Science & Business Media.

Alghamdi, R., and Alfalqi, K. 2015. "A Survey of Topic Modeling in Text Mining," *International Journal of Advanced Computer Science and Applications (IJACSA)* (6:1).

Alzoubi, Y. I., and Gill, A. Q. 2014. "Agile Global Software Development Communication Challenges: A Systematic Review," *PACIS 2014*: AIS.

Andrade, L. s. F., and Fiadeiro, J. L. 2002. "Agility through Coordination," *Information Systems* (27:6), pp. 411-424.

Arun, R., Suresh, V., Madhavan, C. V., and Murthy, M. N. 2010. "On Finding the Natural Number of Topics with Latent Dirichlet Allocation: Some Observations," *Pacific-Asia Conference on Knowledge Discovery and Data Mining*: Springer, pp. 391-402.

Aulkemeier, F., Paramartha, M. A., Iacob, M.-E., and van Hillegersberg, J. 2016. "A Pluggable Service Platform Architecture for E-Commerce," *Information systems and e-business management* (14:3), pp. 469-489.

Balijepally, V., Mahapatra, R., Nerur, S., and Price, K. H. 2009. "Are Two Heads Better Than One for Software Development? The Productivity Paradox of Pair Programming," *MIS Quarterly* (33:1), pp. 91-119.

Balijepally, V., Nerur, S. P., and Mahapatra, R. 2015. "Task Mental Model and Software Developers' Performance: An Experimental Investigation," *Communications of the AIS* (36), p. 4.

Bannerman, P. L., Hossain, E., and Jeffery, R. 2012. "Scrum Practice Mitigation of Global Software Development Coordination Challenges: A Distinctive Advantage?," *HICSS 2012*: IEEE, pp. 5309-5318.
Basili, V. R., Briand, L. C., and Melo, W. L. 1996. "A Validation of Object-Oriented Design Metrics as Quality Indicators," *IEEE Transactions on software engineering* (22:10), pp. 751-761.
Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J., and Thomas, D. 2001. "Manifesto for Agile Software Development." *Manifesto for Agile Software Development* Retrieved February 24, 2016, from http://www.agilemanifesto.org/
Behutiye, W. N., Rodríguez, P., Oivo, M., and Tosun, A. 2017. "Analyzing the Concept of Technical Debt in the Context of Agile Software Development: A Systematic Literature Review," *Information and Software Technology* (82), pp. 139-158.
Bergiel, B. J., Bergiel, E. B., and Balsmeier, P. W. 2008. "Nature of Virtual Teams: A Summary of Their Advantages and Disadvantages," *Management Research News* (31:2), pp. 99-110.
Blei, D. M., Ng, A. Y., and Jordan, M. I. 2003. "Latent Dirichlet Allocation," *Journal of machine Learning research* (3:Jan), pp. 993-1022.
Boehm, B. W. 1988. "A Spiral Model of Software Development and Enhancement," *IEEE Computer* (21:4), pp. 61-72.
Bowen, S., and Maurer, F. 2002. "Process Support and Knowledge Management for Virtual Teams Doing Agile Software Development," *Proceedings 26th Annual International Computer Software and Applications*, pp. 1118-1120.
Campanelli, A. S., and Parreiras, F. S. 2015. "Agile Methods Tailoring - a Systematic Literature Review," *The Journal of Systems and Software* (110), p. 85.
