PUTTING THE "SOCIO" IN SOCIO-TECHNICAL DEVELOPMENT

Investigating the Effects of Psychological Safety in Agile Information Systems Development

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Abstract

An essential part of project management is the management of teams, their actions, and their social systems. Team processes, behavior, and routines used by team members play important parts in the success of projects. Over the last two decades, agile methods have become a dominating force in information systems development approaches. Agile methods emphasize both the need for accepting and embracing constant change in the project and its environment as well as the need for many, regular, and close social interactions within the team. These aspects have been defining for the incarnation of agile practices, such as daily stand-up meetings or retrospectives. Contrary to what one might expect, agile projects still have come short of their anticipated benefits and research has yet to find answers why.

The concept of psychological safety could be suited perfectly to explain — and reverse — the shortcomings of agile methods. As agile methods describe a multitude of practices to implement as team routines aimed at fostering team responses to changes and team interactions, these practices present themselves as critical artifacts for effective project management. At the same time, to reap the benefits of these highly interactive and social-focused agile practices, team members need to feel safe to speak freely and openly, which has been conceptualized as psychological safety. How these concepts interact and what this implies for (agile) project management, however, is unknown.

This dissertation addresses this puzzle by conducting four independent yet interrelated studies that (1) formally investigate the current body of knowledge and motivates the need for novel explanations, (2) conduct

exploratory research to derive a model of the interaction between agile practices, psychological safety, and resilience, (3) offers a quantitative evaluation of the preliminary model, as well as (4) provide additional robustness checks by evaluating a rival theory. Collectively, these studies advance our understanding of the interweaving of agile practices, psychological safety, and resilience, therefore paving the way for improved agile project management.

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Abbreviations

AISD ..... Agile Information Systems Development

CB ..... Covariance-Based

LDA ..... Latent Dirichlet Allocation

IS ..... Information Systems

ISD ..... Information Systems Development

IT ..... Information Technology

PLS ..... Partial-Least-Squares

PS ..... Psychological Safety

SAPs ..... Social Agile Practices

SEM ..... Structural Equation Modeling

Change is the law of life.

> And those who look only to the past or the present
> are certain to miss the future.
>
> *John F. Kennedy*

Chapter 1: Dissertation Overview

1.1 Introduction

Two decades after the Agile Manifesto (Beck et al. 2001), *agile information systems development* (AISD) methodologies dominate the world of *information systems development* (ISD) methodologies (VersionOne 2020). However, AISD methodologies embody a key tension: While they intensify communication and social interaction and emphasize team autonomy and self-management, they are often introduced into environments that operate under fundamentally different and incompatible paradigms — for instance, stern hierarchies or knowledge silos. As a consequence, we do not know how they can effectively be implemented — as further supported by mixed results of real-world performance, which show a disillusion of the rush of AISD's early rock-star-like popularity (Niederman et al. 2018).

Practitioner reports have proposed social and psychological aspects as the missing link to solve this puzzle of AISD's promises versus high failure rates, its disaccords versus continuously rising popularity (DevOps Research & Assessment and Google Cloud 2019; Freudenberg and Sharp 2010). Especially as AISD is emphasizing team autonomy and the need for continuous communication, collaboration, and synchronization as well as introspection and adaptation (Beck et al. 2001), social and psychological effects are a natural match for resolving current issues in AISD. A key concept of recent organizational psychology offering an explanation for this puzzle is *psychological safety*. Psychological safety explains, among other, team learning (Bunderson and Boumgarden 2010), a team's ability to learn from failures (Carmeli and Gittell 2009; Jehn et al. 2014), and

overall team performance (Schaubroeck et al. 2011) — especially in diverse or cross-functional teams (Singh et al. 2013). Explaining these aspects of general teamwork, psychological safety is a promising candidate to explain why certain AISD teams thrive despite incompatible paradigms while others fail: Increased team learning, especially from failures and in cross-functional teams, is likely to help teams adapt to and work around changing or adverse environments, such as stern hierarchies or knowledge silos.

To zoom out again, psychological safety and its positive effect on the team capability of learning from failures is further beneficial to tackle one of AISD's core values: Embracing change. Being one of the more pronounced differences to traditional *information systems* (IS) development methods (Cockburn and Highsmith 2001; Conboy 2009; Dybå and Dingsøyr 2008), it has been reflected in academia by defining AISD (or more precisely: *agility in an ISD context*) as:

> *"the continual readiness of an ISD method to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value (economy, quality, and simplicity), through its collective components and relationships with its environment" (Conboy 2009, p. 340).*

In contrast to this, traditional methods aim at predicting requirements at the project beginning and then implementing this plan without major changes. AISD treats changes as an inevitable force to be reckoned with and therefore incorporates constant feedback and iterative changes in the project lifecycle. This, however, adds an additional layer of complexity compared to non-agile approaches (e.g., Niederman et al. 2018). AISD teams, therefore, need to be *resilient* (i.e., having the ability to withstand

disruptive factors; Chakravarty et al. 2013), a trait mainly gained through constant feedback, communication, and synchronization (Hartwig et al. 2020; Son et al. 2020). As communication, collaboration, and synchronization (i.e., social interactions) are not only directly (i.e., through practices) enforced but also required by indirect factors (i.e., needed level of resilience), social and psychological effects, which might influence these interactions, are auspicious candidates for explaining and bridging the gap between theoretical expectations and practical reality.

1.2 Problematization and Research Question

In industry, different teams report different experiences and preferences regarding AISD practices (VersionOne 2020). How do these differences come to be? Do they, as one might presume, originate in differences in project characteristics? Are team composition and individual characteristics more suitable explanators? These questions relate back to the tension of AISD's core values and AISD's environmental or paradigm fit. The sometimes implicit (e.g., the need for communication when sensing or responding to change), sometimes explicit (e.g., the emphasis of individuals and interactions over processes and tools) requirements AISD places on the social and psychological embedding, such as insufficient team autonomy or interpersonal conflict, are, if not met, roadblocks for any team aiming for agility (Dreesen et al. 2020; Jehn et al. 2014; Sawyer et al. 2010). Similarly, increased interactions are not always helpful, as too much communication can lead to overhead and tensions within an otherwise agile team (Ely and Thomas 2001; Leonard et al. 2004; MacMillan et al. 2004).

Aside from AISD projects in general, researchers and practitioners alike report difficulties in agile transformation projects as well (i.e., the transformation from traditional, waterfall-like projects to agile; e.g., Barroca et al. (2019); Maples (2009)). How do agile transformations differ from other transformation projects? Why are established change management approaches not working (well) for agile transformations? As becoming apparent when investigating failed agile transformation projects, our current knowledge is insufficient for explaining the issues of implementing AISD methods (Diegmann et al. 2020). General change management, method tailoring, or organizational transformation literature might, on an abstract level, describe the broader context of failure (e.g., Fitzgerald et al. 2006a; Iivari and Iivari 2011) but fall short of offering explanations for the failures or issues of AISD projects, especially for agile transformation projects. As an example, change management literature so far has mostly dealt with top-down managed teams from the perspective of top and middle management (c.f. Todnem By 2005), and has mostly ignored the self-organizing, bottom-up way and transparency that AISD methods entail. For instance, practitioners report that many have tried to transform towards agile but ended up being less agile than before – practitioners further state that new insights (based on best practices) are needed, especially on the "human-side of the equation" (McGregor and Doshi 2018).

Such a "human-side"-centric concept might stem from organizational psychology: Psychological safety is a prime candidate to not only explain many social and psychological issues in AISD, but also offer avenues for improving the status quo (Bunderson and Boumgarden 2010; Carmeli and Gittell 2009; Jehn et al. 2014; Schaubroeck et al. 2011; Singh et al.

2013). While extant research thus provides ample insights into psychological safety, its applicability and effects in AISD teams is yet unknown. Research has investigated psychological safety in teams sharing some similarities to AISD, for instance, diverse teams (Singh et al. 2013), yet teams which combine a multitude AISD-specific characteristics (e.g., cross-functionality, ritualized and regular social interactions, or resilience) have not been investigated. Psychological safety's applicability and utility for explaining shortcomings of AISD and means of improvement are therefore unknown.

As research offers only limited insight into the complex interweaving of social and psychological effects at play in AISD teams and no guidance on how to overcome these bottlenecks, a practice-oriented convergence to the underlying research problem is warranted. This dissertation, following this argumentation, therefore pursues the following overarching research question:

> *How do Agile Practices and Psychological Safety interact and affect Team Resilience?*

This research question is composited of multiple underlying questions, which are introduced in detail in 0, but will also inform the structure of this dissertation as laid out next.

1.3 Structure of this Dissertation

As this dissertation is composed cumulatively, the overarching research question is addressed by four independent yet interrelated studies. The first study uncovers the need for more social- and team-focused research on AISD (*Study 1, Chapter 6*). The second study explores this problem

domain by means of a qualitative, multiple-case study (*Study 2, Chapter 7*). The third study evaluates the resulting model quantitatively by means of a questionnaire and covariance-based structural equation modeling (*Study 3, Chapter 8*). The fourth and final study adds a robustness check by evaluating a rival theory (*Study 4, Chapter 9*). Table 1-1 provides a summative overview of each study and its status as regards publication. Additional details per study, for instance, regarding the research design and how the studies interrelate, can be found in Chapter 3.

All studies in this dissertation result from varying levels of collaborative research endeavors. Table 1-2 therefore highlights each co-author's detailed contributions to the respective studies and highlight my own contributions per study. In Study 1, the initial research design was proposed by Tim Dreesen and refined by Phil Hennel, while most of the following analysis, theorizing and writing was done as by Phil Hennel, Tim Dreesen, and Christoph Rosenkranz. The data collection process was additionally supported by Björn Binzer. Study 2 was mostly driven by Phil Hennel, but the data collection process was supported by Tim Dreesen and both theorizing and write-up was led by Phil Hennel and supported by Christoph Rosenkranz. Studies 3 and 4 were conducted similarly to Study two but with more involvement of Tim Dreesen in terms of data collection and general, mutual support regarding research design and data analysis. The actual processes of data collection and analysis, however, were done by Phil Hennel individually, as was, in contrast to Study 2, the write-up.

This dissertation proceeds as follows. 0 presents an overview of related work and puts this dissertation into context. The foundations of AISD are laid out, and the ancillary psychological concepts are introduced. Chapter

3 describes the research strategies and data sources used by the studies within this dissertation. Chapter 4 summarizes each paper's individual contributions and outlines the overarching and combined contributions as well as limitations and avenues for future research. Before presenting each study in detail, Chapter 5 provides a brief conclusion. Lastly, in each of the Chapters 6 to 9 one of the papers corresponding to one of the four studies is presented.

#	Study Title	Aspect	Research Design	Study Status
1	Journey Towards Agility: Three Decades of Research on Agile Information Systems Development	Uncover the need for social- and team-focused research on AISD	Computer-aided analysis of peer-reviewed research articles on AISD. Utilization of Latent Dirichlet Allocation for automated and less subjective approach for clustering topic-wise similar studies. Qualitative analysis and interpretation of the results.	Presented at the *International Conference on Information Systems 2018*; two rounds of reviews at *Project Management Journal.*
2	Investigating the "Socio" in Socio-Technical Development: The Case for Psychological Safety in Agile Information Systems Development	Qualitative exploration of the problem domain	Multiple-case study, based mostly on semi-structured interviews around social- and psychological aspects of AISD. Qualitative analysis and interpretation of the results with the aim of deriving a preliminary model.	Previous version presented at the *International Research Workshop on IT Project Management 2018*; published at *Project Management Journal.*
3	Resilience and Social Agile Practices: The Role of Psychological Safety in Agile Information Systems Development	Quantitative evaluation of the qualitatively derived model	Data collected via questionnaires in a large consulting firm. Covariance-based structural equation modeling for model evaluation and hypothesis testing.	Accepted at the *2nd AIS SIG DITE paper development workshop;* preparing for journal submission in late 2021 or early 2022.
4	Psychological Safety in Agile Information Systems Development: Explaining Team Resilience	Adding a robustness check by evaluating a rival theory	Reused data from #3. Covariance-based structural equation modeling for model evaluation and hypothesis testing of a rival model.	Submitted to the *International Conference on Information Systems 2021.*

Table 1-1. Overview of Studies

Study Title	Journey Towards Agility: Three Decades of Research on Agile Information Systems Development	Investigating the "Socio" in Socio-Technical Development: The Case for Psychological Safety in Agile Information Systems Development	Resilience and Social Agile Practices: The Role of Psychological Safety in Agile Information Systems Development	Psychological Safety in Agile Information Systems Development: Explaining Team Resilience
Research Team	*Hennel*; Dreesen; Binzer; Rosenkranz	*Hennel*; Rosenkranz	*Hennel*; Dreesen; Rosenkranz	*Hennel*; Dreesen; Rosenkranz
Research Design	Dreesen; *Hennel*	*Hennel*	*Hennel*	*Hennel*
Data Collection	*Hennel*; Dreesen; Binzer	*Hennel*; Dreesen	*Hennel*; Dreesen	*Hennel*; Dreesen
Data Analysis	*Hennel*; Dreesen; Rosenkranz	*Hennel*	*Hennel*	*Hennel*
Theorizing	*Hennel*; Dreesen; Rosenkranz	*Hennel*; Rosenkranz	*Hennel*; Rosenkranz	*Hennel*; Rosenkranz
Write Up	Dreesen; *Hennel*; Rosenkranz	*Hennel*; Rosenkranz	*Hennel*	*Hennel*

Table 1-2. Research Team per Study

Chapter 2: Related Work on Psychological Safety and Agile Information Systems Development

2.1 (Agile) Information Systems Development Approaches

For many decades, IS have been and still are most often developed in the form of projects (Hirschheim et al. 1995, p. 33), with many involved stakeholders from various domains, business units, and project team members (Chae and Poole 2005). As the nature of AISD is in many aspects intangible (Cule et al. 2000), many major problems of AISD projects are not so much technological as sociological in nature (DeMarco and Lister 1987, p. 4). For AISD projects, coordination and communication are key success factors (Gallivan and Keil 2003; Ko et al. 2005), and creating a shared understanding is deemed to be a major driver for project success (Corvera Charaf et al. 2013; Gallivan and Keil 2003; Rosenkranz et al. 2013; Tan 1994).

Before diving deeper into the different aspects of AISD, *agile* as a generalizable concept needs to be defined. While no clear consensus has been reached on the exact definition, the definition provided by Conboy (2009), derived from first principles, will be used for this thesis. Conboy (2009) argues that derived from flexibility and leanness, each contrasted and compared with agility as a whole, a definition of *ISD agility* can be derived. For the context of this dissertation, "agile" refers to "ISD agility" especially, albeit not necessarily being limited to ISD contexts. The final definition of *ISD agility* followingly is:

> *"the continual readiness of an ISD method to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value (economy,*

> *quality, and simplicity), through its collective components and relationships with its environment." (Conboy 2009, p. 340)*

Following this, I see agile as the combination of flexibility, leanness, and agility. Further, I differentiate agile as a concept from agile methods, which I see as combinations of values and processes, each supporting the underlying ideas of agile. The latter, often referred to as practices, are rituals or procedures which teams follow in a structured and intentional manner, implemented consciously to become more agile.

2.1.1 Agile Methods and Practices

Diving deeper into this generalized understanding of agility, research has applied the term *agile* to many variations and specializations of project management approaches aimed at adapting to an uncertain environment, often building upon iterative phases (e.g., Ågerfalk et al. 2009; Dybå and Dingsøyr 2008; Werder et al. 2021). This understanding of "agile" resulted in the agglomeration of a spectrum of *agile methods*, collections of prescriptions, ideas, rituals, and procedures or processes often stemming from "best practices" or generalized experiences of practitioners (Abrahamsson et al. 2017; Abrahamsson et al. 2003; Dingsøyr et al. 2012).

As most agile methods consist not only of values but also actionable processes or practices (i.e., manifestations of agile principles), the term *agile practices* has been coined. One such practice is holding brief daily meetings which aim at synchronizing the team, having each member explain their current status, what they have been and what they are working on. This agile practice is often called "daily stand-up meetings" as they are supposed to be done standing to facilitate short and speedy meetings. Another, similar practice are code reviews. Regularly (i.e., in

fixed intervals or per action, e.g., after each merge request) held reviews by team members for other team members' code help to distribute knowledge, facilitate learning, and help identify errors early. Over time, an understanding of interchangeability of practices — the so-called method tailoring — has evolved, leading to a multiverse of agile methods, reusing, adapting, or (re-)inventing agile practices (Campanelli and Parreiras 2015; Fitzgerald et al. 2006a).

One subgroup of agile practices are *social agile practices (SAPs; Hummel et al. 2015).* These are those agile practices that focus or rely on communication or knowledge exchange and facilitate interpersonal (i.e., social) interactions (Hummel et al. 2015). Examples of such practices are daily stand-up meetings (which inherently contain communication), retrospectives (which focus on speaking freely and openly about issues within the team), or pair programming (which usually focuses on one-on-one interaction and resembles intensive social interaction).

2.1.2 The Special Role of Teams in Agile

In general, and zooming out again, the approaches for developing IS range from sequential (Royce 1970) to more cyclic, iterative approaches (Boehm 1988), of which AISD methodologies (Cao et al. 2009b; Vidgen and Wang 2009) represent a subset. They trade stricter control for increased flexibility and autonomy within the team. Due to the iterative nature and due to the increased autonomy in the team, the overall development process is neither planned nor scheduled upfront. In contrast to more traditional approaches, progress is made in small iterative phases, encouraging frequent change and constant (customer) feedback (Cockburn and Highsmith 2001; Highsmith and Cockburn 2001). This

can drastically improve quality by reducing the length of each pre-planned element, effectively making deadlines more manageable (Basten et al. 2021). Planning, therefore, becomes a permanent task instead of a singular event early in the project, and team leadership is established much more via collaboration and is separated farther from project lead (Dybå and Dingsøyr 2008; Dybå and Dingsøyr 2009).

As these characteristics of AISD show, the team is the crucial aspect of AISD in practice. Looking at AISD research, however, it shows that mainly specific and individual or organizational phenomena, such as the use and effects of specific agile practices (e.g., Balijepally et al. 2009; Holmqvist and Pessi 2006; Maruping et al. 2009b) have been investigated. Research also extends into effects regarding projects or organizations as a whole, such as the introduction of AISD methods to teams (e.g., Cao et al. 2009b; Heeager 2012; Hong et al. 2011; Kotlarsky 2007; Mangalaraj et al. 2009).

Research at the core of AISD has long been looking for different factors for explaining why some teams excel in uncertain environments and show strong resilience to requirement changes while others do not. For instance, Lee and Xia (2010) demonstrated the influence team autonomy and diversity can have on project performance, as measured by timeliness, budget, and functionality: Both team autonomy and team diversity have indirect effects on all three dependent variables mediated by team response extensiveness and efficiency. Extending this model of AISD success, Recker et al. (2017) show that management-related AISD practices (e.g., stand-up meetings) affect response extensiveness oppositely to development-related practices (e.g., pair programming). Similarly, Maruping et al. (2009a) explained project quality not only by AISD

practice usage but also that this effect was moderated by requirements change, outcome control, and self-control. These three studies investigate aspects of two of the categories provided by the taxonomy of agility by Conboy (2009): Rapid change (by response extensiveness and effectiveness; Recker et al. 2017) as well as software quality (Maruping et al. 2009a). This dissertation aims at presenting the first steps for extending theory towards the category of learning from change, as will become apparent in the next sections.

2.1.3 Summarizing the Current State of Research on Agile

Combined, these glimpses into the current state of AISD research show that empirical research has been increasing since the call from Dybå and Dingsøyr (2008) for more studies on AISD in general and on other methods than XP in particular. However — and as *Study 1, Chapter 6* shows in more detail — research quality is still not as high as one might have expected (at least when measured via publications in top outlets) and social and psychological factors are still covered sparsely and have not continued to rise as other areas of research did. As the individual and organization-wide effects of AISD have been covered increasingly well, team-level effects are covered much less so. Extending the view beyond IS research, organizational theory, and specifically teamwork research, has included technology as an influencing factor of teamwork (e.g., Kozlowski and Ilgen 2006; Salas et al. 2017), but specific features of agile methods or AISD specifically have not been investigated or conceptualized.

2.2 Team Autonomy

At the same time as AISD focuses on direct collaboration and separating team leadership from project leadership, AISD also asserts that increasing

discretion for teams to organize and execute their tasks themselves also improves results (Beck et al. 2001). The resulting flexibility and adaptiveness are often referred to as team autonomy (Larman 2003; Lee and Xia 2010). Prior literature provides a range of similar definitions, synonyms, and related concepts, such as self-organization (Chow and Cao 2008; Highsmith and Cockburn 2001; Hoda et al. 2013), self-management (Sharp and Robinson 2004), and team empowerment (Larman 2003; Maruping and Magni 2012). Following extant research, I use the following definition of *team autonomy* throughout this dissertation: "[team autonomy is] the degree of discretion and independence granted to the team in scheduling the work, determining the procedures and methods to be used, selecting and deploying resources, hiring and firing team members, assigning tasks to team members, and carrying out assigned tasks" (Lee and Xia 2010, p. 90).

As noted above, the emphasis on team autonomy in AISD stems from the underlying idea that teams need to be given broad discretion in organizing, executing, and prioritizing their work themselves to achieve the most optimal results (Beck et al. 2001). For instance, team autonomy leads to shorter reaction times as teams can more easily reorganize themselves quickly without running up the chain of commands. This shorter path length for communication, coordination, and decision making is therefore improving team resilience.

2.3 Team Resilience

One concept closely linked to efficiency and problem-solving ability — and being also repeatedly linked to AISD — is *team resilience* (Meneghel et al. 2016). AISD explicitly acknowledges the importance of being able to

respond to requirement changes and even embrace change and an ever-changing environment (Beck et al. 2001). Changes, being environmental or related to requirements, impose difficulties for and shocks on the team. AISD teams, therefore, have to have the capacity to recover quickly from changes and difficulties — the textbook definition of resilience (Oxford English Dictionary).

Resilience, in general, has been used in biology to describe the ability of a dynamic multispecies ecological system to persist with the same basic structure when subjected to stress (Holling 1973). Derived from this, resilience in team and organizational research is used to describe a team's ability to "withstand disruptive factors, synonymous with both buffering against disruptive factors and correcting for disruptive factors without significant strategic changes" (Chakravarty et al. 2013, p. 983).

As mentioned at the beginning of this section, AISD explicitly stresses the importance of being able to respond to and even welcome and embrace requirement changes (Beck et al. 2001). Resilience, followingly, is an important team trait for successful AISD teams, as changes in requirements is one of the main reasons ISD projects — still — fail (Maruping et al. 2009a).

While resilience can stem from different sources (e.g., individual characteristics, mood, environment) and can vary depending on the present disruption, one — intuitive and important — way to develop resilience is a critical review by the team of the team and its success (Alliger et al. 2015). Referring back to the previous section on AISD, this "critical review" is implemented in many AISD teams within the practice of retrospectives.

Zooming out from the specific AISD practices, to handle crises "resiliently," communication and collaboration are essential (Hartwig et al. 2020; Son et al. 2020). Teams, keeping themselves synchronized, can adapt quickly and change their strategies "midflight." To do so efficiently and effectively (i.e., comprehensively and transparently), however, team members need to feel that they can voice concerns, criticism, and unpopular or unusual ideas. These actions can be seen as team members feeling free to take interpersonal risks — conceptualized as psychological safety in organizational behavior research (Edmondson 1999).