Cao, J., Xia, T., Li, J., Zhang, Y., and Tang, S. 2009a. "A Density-Based Method for Adaptive Lda Model Selection," *Neurocomputing* (72:7-9), pp. 1775-1781.
Cao, L., Mohan, K., Ramesh, B., and Sarkar, S. 2013. "Adapting Funding Processes for Agile It Projects: An Empirical Investigation," *European Journal of Information Systems* (22:2), pp. 191-205.
Cao, L., Mohan, K., Xu, P., and Ramesh, B. 2009b. "A Framework for Adapting Agile Development Methodologies," *European Journal of Information Systems* (18:4), pp. 332-343.
Chen, C., Huang, E., and Yan, H. 2016. "Detecting the Association of Health Problems in Consumer-Level Medical Text," *Journal of Information Science*), p. 0165551516671629.
Choi, K. S., Deek, F. P., and Im, I. 2008. "Exploring the Underlying Aspects of Pair Programming: The Impact of Personality," *Information and Software Technology* (50:11), pp. 1114-1126.
Conboy, K. 2009. "Agility from First Principles: Reconstructing the Concept of Agility in Information Systems Development," *Information Systems Research* (20:3), pp. 329-355.
Conboy, K., Coyle, S., Xiaofeng, W., and Pikkarainen, M. 2011. "People over Process: Key Challenges in Agile Development," *IEEE Software* (28:4), pp. 48-48.
Conboy, K., and Wang, X. 2009. "Understanding Agility in Software Development through a Complex Adaptive Systems Perspective," in: *ECIS 2009*.
Coria, J. A. G., Castellanos-Garzón, J. A., and Corchado, J. M. 2014. "Intelligent Business Processes Composition Based on Multi-Agent Systems," *Expert Systems with Applications* (41:4), pp. 1189-1205.
Cram, W. A., and Brohman, M. K. 2010. "Beyond Modes: A New Typology of Isd Control," *ICIS 2010*, p. 94.
Cram, W. A., Brohman, M. K., Chan, Y. E., and Gallupe, R. B. 2016. "Information Systems Control Alignment: Complementary and Conflicting Systems Development Controls," *Information Management* (53:2), pp. 183-196.
Cram, W. A., and Newell, S. 2016. "Mindful Revolution or Mindless Trend? Examining Agile Development as a Management Fashion," *European Journal of Information Systems* (25:2), pp. 154-169.
Crispin, L. 2006. "Driving Software Quality: How Test-Driven Development Impacts Software Quality," *IEEE Software* (23:6).
Da Silva, I. F., Neto, P. A. d. M. S., O'Leary, P., De Almeida, E. S., and de Lemos Meira, S. R. 2014. "Software Product Line Scoping and Requirements Engineering in a Small and Medium-Sized Enterprise: An Industrial Case Study," *Journal of Systems and Software* (88), pp. 189-206.
da Silva, T. S., Silveira, M. S., and Maurer, F. 2015. "Usability Evaluation Practices within Agile Development," *HICSS 2015*: IEEE, pp. 5133-5142.
Debortoli, S., Müller, O., Junglas, I., and vom Brocke, J. 2016. "Text Mining for Information Systems Researchers: An Annotated Topic Modeling Tutorial," *Communications of the AIS*).
DeMarco, T., and Lister, T. 1987. *Peopleware: Productive Projects and Teams*. Dorset House Publishing Co., Inc. New York, NY, USA.