2.4 Psychological Safety

Considering all these aspects of AISD research, one clearly sees that successful AISD teams rely heavily on their team members and their mutual interactions. This dissertation posits that implementing AISD practices, which extend beyond pseudo-agility but embrace core agile values such as frequent and intensive interactions ("individuals and interactions", Beck et al. 2001; Hummel et al. 2013), embracing change ("responding to change"; Beck et al. 2001; Conboy 2009), or principles such as team autonomy ("trust them to get the job done"; Beck et al. 2001; Lee and Xia 2010) and self-reflection ("the team reflects on how to become more effective"; Beck et al. (2001); Lehtinen et al. (2017)), entails a variety of social and psychological factors. Especially the AISD practice of retrospectives (derived from the similarly named principle) — a practice where the team meets after each sprint and critically reflects what went good or bad, and how the team wants to change its processes and rituals for the next sprint to improve (Derby et al. 2006) — only may work well when team members openly and honestly talk about the issues within the

team. They need to feel safe to open up about problems and propose novel, possibly controversial, ideas on how to solve these problems. Essentially, prior research on teams has conceptualized an important antecedent of all these factors as psychological safety (Edmondson 1999).

In organizational psychology, *psychological safety* has been defined as "a shared belief held by members of a team that the team is safe for interpersonal risk taking" (Edmondson 1999, p. 354). Recent research used this concept to explain organizational learning (Nembhard and Edmondson 2006), information sharing behavior, and how team members are motivated to speak up for improvements (Detert and Burris 2007; Liang et al. 2012) or to take initiatives to innovate (Baer and Frese 2003). Further, psychological safety improves team learning (Bunderson and Boumgarden 2010), the ability to learn from failures (Carmeli and Gittell 2009; Jehn et al. 2014), and overall performance (Schaubroeck et al. 2011), especially in diverse teams (Singh et al. 2013). In addition to its direct effects, psychological safety has been found to moderate (i.e., mitigate) the negative effect of diversity on performance (Roberge and van Dick 2010).

Psychological safety may offer a conceptualization that helps to explain some of the "unfulfilled promises" of AISD — more precisely, it offers an explanation of when and how benefits from socially-focused AISD practices can be realized, namely in an environment that is perceived as safe to open up and share personal insights. Integrating the importance of resilience — as well as its dependency on critical (team-based) self-reflection — the crucial nature of a psychologically safe environment that enables such self-reflection within a team becomes apparent. Suppose

psychological safety is not or not sufficiently present. In that case, team members of AISD teams might not feel safe enough to voice criticism or concerns (and therefore minimize the effectiveness of SAPs such as retrospectives) or present novel or unusual ideas (and therefore minimize team resilience in crises).

In recent IS research, theories of organizational psychology have been applied, but only with a focus on information technology (IT) use (e.g., Gorecki et al. 2008; Nan 2011; Wang and Hahn 2015). While these ideas of social and psychological effects on teams thus are not entirely new to IS-related research, psychological safety hitherto has not been investigated by AISD research.

2.5 Summary and Working Definitions for this Dissertation

Reflecting on all four of the concepts covered above, the motivation and problematization presented in 0 becomes more eclectic: AISD research has evolved and grown significantly over the past two decades, but a clear understanding of the inner works of AISD remains obscure. Rather than solving the puzzle, research has found new layers of interconnected and interdependent concepts.

Looking at the organizational or individual level, AISD research has found many answers to open questions (e.g., compare the findings from *Study 1, Chapter 6* to Dybå and Dingsøyr (2008)). Still, team-level effects remain sparsely covered (see *Study 1, Chapter 6* and *Study 2, Chapter 7*), albeit they offer a multitude of candidates for explaining the unexplained in AISD: as shown in the previous sections, team autonomy, resilience, and psychological safety have many links to AISD related effects. For instance, resilience has been linked to AISD (Meneghel et al. 2016), but enabling

factors on a social or psychological level within a team have not been covered. Similarly, psychological safety explains many team-level effects related to important aspects of AISD teamwork (e.g., learning from failures; Carmeli and Gittell 2009; Jehn et al. 2014), yet practitioners' calls for more research remain mostly unanswered (DevOps Research & Assessment and Google Cloud 2019).

To close this chapter and to concisely define all important concepts, Table 2-1 lists all important definitions and provides core references for each concept.

Concept	Definition	References
Information Systems Development Agility	The "continual readiness of an ISD method to rapidly or inherently create change, proactively or reactively embrace change, and learn from change while contributing to perceived customer value (economy, quality, and simplicity), through its collective components and relationships with its environment."	Conboy (2009, p. 340)
Agile Methods	Collections of values, prescriptions, ideas, rituals, and procedures or processes often stemming from "best practices" of practitioners.	Abrahamsson et al. (2017); Abrahamsson et al. (2003); Dingsøyr et al. (2012)
Agile Practices	Rituals or procedures which teams follow in a structured manner, implemented consciously to become more agile.	Abrahamsson et al. (2017); Abrahamsson et al. (2003); Dingsøyr et al. (2012)
Social Agile Practices (SAPs)	Agile practices which entail communication practices or practices which aim to exchange knowledge and facilitate interpersonal interaction (especially daily scrums, retrospectives, and pair programming).	Hummel et al. (2015) Tripp et al. (2016)
Team Autonomy	"[...] the degree of discretion and independence granted to the team in scheduling the work, determining the procedures and methods to be used, selecting and deploying resources, hiring and firing team members, assigning tasks to team members, and carrying out assigned tasks."	Lee and Xia (2010, p. 90)
Team Resilience	A team's ability to "[...] withstand disruptive factors, synonymous with both buffering against disruptive factors and correcting for disruptive factors without significant strategic changes."	Chakravarty et al. (2013, p. 983)
Psychological Safety	"[...] a shared belief held by members of a team that the team is safe for interpersonal risk taking."	Edmondson (1999, p. 354)

Table 2-1. Working Definitions of Important Concepts for this Dissertation

Chapter 3: Research Strategy and Data Sources

To answer the overarching line of inquiry and answer the guiding research question outlined in 0, this dissertation is composed of four studies. Specifically, each study addresses one of the following research questions:

RQ 1: *What research topics have been addressed within the last three decades by AISD research, and how do these topics differ in terms of available publications and their distribution over time?* (*Study 1, Chapter 6*)

RQ 2: *How and why does the use of agile practices and their interaction with psychological safety affect project team behavior and, in turn, performance?* (*Study 2, Chapter 7*)

RQ 3: *Does psychological safety moderate the effects of agile practices and affect team resilience?* (*Study 3, Chapter 8*)

RQ 4: *Does psychological safety covariate with agile practices — and does a combined effect affect team resilience?* (*Study 4, Chapter 9*)

To answer these questions, the individual studies follow different methods and research designs. Study one builds upon a structured literature review and a computer-aided analysis approach (i.e., topic modeling) as well as manual coding and sense-making of the results. The second study relies on data gathered from semi-structured interviews and observations, implementing a first- and second cycle of coding for interpretation of the qualitative data. Studies three and four use similar methods and research designs: By means of a quantitative survey, both studies analyze the

gathered data utilizing covariance-based structural equation modeling (CB-SEM).

Regarding the relation between the four studies in brief, the first study motivates the other three by examining the gap in the literature and providing a (generalized) research agenda. The second study lays the groundwork for the actual model evaluation by conducting exploratory research, resulting in a preliminary model. This preliminary model is then evaluated in studies five and six. While study five is concerned with the initial hypothesis testing, study six aims at adding additional confidence in the findings of study three by falsifying a rival theory. Figure 3-1 summarizes the motivations, research designs, and results of each paper, as well as the interrelation between them. Table 3-1 provides a summary of all four studies. In the following, I provide an overview of each of the four studies to explain how they contribute to the overarching research goal and how they are interconnected.

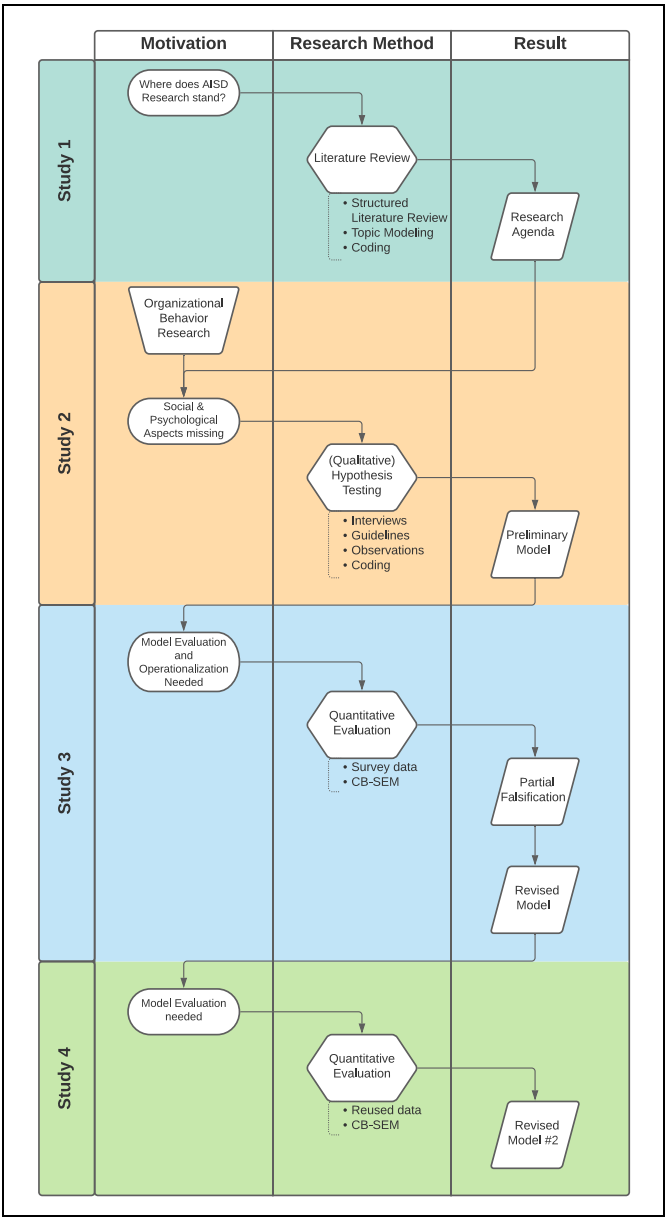

Figure 3-1. Motivations, Research Designs, Results, and Connections between Studies

Study Title	**Journey Towards Agility: Three Decades of Research on Agile Information Systems Development** *(Nominated for Best Paper)*	**Investigating the "Socio" in Socio-Technical Development: The Case for Psychological Safety in Agile Information Systems Development**	**Psychological Safety in Agile Information Systems Development: Explaining Team Resilience**	**Resilience and Social Agile Practices: The Role of Psychological Safety in Agile Information Systems Development**
Research Approach	Inductive literature review and qualitative interpretation	Deductive, embedded, multiple case study	Deductive hypothesis testing via CB-SEM	Deductive hypothesis testing via CB-SEM
Used Guidelines	Levy and Ellis (2006); Miles and Huberman (1994); Saldaña (2016); Vom Brocke et al. (2015); Webster and Watson (2002)	Miles and Huberman (1994); Saldaña (2016)	Brown (2015); Goddard and Melville (2004); Hair (2009); Jackson et al. (2009); Lowry and Gaskin (2014); Saunders et al. (2009)	Brown (2015); Goddard and Melville (2004); Hair (2009); Jackson et al. (2009); Lowry and Gaskin (2014); Saunders et al. (2009)
Empirical Setting	AISD research-oriented (peer-reviewed) publications	Four case organizations (insurance, consulting, small-to-medium enterprise B2B services)	One large, global consulting firm	One large, global consulting firm
Role of Theory	Theory development through literature research	Theory development through field research	Theory testing through hypothesis testing	Theory testing through falsification
Data Sources	775 peer-reviewed research articles	13 semi-structured interviews; supporting documents (guidelines etc.)	Online questionnaire: 173 participants	Online questionnaire: 173 participants (data reused from #3)
Contribution	Research agenda for AISD-related research; insight into the history of AISD research	Identified two-sided, reciprocal relationship between AISD practices and psychological safety; preliminary model for interaction effects and their effect on resilience	Revision of the preliminary model; clearer role of both AISD practices and psychological safety for resilience; furthered the AISD research agenda	Strengthening of the findings from #3; falsification of a rival theory, therefore minimizing the scope of the unknown

Table 3-1. Research Approaches

3.1 Motivating this Investigation: A Critical Look at Current Research

The first study (*Study 1, Chapter 6*) included in this dissertation is centered around the question of *how did AISD research evolve?* More specifically, this study is asking two sub-questions: *(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?* Periodically, meta-reviews have been published for this research area (e.g., Dingsøyr et al. 2012; Dybå and Dingsøyr 2008). These, however, have been either outdated or limited in scope or focus. To make informed statements about the state of AISD research, and ultimately if a niche topic needs additional attention, an updated and broadened review was needed.

To provide such a review, we[1] adopted a structured (Levy and Ellis 2006; Vom Brocke et al. 2015; Webster and Watson 2002) three-step research approach. In the first step, the primary literature review was conducted among the "Senior Scholars' Basket of Journals" and the AIS Toplist (including leading journals not only from IS but also Management and Computer Science) as well as five prominent IS conferences (i.e., AMCIS, ECIS, HICSS, ICIS, PACIS). After applying minimal inclusion and exclusion criteria, the final dataset consists of 569 articles in journals and 206 articles in conference proceedings, totaling 775 articles.

[1] For this dissertation, I will henceforth write as "we" whenever a research team, including but not limited to me, is referenced.

In the second step, we applied a topic modeling (Aggarwal and Zhai 2012; Debortoli et al. 2016) technique, which is considered extremely helpful in discovering hidden topics by classifying, summarizing, and clustering text (Maowen et al. 2012; Srivastava and Sahami 2009) and topic trends over time (Alghamdi and Alfalqi 2015). This semi-automated, computer-aided analysis approach is especially helpful in analyzing large amounts of text (Maowen et al. 2012; Srivastava and Sahami 2009), as is the case with our dataset.

Following qualitative research guidelines, we then followed up with two cycles of coding (Miles and Huberman 1994; Saldaña 2016): In the first cycle of coding, we conducted descriptive coding to categorize our data and lay the groundwork for our second cycle coding as well as further analysis and interpretation (Wolcott 1994, p. 55). In the second cycle of coding, we then applied pattern coding to "identify an emergent theme" which is helpful for "grouping those summaries into a smaller number of sets, themes, or constructs" (Miles and Huberman 1994, p. 69).

Combined, this mixed research approach reduced the human workload drastically but still enabled "human intelligence" to interpret interim results (Saldaña 2016; Strauss and Corbin 1998) — therefore remaining in the area of structured literature reviews and inductive reasoning (Levy and Ellis 2006; Vom Brocke et al. 2015; Webster and Watson 2002). Based on these results, we identified research foci over the last three decades, as well as key outlets and articles. These were then used to infer trends within AISD research over time as well as implications for AISD research — first and foremost a research agenda. We extracted the research agenda from our findings mentioned before as well as our combined experience as researchers in AISD. Especially important for this dissertation is the

identification of calls for socially or psychologically focused research and the — co-existing — dearth of exact these articles compared to other trends in AISD research. The following papers contribute to closing this gap and answering our call from this first study.

3.2 Laying the Groundwork: Exploring Agile Teams

Given the limited body of knowledge on social and psychological aspects of AISD in general and psychological safety in particular, the second study (*Study 2, Chapter 7*) imports research from organizational behavior research and psychology in the context of AISD. This study, therefore, follows a deductive, confirmatory research approach aimed at hypothesis testing within a (multiple) case study setting (Eisenhardt 1989; Miles and Huberman 1994; Saldaña 2016; Yin 1994). Case study research, in general, is a well-established source of knowledge generation in the IS discipline (Benbasat et al. 1987). Case studies are suited to extract in-depth insights about novel or only sparsely understood topics and enable the researcher to integrate the context in which they are embedded (Dubé and Paré 2003; Sarker et al. 2018). While the goal of theory testing is usually well suited for quantitative rather than qualitative research designs, we decided to follow the examples set by extant research when investigating constructs in new or unusual contexts. This research design provides richer explanations and insights for the results and further enables the researcher to reveal complex dynamics among the constructs more easily (e.g., Lee and Xia 2010). As this study is the first to test psychological safety in this specific context, qualitative research approaches enable a better — if needed — adaptation of the construct in question compared to a quantitative research design.

This second study followingly builds, aside from AISD research, upon organizational research and psychology to propose an initial model explaining team resilience and following the first study's call. Team resilience is vital for AISD teams as these follow the idea of "embracing change" (Beck et al. 2001; Conboy 2009), and AISD practices, such as retrospectives, support this as resilience can be built by a critical review by the team of the team and its success (Alliger et al. 2015).

In this study, we build on prior insights (Hummel et al. 2015) and posit that some specific agile practices rely heavily on social interactions (e.g., retrospectives) and need team members to voice concerns and critique and feel safe to take interpersonal risks by doing so. This has been conceptualized in organizational psychology by psychological safety (Edmondson 1999).

As laid out above, this study was conducted as an embedded, multiple-case study (Dubé and Paré 2003; Lee 1989; Yin 2003, p. 49) within three different case organizations. We collected data from various data sources and with different data collection methods. Most importantly, semi-structured interviews, project documentation, instructional and managerial guidelines, as well as field notes were used to generate data.

As we were able to derive the codes from extant literature and our proposed model, we were able to start with a second cycle coding technique, *pattern coding,* as described by Miles and Huberman (1994) and Saldaña (2016). This analysis was followed up with *hypothesis coding*, which is suitable for testing purposes, especially to test for rules, causes, and explanations (Russell Bernard 2002; Saldaña 2016; Weber 1990).

The data suggest that psychological safety plays two significant, cyclical roles in AISD. First, psychological safety determines if team members accept AISD practices and how intensely they engage in AISD practices. Second, psychological safety can be improved and strengthened by implementing SAPs carefully, the application of change management tactics, and listening to the needs and concerns of team members. Taken together, these two roles stress that while AISD practices rely on and are influenced by psychological safety, psychological safety is (re-) enforced by AISD practices, indicating that AISD practices are to some degree dynamic in their representations and implementations. These findings extend previous research on social aspects of agile practices (especially Hummel et al. 2015) by explaining the surrounding context (in this case, psychological safety) of successfully implemented AISD practices.

For practitioners, these findings mean that when considering using agile methods for AISD projects, the increased social aspect should be included in addition to established characteristics and indicators. If an environment with lower psychological safety can be assumed, AISD practices are likely not to fulfill their potential and might even harm the overall transformation process. When already using AISD practices, managers might take a closer look at the psychological safety levels within teams, as some team members might not feel safe (enough) to participate in SAPs. However, also team members themselves should check psychological safety levels in their teams as, ultimately, every team member contributes to the psychological environment. As the literature suggests, being inclusive and open towards team members helps in creating a psychologically safe environment (Edmondson 1999; Nembhard and

Edmondson 2006). Raising psychological safety in the team not only benefits team performance but also raises job satisfaction (Bergheim et al. 2015) and should therefore be in every team member's own interest.

Due to the qualitative nature of this study, only limited indication for the strength and significance of the identified effects is available. The details of the "how" and "how often" of SAP usage should be investigated further as well, possibly via a quantitative method, additionally providing details on strength and significance. Another possibly fruitful avenue for future research might be an interaction between psychological safety and team resilience directly. While we did not find direct evidence in our data, one might imagine an interaction between these two concepts given the importance of resilience in AISD (Meneghel et al. 2016) and the resilience-enabling effects of psychological safety (e.g., improving learning from failures; Carmeli and Gittell 2009; Jehn et al. 2014).

As the data for this study is based on three different cases, two of which are similar in industry, size, and state of agile adoption, with the third case acting as the sole, contrasting case. The explanatory power is therefore limited. Further, all three companies are based in Germany, with only one company being part of an international organization. While the study aimed for a holistic view of each team, we did not conduct interviews with every team member. We can therefore not rule out to have missed individual perceptions of the specific team's level of psychological safety. However, we would argue for this difference to be of only peripheral nature and to not have a significant effect on the study's conclusions due to the very homogeneous nature across all statements.

Similarly, side effects might have been misidentified as a cause due to the nature of a field experiment. For instance, this study cannot clearly separate psychological safety having benefitted from regular meetings or everyone participating in every meeting. Furthermore, our study is limited by the single pathway in a complex nomological network. It is unclear if SAPs only interact with psychological safety within a certain set of boundary conditions and if this (perceived) psychological safety is not determined by — possibly stronger — outside effects. This all leads to the issue that psychological safety is a vast concept, making it possible to find influences on many different aspects of teamwork. Research should nevertheless try to separate signal from noise regarding the effects of psychological safety in AISD teams.

Additionally, the influence of social desirability bias might have distorted our findings. As it is generally more socially desirable to report success rather than failure, participants might have (involuntarily) overstated success and understated failure. We tried to minimize the social desirability bias emerging from our questions. However, a quantitative, survey-based investigation might further reduce this bias due to its unobserved and anonymous nature.

The following two studies (*Study 3, Chapter 8* and *Study 4, Chapter 9*) both have the objective of theory evaluation, therefore following a deductive research approach (Goddard and Melville 2004; Saunders et al. 2009), focusing on using quantitative data to evaluate the previously generated knowledge — that is, testing hypotheses and conducting robustness checks — and taking up the call of this study to investigate the interactions of psychological safety in AISD teams in greater detail.

3.3 Measuring the Effects at Play: Evaluating Preliminary Findings

The third study (*Study 3, Chapter 8*) addresses the need for quantitative evaluation from the second study and presents the findings from a quantitative field study in one large, multinational enterprise. Utilizing online questionnaires, I used 173 usable responses from 63 different teams across four countries and three continents from all major roles active in AISD. The collected data was then used to estimate the research model with covariance-based (CB) structural equation modeling (SEM). I used CB-SEM rather than, for instance, PLS-SEM, as it is more powerful in model validation (Hair 2009; Lowry and Gaskin 2014). Second, CB-SEM is more effective in validating models developed using a well-established theory — being rooted in AISD and organizational psychology research, I deemed CB-SEM appropriate (Lowry and Gaskin 2014).

The main finding from the analysis is that the central hypothesis, a moderation of the effects of social agile practices by psychological safety, cannot be supported. Aside from subpar indicators and indices regarding model fit and explanatory value, this model showed non-significant effects regarding the hypothesized moderation.

As this model is at odds with the findings from the second study (*Study 2, Chapter 7*), a rival theory emerged: Psychological safety might moderate the effects of agile practices.

3.4 Checking for Robustness: Evaluating a Rival Theory

The fourth and final study of this dissertation (*Study 4, Chapter 9*) argues for a rival model to the one tested in *Study 3, Chapter 8*: Psychological

safety and agile practices might not be so much affecting each other via moderation, but psychological safety and social agile practices might reciprocally affect each other (i.e., covariate).

Reusing the data from the third study, I evaluated this rival model as well. The resulting model is mostly satisfactory regarding recommended model fit indices (Brown 2015; Jackson et al. 2009) and missing some just by a margin. Notably within satisfactory criteria are χ^2, Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Relative Fit Index (RFI), and Normed Fit Index (NFI). Below the satisfactory criteria are Non-Normed Fit Index (NNFI; also called Tucker-Lewis Index), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Comparative Fit Index (CFI), Incremental Fit Index (IFI), and Parsimony-Adjusted Measures Index (PNFI). However, all those criteria are only missed by a margin — details of which can be found in *Study 4, Chapter 9*. As I fully agree with the recent arguments by Xia and Yang (2019) "[...] that surpassing a set of cutoff values should not serve as the only justification for the acceptance of a model, and it is more appropriate to consider RMSEA, CFI, and TLI as diagnostic tools for model improvement" (Xia and Yang 2019, p. 421), I argue for accepting this model. This model, however, should remain subject to evaluation by further studies.

While — still — no direct interaction between psychological safety and agile practices can be observed, the remaining model (i.e., effects between agile practices, team autonomy, and resilience, as well as between psychological safety and resilience) is significant and small to large effect sizes are observed. In contrast, the model is much stabler and, using

comparative model fit indices (i.e., AIC, BIC, and Sample-Size Adjusted BIC), better suited for explaining these effects than the model evaluated in *Study 3, Chapter 8*. I conclude that while the rival theory aspect cannot be accepted, the remaining, baseline model from this study can be accepted and may be the foundation for future research on psychological safety and SAPs.

Taken together with the insights from the third study, *Study 4, Chapter 9* does not offer a new solution to the looming question of how psychological safety and social agile practices interact. However, it does add additional confidence in the remaining findings from the third study (*Study 3, Chapter 8*). Additionally, these findings reinforce avenues for future research, as the presuppositions of agile practices and their interaction with psychological safety remain inconclusive.

Chapter 4: Discussion

In this dissertation, the results of four empirical studies in the context of social and psychological effects in AISD teams have been presented. Research has long been calling for a closer investigation of the social and psychological effects in AISD (e.g., Freudenberg and Sharp 2010). This dissertation now contributes significantly in an effort to answer this call and further our knowledge of AISD.

4.1 Summary of Contributions

Study one contributes a unique point of view on the landscape of AISD research and the emerged as well as the emerging topics. Study two contributes novel insights into the social and psychological underpinnings of AISD teams and argues for a novel model explaining the interactions. Studies three and four partly support the model from study two, extend it further and open avenues for future research. Collectively, these four studies contribute to both theory practice in multiple ways.

In the following, I summarize the contributions of each study individually before I discuss theoretical and managerial contributions, limitations, and avenues for future research in more general terms.

4.1.1 Contributions of Study One

Based on the qualitative analysis, this study contributes to theory in two major ways: It provides a retrospection on how AISD research has evolved over time and provides a prospect in the form of a research agenda.

A retrospection is valuable for research as it helps to critically reflect past research foci and their impact. Based on this retrospection, researchers are therefore better suited to make informed decisions on which topic to focus

on next. For instance, our analysis showed a lack of research on social aspects in AISD. This lack is unexpected as the major problems of ISD projects, in general, are often sociological in nature (DeMarco and Lister 1987, p. 4). Social aspects are often blended into other topics, however, mostly in peripheral nature. Research, meanwhile, acknowledges the need for not only a technical but also a social focus on AISD (Conboy et al. 2011; Maruping et al. 2015).

Another finding of the retrospection is the maturity across different topics. 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) call for more sociological studies — which is clearly a call still worth repeating. This study, therefore, also contributes to research by stressing that the calls for (more) research from over a decade ago remain mostly unanswered.

Building upon these findings and the study's first contribution, a research agenda is proposed to offer future research a starting point. The resulting research agenda focuses on technologies and applications and tool support, as well as the need for more research on "social" aspects of "socio-technical systems" development projects. Finally, the research agenda contains a call for more self-reflection and reviews of the literature to highlight gaps and contradictions as well as to build trust in existing findings and conclusions.

Following this proposed research agenda, study two contributes to research by investigating a social and psychological aspect of AISD and

proposes a preliminary model explaining the interactions of AISD practices, psychological safety, and resilience.

4.1.2 Contributions of Study Two

The above-mentioned research agenda motivates this study and its investigation of the interactions of AISD practices, resilience, and psychological safety. Based upon this investigation, this study contributes significantly to AISD research as follows.

The collected data and following analysis suggest that psychological safety plays a two-sided role in AISD. First, psychological safety determines if team members accept SAPs — low psychological safety, for instance, reduces the likeliness of team members to partake in planning meetings and retrospectives, whereas high psychological safety increases this likeliness. Second, psychological safety determines how team members participate in SAPs. If team members participate and psychological safety is low, team members are less likely to speak openly and offer novel ideas, whereas higher psychological safety leads to more engagement, helping behavior, and willingness to offer novel ideas. At the same time, SAPs can improve psychological safety. If change management tactics are applied, the needs and concerns of team members are considered, and SAPs are therefore implemented carefully and in an inclusive manner, AISD practices can positively affect psychological safety.

Collectively, this dual interaction stresses that while SAPs rely on and are influenced by psychological safety, psychological safety is also affected by SAPs, indicating that SAPs are not static but flexible in their implementation. These findings extend previous research on social aspects

of agile practices (especially Hummel et al. 2015) by explaining the context of successfully implemented SAPs.

Further, and as noted by Niederman et al. (2018), conflict and conflict resolution differ in AISD from traditional approaches — and psychological safety is a prime candidate to explain when and why conflict can be beneficial to AISD teams. Similarly, the cyclical nature of this interaction might explain other longitudinal effects in AISD.

4.1.3 Contributions of Study Three

Due to the promising findings of the previous research, a quantitative analysis is warranted to lend additional support to the conclusions or offer alternative explanations. This study provides three main contributions to theory.

First, this study provides first-time empirical evidence for the effects of both team autonomy and social agile practices to realize resiliency effects promised by agile methods. The study concludes that implementing social agile practices can improve team resilience. Further, the observed effect of psychological safety on resilience contributes to theory as it shows, again for the first time, an AISD-specific effect for psychological safety. This study, therefore, establishes a base for future research to investigate the specifics via which social agile practices affect resilience. This effect also offers an explanation why some teams might not show the expected resilience although practicing retrospectives: without sufficient autonomy to act on insights gathered from retrospectives and daily stand-ups, teams cannot realize the expected benefits.

Second, the study falsified some aspects of previous research (i.e., *Study 2, Chapter 7*; published as Hennel and Rosenkranz (2020)), namely the

moderation of the effects of social agile practices by psychological safety. This finding, therefore, contributes to research by falsifying a previous theory — and advancing our understanding of the underlying factors — and by providing the base for subsequent studies, aiming at reconciling the inconsistencies.

Third, the study found initial evidence for an SAP-independent effect of psychological safety on resilience. This means that regardless of the specific practices and their way of being employed, AISD teams need psychological safety to maximize resilience. AISD practices further increase resilience but do not replace the prerequisite for a psychologically safe environment. This lays the groundwork for future research to find a new explanation of why this direct effect outperforms a mediation via social agile practices or vice versa. Research has found a direct effect on performance or, more specifically, a team's ability to learn from failures (Carmeli and Gittell 2009; Jehn et al. 2014), which can be seen as a great parallel to our finding. However, given that retrospectives *serve the purpose of learning from failures*, a moderating effect would seem sensible. This research, therefore, can be the beginning of a conversation of the reasons behind this contradiction.

Additionally, as items from psychological safety had to be dropped, this study contributes by starting a conversation about the appropriateness of these measurement items. The items for psychological safety have been adapted from multiple studies and are therefore likely not to be perfectly optimized. However, as two of the remaining items are targeted clearly towards helping behavior, this could point to either a mismatch of the

items to the construct or maybe a more differentiated view on psychological safety and helping behavior.

4.1.4 Contributions of Study Four

Combining the results of studies two and three, questions remain regarding alternative explanations. Especially the exact form of interaction between psychological safety and SAPs is a point of discussion. This study focuses on clearing this ambiguity and primarily contributes to research in two major ways.

First, this study's primary contribution to theory is the falsification of a rival theory. On a purely argumentative basis, a moderation of the effect of social agile practices on team resilience by psychological safety is convincing and intuitive. As this assumption could not be supported following *Study 3, Chapter 8*, a rival theory was developed to test alternative explanations. Following to this insight, *Study 4, Chapter 9* shows that a covariance-based relationship cannot be supported either. However, with this study, supporting evidence for a less direct and much more oblique relationship between these three constructs is presented. This contributes to research by advancing our understanding of the inner workings of AISD teams and solidifies the groundwork for research on AISD teams by ruling out a rival theory.

Second, and building upon the previous contribution, this study cannot support the previously assumed (i.e., *Study 3, Chapter 8*, published as Hennel and Rosenkranz (2020)) cyclical or reciprocal relationship between psychological safety and social agile practices. This finding, therefore, indirectly contributes to research by providing the base for

future research which investigates this disagreement further to reconciling the opposing findings of studies two, three, and four.

4.2 Synopsis

This dissertation contributes to the ever-growing literature of AISD research through the four empirical studies, as each has its individual contributions and further contributes to the bigger picture of this dissertation. This section serves as a spotlight on the most important aspects highlighted across all studies and through all studies combined.

First, this dissertation extends the existing meta-reviews in two points: It updates and — more importantly — it corroborates previous reviews by introducing a new approach to these meta-reviews. Utilizing topic modeling algorithms for the initial topic creation removes the researcher as bias from the equation — at least until topic interpretation begins. Through this research strategy, many of the subconscious biases can be removed. This does not mean, however, that thoroughly "handcrafted" reviews do not have merit or should not be conducted, quite the contrary. From my perspective, computer-aided analysis methods serve much more to validate previous findings and expand the data sources.

Second, this dissertation contributes to AISD research by deducing a preliminary model — as well as evaluating and revising it — for the under-researched area of social and psychological effects in AISD. In combination, studies two, three, and four provide the basis for approaching the still unknown underpinnings of AISD teamwork. This dissertation does not provide a comprehensive theory but provides a model capable of explaining previously unexplained effects in AISD

teams. This dissertation provides falsifying evidence for two hypotheses, helping future research by eliminating rival theories and by introducing an — evaluated — novel construct with the potential to explain many more effects for AISD research, ultimately providing a new baseline for future researchers interested in social and psychological aspects of AISD. Additionally, the shown inconsistencies between qualitative and quantitative studies might shine a light on this under-researched area of AISD research and might motivate more researchers to investigate social and psychological effects in AISD.

Looping back to my research question posted in Chapter 1,

> *How do Agile Practices and Psychological Safety interact and affect Team Resilience?,*

I conclude that preliminary support for *some* interaction between (social) agile practices and psychological safety exists and that both positively influence team resilience — yet the two most promising interactions had to dismissed. This dissertation, therefore, does not offer a definitive and complete answer to this overarching research question but rather a sound foundation for future research to extend my findings and to identify and classify the exact relationship between agile practices and psychological safety.

4.3 Practical Implications

What does this work mean for practitioners? How does it affect the day-to-day life of AISD teams? First and foremost, this dissertation clearly describes the importance of psychological safety in teams. Not only in AISD teams or agile teams — it provides additional evidence to the ever-

growing literature from organizational research on the multifaceted benefits psychological safety can provide. Practitioners should, therefore, follow existing guidelines on how to increase psychological safety in teams.

Studies two, three, and four demonstrate the effect AISD practices have on team autonomy and team resilience. AISD teams looking to improve their resilience should therefore invest in these AISD practices.

Aside from their theoretical contributions, studies three and four also provide a unique practical contribution: Because the interaction between psychological safety and (social) agile practices remains ambiguous, there is (yet) no "right" way to implement AISD practices and keeping psychological safety in mind. Much more, practitioners should be careful and keeping this ambiguousness as a motivator to (1) critically reflect the status quo, (2) evaluate the effects and change or transformation might have had on the team — including on the psychological safety —, and (3) critically reflect every change and transformation before committing to it.

Study one further provides additional practical implications. While targeted primarily at a scientific audience, it provides a more accessible overview and access to both emerging and established research in the field of AISD. Knowing the current and past trends might help increase the transfusion of knowledge from academia into practice. Further, it might highlight the dependency of the IS discipline on data. More importantly, its dependency on data access. This dissertation is a perfect example of how important data access is: Without the trust of our industry partners from the cases in study two, not only would we have failed to complete study two, but studies also three and four would have been impossible as well.

4.4 Limitations

This dissertation as a whole, as well as the included studies individually, are limited in some respects. Most importantly, the incompleteness of the findings limits this dissertation. As studies three and four have shown, I was unable to corroborate the findings from study two. The interaction between (social) agile practices and psychological safety, therefore, remains ambiguous.

Additionally, my quantitative evaluation (studies three and four) was set in one single consulting firm. While this firm is large, active on a global scale, and participants were from varying countries and specializations, the dataset does not account for a large variety of company cultures and values. This factor could limit the transferability of all related findings.

Similarly, the data sources for study two were limited to German companies — or at least their German branches. This could have similar effects as the previous point: With no to little variation in culture or values (based on the national context), these findings might not be easily transferable. I am confident that the findings will hold for many other contexts, but they might differ in different regions or cultures. For instance, in less individualistic and more collectivistic cultures, teams might be on a higher average level of psychological safety because of the surrounding culture and the related social norms (Schreier et al. 2010). At the same time, one might argue that collectivism leads to less overall psychological safety due to the tendency to be more polite and avoiding offensive statements (Miyahara et al. 1998).

As for study one, the most extensive limitation is the same reason the study was possible in this way: the degree of automation. Study one did not rely

on a completely automated process, but the topic modeling itself was autonomous and a "black box" for the research team. On the one hand, this enabled us to process a large volume of literature. On the other hand, this means that the results might be biased without us knowing due to the nature of the process.

Collectively, this dissertation is therefore clearly limited in some respects. This section and the limitations mentioned within each study individually aim to describe all shortcomings as clearly and transparently as possible. Therefore, I argue that these limitations are ancillary compared to the contribution this work provides. Most of the limitations mentioned above and in the studies individually are much more avenues for future research to explore and extend into.

4.5 Future Research

This dissertation opens multiple, different avenues for future research, both for addressing remaining limitations as well as for extending the presented contributions. Each study presents individual ideas for future research and this section highlights possibilities for future research that can be derived from this dissertation in general. The overarching topics are (1) a need for replications studies, (2) a need for a new explanation of the missing link between agile practices and psychological safety, and (3) a need for longitudinal studies.

4.5.1 Replication

Due to the novelty and exploratory nature of the underlying argumentation and operationalization presented in this dissertation, future research should conduct replication studies. Replicating would

either increase trust in the findings and conclusions presented before or offer alternative explanations and boundary conditions, ultimately furthering research.

Methodological replications in different contexts might be most interesting, as they directly address concerns regarding the transferability of my findings and conclusions. For instance, a replication in a different culture could add important boundary conditions. One possible setting could be a more collectivistic culture than the individualistic western-European culture present in most of my data sets. While studies three and four include data from dominantly collectivistic cultures in Asia, the number of participants is too low to conduct reliable group comparisons.

4.5.2 The Missing Link between Agile Practices and Psychological Safety

Thinking about how research could extend this dissertation and considering the insights gathered from all the included studies, explaining the exact link between agile practices and psychological safety is, in my opinion, the most valuable direction future research could embark on. Studies one and two outline the motivation for doing so: a clear need for explaining the social and psychological effects at play are unknown and are linked to team resilience — therefore impacting AISD success.

Study two also suggests one way how these two constructs might be linked: In a cyclical, interdependent, possibly reciprocal interaction. While study two could not clearly identify an ordering within or time-dependency of this interaction, future research could take this insight into account when preparing future studies and the specific research design.

More elaboration on this longitudinal research direction can be found in the next section.

Studies three and four, however, are — based on our current understanding — at odds with the findings from study two: Having to dismiss both hypotheses (i.e., psychological safety covariantly interacts with agile practices or psychological safety moderates the effects of agile practices), hints much more at no direct interaction between psychological safety and agile practices than to any sort of interaction, including a time-based dependency. Solving this puzzle could enable a much more detailed and fact-based approach to AISD management, practice selection, and practice implementation — ultimately leading to improved team resilience and performance.

A first step for future research could be a diligent review of the applied research designs and data sources, as those two aspects might have inconspicuously biased the results. If research does not find any indications for a bias regarding research design, I propose a replication in a different context. My reasoning for this is that culture, especially organizational culture, might have had a non-trivial role to play within this study. As all quantitative data came from different teams from different sections but still from one firm, the organizational culture might have led to a "default state" of a psychologically safe environment.

An additional factor, which might be worthwhile for future research to investigate is the influence of the global COVID-19 pandemic. As the data collection for studies three and four (see Chapter 8 and Chapter 9) was happening at a time where almost any country had some form of a stay-at-home or home-office directive in place, this unusual and unfamiliar

situation might have impacted participants' perception of their situation and team. For instance, this new situation might have put another complexion on their work situation and led them to reevaluate their work situation more favorably than the possibly incomprehensible global pandemic-related situation. Investigating how this state of emergency might have influence these and similar studies could open up new explanations and, therefore, new avenues for research to find the "missing link" between agile practices and psychological safety as described in study three.

4.5.3 Longitudinal Studies

Aside from the additional trust for these findings, research could build by conducting longitudinal studies, a longitudinal approach could also offer new, valuable insights. Especially the still unclear relationship between agile practices and psychological safety (see section above), could benefit from such a research approach. As the relationship has been theorized as cyclical or reciprocal in nature (see Chapter 7), a longitudinal approach could better unveil underlying reciprocal or cyclical structures.

More detailed insights into this relationship could also answer additional questions, yet unanswered by this dissertation: Do agile practices perform *before versus after* psychological safety reaches a critical level? Do both agile practices and psychological safety drive changes in each other in both ways? The detailed description of constructs, measurement items, and analyses presented in this dissertation should help future research design such a longitudinal research approach more easily.

Chapter 5: Conclusion

How do agile practices improve teamwork? What are preconditions to implementing agile practices effectively? This dissertation certainly cannot answer these questions holistically — it can, however, offer first insights into the underpinnings of the effects at play and lays a foundation on which future research can build to extend our understanding of how agile works. Through four empirical studies, this dissertation asks (1) *how did AISD research evolve and how is the current state of research regarding social and psychological factors in AISD,* (2) *how do agile practices and psychological safety interact and affect team resilience,* (3) *does psychological safety moderate the effects of agile practices on team resilience* and (4) *do psychological safety and agile practices covariate — and does this explain the theorized combined effect on team resilience?*

As laid out in the previous chapter, these studies offer tangible insights into the inner workings of AISD practices in relation to social and psychological aspects. In particular, this dissertation shows a need for explaining AISDs shortcomings, especially in social and psychological aspects (0, 0, and Chapter 6), provides exploratory insights into these aspects (Chapter 4, as well as Chapter 7) and offers an evaluation of these novel insights (Chapter 3, Chapter 8, and Chapter 9) as well as avenues for future research (Chapter 4 and Chapter 9).

With an already quite extensive history of AISD research, new opportunities and challenges still arise (Chapter 3). This dissertation tries to contribute in a timely and relevant manner to this still-growing research stream, hoping to make tangible impacts — both theoretical and practical in nature.

Chapter 6: Journey Towards Agility: Three Decades of Research on Agile Information Systems Development

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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.

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6.1 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.

6.2 Related Work and Background

6.2.1 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. 2009b; 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).

6.2.2 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.

6.3 Research Method

6.3.1 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[2] (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:

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

> *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 6-1 gives further information concerning the distribution of the results.

6.3.2 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.

6.3.3 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.

6.4 Results

Figure 6-2 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 6-1 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.

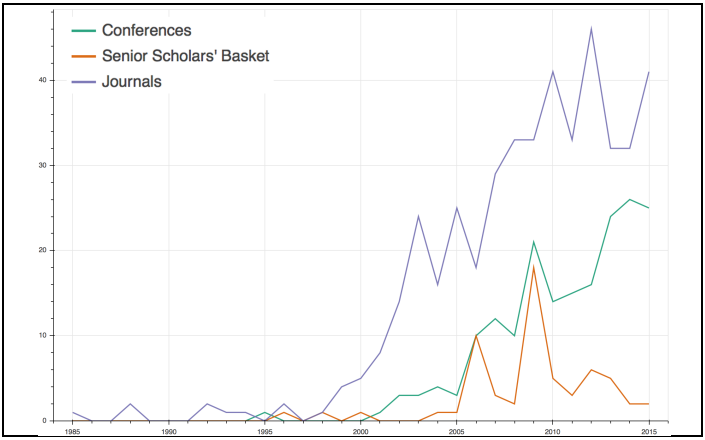

Figure 6-1. Articles in the Senior Scholars' Basket, Journals, and Conferences Per Year

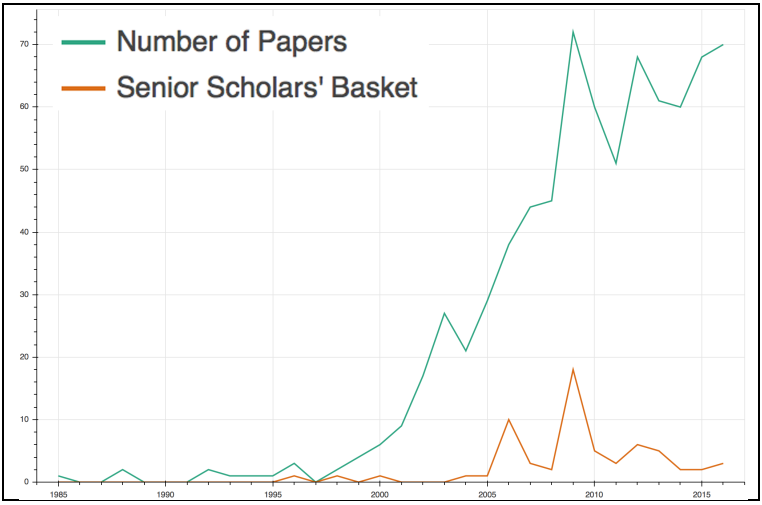

Figure 6-2. Number of Articles Found Per Year

Total number of articles and in Senior Scholars' Basket

Table 6-2 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 6-2, 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").

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
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 6-1. Distribution of Results Across Outlets with at Least Five Result

Outlets are sorted in descending order by their number of publications (see column "#")

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
	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

Group	Topic	Rank	Keywords
	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
Stakeholders and Requirements Engineering	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
	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

Group	Topic	Rank	Keywords
	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 6-2. 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

6.4.1 Research Foci Over the Last Decades

Although at first glance our topics presented in Table 6-2 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 6-2, 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 6-3), "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.

6.4.2 Key Outlets and Articles

Based on the number of publications per outlet displayed in Figure 6-4, 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".

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.

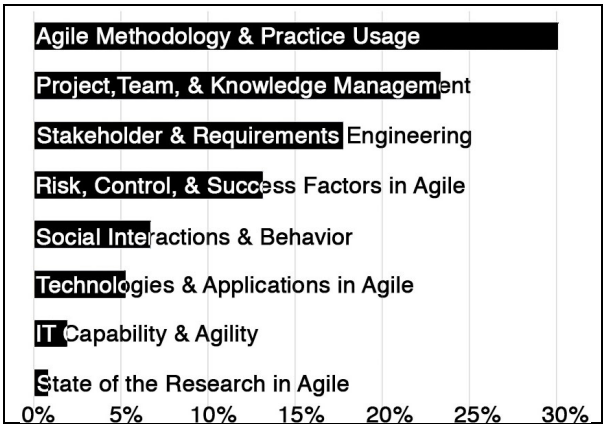

Figure 6-3. Topic Group Distribution

Distribution in percent of tokens (Σ = 99.9%)

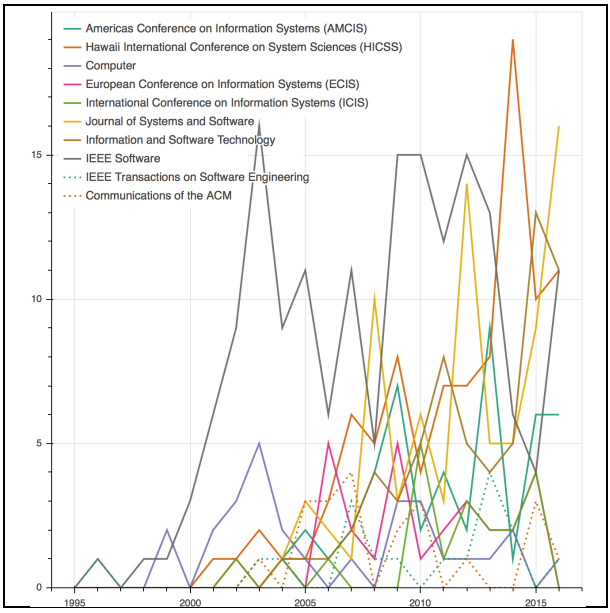

Figure 6-4. Top 10 Most Published-in Outlets Over Time

Looking at the history of the most published-in outlets (see Figure 6-3), 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.

Table 6-3 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 6-3 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).

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)

Topic	Top 2 Most Covering Papers
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 6-3. Topics and Top Two Most Covering Papers

6.5 Discussion

6.5.1 Trends

By further investigation of our timeline regarding the distribution of published articles (see Figure 6-2 and Figure 6-1) and distribution of topics (see Figure 6-3), 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.