Denne, M., and Cleland-Huang, J. 2004. "The Incremental Funding Method: Data-Driven Software Development," *IEEE software* (21:3), pp. 39-47.
Dikert, K., Paasivaara, M., and Lassenius, C. 2016. "Challenges and Success Factors for Large-Scale Agile Transformations: A Systematic Literature Review," *The Journal of Systems and Software* (119), p. 87.
Dingsøyr, T., Nerur, S., Balijepally, V., and Moe, N. B. 2012. "A Decade of Agile Methodologies: Towards Explaining Agile Software Development." Elsevier.
Domino, M. A., Collins, R. W., and Hevner, A. R. 2007. "Controlled Experimentation on Adaptations of Pair Programming," *Information Technology Management* (8:4), pp. 297-312.
Dybå, T., and Dingsøyr, T. 2008. "Empirical Studies of Agile Software Development: A Systematic Review," *Information and software technology* (50:9), pp. 833-859.
Edwards, H. K., and Sridhar, V. 2003. "Analysis of the Effectiveness of Global Virtual Teams in Software Engineering Projects," in: *HICSS 2003*. IEEE.
Eloranta, V.-P., Koskimies, K., and Mikkonen, T. 2016. "Exploring Scrumbut—an Empirical Study of Scrum Anti-Patterns," *Information and Software Technology* (74), pp. 194-203.
Feller, J., Finnegan, P., and Hayes, J. 2008. "Delivering the Whole Product: Business Model Impacts and Agility Challenges in a Network of Open Source Firms," *Journal of Database Management* (19:2), pp. 95-108.
Fitzgerald, B., Hartnett, G., and Conboy, K. 2006a. "Customising Agile Methods to Software Practices at Intel Shannon," *European Journal of Information Systems* (15:2).
Fitzgerald, B., Slaughter, S. A., and Ågerfalk, P. J. 2006b. "Call for Papers - Information Systems Research Special Issue: Flexible and Distributed Information Systems Development," *Information Systems Research* (17:3), pp. 323-325.
Freudenberg, S., and Sharp, H. 2010. "The Top 10 Burning Research Questions from Practitioners," *Ieee Software* (27:5), pp. 8-9.
Fruhling, A., and de Vreede, G.-J. 2006. "Field Experiences with Extreme Programming: Developing an Emergency Response System," *Journal of Management Information Systems* (22:4), pp. 39-69.
Fruhling, A., and Vreede, G.-J. D. 2006. "Field Experiences with Extreme Programming: Developing an Emergency Response System," *Journal of Management Information Systems* (22:4), pp. 39-68.
Gregory, T., Mathiassen, L., and Sambhara, C. 2013. "Chains of Control in Agile Software Development," in: *AMCIS 2013*. Chicago, USA.
Griffiths, T. L., and Steyvers, M. 2004. "Finding Scientific Topics," *Proceedings of the National academy of Sciences* (101:suppl 1), pp. 5228-5235.
Guinea, A. S., Nain, G., and Le Traon, Y. 2016. "A Systematic Review on the Engineering of Software for Ubiquitous Systems," *The Journal of Systems and Software* (118), p. 251.
Gupta, R. K., and Reddy, P. M. 2016. "Adapting Agile in a Globally Distributed Software Development," in: *HICSS 2016*. IEEE, pp. 5360-5367.
Hansson, C., Dittrich, Y., and Randall, D. 2006. "How to Include Users in the Development of Off-the-Shelf Software: A Case for Complementing Participatory Design with Agile Development," *HICSS 2006*: IEEE, pp. 175c-175c.
Hobbs, G., and Scheepers, R. 2010. "Agility in Information Systems: Enabling Capabilities for the It Function," *Pacific Asia Journal of the Association for Information Systems* (2:4).
Hobbs, G., and Scheepers, R. J. P. P. 2009. "Identifying Capabilites for the It Function to Create Agility in Information Systems," in: *PACIS 2009*. p. 20.
Hummel, M., Rosenkranz, C., and Holten, R. 2013. "The Role of Communication in Agile Systems Development," *Business & Information Systems Engineering* (5:5), pp. 343-355.
Inayat, I., Salim, S. S., Marczak, S., Daneva, M., and Shamshirband, S. 2015. "A Systematic Literature Review on Agile Requirements Engineering Practices and Challenges," *Computers in human behavior* (51), pp. 915-929.
Jain, R., Cao, L., Mohan, K., and Ramesh, B. 2015. "Situated Boundary Spanning: An Empirical Investigation of Requirements Engineering Practices in Product Family Development," *ACM Transactions on Management Information Systems* (5:3), p. 16.
Jalali, S., Wohlin, C., and Angelis, L. 2014. "Investigating the Applicability of Agility Assessment Surveys: A Case Study," *Journal of Systems and Software* (98), pp. 172-190.
Jørgensen, M. 2016. "A Survey on the Characteristics of Projects with Success in Delivering Client Benefits," *Information and Software Technology* (78), pp. 83-94.
Karlsson, F., and Ågerfalk, P. 2009. "Exploring Agile Values in Method Configuration," *European Journal of Information Systems* (18:4), pp. 300-316.