6.5.2 Implications

Combining the outlined descriptions and looking at the evolution of topics present in research (see Figure 6-5 and Figure 6-6), 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 6-5 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 6-2), topic group distributions (see Figure 6-3), and the distributions over time (see Figure 6-5), 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 6-3 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.

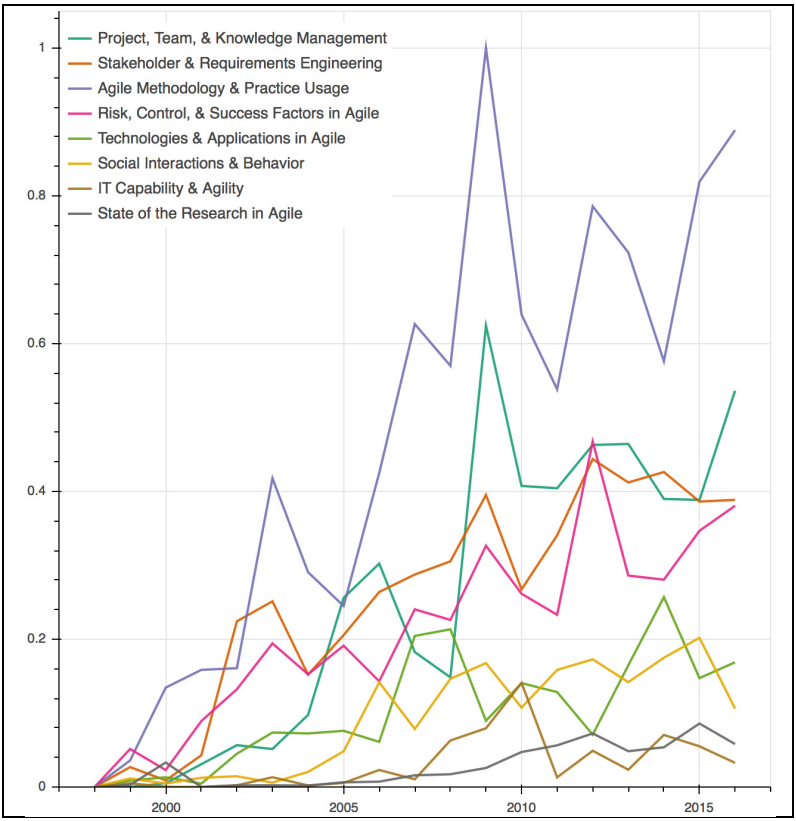

Figure 6-5. Total Normalized Topic Group Distributions Over Time (1998-2016)

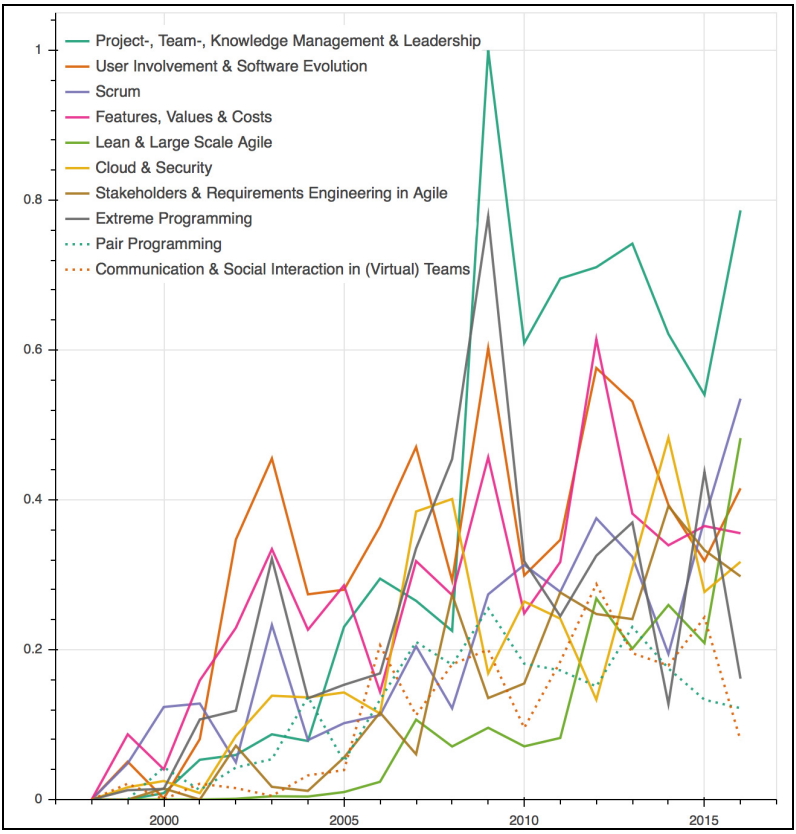

Figure 6-6. Total Normalized Top 10 Topic Distributions Over Time (1998-2016)

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 6-2) and the low overall distribution (see Figure 6-3) 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.

6.6 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.

6.7 Acknowledgements

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Chapter 7: Investigating the "Socio" in Socio-Technical Development: The Case for Psychological Safety in Agile Information Systems Development

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Abstract

One constitutional part of project management is the management of teams, their actions, and their social mechanisms. Team processes, behavior, and agile practices used by team members play an important part for the success of projects. To reap benefits from these highly interactive and social-focused practices, team members need to feel safe to speak freely. We propose a model that conceptualizes the effects of psychological safety and (social) agile practices on team performance. The proposed model combines recent research from organizational psychology and agile information systems development to provide a better understanding of the team-level effects. Our findings from three case studies conducted in two large insurance companies and one software development company suggest that social agile practices positively influence psychological safety, transparency, communication, and ultimately productivity.

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7.1 Introduction

Approaching the end of the second decade after the *Agile Manifesto* (Beck et al. 2001), the initial wave of enthusiasm is part of the past, and agile approaches have been disillusioned by mixed results concerning their performance in practice (Hoda et al. 2011; Janes and Succi 2012). However, agile practices are still becoming more and more popular in industry (VersionOne 2018), research is still publishing special issues on agile (e.g., Niederman et al. 2018), and agile approaches have recently been integrated in *A Guide to the Project Management Body of Knowledge* — Sixth Edition (e.g., Project Management Institute [PMI] 2017).

Agile methods put emphasis either on management practices such as daily standups (e.g., Scrum; Schwaber 1995) or development practices such as pair programming (e.g., XP; Beck and Andres 2004). They aim at simultaneously decreasing sunk costs and path dependencies while increasing flexibility and strengthening a team's resilience to a changing environment, ultimately benefiting project success. With emphasizing the need for highly iterative project progress, constant feedback and communication, and synchronization, the need for team management and team collaboration increases as well—making it even more important to understand the social behavior and mechanisms of action of agile practices in teams (Kautz et al. 2007; Lee and Xia 2010; Persson et al. 2012; Sarker et al. 2009).

Looking back at extant research on agile, it becomes apparent that while agile is centered on teamwork, it adds an additional layer to traditional teams—especially agile's focus on embracing change as an inevitable factor instead of avoiding it at all costs differentiates agile practices from

traditional methods of project management. Moreover, organizations face a multitude of challenges when introducing agile practices (e.g., Dikert et al. 2016; Gregory et al. 2016; Ramesh et al. 2010; VersionOne 2018), further implying the special nature of agile approaches when compared to traditional project management approaches.

However, research has not yet caught up with industry, and team-level research on *agile information systems development (AISD)* is scarce (Diegmann et al. 2018; Lee and Xia 2010). Existing studies mostly have investigated specific and individual or organizational phenomena, such as the use and effects of specific agile practices (e.g., Balijepally et al. 2009; Holmqvist and Pessi 2006; Maruping et al. 2009b; Recker et al. 2017; Tripp and Armstrong 2018; van Oorschot et al. 2018), or effects regarding whole projects or organizations, such as the introduction of AISD approaches to teams (e.g., Cao et al. 2009b; Heeager 2012; Hong et al. 2011; Kotlarsky 2007; Mangalaraj et al. 2009), or the usage of AISD practices in large-scale, multi-team environments or portfolios (e.g., Dikert et al. 2016; Dingsøyr et al. 2018; Sweetman and Conboy 2018). Team-level effects, however, are mostly absent from these works, with only few exceptions (e.g., DevOps Research & Assessment and Google Cloud 2019; Lindsjørn et al. 2016; Przybilla et al. 2018; Schmidt et al. 2014).

This is perplexing because information system development (ISD) is mostly conducted in teams and quintessentially is a team effort (Sawyer et al. 1997; Sawyer et al. 2010; Siau et al. 2010). ISD generally takes place in the form of projects (Hirschheim et al. 1995, p. 33) or within product teams (Gerwin and Barrowman 2002), with many involved stakeholders and team members (Chae and Poole 2005). As a result, many of the problems associated with ISD projects are sociological, rather than

technological, in nature (DeMarco and Lister 1987, p. 4; Sawyer et al. 1997; Sawyer et al. 2010). For example, coordination and communication between various stakeholders are necessary for successful ISD (Corvera Charaf et al. 2013; Gallivan and Keil 2003; Ko et al. 2005), and creating mutual understanding and common ground between different involved stakeholders is a major driver of ISD success (Bittner and Leimeister 2014; Gallivan and Keil 2003; Rosenkranz et al. 2013; Rosenkranz et al. 2014; Tan 1994). Moreover, not only do practitioners call for more research on social aspects of AISD teams (Freudenberg and Sharp 2010), but also scant research exists on social aspects of the development of socio-technical systems in general, which information systems (IS) essentially are (e.g., Kautz 2007; Long and Siau 2007; Sawyer et al. 2010; van Kelle et al. 2015). To understand the mechanisms of action at work in AISD teams and their effects, an operationalization on a team level is needed. Further, due to the increased importance of social interactions in AISD compared to traditional approaches to project management and ISD (Hummel et al. 2015), team-level effects in AISD likely differ from those found in traditional approaches and social aspects may vary. Importantly, our knowledge of the ISD process itself is often characterized as a "black box" (Siau et al. 2010, p. 92); only little ISD research goes beyond ISD methods, and there is a need for theory and studies about social behavior and processes of communication, negotiation, and learning (Kautz et al. 2007, p. 235). IS researchers therefore call for more conceptual and empirical research on team-level effects in AISD (Conboy 2009; Mangalaraj et al. 2009; McAvoy and Butler 2009; McAvoy et al. 2013). Without extended knowledge on these important effects, AISD project management remains

driven by chance and individual, isolated, and anecdotal knowledge and experience.

With this study, we follow this call and—in contrast to previous studies, which centered around method selection or project level performance (e.g., Tripp and Armstrong 2018; van Oorschot et al. 2018)—aim at investigating the specific practices and their behavioral implications from a team-level perspective. To open the black box of the ISD process and conceptualize this for the domain of AISD, we build on and adapt findings of team and organizational behavior research, which has already taken technology-induced effects into account (e.g., Ilgen et al. 2005; Kozlowski and Ilgen 2006) and has explored social aspects of inter-team-member cognitive effects (e.g., shared cognition (Healey et al. 2015) or adaptive structuration theory (DeSanctis and Poole 1994)).

More specifically, we conceptualize the ISD process as being stimulated by agile practices, which in turn affect and are affected by psychological safety. When embracing change, as it is one of AISD's core values, teams need to be resilient to the shocks and changes of a turbulent environment (Conboy 2009). To achieve *team resilience* (Meneghel et al. 2016), a team needs to provide structure and an environment which enable open, free, and safe communication—psychological safety is a necessity for resilience (Lengnick-Hall et al. 2011). For example, a regularly held retrospective aims at free, open, and honest exchange among team members and their views on issues in the project and the team; AISD cannot work without psychological safety — that is, "a shared belief held by members of a team that the team is safe for interpersonal risk taking" (Edmondson 1999, p. 354), which is a driver for free, open, and honest communication (e.g., Edmondson 1999).

We chose psychological safety as a central concept for three reasons. First, a healthy and supportive (i.e., psychologically safe) organizational environment has been shown to be closely connected to team resilience (e.g., Bardoel et al. 2014; Lengnick-Hall et al. 2011), which in turn is associated with AISD's capability to respond to change (Chakravarty et al. 2013). Second, psychological safety influences team performance significantly (e.g., Bunderson and Boumgarden 2010; Carmeli and Gittell 2009; Schulte et al. 2012), and it has been suggested as a key antecedent of team performance in ISD as well (DevOps Research & Assessment and Google Cloud 2019). Third, it touches on many "pain points" of agile teams, for instance, by its mitigating capacity of negative effects of team diversity (Roberge and van Dick 2010) or its positive effect on team diversity climate (Singh et al. 2013). Promising recent (e.g., Bunderson and Boumgarden 2010; Carmeli and Gittell 2009; Schulte et al. 2012) and well-established research (e.g., Edmondson 1999) on psychological safety and its influence on team performance has not yet been integrated into project management and ISD research and has not been evaluated on their applicability and significance in AISD project management. When a whole range of similar, socially focused, practices are implemented (i.e., an agile approach is applied), this becomes even more important. Additionally, agile practices, such as regular retrospectives, add structure to a team's processes, which, in turn, strengthens psychological safety (Bunderson and Boumgarden 2010), suggesting a mutual interdependency. Consequently, the following research question guides our study:

> *How and why does the use of agile practices and their interaction with psychological safety affect project team behavior and, in turn, performance?*

We therefore propose a model to investigate the effects of psychological safety on the use and effects of (social) agile practices. Specifically, we suggest that *social agile practices* (SAPs; Hummel et al. 2015)—that is, practices such as daily standup meetings or pair programming, which contribute directly to direct communication, collaboration, and interaction among team members—are likely to affect and to be affected by psychological safety, and therefore have an indirect effect on performance. With agile practices not only being popular in ISD projects in general (VersionOne 2018), but also being transferred to other task domains (Niederman et al. 2018), this becomes a crucial focus for research on project management as well.

To provide a first evaluation of our model and to test this model's propositions, we conducted a multiple case study in two major insurance companies and one software development company. Based upon empirical data gathered in these cases, we performed a two-step deductive coding process. We present the results in this article. Providing deeper insights into benefits and presuppositions of AISD practices aids research and practice, as these insights could help to reduce the number of failed projects.

In the following, we give an overview about related work, derive the proposed model and corresponding propositions, and describe the cases and coding process. Finally, we discuss our results and implications.

7.2 Related Work

7.2.1 Information Systems Development, Project Management, and Agile Approaches

Software-based IS are often developed in the form of projects (Hirschheim et al. 1995, p. 33), with many involved stakeholders and project team members (Chae and Poole 2005). The nature of ISD is in many aspects intangible (Cule et al. 2000), and the major problems of ISD projects are not so much technological as sociological in nature (DeMarco and Lister 1987, p. 4). Communication, collaboration, and coordination are necessary for successful implementation (Gallivan and Keil 2003; Ko et al. 2005; Rosenkranz et al. 2017), and creating a shared understanding is deemed to be a major driver for ISD success (Corvera Charaf et al. 2013; Gallivan and Keil 2003; Rosenkranz et al. 2013; Tan 1994).

In practice, approaches for developing software-intensive IS range from sequential approaches (Royce 1970) to more cyclic, iterative approaches (Boehm 1988). Most project management and ISD methods supposedly aim to facilitate communication and knowledge transfer among different participants and stakeholders. For example, rational unified process and various other approaches are often stated to have been created just for this purpose (Kroll and Kruchten 2003, pp. 145-149; Kruchten 2004, pp. 5, 92). The majority of traditional project management and ISD methods, either sequential or iterative, is plan-driven and relies on formal communication such as specification documents or models to control communication and knowledge transfer among project members and other stakeholders (Black et al. 2009; Boehm and Turner 2004; Kraut and Streeter 1995). For example, requirements are usually stated within a

requirements document, which at the end of the system analysis phase is a specification of the system to be built (Pohl 1994). In rapidly changing environments, however, it is hard for formal mechanisms of communication such as project plans, models, or specification documents to react quickly enough, and plan driven and sequential approaches falter (Byrd et al. 1992; Herbsleb and Mockus 2003; Kraut and Streeter 1995): "Rather than being bastions of order in an uncertain world, traditional teams may indeed become chaotic should their plan-driven organization be overwhelmed by events" (Vidgen and Wang 2009, p. 374).

Agile principles and new management concepts such as Scrum or Extreme Programming have emerged during the last decades and have built upon iterative work as the lowest common denominator (Beck and Andres 2004; Beck et al. 2001; Martin 1991; Poppendieck and Poppendieck 2003; Schwaber 1995). The resulting AISD approaches (Cao et al. 2009b; Vidgen and Wang 2009) trade strict control for more flexibility and autonomy within the team, the overall development process is not planned and scheduled upfront, and progress is made in small iterative phases, while encouraging change and constant feedback (Cockburn and Highsmith 2001; Highsmith and Cockburn 2001). Planning becomes a permanent task, and team leadership is established via collaboration and is separated from project lead (Dybå and Dingsøyr 2008; Dybå and Dingsøyr 2009).

While the team is thus highlighted as the crucial aspect of AISD in practice, extant research on AISD approaches mainly has investigated specific and individual or organizational phenomena, such as the use and effects of specific agile practices (e.g., Balijepally et al. 2009; Holmqvist and Pessi 2006; Maruping et al. 2009b; van Oorschot et al. 2018), or effects

regarding whole projects or organizations, such as the introduction of AISD methods to teams (e.g., Cao et al. 2009b; Heeager 2012; Hong et al. 2011; Kotlarsky 2007; Mangalaraj et al. 2009), or the usage of AISD approaches in large-scale, multi-team environments or portfolios (e.g., Dingsøyr et al. 2018; Sweetman and Conboy 2018).

As existing research thus covers individual and organization-wide level of effects on AISD, team-level effects are covered less so, and existing results are contradictory. For example, team research has included technology as an influencing factor of team work (e.g., Kozlowski and Ilgen 2006), but specific features of (A)ISD have not been observed. Some studies have found that cohesive (i.e., non-diverse) teams are the optimal base for applying agile practices (Cao et al. 2009b; Fruhling and de Vreede 2006), while other studies suggest that diversity amplifies creativity and problem-solving ability (Bear and Woolley 2011; Lee and Xia 2010; Phillips et al. 2006) and therefore might provide benefits for AISD. These inconsistencies are especially important for AISD, as AISD teams rely heavily on efficiency (to respond quickly to changes; Conboy 2009) and problem-solving ability (to complete complex, non-routine tasks; Lee and Xia 2010).

7.2.2 Team Resilience

One concept closely linked to efficiency and problem-solving ability (i.e., team effects), which has also been repeatedly linked to AISD, is *team resilience* (Meneghel et al. 2016). AISD explicitly acknowledges the importance of being able to respond to requirement changes and even embrace change and an ever-changing environment (Beck et al. 2001). As changes impose difficulties for the team, AISD teams have to have the

capacity to recover quickly from changes and difficulties, which is the textbook definition of resilience (Oxford English Dictionary). As AISD explicitly stresses the importance of being able to respond to requirement changes (Beck et al. 2001), resilience supposedly is an important team trait for successful AISD, as changes in requirements is one of the main reasons ISD projects fail (Maruping et al. 2009a).

Resilience in general has been used in biology to describe the ability of a dynamic multispecies ecological system to persist with the same basic structure when subjected to stress (Holling 1973). Derived from this, team resilience is used to describe a team's ability to "withstand disruptive factors, synonymous with both buffering against disruptive factors and correcting for disruptive factors without significant strategic changes" (Chakravarty et al. 2013, p. 983). As an important aspect for this study of team resilience is its influence on performance in teams in general (Meneghel et al. 2016).

While resilience can stem from different sources (e.g., individual characteristics) and can vary depending on the present disruption, one—intuitive and important—way to develop resilience is a critical review by the team of the team and its success (Alliger et al. 2015). That way, a team can spot weaknesses in its processes and ways of work and improve itself. Team members therefore have to feel that they can voice concerns and critique and feel safe to take interpersonal risks by doing so. This has been conceptualized in organizational psychology by psychological safety (Edmondson 1999).

7.2.3 Psychological Safety

Psychological safety, which originates from concepts such as leadership style or cohesiveness, is seen by research in organizational behavior as an important one, especially in regard to innovativeness and learning behavior (Baer and Frese 2003; Nembhard and Edmondson 2006). Psychological safety affects and moderates a latitude of team-level effects (Martins et al. 2013; Roberge and van Dick 2010), among them learning, innovativeness, self-reflection, and overall performance. As AISD practices rely heavily on social interactions, self-organization, and self-reflection, strengthening team learning behavior, information sharing behavior, innovating capacity, and improve team members' motivation to speak up for organizational improvements can be expected to improve agile team performance. Psychological safety affects all of these aspects (Baer and Frese 2003; Detert and Burris 2007; Liang et al. 2012; Nembhard and Edmondson 2006), which leads us to suggest that psychological safety plays an important role in moderating corresponding effects of AISD practices.

Psychological safety, a shared belief held by members of a team that the team is safe taking actions which could be interpersonally risky in other teams (Edmondson 1999, p. 354), has been used by researchers to explain organizational learning (Nembhard and Edmondson 2006), information sharing, and how team members are motivated to speak up for improvements (Detert and Burris 2007; Liang et al. 2012) or to take initiatives to innovate (Baer and Frese 2003). Structure (e.g., in the form of clear procedures for coordinating and prioritizing work) fosters psychological safety, especially in self-managed teams, and improves team learning (Bunderson and Boumgarden 2010). Further, an influence of

psychological safety on the ability to learn from failures has been identified (Carmeli and Gittell 2009; Jehn et al. 2014).

Furthermore, psychological safety moderates (i.e., mitigates) the negative effect of diversity on performance (Roberge and van Dick 2010). A direct effect on performance (Schaubroeck et al. 2011), especially in diverse teams (Singh et al. 2013), is apparent as well.

In sum, extant research has applied theories of organizational psychology while being focused on IT use rather than on AISD (e.g., DeSanctis and Poole 1994; Gorecki et al. 2008; Nan 2011; Wang and Hahn 2015). While research on teams thus is not completely new to AISD research, psychological safety and its relationship to team resilience have not been investigated, but are seen as an important factor for AISD practitioners (DevOps Research & Assessment and Google Cloud 2019).

7.3 Theory Development

Considering that research yet has to identify the preconditions for successful implementation and use of AISD, we propose to contribute to closing this research gap with a conceptual model. Based on previous work (Diegmann and Rosenkranz 2017), we argue that social agile practices (SAPs) in and of themselves do not necessarily provide any benefit to performance. Instead, we propose that this benefit can only be realized if team members feel that they can speak freely and voice concerns or give alternative, possibly controversial, solutions. In support of this claim, empowering management, flat hierarchies, a collaborative environment, which enables team members to express their opinions have been found to be important facilitators for AISD (Batra et al. 2016; Chow and Cao 2008) and similarly for learning organizations in general (Eisenberg et al. 2013;

Ellinger and Bostrom 1999). Therefore, we propose psychological safety to moderate the effect of SAPs. If the team is not feeling save (i.e., low psychological safety), the AISD practices only provide marginal benefits or even reduce performance. If, however, the team does feel safe (i.e., high psychological safety), SAPs unfold their full potential and the team gets performance benefits from the implementation of SAPs.

We further argue for a feedback loop in that SAPs in turn lay the groundwork for emergent psychological safety in AISD teams by providing safe environments (e.g., via daily standup meetings) and fostering mutual support and responsibility (e.g., via collective code ownership). Note that we are not interested in textbook agile approaches, but the individual configurations of SAPs (i.e., the respective method tailoring result employed in our cases). We are therefore looking at the number of, as well as the frequency and quality of employed SAPs rather than the differences between what agile methods call for and how these are implemented in the different cases.

While these phenomena have been investigated on their own and mainly in the context of general or occasional teams (e.g., randomized samples in experiments), AISD research has not put these theories together and evaluated these effects in the specific context of AISD teams in the field, although AISD methods rely heavily on team work, team composition, communication, and interpersonal relationships (Beck et al. 2001; Lee and Xia 2010; Maruping et al. 2009a; Rosenkranz et al. 2013; Sawyer et al. 2010). If our assumptions hold true, the proposed model helps in explaining team-level effects in AISD and in turn gives guidance to

improve team resilience and performance. Figure 7-1 displays our proposed model and Table 7-1 summarizes the constructs.