Kazman, R., Bass, L., and Klein, M. 2006. "The Essential Components of Software Architecture Design and Analysis," *Journal of Systems and Software* (79:8), pp. 1207-1216.
Krzanik, L., Rodriguez, P., Simila, J., Kuvaja, P., and Rohunen, A. 2010. "Exploring the Transient Nature of Agile Project Management Practices," *HICSS 2010*: IEEE, pp. 1-8.
Laanti, M. 2013. "Agile and Wellbeing--Stress, Empowerment, and Performance in Scrum and Kanban Teams," *HICSS 2013*: IEEE, pp. 4761-4770.
Larman, C. 2003. *Agile and Iterative Development: A Manager's Guide*. Pearson Education.
Lawrence, C., and Rodriguez, P. J. I. 2012. "The Interpretation and Legitimization of Values in Agile's Organizing Vision," *ECIS 2012*, pp. 15-2012.
Lee, G., and Xia, W. 2010. "Toward Agile: An Integrated Analysis of Quantitative and Qualitative Field Data on Software Development Agility," *MIS Quarterly* (34:1), pp. 87-115.
Levy, Y., and Ellis, T. J. 2006. "A Systems Approach to Conduct an Effective Literature Review in Support of Information Systems Research," *Informing Science* (9), pp. 181-212.
Lukins, S. K., Kraft, N. A., and Etzkorn, L. H. 2010. "Bug Localization Using Latent Dirichlet Allocation," *Information and Software Technology* (52:9), pp. 972-990.
Madsen, S., and Matook, S. 2010. "Conceptualizing Interpersonal Relationships in Agile Is Development," *ICIS 2010*, p. 102.
Maowen, W., Dong, Z. C., Weiyao, L., and Qiang, W. Q. 2012. "Text Topic Mining Based on Lda and Co-Occurrence Theory," *Computer Science & Education (ICCSE) 2012*: IEEE, pp. 525-528.
Maruping, L. M., Venkatesh, V., Thatcher, S. M., and Patel, P. C. 2015. "Folding under Pressure or Rising to the Occasion? Perceived Time Pressure and the Moderating Role of Team Temporal Leadership," *Academy of Management Journal* (58:5), pp. 1313-1333.
Maruping, L. M., Zhang, X., and Venkatesh, V. 2009. "Role of Collective Ownership and Coding Standards in Coordinating Expertise in Software Project Teams," *European Journal of Information Systems* (18:4), pp. 355-371.
Miles, M. B., and Huberman, A. M. 1994. *Qualitative Data Analysis : An Expanded Sourcebook*. Thousand Oaks: Sage Publications.
Mimno, D., Wallach, H. M., Talley, E., Leenders, M., and McCallum, A. 2011. "Optimizing Semantic Coherence in Topic Models," *Proceedings of the conference on empirical methods in natural language processing*: Association for Computational Linguistics, pp. 262-272.
Mossige, M., Gotlieb, A., and Meling, H. 2015. "Testing Robot Controllers Using Constraint Programming and Continuous Integration," *Information and Software Technology* (57), pp. 169-185.
Nejmeh, B. A., and Thomas, I. 2002. "Business-Driven Product Planning Using Feature Vectors and Increments," *IEEE software* (19:6), pp. 34-42.
Nurdiani, I., Börstler, J., and Fricker, S. A. 2016. "The Impacts of Agile and Lean Practices on Project Constraints: A Tertiary Study," *Journal of Systems and Software* (119), pp. 162-183.
Parrish, A., Smith, R., Hale, D., and Hale, J. 2004. "A Field Study of Developer Pairs: Productivity Impacts and Implications," *IEEE software* (21:5), pp. 76-79.
Pedregosa, F., Varoquaux, G., Gramfort, A., Michel, V., Thirion, B., Grisel, O., Blondel, M., Prettenhofer, P., Weiss, R., and Dubourg, V. 2011. "Scikit-Learn: Machine Learning in Python," *Journal of machine learning research* (12:Oct), pp. 2825-2830.
Poppendieck, M., and Poppendieck, T. 2003. *Lean Software Development: An Agile Toolkit*, (1 ed.). Addison-Wesley Longman, Amsterdam.
Pyhajarvi, M., Rautiainen, K., and Itkonen, J. 2003. "Increasing Understanding of the Modern Testing Perspective in Software Development Projects," *HICSS 2003*: IEEE, p. 10 pp.
Rajagopalan, S., Mathew, S., and Sugumaran, V. 2016. "Fit of Development Methodologies in Software Projects," in: *AMCIS 2016*.
Rajlich, V. 2006. "Changing the Paradigm of Software Engineering," *Communications of the ACM* (49:8), pp. 67-70.
Read, A., Briggs, R., and Vreede, G.-J. 2012. "Describing Agile Requirements Development and Communication Using Complex Adaptive Systems Theory," in: *AMCIS 2012*. Seattle, USA.
Recker, J., Holten, R., Hummel, M., and Rosenkranz, C. 2017. "How Agile Practices Impact Customer Responsiveness and Development Success: A Field Study," *Project Management Journal* (48:2), pp. 99-121.
Rothenberg, C. E., Chua, R., Bailey, J., Winter, M., Correa, C. N., de Lucena, S. C., Salvador, M. R., and Nadeau, T. D. 2014. "When Open Source Meets Network Control Planes," *Computer* (47:11), pp. 46-54.