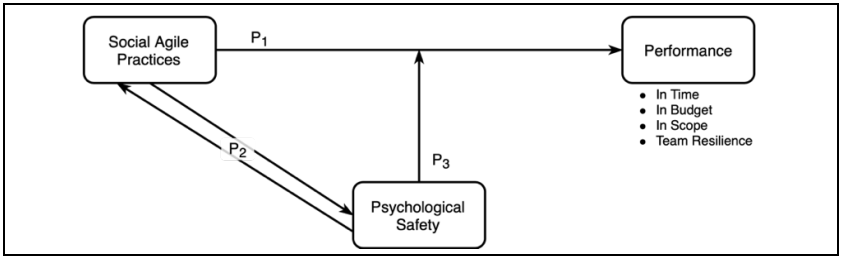

Figure 7-1. Proposed research model.

Name	Definition	References
Social Agile Practices (SAPs)	Agile practices entailing communication practices or practices aiming at exchanging knowledge and facilitating interpersonal interaction (e.g., daily scrums, retrospectives, or pair programming).	Hummel et al. (2015)
Psychological Safety	Psychological safety is defined as "a shared belief held by members of a team that the team is safe for interpersonal risk taking" (Edmondson, 1999, p. 354), meaning that team members are more likely to engage in behaviors such as seeking feedback, asking for help, speaking up about concerns or mistakes, or coming up with innovative ideas when psychological safety is high.	Edmondson (1999)
Performance	Composed of on-time completion, on-budget completion, software functionality, and resilience. Resilience describes how quickly a team is likely to recover or bounce back from failure once failure has occurred. Also defined as "being able to withstand disruptive factors, synonymous with both buffering against disruptive factors and correcting for disruptive factors without significant strategic changes" (Chakravarty et al., 2013, p. 983).	Lee & Xia (2010) Alliger et al. (2015) Hashimoto et al. (1982) Chakravarty et al. (2013)

Table 7-1. Construct Summaries

As structure helps self-managed teams to improve their learning from failures (Bunderson and Boumgarden 2010) and as SAPs provide this structure both in the form of daily routines (e.g., daily standup meetings), and in the form of mentoring and help-providing structures (e.g., through

pair programming or collective code ownership), we argue that the usage of SAPs positively influences performance and we propose P_1:

P_1: *Usage of social agile practices positively affects performance.*

Linking psychological safety with AISD, we argue that SAPs foster psychological safety by providing a safe environment for speaking up (e.g., during daily standup meetings or sprint reviews) and by creating a perception of shared responsibility and mutual support (e.g., via shared code ownership or pair programming), because structure (e.g., provided by daily standup meetings or mentoring during pair programming) is beneficial to psychological safety (Bunderson and Boumgarden 2010). At the same time, research suggests that psychological safety plays an important role regarding social interaction in teams (Baer and Frese 2003; Detert and Burris 2007; Liang et al. 2012; Nembhard and Edmondson 2006). Especially with regard to the emphasis, SAPs place on social interaction, psychological safety acts as an enabler for SAPs by empowering team members to speak freely with one another, cooperate, and resolve conflicts (Roberge and van Dick 2010). Taken together, this results in proposition P_2:

P_2: *Increased usage of social agile practices positively affects psychological safety, and increased psychological safety enforces the use of social agile practices.*

Building upon this argument for P_2, psychological safety not only enforces SAPs, it is a prerequisite for SAPs to unfold their positive effects. Without feeling safe to voice concerns (e.g., during reviews or pair programming), SAPs are destined to be less successful than when team members feel safe to engage in SAPs. P_3 resembles this proposition:

P_3: *Psychological safety enables and enforces the positive effect of social agile practices on performance.*

7.4 Research Design

7.4.1 Case Overviews and Data Collection

To test our propositions and evaluate our proposed model, we conducted an embedded, confirmatory multiple case study (Dubé and Paré 2003; Lee 1989; Yin 2003, p. 49) within three different case organizations (see Table 7-2). The cases were sampled following a joint literal (conditions of the case lead to predicting the same results) and theoretical replication logic (conditions of the case lead to predicting contrasting results). The two similar cases are set in large insurance companies (Insure1 and Insure2), one of which is active internationally and one only nationally. The third case (Develop1), selected as a deliberate theoretical contrast, is set in a small-to-medium sized software development company, focusing on business-to-business (B2B) services. Develop1 began to use agile practices eight years ago, Insure1 and Insure2 both are in the process of introducing agile practices, which started in both cases a little over a year ago. The main unit of analysis (i.e., "what" is the case to be studied) is the team, with team members as subunits. All examined organizational units are based in Germany.

We collected data from various data sources and with different data collection methods. Semi-structured interviews, project documentation, instructional and managerial guidelines, and field notes were used to generate data. The participants for the semi-structured interviews were sampled to cover common roles in AISD projects, but also to interview those team members, which can give detailed insight in and an overview of

current and recent projects. Supplementary documentation, such as project and team descriptions, as well as internal guidelines, were used to identify suitable participants. An interview guideline (Appendix A) served as a rough structure, with room for deviation and probing questions, and each interview proceeded individually. The interview guideline was not shared with the interviewees and we only used it as a checklist and outline. The aim was to encourage the interviewees to provide a narrative of their experiences as freely as possible. We interviewed both project managers and project workers. Administrative documents, work descriptions, interview transcripts, and field notes were collected in a case study database. We collected data from July 2018 to August 2018 while conducting 13 face-to-face interviews at the companies' sites (see Table 7-3). All participants of Insure1 and Insure2 were part of an agile transformation team, enabling us to gain an overview over all agile teams and, more importantly, were able to tell us about any lessons learned. All participants from Develop1 were part of a development team.

Experience in AISD and ISD in general were collected via a voluntary questionnaire. Where participants did choose to not fill out this questionnaire, the experience was derived from the dates mentioned during the interviews and marked with "—" where no data was found.

While loosely following the guideline, space for probing and open questions was available. During these interviews, the participants were asked about the implemented agile practices and about teamwork in general. Furthermore, we asked participants about their perceptions of the applicability and success of agile practices as well as team climate and interactions between team members. Our guidelines were derived from

extant literature. The interviews lasted about 60 minutes and were recorded and transcribed. This resulted in about 169 recorded transcript pages (size DIN A4). Follow-up emails were sent to request clarifications and to offer informants the possibility to provide feedback and comments.

The interview protocol and guideline were checked against Bouchard (1976) and Mishler (1986). The guideline was especially checked regarding the sequence of questions; however, since the interviews were basically open, as few direct questions as possible were asked and leading questions were avoided (Loftus 1975).

Name	Industry	Size	State of Agile Adoption
Insure1	Insurance	Large, international company	Agile transformation in progress
Insure2	Insurance	Large, national company	Agile transformation in progress
Develop1	B2B Software Development	Small-to-medium sized company	Adopted since founding in 2010

Table 7-2. Case Site Overview

			Experience in	
ID	Case	Role / Assignment	AISD	ISD
I1-1	Insure1	Specialist for IT portfolio management in the agile transformation team	> 2 years	> 10 years
I1-2	Insure1	Specialist charged with initial setup of soon-to-be agile teams	> 2 years	> 10 years
I1-3	Insure1	Specialist for change management in the agile transformation team	> 2 years	> 2 years
I1-4	Insure1	Specialist charged with creating a team vision in the agile transformation team	> 5 years	> 5 years
I2-1	Insure2	Team leader of the agile transformation team	> 2 years	-
I2-2	Insure2	Product architect and scrum master	> 3 years	-
I2-3	Insure2	Specialist for quality assurance	> 2 years	> 5 years
I2-4	Insure2	Program manager for Insure2	> 2 years	> 10 years
I2-5	Insure2	Specialist for strategy and enterprise architecture in the agile transformation team	> 2 years	-
S-1	Develop1	Scrum master	4 years	4 years
S-2	Develop1	Specialist for software and application architecture	4 years	4 years
S-3	Develop1	Developer and tester	4 years	4 years
S-4	Develop1	Developer	4 years	4 years

Table 7-3. Interviewee Overview

7.4.2 Data Analysis

Coding techniques and checklists (Miles and Huberman 1994, pp. 170-244; Yin 2003, pp. 109-138) were afterwards used to connect data with constructs from our model and the propositions. The data analysis process is outlined in Figure 7-2. We used the software MaxQDA for coding our data. Following Saldaña (2016), we applied different coding strategies. 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 and second step.

First, we derived the codes from extant literature and our proposed model (displayed in Figure 7-1). Extant literature predetermines our codes as, for instance, the sets of available SAPs are already identified by Hummel et al. (2015) and Tripp et al. (2016). Based on these predetermined codes, we set out to identify and refine our proposed constructs by means of *pattern coding* as described by Miles and Huberman (1994) and Saldaña (2016). 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). This analysis was performed on the conducted interviews and supplemental material (e.g., field notes, instructional material/managerial guidelines). The theoretical constructs of SAPs (Hummel et al. 2015) and psychological safety (Edmondson 1999) served as guidelines.

The second coding step in our coding process follows *hypothesis coding*, which is suitable for testing purposes; especially to test for rules, causes, and explanations (Russell Bernard 2002; Saldaña 2016; Weber 1990). Further, hypothesis coding can be applied in a later coding stage to confirm or disconfirm developed assertions—as is the case for this study (Saldaña 2016). In this step, we aimed at identifying statements in the conducted interviews and supplemental material (e.g., field notes, instructional material/managerial guidelines) to support or reject our propositions. Once again, the theoretical constructs of SAPs (Hummel et al. 2015) and psychological safety (Edmondson 1999) served as guidelines for coding the interviews. Further, we used supplementary data sources (as mentioned above) to set participants' statements into clearer context.

We followed three tactics to increase construct validity (Lee 1989; Yin 2003, pp. 40-44). We used multiple sources of evidence (multiple key informants) and established a chain of evidence (case study database) during data collection. Furthermore, all key informants reviewed draft reports of the case study. In the data analysis, we addressed internal validity by pattern matching (linking the propositions and constructs to data from the case study database) and explicit explanation building. Since this case study was explicitly designed to test the propositions of our model, we used replication logic and theoretical logic in the setup of multiple cases for ensuring external validity. The multiple case study design was explicitly chosen to ensure analytical generalization. For addressing reliability, for each case in this study, we collected transcripts and protocols from the interviews. Following Dibbern et al. (2008) and based on Dubé and Paré (2003), Appendix B gives a detailed overview about the attributes used to assess the case study's rigor.

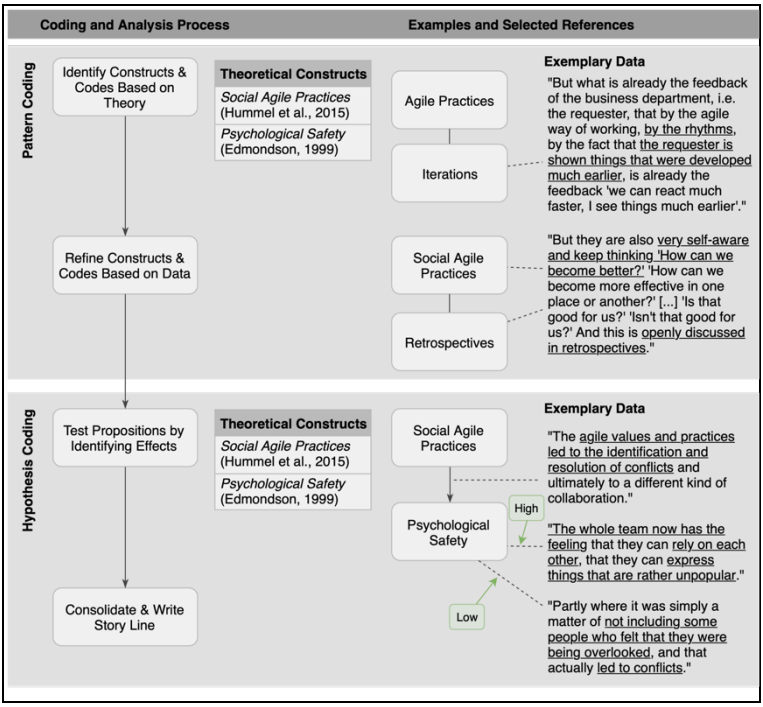

Figure 7-2. Coding process with illustrations.

7.5 Results

The main coding matrix resulting from our analysis is displayed in Table 7-5. Depending on the frequency and clarity of identified codings in our data, we labeled the vividness of each code as either high (i.e., found often and clearly) or low (i.e., found seldom and/or only indirectly). As can be seen, all three cases implement a similar, yet different set of agile practices. During the interviews, we asked the participants to reflect on their specific circumstances, especially their set of SAPs. Also, the levels of psychological safety are slightly different between the cases. However, all three cases aim for a high level of psychological safety:

"It is very important to Insure1 that employees can always give their honest opinion." (I1-1, Q1)

"The wonderful thing is that you don't have to be afraid that some statement will be used against you, because you might be evaluated thereafter." (I1-2, Q2)

"It is very important to me ... that they know that I am a totally open guy ... and that they can and should say everything they care about." (I2-1, Q3)

"Yes, it's very friendly here, very humane." (S-1, Q4)

The few instances in which a less safe environment was mentioned were either in relation to situations before the agile-transformation:

"[if someone made a mistake, ...] there was often the escalation toward project management before." (I2-5, Q5)

or in relation to (emotional or task) conflicts, which arose at the very beginning of the agile transformation process due to the increased transparency and interdependency of work but always were resolved later on:

"Partly where it was simply a matter of not including some people who felt that they were being overlooked, and that actually led to conflicts ... These were both, personal conflicts as well as professional ones. ... However, the team often found this resolution process very fruitful. One has developed a joint solution and thus there is a better feeling later. Everyone has contributed and is involved. Everyone has a bringing-us-together function, so the team is more connected." (I1-4, Q6)

Code Group	Code	Insure1	Insure2	Develop1
Social Agile Practices*	Daily Standups	high	high	high
	Reviews and Retrospectives	high	high	high
	Pair Programming	**low**	high	**low**
	Sprint Planning and Prioritization	high	high	high
	Collective Code Ownership	-	-	high
	Cross-Functional Teams	high	high	high
	... affect Psychological Safety	high	high	-
	... affect Performance	high	high	high
Psychological Safety	Safe environment	high	high	high
	Neither safe nor unsafe environment	**low**	-	high
	Unsafe environment	**low**	**low**	-
	... affects SAPs	high	high	high
	... moderates SAPs → Performance	high	high	high
Performance	... increased with SAPs	high	high	high
	... decreases with SAPs	**low**	**low**	-

Table 7-4. Identified Codes and Codings

** Of all SAPs, only the codes that were found are listed.*
("high" marks a code that was identified clearly and often; "low" marks a code that was identified seldom and/or only indirectly)

An important aspect in these statements is set in comparison to the "before agile" state of the organization. As will become clear in the following paragraphs, the overall situation painted by the participants was positive and accepting; although some hurdles had to be overcome, and the transformation into agile ways was sometimes perceived as difficult. For instance, two of three cases showed a partial negative effect of SAPs on performance:

> *"There were also team members who said, 'this [our set of practices] is all bullshit and does us no good.'" (I1-1, Q7)*

However, these team members changed their attitude later on or their attitude was based on fear for increased transparency on their work:

> *"That is a safeguard, some do not want to make their work transparent [e.g., by participating in daily standup meetings], because then one would see what someone is doing and what not." (I1-4, Q8)*

> *"[there are some who] were very hostile and played with prejudices [in the beginning] who now [after some successful projects, ...] if something goes well, say 'sure, we did that the agile way.'" (I1-4, Q9)*

As becomes clear through these statements, transparency was a critical factor in the agile transformation and plays an important role in successful AISD, as, for example a facilitator for trust, communication, and knowledge sharing (Laanti et al. 2011; McHugh et al. 2011).

In regard to our propositions and as displayed in Table 7-4, we found support for all three propositions as displayed in Figure 7-1 and outlined in the theory development section. Support for proposition P_1 can be found in all three cases:

> *"In my opinion, Scrum helps to really deliver quality." (I2-2, Q10)*

> *"I know they [the team] perform and that we're in roll-out now. And obviously—it worked." (I2-5, Q11)*

> *"And towards the end, we had actual change requests. [...] There you can see the complete harmony between what I expected and what I got." (I2-5, Q12)*

Similarly, proposition P_2 is supported by two of three cases. One aspect, as identified by I1-3, is that by "forcing" people together, by promoting social interactions, people are more likely to develop a common understanding:

> *"You can't avoid each other. ... You're already working things out together. You must at least create a basic understanding together and through this you must speak a common language [e.g., during retrospectives]. So, we have invested a lot of time in a common understanding ... However, I believe that this is very valuable in the long term." (I1-3, Q13)*

I2-5 made a very similar argument. He thinks that an iterative approach, combined with learning and a common vision help in establishing trust:

> *"All this didn't work overnight. It has gone through a process and trust has been built up among each other. And you can actually say that people have grown more attached to each other and what you produce here as a product ... that can be sold on the market, that's their baby. They developed a deep identification with their work [after the introduction of agile practices]." (I2-5, Q14)*

Further support for proposition P_2 can be found in all three cases. Insure1's internal guidelines document core organizational values close to the four values postulated in the *Agile Manifesto*, and participants of Insure1 were especially outspoken about the effects of a safe environment on the agile practices:

> *"Colleagues should simply be open—to new topics and simply have fun trying things out." (I1-2, Q15)*

> *"I think to be able to work really well together; it is important to be part of the team." (I1-3, Q16)*

The cyclical relationship between psychological safety and SAPs, as described in P_2, has been raised by participants as well:

> *"Many have not yet understood this concept of a learning organization either. 'Why do you do this different now again?' 'We've only just gotten used to the old way. Why does it have to be any different now?' And these constant changes over and over again, that is just really difficult for some people." (I1-2, Q18)*

However, this resistance can be tackled by employing change management tactics. The same applies for the partially negative effects of SAPs mentioned beforehand. For instance:

> *"Just look at the team a bit, have a little more sense for the needs. And you have to sell why you want to do it this way." (I1-3, Q19)*

Insure2 reiterates that psychological safety influences their way of work and the selection of SAPs:

> *"In the end, we simply encourage the team members to get involved and perhaps make suggestions on how to improve processes [and practices]." (I2-4, Q20)*

> *"This is the agreement: You do your thing. I trust you, and I got your backs—and this deal unfolds creativity and motivation. It's not easy to copy [practices by the book] because it's based on rather soft factors." (I2-5, Q21)*

Finally, we see support for proposition P_3 in all three cases as well. Some statements were less clear:

> *"I think that this [i.e., Scrum-like practices] works very well, as long as you have a scrum team, which works well as a team." (I2-2, Q22)*

which hint at a trusting and friendly (i.e., psychologically save) team as a prerequisite for success of AISD practices. Other statements were clearer but discussing the effects of low psychological safety:

> *"Sure, it becomes very transparent how I do something, how I work. ... you also have to share a lot [e.g., during retrospectives]. And that's just difficult for many people at first." (I1-2, Q23)*

> *"Sometimes there was pure rejection and statements like 'we have tried agile before and it didn't work.' If you look more closely and ask what went wrong—this had nothing to do with Scrum or the methodology, but rather with [affective and task-related] conflicts in the team that had not been resolved." (I1-4, Q24)*

On the other hand, we found similarly clear statements discussing the effects of high psychological safety in Develop1. Asked about the most important success factors for the success of their agile implementation, S-1 said:

> *"Communication, honesty, and candor." (S-1, Q25)*

These three factors are all linked to psychological safety, as psychological safety is based around honesty and candor and improves communication.

Combining all statements, we find support for all our propositions, which leads to implications for both research and practice and opens new avenues for future research.

7.6 Discussion, Implications, and Limitations

As AISD methods rely heavily on team work, communication, interpersonal relationships, and social interaction in general (Beck et al. 2001; Lee and Xia 2010; Maruping et al. 2009a; Rosenkranz et al. 2013; Sawyer et al. 2010), a supportive, friendly, and open environment is clearly a hotbed for successful AISD implementation. Further, we found evidence for the influence of SAPs on performance in general (e.g., Q10) and resilience in particular (e.g., Q12). We outlined in the previous section and displayed in Table 7-4 the support for all our propositions, especially for the importance of psychological safety—leading to a supportive, friendly, and open environment. It is demonstrated that psychological safety can play a role in making SAPs more effective, and that effective SAPs can add to the sense of psychological safety experienced by agile team members.

7.6.1 Discussion of Propositions

In the following, we will take a closer look into each of our propositions regarding the identified support and the respective transferability.

P_1: Usage of Social Agile Practices Positively Affects Performance.

As pointed out in our results section, we found clear support for our proposition P_1. While the usage of these practices sometimes led to a—temporary—decrease in performance (e.g., due to an increase in need for communication), ultimately, interviewees reported an increase in performance due to the usage of SAPs compared to their previous, waterfall-driven approach. Our main focus was on the overall usage of SAPs, rather than the how and how often usage of singular practices. Nevertheless, we found evidence for the importance of careful and

conscious adoption and implementation of SAPs. For instance, as reported in Insure1, if team members slip on their participation of daily standup meetings, the beneficial effects of regular meetings cannot be realized. We decided not to include this finding as a proposition, as it would go beyond the scope of this study.

While this effect cannot be translated to purely traditional, non-agile projects, it can be transferred to any project implementing SAPs, regardless of the underlying software development methodology or ideology.

P_2: Increased Usage of Social Agile Practices Positively Affects Psychological Safety and Increased Psychological Safety Fosters the Use of Social Agile Practices.

The previous section gives examples for the strong support we found for P_2. However, some interviewees pointed out that the way in which SAPs were introduced and overseen by, for instance, the scrum master, influenced the respective effect on psychological safety. If SAPs were forced onto the team, psychological safety did—in some cases—not manifest as quickly and strongly as in others.

This specific effect can only be observed in teams engaging in SAPs; however, we found no evidence suggesting that the underlying task domain would play a role for this effect. We further assume that the effect is especially visible in any practices focusing strongly on social interactions (e.g., retrospectives), due to the implied hierarchy and power structure when forcing a practice onto a team. It is important to note that a forced usage of SAPs (e.g., by publicly shaming team members into cooperation) might very well further decrease psychological safety over time, turning

this effect into a downward spiral. However, we found no indication of this trend occurring in our sample.

P_3: Psychological Safety Enables and Enforces the Positive Effect of SAPs on Performance.

Based on the statements in our data set, we are confident, that this finding is robust. We identified strong support for the enabling effect of psychological safety across all cases. Further, as this effect is not cyclical as is proposition P_2, we believe that this effect is even more robust.

In regard to transferability, we see agile teams as the core beneficiaries of this effect. However, we could believe other, non-agile practices and routines, which rely on social interaction, to be heavily impacted by psychological safety—at least by psychological safety as a moderator of any positive effects derived by said practices and routines.

7.6.2 Consolidation

The collected data suggests that psychological safety plays two significant, cyclical roles in AISD. First, psychological safety determines if team members accept SAPs (e.g., Q18). If psychological safety is low, team members are less likely to partake in planning meetings and retrospectives. If, in contrast, psychological safety is high, team members are more likely to accept SAPs and give them a try. Second, psychological safety determines how team members participate in SAPs (e.g., Q22). If psychological safety is low and they do participate in SAPs, they are less likely to speak their minds, are less likely to give valuable input to achieve successful outcomes, and are less likely to offer ideas for continuous improvement. In contrast, a higher psychological safety leads to more engagement, more helping behavior, and an increased willingness to offer

new ideas and give valuable input which ultimately leads to improved outcomes and a learning organization.

However, if psychological safety is low, it can be improved and strengthened by implementing SAPs carefully (e.g., Q13). As we have seen in the previous section, it is important to apply change management tactics and listen to the needs and concerns of team members.

Taken together, these two roles stress that while SAPs rely on and are influenced by psychological safety, psychological safety is enforced by SAPs, indicating that SAPs are not static, but to some degree dynamic (e.g., Q14) in their implementations. These findings extend previous research on social aspects of agile practices (especially Hummel et al. 2015) by explaining the surrounding context (in this case psychological safety) of successfully implemented SAPs. As put by Niederman et al. (2018), conflict and conflict resolution differ in AISD from traditional approaches. Psychological safety may explain when and why conflict can be beneficial to AISD teams.

7.6.3 Future Research and Implications

This study opens up new avenues for future research. Having support for the influence of psychological safety means that research now should investigate in more detail which boundary conditions are in effect for psychological safety to influence SAPs. Further, a quantitative evaluation of this model could yield additional insights. Due to the qualitative nature of this study, we have only limited indication for the strength and significance of the identified effects. Additionally, future research might look into the details of the "how" and "how often" of SAP usage, as we did find evidence for the significant effect of how and how often an SAP was

adopted, implemented, and used. While the interviews indicate significant and strong effects, a quantitative follow-up study would increase the confidence in our results. Methodological replication studies outside of the task domain of software development might further define and refine the boundary conditions of our findings and help in building trust to our argumentation for transferability of our findings to different task domains. While our study was conducted in a new product development setting, all participants worked in software-related new product development projects. While software- and non-software based new product development projects share many similarities (e.g., unclear or at least changing requirements), they have differences. For instance, software can often be modified cheaply even after the end user has started using the product—modifying an in-use, non-software product is distinctly more costly and difficult. These differences might lead to different findings in a non-software new product development project and might be a fruitful avenue for future research. Additionally, we see an avenue for future research on the applicability of our findings in other task domains and industries, as all of our cases worked on new product development tasks in the insurance industry. Another, possibly fruitful avenue for future research might be an interaction between psychological safety and team resilience directly. While we did not find direct evidence in our data or our literature review, one might imagine an interaction between these two concepts, possibly over time.

For practitioners, these results have important implications as well. When considering using agile methods for AISD projects, the increased social aspect should be considered in addition to established characteristics. If an environment with lower psychological safety can be assumed, AISD

practices are likely to not fulfill their potential and might harm the process. When considering transforming to an agile approach or implementing AISD practices, managers should, in addition to the previous point, consider the additional tension a transformation might bring to those how are adjusted to, for instance, a waterfall method. These tensions might need additional consideration, preparation, and an even higher level of psychological safety, compared to a new team. When already using AISD practices—but the team members might not participate or if these practices appear useless—managers might take a closer look at the psychological safety in the team in general and during the execution of these practices. As presented in the results section, some team members might not feel safe (enough) to participate in SAPs. Similar to managers, team members themselves could benefit from checking the psychological safety in their teams as, ultimately, every team member contributes to the team climate and psychological environment. As literature suggests, being inclusive and open towards team members helps in creating a psychologically safe environment (Edmondson 1999; Nembhard and Edmondson 2006). Raising psychological safety in the team is not only benefiting team performance, it also raises job satisfaction (Bergheim et al. 2015) and should therefore be in every team member's own interest. Therefore, a psychological safe environment appears to be extremely important to successful implementation of AISD methods. This means that before and during an agile transformation, an open and honest environment without fear for retribution or penalties has to be created and reinforced. Furthermore, practitioners should be aware of the cyclic relationship between SAPs and psychological safety. While psychological safety is an important factor for successful AISD implementation, SAPs

enforce psychological safety and psychological safety influences the engagement of team members in SAPs and their selection of preferred SAPs. This concept of a learning organization is seen as a threat by some team members, but with appropriate change management, this constant process refinement can be beneficial to both team members and the organization as a whole.

7.6.4 Transferability to General Project Management

Industrial practice has not only identified social aspects as important drivers for success in AISD (e.g., McGregor and Doshi 2018), reports of successful implementation and adaptation of agile approaches surface as well (e.g., Rigby et al. 2018). More specifically, agile is considered harmful if implemented superficially—if teams cannot experiment and manage themselves, they stop learning and stop putting their best efforts into their work (McGregor and Doshi 2018). An environment of high psychological safety is therefore needed to reap the benefits of agile approaches, especially in uncertain or changing environments—and for these environments, industrial practice has seen success in implementing agile approaches outside of software development. For instance, a company in engineering and construction was able to succeed in a business turnaround following a crisis of declining demand by implementing agile practices as a new way of work, resulting not only in reduced costs, but also in an increase in employee motivation and acquired skillsets (Rigby et al. 2018).

While our interviews were set in a software development context, we strongly believe, that our findings are transferable to agile teams in other task domains. Most interviewees from Insure1 stated that they have experience working outside of software development as task domain and

indicated that their experiences regarding SAPs and psychological safety were not exclusive to the software development task domain. While some SAPs, such as pair programming, are specific to software development, substitutes exist (e.g., pair writing). Furthermore, as agile approaches in general (and therefore AISD practices), are increasingly diffused from information systems development to other domains, our findings help in understanding these mechanisms of action not only in the AISD domain and might help in more direct and effective implementation of AISD practices inside and outside of information systems development.

What these previous paragraphs amount to is the importance of a supportive, friendly, and open environment, especially in teams working in highly volatile and changing environments, or teams transitioning to agile approaches. To sum up, our findings are applicable to general project management in that we showed an interaction of SAPs on psychological safety, which, in turn, affects transparency, communication, and ultimately productivity. It follows that any intervention (such as SAPs) that increases psychological safety might solve transparency and communication issues and can benefit productivity.

7.6.5 Limitations

This study is not without limitations. First, this study considers only three different cases, two of which are similar in industry, size, and state of agile adoption. The third, as the sole contrasting case, has only limited explanatory power. By increasing the number of cases, our findings could be refined and gain in validity if confirmed. Second, all three companies are based in Germany, with only one company being part of an international organization. Future research could conduct similar studies

in other countries and cultural regions to evaluate the influence of cultural aspects on the importance of psychological safety. Third, we did not conduct interviews with every team member. It is likely that the perceptions of the specific team's level of psychological safety and its influence on the success of SAPs varies. We believe this difference to be of only peripheral nature and to not have a significant effect on our conclusions due to the very homogeneous nature of the statements in all interviews. Similarly, we cannot rule out that in some cases, we have identified a side effect as a cause, due to the nature of a field experiment—for instance, we cannot differentiate if psychological safety benefitted from having regular meetings or having everyone participating in every meeting. However, as our cases were similar, yet not identical (e.g., not all teams in Insure1 had everyone always participate, others did), we are confident in the reliability and validity of our findings. Future research might still be able to strengthen the trustworthiness of our findings. Furthermore, our study is limited by the single pathway in a complex nomological network described. It is unclear, if SAPs always interact with psychological safety and if this (perceived) psychological safety is not determined by—possibly stronger—outside effects. The same limitation applies for the observed influence on performance. A great deal of outside effects (e.g., team members' capabilities, market forces) might affect performance stronger and more significantly than the effects of SAPs and psychological safety. This all leads to the issue that psychological safety is a very broad concept, making it possible to find influences on many different aspects of teamwork. However, we do think that our reasoning for these *specific* effects is sound and significant. We would nevertheless suggest future research to dig deeper into this issue and to try to isolate the

effects of psychological safety in AISD teams, for instance, via controlled interventions.

The fifth limitation is the influence of social desirability bias, as it is generally more socially desirable to report success rather than failure. Nederhof (1985) suggests postulating questions that are neutral. We tried to minimize the social desirability bias emerging from our questions. However, due to the clear preferability of success over failure, social desirability bias was still likely to emerge from questions during our interviews.

7.7 Conclusion

In this article, we constructed and argued for a novel model, explaining the interplay between psychological safety and AISD practices. As explained above, we were able to show that psychological safety is a critical success factor for agile teams. With the diffusion of agile practices outside of the domain of information systems development, our findings provide insights for general project management. However, due to the discussed limitations, future research on team-level effects in AISD is needed to further improve AISD, reducing the number of failed AISD projects, and to review the applicability of our findings in additional contexts.

7.8 Appendix A

This interview protocol served as a rough guideline in the interviews. However, most of the interviews followed a natural, but individual course.

Background

- Please tell us about yourself; your background; your role in the team
- Please tell us about the business unit within your organization:
    - What is the overall structure of the unit?
    - Is the use of certain tools and practices mandatory?
    - What discretion do project team members have in choosing the technologies and practices they will use?
    - Is there a formal development methodology espoused by the organization?
    - Please describe what you perceive as the most important success factor for your team with respect effective and efficient software development within your organization.

Assessment of Current Practice – Activities and Routines

- How far along is the project? At a very high level, could you walk me through the history of the project and the future plans for the project?
- Please tell me about the structure of your team and the regular activities within your team—who does what and why?
- What are the (key) roles (e.g., scrum master, agile coach, project manager) or positions on this project?

- What are the (key) activities (e.g., dailies, retrospectives) in this project?
- How do team members communicate within the project?
    - Which media or tools are used?
    - Are there any expectations with respect to who should or may speak to whom?
    - Do team members talk freely to one another—do they talk only about work-related topics or also about personal topics? Do team members know each other personally?
- Who defines, selects, and oversees the activities and routines that are used on the project?
    - How do those individuals ensure that the activities and routines are carried out in the way that they prefer?
    - How would you characterize the interaction between these individuals and other members?
- In your perception, *why* does the team work in the way that it does? Is it a formal rule, an informal convention, or was it always done this way?
- Are these work practices and ways of interacting similar to other projects that are going on right now? Is it the same as historical ways of doing things?
- Has anyone proposed changes to the work practices or ways of interacting employed on this project? If so, why?

Psychological Safety and Trust/Personal Perceptions of Control

- How do you think team members feel in your team? Do they feel free to express unconventional or new ideas/voice concerns/raise tough issues?
- Do you think team members feel valued?
- Do you think it is easy for team members to ask each other for help?
- Do you think team members feel that their mistakes might be held against them?
- Do you think team members trust each other?
- Do you feel controlled?
- Do you think team members have always in mind what is best for the team?
- How are your personal/project outcomes judged? Is this somehow linked to your pay schedule?
- Do you think that flexibility and/or personal discretion are important for the overall outcomes of your team?
- Do you perceive any tension between the need for control and the allowance of flexibility in the team's daily work routines?
- Do you think that some control is beneficial to the overall outcomes of your team?

Requirements Changes

- Did you perceive requirements changing during the project? In your opinion, what were reasons for it?
- Do you think that these changing requirements may also result in technical and managerial issues?
- During times of high time pressure—did someone "take the lead" to organize the team or did everyone proceed as usual? Did people change in their behavior or role enactment?

Resilience

- Do you think the team is able to recover quickly (using little to time, resources, etc.) from unforeseen crises/events shocks (e.g., requirement changes)?
- If an unforeseen crisis/event/shock occurs, how does the team react? Do people act differently? Do routines change?
- How do you perceive the diversity of your team—regarding skill sets/regarding gender, ethnicity, culture, and so forth.

7.9 Appendix B

Research Design	
Nature of study	Positivist, explanatory study recognizing subjective and interpretive elements in every research (cf. Lee 1989a; Lee 1989b; Lee 1991)
Clear research questions	Yes.
A priori specification of constructs	Yes (explanatory character).
Clean theoretical slate	No, propositions were formulated a priori (explanatory character).
Theory of interest	Psychological safety
Rival theory included	No, because it was the first test of the model.
Multiple case design	Yes, three organizations with multiple projects, with every project representing a case (with multiple projects embedded).
Replication logic	Both theoretical and literal replication logic.
Unit of analysis	Projects in three different companies; however, all case studies are embedded and involve more than one unit of analysis. This occurs when, within a single case, attention is also given to a subunit or subunits. Although the specific projects represent the main unit of analysis, the individual project team members represent a subunit. Any subunit is part of/or embedded in the larger system (i.e., project) and it is important to understand the subunits in the larger system.
Pilot case	Not conducted, since it is highly recommended for exploratory studies only.
Team-based research	Yes, three researchers.
Different roles of investigators	First author and another researcher undertook data collection. First author and another researcher coded and interpreted the data independently before discussing and resolving differences. Second author acted as discussant and challenger for the data.

Context Description	
Detailed site description	Yes.
Case period	The case material was collected during a period of two months with several onsite visits and phone calls.
Longitudinal design	No.
Time spent on-site by the researchers	Yes, for setting up the case study design, for conducting interviews.
Nature of data collection	Both retrospective and ongoing.
Data Collection Process	
Multiple data collection methods	Yes, data was solicited from different stakeholders via interviews; administrative documents, work descriptions, printouts of project reports, interview transcripts and field notes were collected and added to the analysis.
Qualitative and quantitative data	Mostly qualitative.
Data triangulation	Yes.
Case study protocol	Yes.
Case study database	Yes, using MaxQDA and Microsoft Excel.
Data Collection Methods	
Interviews	Yes.
Documentation	Yes (e.g., administrative documents for project and interviewee selection).
Observation	No.
Questionnaires	No.
Artifacts	No.
Time series	No.
Sampling strategy	Convenient sampling and quota sampling for the interview participants (three organizations which offered access to projects).

Data Analysis Process	
Field notes	Yes.
Coding	Yes, coding techniques and checklists were used to connect data with the propositions.
Data displays	Yes.
Flexible and opportunistic process	Yes.
Logical chain of evidence	Yes.
Empirical testing	Yes.
Explanation building	Yes.
Time series analysis	No.
Searching for cross-case patterns	Yes.
Use of natural controls	Yes; focusing on informants that participated in more than one of the projects.
Quotes (evidence)	Yes.
Project reviews	Yes.
Comparison with extant literature	Yes.

Table 7-5. Attributes Used to Assess the Case Study

Following Dibbern et al. (2008) and based on Dubé and Paré (2003)

Chapter 8: Resilience and Social Agile Practices: The Role of Psychological Safety in Agile Information Systems Development

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Abstract

While agile methods are still rising in popularity, mixed results concerning real-world performance added an off taste of AISD's success story rush. As agile methods add an additional layer of complexity compared to traditional methods, new challenges arise. With agile's focus on social interactions, those challenges are often more sociological than technological in nature. Adding the underlying goal of embracing change, teams need to improve their resilience. We argue for an integrated model, combining agile practices, resilience, and psychological safety, to explain how agile teams become more resilient. To provide a first evaluation and to test our hypotheses, we conducted a quantitative field study in one large, multinational enterprise. Our findings offer new avenues for future research, investigating the benefits and presuppositions of agile practices. Practitioners might use our findings to improve resilience by increasing psychological safety and focusing on (social-focused) agile practices to reduce the number of failed projects.

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8.1 Introduction

The rapid pace of digital innovations and the effects of digital transformation in general (Wessel et al. 2021) have led to a similar rise in the use of *agile information systems development (AISD)* methods (Conboy 2009; Hummel et al. 2013; Lindsjørn et al. 2016). As now more than 90% of development teams report using agile practices such as sprint retrospectives, continuous delivery, or pair programming (VersionOne 2020), we also see that the initial wave of enthusiasm is part of the past. Real-world performance has failed to meet the early promises of AISD and has disillusioned AISD's popularity rush (Niederman et al. 2018). An explanation for these shortcomings of AISD in practice, however, is missing. The iterative nature of AISD adds new and unique effects and increases the overall process complexity compared to non-agile teams (e.g., Niederman et al. 2018). Moreover, AISD is not only focusing on the ever-changing nature of the information system development (ISD) process but also aims at embracing change as an inevitable force; this differentiates it fundamentally from traditional project management and ISD methods, which instead aim at avoiding it a priori (Cockburn and Highsmith 2001; Conboy 2009; Dybå and Dingsøyr 2008) and demands increased resilience of AISD teams.

AISD has been associated with face-to-face and personal interaction in small, self-organizing, often autonomous, and co-located teams (Hoda et al. 2012; Hummel et al. 2013; Matook et al. 2016). Many close and regular social interactions are deemed desirable for agile practices to unleash their full potential (Hummel et al. 2013; Hummel et al. 2015). AISD practices are geared to decrease sunk costs and path dependencies (Aaen 2008) while

simultaneously increasing flexibility and team autonomy (Andrias et al. 2018; Hoda et al. 2013), ultimately strengthening a team's resilience to a supposedly ever-changing environment (Tolf et al. 2015). This has become increasingly important to reduce project failures and increase project success (Chow and Cao 2008). Underlying this is one of AISD's core values: embracing change (Beck et al. 2001).

This idea of not only accepting but also embracing change implies that teams can handle the shocks that changes inevitably yield — resulting in an increased need for resilience in AISD teams and further emphasizing the need for a highly iterative process as well as constant feedback, communication, and synchronization among team members. Not only because of this but also because of the management-focused AISD practices, we argue for the importance of understanding *social* behavior in ISD teams (Kautz et al. 2007; Lee and Xia 2010; Persson et al. 2011; Sarker et al. 2009). Combining these aspects, the importance of social interactions and the dependency of AISD teams on resilience, an opportunity to explain AISD's shortcomings opens up.

Research has apparently not yet caught up with practitioners, and especially *team*-centric research on AISD is still scarce (Diegmann et al. 2018; Lee and Xia 2010). While individual or organization-wide phenomena (e.g., Balijepally et al. 2009; Holmqvist and Pessi 2006; Maruping et al. 2009b; Recker et al. 2017; Tripp and Armstrong 2018; van Oorschot et al. 2018), or effects regarding whole projects or organizations (e.g., Cao et al. 2009b; Heeager 2012; Hong et al. 2011; Kotlarsky 2007; Mangalaraj et al. 2009), have been investigated, team-centric effects and social or psychological factors, are mostly absent from these studies — with only a few exceptions (e.g., Hennel & Rosenkranz 2020).

This lack is perplexing because ISD is, in the end, a team effort (Sawyer et al. 1997; Sawyer et al. 2010; Siau et al. 2010). Research has known for long that a team is more than the sum of its individual members — for instance, collective intelligence, a measurement for the general intelligence factor of groups rather than individuals, correlates with the average intelligence of team members but is not explained by it (Woolley et al. 2010). Another example is the differentiation between mental models and shared mental models. While the latter incorporates the former, they need to be shared across the team to realize individual strengths (Converse et al. 1993), which has also been conceptualized specifically for the domain of AISD (Diegmann and Rosenkranz 2016) and offers further evidence for the importance of team-centric research in AISD. Moreover, practitioners call for more research on social aspects of AISD teams (Freudenberg and Sharp 2010), but scant research exists on social aspects of the development of socio-technical systems in general, which information systems essentially are (e.g., Kautz 2007; Long and Siau 2007; Sawyer et al. 2010; van Kelle et al. 2015). Especially for the specifics of AISD, a lack of research on social issues is being reported (Diegmann et al. 2018).

At the same time, organizational behavior research offers a well-researched concept that could help bridge this gap: psychological safety. As it is essential for a team's innovativeness and learning behavior (Baer and Frese 2003; Nembhard and Edmondson 2006) and, more generally, moderates various team-level effects (Martins et al. 2013; Roberge and van Dick 2010), it could lay the foundation for explaining yet unexplained team-centric effects in AISD. We, therefore, formulate the following research question:

Does Psychological Safety Moderate the Effects of Agile Practices on Team Resilience?

With this study, we deliberately depart from previous studies, which centered around method selection or project level performance (e.g., Tripp and Armstrong 2018; van Oorschot et al. 2018). Instead, we investigate the specific practices and their behavioral implications from a team-centric perspective. We propose a model based on extant literature across domains, explaining how agile practices and psychological safety can explain resilience in AISD teams. We hypothesize a moderation of effects stemming from agile practices by psychological safety, a direct effect of agile practices on resilience, and a mediation of this effect by team autonomy. To provide a first evaluation of our model and to test this model's hypotheses, we conducted a quantitative field study in one large, multinational enterprise. While a moderation of the effects of agile practices by psychological safety could not be supported with our data, we found supporting evidence for a direct effect of psychological safety on resilience and significant effects of social-focused agile practices. These findings offer new avenues for future research, investigating the benefits and presuppositions of AISD practices. Practitioners might use these findings to improve resilience by increasing psychological safety in teams and focusing on social agile practices to reduce the number of failed projects.

The paper is structured as follows. First, we will lay the theoretical background and develop our theory and model. Next, we present our data collection and data analysis process. Finally, we present and discuss the results of our analysis as well as our contributions to research and practice. Based on this discussion, we give avenues for future research.

8.2 Related Work and Theoretical Background

As IS are projects at their core (Hirschheim et al. 1995, p. 33), they involve various stakeholders, including team leaders or members, project managers, upper management, or customers (Chae and Poole 2005). Approaches specialized for IS projects range from traditional, more sequential (Royce 1970) to more iterative, cyclic approaches (Boehm 1988). More specifically, AISD methods (e.g., Cao et al. 2009b) trade strict control and hierarchies for more flexibility and autonomy within the team, especially by progressing in short, iterative phases (Cockburn and Highsmith 2001). They embrace constant adaption in favor of pre-planning and expect constant change and encouraging regular feedback (Cockburn and Highsmith 2001). Planning, therefore, becomes a permanent and repeating task, meaning that team leadership is established much more via face-to-face communication and collaboration and is further separated from the project lead (Dybå and Dingsøyr 2008).

This change characterizes the underlying issue of many AISD-related projects compared to traditional ISD development approaches: the sociological rather than the technological problems are most pressing (DeMarco and Lister 1987, p. 4) and the overall nature of AISD is in many aspects intangible (Cule et al. 2000). A shared vision and language (Corvera Charaf et al. 2013; Gallivan and Keil 2003; Rosenkranz et al. 2013) through coordination and communication must be developed for successful (A)ISD projects (Gallivan and Keil 2003; Ko et al. 2005). AISD provides a multitude of different practices targeted at fostering social interactions (Dreesen et al. 2020; Hummel et al. 2013; Hummel et al. 2015). This led researchers to categorize these practices is into *social* (e.g.,

retrospectives, daily stand-up meetings) and *non-social* (e.g., continuous integration, simple design) practices (Hummel et al. 2015) — from which we will look more closely on the social agile practices, as those are centered around collaboration, coordination, and communication — that is, social interactions.

As AISD focuses on collaboration and separating team leadership from project leadership and asserts that increasing discretion for teams to organize and execute their tasks themselves also increases outcomes (Beck et al. 2001), the resulting flexibility and adaptiveness are represented as team autonomy (Larman 2003; Lee and Xia 2010). While literature offers varying definitions (Chow and Cao 2008; e.g., as self-organization; Highsmith and Cockburn 2001; Hoda et al. 2013; or as team empowerment; Larman 2003; Maruping and Magni 2012), we define *team autonomy* as "the degree of discretion and independence granted to the team in scheduling the work, determining the procedures and methods to be used, selecting and deploying resources, hiring and firing team members, assigning tasks to team members, and carrying out assigned tasks" (Lee and Xia 2010, p. 90).

One concept closely linked to collaboration, autonomy, and leadership (i.e., social and team-centric effects), and therefore also closely linked to AISD, is *team resilience* (Meneghel et al. 2016). One of AISD's core values is acknowledging the importance of responding to changes in requirements or the environment, as well as the uncertainty and ever-changing nature of ISD projects. AISD is therefore seen to center around the idea of embracing change (Beck et al. 2001). However, these constant changes impose difficulties for any team, meaning that AISD teams have to be able to recover quickly from changes, shocks, and difficulties — the

textbook definition of resilience (Oxford English Dictionary). Successful AISD teams, therefore, integrate resilience as a core team trait. This reliance on resilience is further emphasized by continuously changing requirements being one of the major reasons ISD projects fail (Maruping et al. 2009a) and as these requirement changes represent one primary source of changes and shocks AISD teams experience frequently.