Rowe, F. 2014. "What Literature Review Is Not: Diversity, Boundaries and Recommendations," *European Journal of Information Systems* (23:3), pp. 241-255.
Royce, W. W. 1970. "Managing the Development of Large Software Systems: Concepts and Techniques," *Proceedings of WesCon*.
Saldaña, J. 2016. *The Coding Manual for Qualitative Researchers*. London: SAGE.
Salovaara, A., and Tuunainen, V. K. 2013. "Software Developers' Online Chat as an Intra-Firm Mechanism for Sharing Ephemeral Knowledge," in: *ICIS 2013*.
Sarker, S., and Sarker, S. 2009. "Exploring Agility in Distributed Information Systems Development Teams: An Interpretive Study in an Offshoring Context," *Information Systems Research* (20:3), pp. 440-462.
Smits, H. 2007. "The Impact of Scaling on Planning Activities in an Agile Software Development Center," *HICSS 2007*: IEEE, pp. 274c-274c.
Srivastava, A. N., and Sahami, M. 2009. *Text Mining: Classification, Clustering, and Applications*. CRC Press.
Strasser, A., and Westner, M. 2015. "Information Systems Offshoring: Results of a Systematic Literature Review," *Journal of Information Technology Management* (26:2), pp. 70-142.
Strauss, A., and Corbin, J. 1998. *Basics of Qualitative Research*. London: Sage.
Tripp, J. F., Riemenschneider, C., and Thatcher, J. B. 2016. "Job Satisfaction in Agile Development Teams: Agile Development as Work Redesign," *Journal of the Association for Information Systems* (17:4), p. 267.
Tripp, J. F., and Riemenschneider, C. K. 2014. "Toward an Understanding of Job Satisfaction on Agile Teams: Agile Development as Work Redesign," *HICSS 2014*: IEEE, pp. 3993-4002.
Turk, D., Robert, F., and Rumpe, B. 2005. "Assumptions Underlying Agile Software-Development Processes," *Journal of Database Management* (16:4), pp. 62-87.
Venugopal, C. 2005. "Single Goal Set: A New Paradigm for It Megaproject Success," *IEEE software*:5), pp. 48-53.
Version One. 2018. "12th Annual State of Agile Report," Version One.
Vodde, B., and Koskela, L. 2007. "Learning Test-Driven Development by Counting Lines," *IEEE Software* (24:3).
Vom Brocke, J., Simons, A., Riemer, K., Niehaves, B., Plattfaut, R., and Cleven, A. 2015. "Standing on the Shoulders of Giants: Challenges and Recommendations of Literature Search in Information Systems Research," *Communications of the association for information systems* (37), p. 9.
Wale-Kolade, A. Y. 2015. "Integrating Usability Work into a Large Inter-Organisational Agile Development Project: Tactics Developed by Usability Designers," *Journal of Systems and Software* (100), pp. 54-66.
Wang, X., Conboy, K., and Pikkarainen, M. 2012. "Assimilation of Agile Practices in Use," *Information Systems Journal* (22:6), pp. 435-456.
Webster, J., and Watson, R. T. 2002. "Analyzing the Past to Prepare for the Future: Writing a Literature Review," *MIS Quarterly* (26:2), p. 11.
Wiener, M., Mähring, M., Remus, U., and Saunders, C. S. J. M. Q. 2016. "Control Configuration and Control Enactment in Information Systems Projects: Review and Expanded Theoretical Framework," (40:3), pp. 741-774.
Williams, L., and Cockburn, A. 2003. "Agile Software Development: It's About Feedback and Change," *Computer* (36:6), pp. 39-44.
Wolcott, H. F. 1994. *Transforming Qualitative Data : Description, Analysis, and Interpretation*. Thousand Oaks, Ca.: Sage.
Woods, E. 2015. "Aligning Architecture Work with Agile Teams," *IEEE Software* (32:5), pp. 24-26.
Xu, P., and Shen, Y. 2016. "Empowering Leadership, Transactive Memory Systems and Agility in Software Development Teams: A Theoretical Framework," in: *AMCIS 2016*.
Zheng, Y., Venters, W., and Cornford, T. 2011. "Collective Agility, Paradox and Organizational Improvisation: The Development of a Particle Physics Grid," *Information Systems Journal* (21:4), pp. 303-334.
Zhi, J., Garousi-Yusifoğlu, V., Sun, B., Garousi, G., Shahnewaz, S., and Ruhe, G. 2015. "Cost, Benefits and Quality of Software Development Documentation: A Systematic Mapping," *Journal of Systems and Software* (99), pp. 175-198.