Looking at *resilience* in a more general way has been used in biology to describe the ability of a dynamic multispecies ecological system to persist with the same basic structure when subjected to stress (Holling 1973). Organizational psychology derived from this the description of a team's ability to "withstand disruptive factors, synonymous with both buffering against disruptive factors and correcting for disruptive factors without significant strategic changes" (Chakravarty et al. 2013, p. 983). More recently, team performance has been found to be influenced by a team's resilience in general (Meneghel et al. 2016). Originating from various possible sources (e.g., individual characteristics), the specific form of resilience can vary depending on the disruption itself (Hartwig et al. 2020; Son et al. 2020). However, to handle a crisis "resiliently," communication and collaboration are essential (Hartwig et al. 2020; Son et al. 2020). A team, keeping itself synchronized, can adapt quickly, and change strategies "midflight." However, to do so efficiently and effectively (i.e., comprehensively and transparently), team members need to feel that they can voice concerns, criticism, and unpopular or unusual ideas. These actions can be seen as team members feeling free to take interpersonal risks, conceptualized as psychological safety (Edmondson 1999).

Quite similar to resilience and originating from concepts such as leadership style or cohesiveness, *psychological safety* is paramount concerning innovativeness and learning behavior in teams (Baer and Frese 2003; Nembhard and Edmondson 2006). In general, it has been found to moderate various team-level effects (Martins et al. 2013; Roberge and van Dick 2010): learning and self-reflection, innovativeness, and overall performance. As AISD practices rely heavily not on social interactions but all these aspects of teamwork — more generally speaking, AISD emphasizes self-organization and self-reflection. Psychological safety can therefore be expected to improve AISD team performance by strengthening team learning and information sharing behavior, innovation capacity, and improve team members' overall motivation to speak up for organizational improvements.

Based on this variety of effects originating from psychological safety (Baer and Frese 2003; Detert and Burris 2007; Liang et al. 2012; Nembhard and Edmondson 2006), we suggest that psychological safety plays a vital role in efficiently and effectively implemented AISD practices. Adding to this, structure (e.g., in the form of clear procedures for coordinating and prioritizing work, such as with AISD practices) fosters psychological safety, especially in self-managed teams, and improves team learning (Bunderson and Boumgarden 2010) as well as unlearning (Matook and Blasiak 2020). Taking on the idea of unlearning, psychological safety has been identified as a driver of the ability to learn from failures specifically (Carmeli and Gittell 2009; Jehn et al. 2014), adding to the notion of being closely linked to resilience and overall AISD success.

With psychological safety, organizational psychology offers an explanation for many unclear phenomena in AISD team research

(Diegmann et al. 2018; Hennel and Rosenkranz 2020). The specifics, however, that are at play in AISD teams should be investigated thoroughly to understand if and how it enables and fosters AISD success (Diegmann and Rosenkranz 2017; Dreesen et al. 2020; Hennel and Rosenkranz 2020), as most extant research is focused more on IT use rather than AISD (e.g., DeSanctis and Poole 1994; Gorecki et al. 2008; Nan 2011; Wang and Hahn 2015) — with few exceptions. For instance, Sarker and Sarker (2009) provide insights into the specifics of AISD methods in geographically distributed projects. Similarly, Iivari and Iivari (2011) explain the relationship between organizational culture and AISD, especially in early stages.

We, therefore, argue that this investigation is needed. AISD methods rely more heavily on communication and social interaction between team members than traditional methods — and following our above outlined theoretical background and suggestions from practitioners (DevOps Research & Assessment and Google Cloud 2019), psychological safety could act as the "theoretical glue" for combining insights from different perspectives: the "socio" (i.e., the behavior-oriented research) and the technical (i.e., the ISD-oriented research).

8.3 Hypothesis Development

To investigate these interactions, we build on and adapt findings of ISD, AISD, team and organizational behavior research. While technology-induced effects (e.g., Ilgen et al. 2005; Kozlowski and Ilgen 2006) and social aspects of inter-team-member cognitive effects (e.g., shared cognition (Healey et al. 2015) or adaptive structuration theory (DeSanctis and Poole 1994)) have been taken into account as well, interactions

regarding psychological safety, in particular, have not. Further, we build on insights from previous qualitative research on psychological safety in AISD teams (Hennel and Rosenkranz 2020). We provide concise definitions for each construct in Table 8-1.

More specifically, we conceptualize the AISD process as being stimulated by agile practices, which in turn might be affected by psychological safety. When embracing change, as it is one of AISD's core values, teams must be resilient to the shocks and changes of a turbulent environment (Conboy 2009). To achieve team resilience (Meneghel et al. 2016), a team needs structure and an open, free, and safe space for communication, which means a team needs to be psychologically safe to enable resilience (Lengnick-Hall et al. 2011). For example, a regularly held retrospective meeting aims at free, open, and honest exchange among team members and their issues in the project or the team and provides structure. If psychological safety is not — sufficiently — present, the retrospective is unlikely to touch on all critical issues, therefore not reaching its underlying motivation and goal. We conclude that therefore AISD cannot work efficiently and effectively without psychological safety. Finally, resilience needs flexibility and room for change to be able to change quickly. For this, a team needs to have some autonomy — a requirement for AISD in general.

Construct	Definition	Reference
Team Autonomy	"[...] the degree of discretion and independence granted to the team in scheduling the work, determining the procedures and methods to be used, selecting and deploying resources, hiring and firing team members, assigning tasks to team members, and carrying out assigned tasks."	Lee and Xia (2010, p. 90)
Social Agile Practices	Agile practices which entail communication practices or practices which aim to exchange knowledge and facilitate interpersonal interaction (especially daily scrums, retrospectives, and pair programming). Based on previous quantitative evaluations (Hennel Under Review), we focus on retrospectives and daily stand-up meetings.	Hummel et al. (2015) Tripp et al. (2016) Hennel (Under Review)
Psychological Safety	"[...] a shared belief held by members of a team that the team is safe for interpersonal risk taking."	Edmondson (1999, p. 354)
Resilience	A team's ability to "[...] withstand disruptive factors, synonymous with both buffering against disruptive factors and correcting for disruptive factors without significant strategic changes."	Chakravarty et al. (2013, p. 983)

Table 8-1. Construct Definitions

We chose psychological safety as a central construct for three reasons. First, a healthy and supportive (i.e., psychologically safe) organizational environment has been found to be closely connected to team resilience (e.g., Bardoel et al. 2014; Lengnick-Hall et al. 2011), which in turn has been associated with AISD's capability to respond to change (Chakravarty et al. 2013). Second, psychological safety significantly influences team performance in general (e.g., Bunderson and Boumgarden 2010; Carmeli and Gittell 2009; Schulte et al. 2012) and has been suggested as a critical antecedent of team performance in ISD as well (DevOps Research & Assessment and Google Cloud 2019). Third, psychological safety helps reduce harmful effects inherent to many agile teams, for instance, by its mitigating capacity of harmful effects of team diversity (Roberge and van Dick 2010). Similar to its mitigating capacity, psychological safety shows

a promoting capacity: it boosts positive effects, for instance, via team diversity climate (Singh et al. 2013). While recent (e.g., Bunderson and Boumgarden 2010; Carmeli and Gittell 2009; Schulte et al. 2012) as well as established research (e.g., Edmondson 1999) on psychological safety and its influence on team performance has been very promising, it has not yet been integrated into ISD research generally or AISD research specifically aside from few studies (Hennel Under Review; Hennel and Rosenkranz 2020). This is perplexing, as these effects are likely to be multiplied when a whole range of similar — social-focused and structure-providing — practices are applied.

To provide deeper insights into how psychological safety acts within agile teams, we, therefore, propose a rival model to previous research (Hennel Under Review) on the interaction of psychological safety and AISD. As we falsified a previously assumed moderating effect by psychological safety (Hennel Under Review), we now turn to a new viewpoint. Specifically, we aim at supporting or falsifying the rival theory that psychological safety is not a mere "bystander" but a moderating effect on effects of *social agile practices* (SAPs; Hummel et al. 2015) — that is, practices such as daily stand ups, retrospectives, or pair programming, which rely heavily on communication, collaboration, and (social) interactions. We propose this because psychological safety is an important prerequisite for efficient and effective AISD practice implementation: if team members do not feel safe to communicate freely, openly, and honestly, social agile practices cannot realize their full potential (Hennel and Rosenkranz 2020). With agile practices not only being popular in ISD projects in general (VersionOne 2020) but also being transferred to other task domains (Niederman et al. 2018), this becomes a crucial focus for research on generalized project

management as well. For easier reading, we define the effectiveness of social agile practices as the amount of use (i.e., how often is this practice used), the regularity with which this practice is used, and the extensiveness of the implementation or team-specific usage — the items listed in Table 8-5 display these characteristics as well.

Based on the above argumentation, we postulate the following hypotheses:

H_{1a}: *Psychological Safety moderates the effect of Social Agile Practices on Team Autonomy: an increased level of Psychological Safety leads to an increased effect of Social Agile Practices on Team Autonomy.*

H_{1b}: *Psychological Safety moderates the effect of Social Agile Practices on Resilience: an increased level of Psychological Safety leads to an increased effect of Social Agile Practices on Team Autonomy*

As innovativeness, self-reflection, and learning — especially from failures — are linked to psychological safety (Carmeli and Gittell 2009; Jehn et al. 2014), we argue that psychological safety is an important influencing factor for resilience. Therefore, we hypothesize:

H_2: *An increased level of Psychological Safety leads to improved Resilience.*

At the core of agile values and especially at the core of retrospectives is the idea of constantly improving a team's efficiency and effectiveness by inspecting and adapting (Deemer et al. 2012; Derby et al. 2006). Following this, we argue that retrospectives, by definition, improve a team's resilience. This happens by priming the team to adapt to changing

circumstances and constant re-orientation and self-inspection. Similarly, daily stand-up meetings help the team stay synchronized and ask for and offer help — other forms of preparing for change and adapting to change. Finally, pair programming helps to distribute knowledge among team members. Taken together, we argue for social agile practices to influence resilience positively:

H_3: *Increased effectiveness of Social Agile Practices leads to an improved Resilience*

This iteration of process changes and self-adjustment can be interpreted as a futile hotbed for team autonomy. As processes, tools, or interactions change constantly, teams self-organize in daily stand-ups and retrospectives and controlling themselves via, for instance, pair programming, a team continuously explores its autonomy (Hoda et al. 2013; Tripp et al. 2016). It is therefore likely to extend its sphere of influence over time and, ultimately, its autonomy:

H_4: *Increased effectiveness of Social Agile Practices leads to an increase in Team Autonomy.*

While our model leans on extant research on team autonomy (Larman 2003; Lee and Xia 2010), this literature provides quite varying definitions for team autonomy and other closely related concepts, including self-organization (Highsmith and Cockburn 2001) or team empowerment (Larman 2003). Following Lee and Xia (2010), we define team autonomy "as the degree of discretion and independence granted to the team in scheduling the work, determining the procedures and methods to be used, selecting and deploying resources, hiring and firing team members, assigning tasks to team members, and carrying out assigned tasks" (Lee and

Xia 2010, p. 90), as it is a broad and flexible, yet not unclear definition of team autonomy.

Using this understanding of team autonomy, the positive effect that team autonomy has on resilience has been identified before in other contexts, such as nursing and intensive care units (e.g., Kerr 2009; Mcdonald et al. 2016). In AISD contexts, one can presume that team autonomy similarly leads to shorter reaction times as the team can more easily reorganize themselves quickly without running up the chain of commands. This shorter path length for communication, coordination, and decision making is therefore leading to a more resilient response, leading us to postulate:

H_5: *Increased Team Autonomy leads to an improvement in Resilience.*

The resulting research model illustrating these hypotheses is pictured in Figure 8-1. While one might argue that SAPs might directly affect psychological safety (and therefore lead to a mediation on resilience via psychological safety; Hennel and Rosenkranz 2020), we argue that psychological safety is much more a prerequisite for SAPs than vice versa as those practices, which have the potential to foster psychological safety (e.g., daily stand-ups, retrospectives) also require the team members to participate willingly and openly — therefore taking an interpersonal risk. This risk-taking behavior would therefore imply a psychologically safe environment. Our research model, however, has the added benefit of also explaining why the same way of implementing SAPs can lead to different outcomes in different environments.

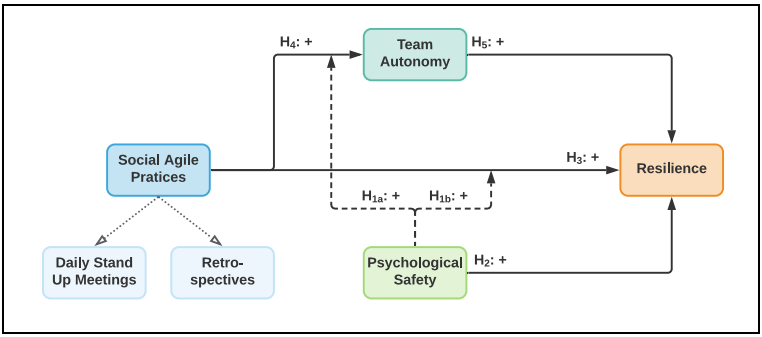

Figure 8-1. Research Model and Hypotheses

Independent variables in blue, mediators in yellow, dependent variables in orange. Dotted lines represent a covariance; first-order constructs have rounded corners.

8.4 Measurement and Data Collection

We collected data from one large, multinational consulting firm utilizing an online questionnaire. The target organization counts more than 500,000 employees worldwide. To be invited to participate in this study, projects had to be ISD projects and had to self-identify as following an agile approach, whereby no particular methodology was prescribed. Using a snowballing approach, we were able to recruit heads of divisions or teams who, in turn, recruited their team members as participants. In total, we collected 173 usable responses from 63 different teams across four countries and three continents. The data collection lasted from August 2020 to March 2021. A summary of the descriptive statistics of the final survey sample, including further detailed information about the individual respondents' characteristics, can be retrieved from Table 8-2 and Table 8-3. However, as this information was optional to participants, we received only 51 responses on the data listed in Table 8-2 and Table 8-3.

Using extant literature as a baseline, we followed Tripp et al. (2016) for measuring agile practice usage. Because of our focus on *social* agile practices, we selected only those practices for measurement from the source, which have a social component (Hummel et al. 2015). Further, Lee and Xia (2010) were used as the item source for team autonomy. Finally, we combined items from multiple studies on psychological safety (Detert and Edmondson 2011; Edmondson 1999; Majchrzak and Jarvenpaa 2010; Pearsall and Ellis 2011; Schaubroeck et al. 2011) to generate a non-overlapping measurement for psychological safety. All measurement items were implemented using Likert-scales, following extant literature and building upon already evaluated measurement items.

To minimize biases such as social desirability bias (Nederhof 1985, p. 264), we followed best practices such as postulating neutral questions concerning social desirability as far as possible. Further, as it is likely that anonymous and self-administered questionnaires have less distortion, we distributed all questionnaires online, collected no personal information, and made sure that neither team leaders nor we could access raw or non-pseudonymized data.

Individual Characteristics		
Education	University entrance qualification	2%
	Bachelor's degree	49%
	Master's degree or Diploma	39%
	Not specified	10%
Employment	Less than one year	11%
	1 to 5 years	58%
	5 to 10 years	22%
	10 to 15 years	18%
Age	20 to 25	18%
	25 to 30	25%
	30 to 40	33%
	40 to 50	8%
	Not specified	16%
Role	Architect	4%
	Business Analyst	6%
	Developer	37%
	Scrum Master	16%
	Tester	10%
	other	14%

Table 8-2. Individual Characteristics

Project Characteristics		
Setting	International	51%
	Domestic	46%
	Not specified	3%
Team Size	Less than 5	7%
	5 to 10	45%
	10 to 25	32%
	25 to 50	11%
	More than 50	5%
Co-Location	Complete co-location	16%
	(Some) distribution	44%
	Distribution and outsourcing	28%
	Not specified	12%

Table 8-3. Project Characteristics

8.5 Data Analysis and Hypothesis Testing

We estimated the research model using covariance-based (CB) structural equation modeling (SEM). We adopted CB-SEM instead of alternative techniques such as partial least squares (PLS) SEM mainly for two reasons. First, CB-SEM is more potent in model validation since it can calculate the overall fit of a proposed model by comparing the proposed and observed covariance matrices (Hair 2009; Lowry and Gaskin 2014). Second, CB-SEM is more effective in validating models developed using a well-established theory. As our research model is deeply rooted in AISD and organizational psychology research, and large parts have been covered in a previous study (Hennel and Rosenkranz 2020), we deemed CB-SEM appropriate (Lowry and Gaskin 2014). We used Mplus 8.6 (Muthén and Muthén 1998-2017) for model estimation.

To ensure that the underlying measurement instruments are valid and reliable, we first conducted four analyses: (1) we tested for support of internal, convergent, and discriminant validity, (2) we tested for strong reliabilities, (3) we tested for multicollinearity, and (4) we tested for common method bias.

To ensure internal reliability, a composite reliability (CR) score of .700 or higher is recommended (Hair et al. 2016). All constructs exceed this threshold (see Table 8-4). Further, all constructs, aside from retrospectives and resilience, exceed .800 but do not exceed .900. Exceeding .900 can be interpreted as suboptimal as well — in this case, retrospectives and resilience exceed .900 and should therefore be considered borderline. Convergent validity is supported by large (standardized) loadings for all constructs as well (see Table 8-5).

Construct	TA	RTR	DSU	PS	RES	CR	R^2
Team Autonomy (TA)	**.604**					.820	.268
Retrospective (RTR)	.255	**.915**				.970	.345
Daily Stand Ups (DSU)	.256	.347	**.622**			.831	.348
Psychological Safety (PS)	-.017	.085	.085	**.620**		.830	
Resilience (RES)	.462	.245	.246	.275	**.780**	.914	.388

Table 8-4. Correlation Matrix

with Average Variance Extracted (AVE; bold), Composite Reliability (CR), and Explained Variance (R^2)

Based on the average variance extracted (AVE) value of a latent construct being larger than its squared correlation with any other latent construct in the model, our model passes the test for discriminant validity, and therefore convergent and discriminant validities can be confirmed (see Table 8-4). Given that the correlations of independent variables are below the recommended threshold of .600 (Grewal et al. 2004), we presume multicollinearity not to be a significant issue for either the model or dataset (see Table 8-4).

Given that most of our data is based on self-reported survey data, we used two kinds of approaches to examine common method bias. First, we used procedural remedies to invoke an up-front research design to blunt common method bias (Podsakoff et al. 2003). We provided extensive instructions to participants to focus on the survey and remember their work. Further remedies include randomized items so that participants would be less likely to detect underlying constructs, attention-trap questions, and inversely coded items. Second, we evaluated the correlations among constructs. The most important problem with common method bias is high correlations among constructs. Following Pavlou et al. (2007), the correlation matrix (see Table 8-4) indicates that

all correlations were significantly below the recommended threshold of .900 (and above -.900), which indicates that common method bias is not likely to be a severe threat in the model.

Item	Wording	References	Factor	Construct
RTR_1*	On a regular basis, our team reflects on previous work and looks for ways to improve team performance.	Tripp et al. (2016)	.674	Retrospective (RTR)
RTR_2	At the end of each work cycle, the team asks itself "what went well during the last work cycle."		.933	
RTR_3	At the end of each work cycle, the team asks itself "what could be improved during the next cycle."		.980	
DSU_1*	Our team has a short meeting every day to discuss what is going on with the project.		.558	Daily Stand-Ups (DSU)
DSU_2	Each day, all team members share with the team what they are working on.		.876	
DSU_3•	The team discusses issues together daily.		.695	
TA_1*	The project team was allowed to freely choose tools and technologies.	Lee and Xia (2010)	.539	Team Autonomy (TA)
TA_2	The project team had control over what they were supposed to accomplish.		.771	
TA_3	The project team was granted autonomy on how to handle user requirements changes.		.783	
TA_4*	The project team was free to assign personnel to the project.		.543	
PS_1*	Members of my team are able to bring up problems and tough issues.	Detert and Edmondson (2011); Edmondson (1999); Majchrzak and Jarvenpaa (2010); Pearsall and Ellis (2011); Schaubroeck et al. (2011)	.203	Psychological Safety (PS)
PS_2*	It is safe to take a risk in my team.		.017	
PS_3*	In my team, my unique skills are valued and utilized.		.305	
PS_4	It is difficult to ask other members of my team for help.		.826	
PS_5	If you make a mistake on this team, it is often held against you.		.770	
PS_6	In my team, it is not advisable to bring up problems and tough issues.		.765	
PS_7*	If you make a mistake on this team, it is never held against you.		.088	
PS_8*	No one on this team would deliberately act in a way that undermines my efforts.		.051	

RES_1*	This team can be characterized as resilient.	Chakravarty et al. (2013)	.573	Resilience (RES)
RES_2*	The team always finds a way to make things work.		.601	
RES_3*	The team has the ability to absorb shocks.		.630	
RES_4	The team builds capabilities to defend against a wide range of scenarios.		.937	
RES_5	The team is pliable in that we can adjust to abnormal conditions and then bounce right back when conditions come back to normal.		.827	

Table 8-5. Questionnaire Items and Factor Loadings

** Following Gefen and Straub (2005), we omitted all items loading below .700*
• Due to instable loading factors and closeness to .700, we kept these factors improve overall model accuracy

Details on the path weights and the hypotheses testing results are displayed in Figure 8-2. Results. Regarding our hypotheses, hypotheses $H1_a$ and $H1_b$ must be rejected due to non-significance. Figure 8-3, Figure 8-4, and Table 8-6 provide details on the interactions. Especially notable is the sign change for each interaction between lower and upper confidence intervals, further indicating the non-significance of these hypotheses. While H_2 was found to be significant ($p \leq .05$) at .229, H_3 and H_4 showed to be non-significant. Finally, H_5 was significant as well ($p \leq .01$) with a coefficient of .396. We, therefore, conclude that while H_{1a} and H_{1b}, H_3 and H_4 must be rejected, H_2 and H_5 are supported.

While team autonomy has a relatively low R^2 value of .268, daily stand-ups and retrospectives (i.e., our first-level constructs which form our second order construct social agile practices, which explains team autonomy) are just two of many factors explaining how a team gains autonomy. For instance, other agile practices (e.g., sprints and sprint planning meetings in which a team has considerable influence on which work packages are worked on next) certainly increase a team's autonomy. Similarly, control styles (Remus et al. 2019) and control modes (Kirsch 1997) significantly drive a team's autonomy. However, as these specific effects were only part of our research question, we see the moderate R^2 value of .388 for resilience as more important. Considering that resilience has many other possible influencing factors, accounting for roughly a third of the explanatory value is a significant outcome.

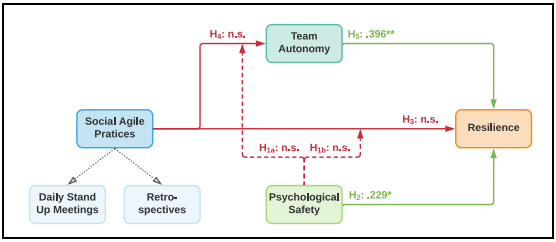

Figure 8-2. Results

Supported hypotheses printed in green, rejected hypotheses in red.
**: p ≤ .05; **: p ≤ .01; ***: p ≤ .001; n.s.: p > .05*

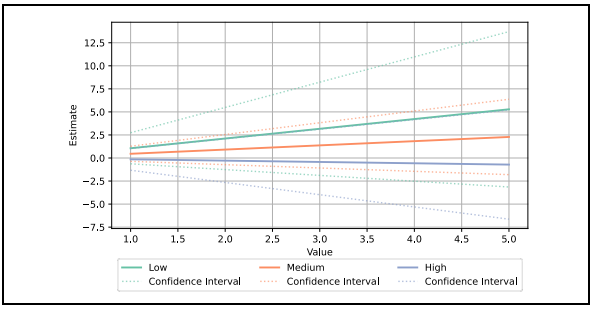

Figure 8-3. Interaction Effect of SAPs and PS on Resilience

Slopes at Low (-1SD), Medium (±0SD), and High (+1SD) Moderation Levels with 95% Confidence Intervals

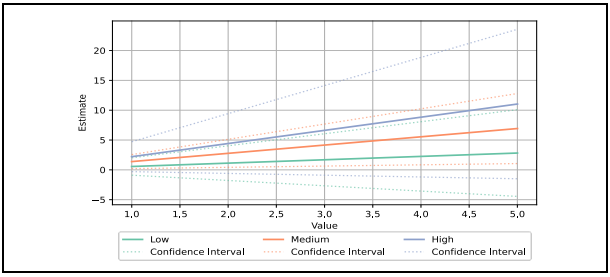

Figure 8-4. Interaction Effect of SAPs and PS on Team Autonomy

Slopes at Low (-1SD), Medium (±0SD), and High (+1SD) Moderation Levels with 95% Confidence Intervals

Interaction Level		Lower			Estimate	Upper		
		.5%	2.5%	5%		5%	2.5%	.5%
SAPs and Psychological Safety on Resilience	Low	-1.159	-.629	-.358	1.056	2.471	2.742	3.271
	Medium	-.618	-.361	-.230	.457	1.143	1.274	1.531
	High	-1.699	-1.327	-1.137	-.143	.850	1.041	1.413
SAPs and Psychological Safety on Team Autonomy	Low	-1.347	-.890	-.656	.564	1.784	2.017	2.474
	Medium	-.157	.211	.400	1.385	2.371	2.559	2.928
	High	-1.085	-.298	.104	2.207	4.309	4.712	5.499

Table 8-6. Interaction Estimates and Confidence Intervals

At -1 / ±0 / +1 Standard Deviations

8.6 Discussion

Building upon previous research, we motivated a research model, argued for our hypotheses, and have shown which we could support and which we had to reject based on an empirical investigation. While our initial model could not be confirmed in the most critical aspects, we provide three main contributions to theory and practice.

First, we provide empirical evidence for the importance of both team autonomy and social agile practices, namely daily stand-ups and retrospectives, to realize resiliency effects promised by agile methods. Interpreting the partial mediation represented by H_4 and H_5, we see that both retrospectives and team autonomy can realize positive effects on resilience on their own, but also that the mediating effect improves the explained variance. We conclude that implementing social agile practices, especially enabling a team to continuously improve and synchronize, as well as by allowing a team to experiment autonomously (at least in parts), can improve team resilience. Further, we found a direct effect of psychological safety on resilience. This insight contributes to theory as it shows, for the first time, an AISD-specific effect for psychological safety and establishes a base for future research to investigate the specific dependencies via which social agile practices affect resilience. For practitioners, this finding stresses the importance of implementing retrospectives for reaping resiliency benefits. Further, it offers an explanation why some teams might not show the expected resilience although practicing retrospectives: if the team in question has not the required autonomy to act on their insights gathered from retrospectives and daily stand-ups, it cannot realize the benefits.

Second, we have shown that this quantitative evidence cannot support the previously assumed (Hennel and Rosenkranz 2020) moderating relationship between psychological safety and social agile practices. However, this finding also opens an avenue for future research: investigating the underlying differences between the qualitative indications for this relationship and the quantitative operationalization, measurement, and analysis might yield new insights and reconcile the different findings. Finding an explanation for these differences could ultimately yield important new insights into the underpinnings of AISD and how to improve project success rates and employee wellbeing. This finding, therefore, contributes to research by first falsifying a previous theory and therefore advancing our understanding of the underlying concepts, and second by providing the base for subsequent studies, investigating this discrepancy further, and reconciling varying findings.

Third, we have found initial evidence for a direct influence of psychological safety in AISD contexts independent from the effects of AISD practices or team autonomy. We interpret this relationship in the following way: while psychological safety might not directly affect or be affected by retrospectives and daily stand-ups or vice versa, it represents an important antecedent of resilience. Regardless of the specific practices and their way of being employed, AISD teams need psychological safety to become as resilient as possible. AISD practices themselves might further increase resilience but do not eliminate the need for a psychologically safe environment. For research, this finding creates a new puzzle to be solved: we need a new explanation of why a direct effect can better explain the effect of psychological safety on resilience than a moderating effect on social agile practices' effects. A direct effect on performance or, more

specifically, a team's ability to learn from failures (Carmeli and Gittell 2009; Jehn et al. 2014) can be seen as a great parallel to our finding. However, given that retrospectives *serve the purpose of learning from failures*, a moderation effect would make more sense at first. For practitioners, this finding does not invalidate our previously mentioned finding regarding the importance of social agile practices. Instead, it adds another layer of influencing factors: as retrospectives, daily stand-ups, and psychological safety affect resilience independently, practitioners need to have all factors in mind to realize benefits most effectively.

Our findings are based on data gathered from one corporation, which limits the transferability of our conclusions. However, as the participants worked across different divisions, on different continents, in different teams, and in different roles, we argue for an acceptable level of transferability and call for replication in different contexts. Further, all data were collected via self-report questionnaires. This research design could increase the effect social desirability bias has on our study. Participants could be more likely to overestimate psychological safety. It is generally more socially desirable to report a successful and well-working team compared to the opposite. As stated in the section "Measurement and Data Collection", we followed Nederhof (1985) to minimize the effect. Since our questionnaire was both anonymous and online available at any place and any time, we suggest that our research design reduced the influence of social desirability bias to an acceptable level while still being practicable. Situational factors, such as mood or current time pressure, could also have influenced participant's responses. Future research could eliminate these concerns by replicating this study or conducting a longitudinal analysis. Finally, we had to drop items from psychological

safety and team autonomy. The items for psychological safety have been adapted from multiple studies and are therefore more likely not to be perfectly optimized. Two of the remaining items are targeted towards helping behavior in the team — this could be a promising avenue for future research to investigate further why the remaining items lean heavily, yet not exclusively on helping behavior.

8.7 Conclusion

In this paper, we addressed the call for further research on social and psychological effects in AISD. Through a quantitative field study, we shed light on the interaction of social agile practices, team autonomy, and psychological safety. More importantly, we have shown differences between the qualitative results of previous studies, evaluated an alternative model, and discussed the limitations of this study as well as our contributions to research and practice. Future research should take these initial findings and build upon the study's limitations to further our insight into how socio-technical effects are at play in AISD projects.

Chapter 9: Psychological Safety in Agile Information Systems Development: Explaining Team Resilience

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Abstract

While agile methods are still rising in popularity, mixed results concerning real-world performance added an off taste of AISD's success story rush. As agile methods add an additional layer of complexity compared to traditional methods, new challenges arise. With agile's focus on social interactions, those challenges are often more sociological than technological in nature. Adding the underlying goal of embracing change, teams need to improve their resilience. Based on previous research, which suggested a novel, integrated model, combining agile practices, resilience, and psychological safety, we evaluate an alternative rival theory. Based on the same dataset from a quantitative field study in one large, multinational enterprise, we provide additional evidence, supporting previous findings, as well as falsifying new hypotheses. Our findings reinforce avenues for future research, as the presuppositions of agile practices and their interaction with psychological safety remain inconclusive.

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9.1 Introduction

The advent of digital transformation (Wessel et al. 2021) and the rapid pace of digital innovations have led to a similar rise in the use of *agile information systems development (AISD)* methods (Conboy 2009; Hummel et al. 2013; Lindsjørn et al. 2016). Nowadays, more than 90% of development teams report that they use agile management or engineering practices such as sprint retrospectives, continuous delivery, or pair programming in their daily work (VersionOne 2020), dominating the world of information systems development (ISD). Yet, the initial wave of enthusiasm is part of the past: mixed results concerning real-world performance have disillusioned the rush of AISD's early popularity (Niederman et al. 2018), and research is lacking an explanation for these shortcomings of AISD in practice. The existing research clearly shows that AISD adds an additional layer of complexity — in terms of effects at play — compared to non-agile teams (e.g., Niederman et al. 2018), primarily due to its iterative nature. AISD's focus on embracing change as an inevitable force instead of avoiding or predicting it in the beginning at all costs differentiates it fundamentally from traditional project management and ISD methods (Cockburn and Highsmith 2001; Conboy 2009; Dybå and Dingsøyr 2008). Moreover, organizations still face a multitude of new challenges when introducing and maintaining AISD (e.g., Dikert et al. 2016; Gregory et al. 2016), further emphasizing the unique nature of agile methods compared to traditional approaches.

AISD has been associated with face-to-face and personal interaction in small, self-organizing (i.e., autonomous), and often co-located teams (Hoda et al. 2012; Hummel et al. 2013; Matook et al. 2016). In general,

emphasizing many, close, and regular social interactions is deemed desirable for many agile practices to unleash their true potential (Hummel et al. 2013; Recker et al. 2017). At the same time, AISD practices aim to decrease sunk costs and path dependencies (Aaen 2008) while simultaneously increasing flexibility and team autonomy (Andrias et al. 2018; Hoda et al. 2013). Also, strengthening a team's resilience to a changing environment (Tolf et al. 2015) has become mandatory to reduce project failures and increase project success (Chow and Cao 2008). The underlying idea of embracing change (Beck et al. 2001) and the resulting need for resilience in AISD teams further emphasizes the need for a highly iterative process as well as constant feedback, communication, and synchronization among team members. The need for team management and collaboration increases as well — stressing the importance of understanding *social* behavior in ISD teams (Kautz et al. 2007; Lee and Xia 2010; Persson et al. 2011; Sarker et al. 2009). By combining the importance of social interactions and the dependency of AISD teams on resilience, an opportunity to explain AISD's shortcomings presents itself.

However, in our previous study (Hennel Under Review), we investigated the effect of psychological safety on team resilience and evaluated a possible interaction effect between social-focused agile practices and psychological safety. While we found strong support for the importance of both social agile practices and psychological safety for a team's resilience, we found — contradictory to initial findings (Hennel and Rosenkranz 2020) — that psychological safety and social agile practices do not covariate. To bridge these different findings, we formulate the following research question:

How do Agile Practices and Psychological Safety interact and affect Team Resilience?

With this study, we explicitly build on our previous findings (Hennel Under Review; Hennel and Rosenkranz 2020). Our objective is to contribute to our understanding of team resilience in agile teams by either explaining this interaction via moderation or lend further support to the idea of a less direct interaction and build avenues for future research. To provide a first evaluation of a possible covariation, we used the same data from the same quantitative field study in one large, multinational enterprise as we did in our previous study (Hennel Under Review).

The paper is structured as follows. First, we will lay the theoretical background and develop our theory and model. Next, we present our research design, which is our data collection and analysis process. Finally, we present and discuss the results of our analysis as well as our contributions to research and practice and give avenues for future research.

9.2 Theoretical Background

IS are developed as projects (Hirschheim et al. 1995, p. 33), with various stakeholders, including team members or team leaders, project managers, top management, or customers (Chae and Poole 2005). IS development approaches range from sequential (Royce 1970) to iterative, cyclic approaches (Boehm 1988). AISD methods (e.g., Cao et al. 2009b) trade strict control for more flexibility and autonomy within the team, especially by progressing in small, iterative phases, constant adaption in favor of pre-planning and expecting constant change and encouraging

constant feedback (Cockburn and Highsmith 2001). Planning, therefore, becomes a permanent task, meaning that team leadership is established much more via collaboration and further separating it from the project lead (Dybå and Dingsøyr 2008). Related to this, the nature of AISD is in many aspects intangible (Cule et al. 2000), and the most pressing problems of AISD projects are not so much technological as sociological (DeMarco and Lister 1987, p. 4). A shared vision and language (Corvera Charaf et al. 2013; Gallivan and Keil 2003; Rosenkranz et al. 2013) through coordination and communication must be developed for successful ISD projects (Gallivan and Keil 2003; Ko et al. 2005). AISD provides a multitude of different practices. One popular categorization is into *social* (e.g., retrospectives, daily stand-up meetings) and *non-social* (e.g., continuous integration, simple design) practices (Hummel et al. 2015) — from which we will look more closely on the social agile practices, as those are centered around collaboration, coordination, and communication — that is, social interactions. As AISD focuses on collaboration and separating team leadership from project leadership and asserts that increasing discretion for teams to organize and execute their tasks themselves also increases outcomes (Beck et al. 2001), the resulting flexibility and adaptiveness are represented as team autonomy (Larman 2003; Lee and Xia 2010). While literature offers varying definitions (Chow and Cao 2008; e.g., as self-organization; Highsmith and Cockburn 2001; Hoda et al. 2013; or as team empowerment; Larman 2003; Maruping and Magni 2012), we define *team autonomy* as "the degree of discretion and independence granted to the team in scheduling the work, determining the procedures and methods to be used, selecting and

deploying resources, hiring and firing team members, assigning tasks to team members, and carrying out assigned tasks" (Lee and Xia 2010, p. 90).

One concept closely linked to collaboration, autonomy, and leadership (i.e., social and team-centric effects), which has also been repeatedly linked to AISD, is *team resilience* (Meneghel et al. 2016). AISD explicitly notices the importance of responding to changes in requirements or the environment, acknowledging the uncertainty and ever-changing nature of ISD projects, and is centering around the idea of embracing change (Beck et al. 2001). However, constant changes impose difficulties for any team, meaning that AISD teams have to be able to recover quickly from changes, shocks, and difficulties, which is the textbook definition of resilience (Oxford English Dictionary). As AISD explicitly stresses its importance (Beck et al. 2001), resilience supposedly is a core team trait for successful AISD teams. This reliance on resilience is further emphasized by continuously changing requirements being one of the major reasons ISD projects fail (Maruping et al. 2009a). These requirement changes represent one primary source of changes and shocks AISD teams experience frequently.

Resilience, in general, has been used in biology to describe the ability of a dynamic multispecies ecological system to persist with the same basic structure when subjected to stress (Holling 1973). Derived from this, team resilience is used in organizational psychology to describe a team's ability to "withstand disruptive factors, synonymous with both buffering against disruptive factors and correcting for disruptive factors without significant strategic changes" (Chakravarty et al. 2013, p. 983). More recently, team performance has been found to be influenced by a team's resilience in

general (Meneghel et al. 2016). Originating from various possible sources (e.g., individual characteristics), the specific form of resilience can vary depending on the disruption itself (Hartwig et al. 2020; Son et al. 2020). Communication and collaboration are essential factors for handling a crisis resiliently (Hartwig et al. 2020; Son et al. 2020). A team, keeping itself synchronized, can adapt quickly, and change strategies "midflight." To do so efficiently and effectively — that is, comprehensively and transparently — team members need to feel that they can voice concerns, criticism, and unpopular or unusual ideas — taking interpersonal risks by doing so. This characteristic has been conceptualized as psychological safety (Edmondson 1999).

Psychological safety, similar to resilience, originating from concepts such as leadership style or cohesiveness, is paramount concerning innovativeness and learning behavior in teams (Baer and Frese 2003; Nembhard and Edmondson 2006). More generally speaking, it has been found to moderate various team-level effects (Martins et al. 2013; Roberge and van Dick 2010): learning, innovativeness, self-reflection, and overall performance. As AISD practices rely heavily on social interactions, self-organization, and self-reflection to strengthen team learning behavior, information sharing behavior, innovating capacity, and improve team members' motivation to speak up for organizational improvements, psychological safety can be expected to improve AISD team performance.

As psychological safety affects all these aspects (Baer and Frese 2003; Detert and Burris 2007; Liang et al. 2012; Nembhard and Edmondson 2006), which leads us to suggest that psychological safety plays a vital role in affecting corresponding effects of AISD practices. Adding to this, structure (e.g., in the form of clear procedures for coordinating and

prioritizing work, such as with AISD practices) fosters psychological safety, especially in self-managed teams, and improves team learning (Bunderson and Boumgarden 2010) and unlearning (Matook and Blasiak 2020). Further, psychological safety has been identified as a driver of the ability to learn from failures specifically (Carmeli and Gittell 2009; Jehn et al. 2014), adding to the notion of being closely linked to resilience and overall AISD success.

In sum, only limited research goes deeper into the social aspects of AISD teams (Diegmann et al. 2018; Hennel and Rosenkranz 2020). For instance, Sarker and Sarker (2009) provide insights into the specifics of AISD methods in geographically distributed projects. Similarly, Iivari and Iivari (2011) explain the relationship between organizational culture and AISD, especially in early stages. However, most research is focused more on IT use rather than AISD (e.g., DeSanctis and Poole 1994; Gorecki et al. 2008; Nan 2011; Wang and Hahn 2015), and a concept such as psychological safety has yet to be evaluated more closely in an AISD context to understand if and how it enables and fosters AISD success (Diegmann and Rosenkranz 2017; Dreesen et al. 2020; Hennel and Rosenkranz 2020).

We argue that this investigation is needed, as AISD methods rely more heavily on communication and social interaction between team members than traditional methods. Following our above theoretical argumentation and suggestions from practitioners (DevOps Research & Assessment and Google Cloud 2019), psychological safety could act as the "theoretical glue" for combining insights from different perspectives: the "socio" (i.e., the behavior-oriented research) and the technical (i.e., the ISD-oriented research).

9.3 Hypotheses Development

To extend these preliminary findings and to investigate the above-outlined interactions, we build on and adapt findings of team and organizational behavior research as well as our own research. While technology-induced effects (e.g., Ilgen et al. 2005; Kozlowski and Ilgen 2006) and social aspects of inter-team-member cognitive effects (e.g., shared cognition (Healey et al. 2015) or adaptive structuration theory (DeSanctis and Poole 1994)) have been taken into account as well, interactions regarding psychological safety, in particular, have not (Hennel Under Review; Hennel and Rosenkranz 2020). Further, we build on insights from previous qualitative (Hennel and Rosenkranz 2020) and quantitative (Hennel Under Review) research on psychological safety in AISD teams. We provide concise definitions for each construct in Table 9-1.

More specifically, we conceptualize the AISD process as being stimulated by agile practices, which in turn might be affected by psychological safety. When embracing change, as it is one of AISD's core values, teams must be resilient to the shocks and changes of a turbulent environment (Conboy 2009). To achieve team resilience (Meneghel et al. 2016), a team needs structure and an open, free, and safe space for communication, which means a team needs to be psychologically safe to enable resilience (Lengnick-Hall et al. 2011). For example, a regularly held retrospective meeting aims at free, open, and honest exchange among team members and their issues in the project or team and provides structure. If psychological safety is not — sufficiently — present, the retrospective is unlikely to touch on all critical issues, therefore not reaching its underlying motivation and goal; AISD cannot work efficiently and effectively without psychological safety. Finally, resilience needs flexibility and room

Construct	Definition	Reference
Team Autonomy	"[...] the degree of discretion and independence granted to the team in scheduling the work, determining the procedures and methods to be used, selecting and deploying resources, hiring and firing team members, assigning tasks to team members, and carrying out assigned tasks."	Lee and Xia (2010, p. 90)
Social Agile Practices	Agile practices which entail communication practices or practices which aim to exchange knowledge and facilitate interpersonal interaction (especially daily scrums, retrospectives, and pair programming).	Hummel et al. (2015) Tripp et al. (2016)
Psychological Safety	"[...] a shared belief held by members of a team that the team is safe for interpersonal risk taking."	Edmondson (1999, p. 354)
Resilience	A team's ability to "[...] withstand disruptive factors, synonymous with both buffering against disruptive factors and correcting for disruptive factors without significant strategic changes."	Chakravarty et al. (2013, p. 983)

Table 9-1. Construct Definitions

for change to be able to change quickly. For this, a team needs to have some autonomy — a requirement for AISD in general.

We chose psychological safety as a central construct for three reasons. First, a healthy and supportive (i.e., psychologically safe) organizational environment has been found to be closely connected to team resilience (e.g., Bardoel et al. 2014; Lengnick-Hall et al. 2011), which in turn has been associated with AISD's capability to respond to change (Chakravarty et al. 2013). Second, psychological safety significantly influences team performance in general (e.g., Bunderson and Boumgarden 2010; Carmeli and Gittell 2009; Schulte et al. 2012) and has been suggested as a critical antecedent of team performance in ISD as well (DevOps Research & Assessment and Google Cloud 2019). Third, psychological safety helps reduce harmful effects inherent to many agile teams, for instance, by its mitigating capacity of harmful effects of team diversity (Roberge and van Dick 2010). Similar to its mitigating capacity, psychological safety shows

a promoting capacity: it boosts positive effects, for instance, via team diversity climate (Singh et al. 2013). While recent (e.g., Bunderson and Boumgarden 2010; Carmeli and Gittell 2009; Schulte et al. 2012) as well as established research (e.g., Edmondson 1999) on psychological safety and its influence on team performance has been very promising, it has not yet been integrated into ISD research generally or AISD research specifically. When a whole range of similar — social-focused and structure-providing — practices are applied, this becomes even more important as those effects might stack and further amplify. We define such AISD practices as *social agile practices* (SAPs; Hummel et al. 2015) — that is, practices such as daily stand ups, retrospectives, or pair programming, which rely heavily on communication, collaboration, and (social) interactions. With agile practices not only being popular in ISD projects in general (VersionOne 2020) but also being transferred to other task domains (Niederman et al. 2018), this becomes a crucial focus for research on generalized project management as well. For easier reading, we define the effectiveness of social agile practices as the amount of use (i.e., how often is this practice used), the regularity with which this practice is used, and the extensiveness of the implementation or team-specific usage—the items listed in Table 9-4 display these characteristics as well.

Based on the above argumentation, we postulate the following hypothesis:

> **H_1:** *Psychological Safety and Social Agile Practices affect each other reciprocally: an increased level of Psychological Safety leads to increased effectiveness of Social Agile Practices and vice versa.*

The following hypotheses are now in line with the model proposed and evaluated by Hennel (Under Review). Learning behavior, especially the

capability to learn from failures, innovativeness, and self-reflection, is closely linked to psychological safety (Carmeli and Gittell 2009; Jehn et al. 2014). This leads us to propose that psychological safety is an important influencing factor for resilience, as these capabilities enable resilient responses. Therefore, we hypothesize:

> **H_2:** *An increased level of Psychological Safety leads to improved Resilience.*

Taking on the core motivation for retrospectives — i.e., constantly improving a team's efficiency and effectiveness by inspecting and adapting (Deemer et al. 2012; Derby et al. 2006) — we argue that retrospectives, by definition, improve a team's resilience by priming the team to adapt to changing circumstances constantly. Similarly, daily stand-up meetings help the team stay synchronized and ask for and offer help. Finally, pair programming helps to distribute knowledge among team members. Taken together, we argue for social agile practices to influence resilience positively:

> **H_3:** *Increased effectiveness of Social Agile Practices leads to an improved Resilience*

Further, we see this cyclic process of self-adjustment as a hotbed for team autonomy. By constantly changing processes, tools, or interactions, self-organizing in daily stand-ups and retrospectives, and self-controlling via, for instance, pair programming, a team continuously explores its autonomy (Hoda et al. 2013; Tripp et al. 2016). It is likely to extend its sphere of influence over time and, ultimately, its autonomy:

H_4: *Increased effectiveness of Social Agile Practices leads to an increase in Team Autonomy.*

As our model, therefore, builds upon extant research on topics such as self-organization (Highsmith and Cockburn 2001), team autonomy (Larman 2003; Lee and Xia 2010), or team empowerment (Larman 2003), we see the definition of team autonomy by Lee and Xia (2010) as matching best to our context: team autonomy is "the degree of discretion and independence granted to the team in scheduling the work, determining the procedures and methods to be used, selecting and deploying resources, hiring and firing team members, assigning tasks to team members, and carrying out assigned tasks" (Lee and Xia 2010, p. 90). Using this understanding of team autonomy, the positive effect that team autonomy has on resilience has been identified before in other contexts, such as nursing and intensive care units (e.g., Kerr 2009; Mcdonald et al. 2016) and has been shown to exist in AISD contexts as well — as one can presume that it similarly leads to shorter reaction times as the team can more easily reorganize themselves quickly without running up the chain of commands and that this shorter pathlength for communication, coordination, and decision making is therefore leading to a more resilient response (Hennel Under Review). This leads us to postulate:

H_5: *Increased Team Autonomy leads to an improvement in Resilience.*

The resulting research model illustrating these hypotheses is pictured in Figure 9-1.

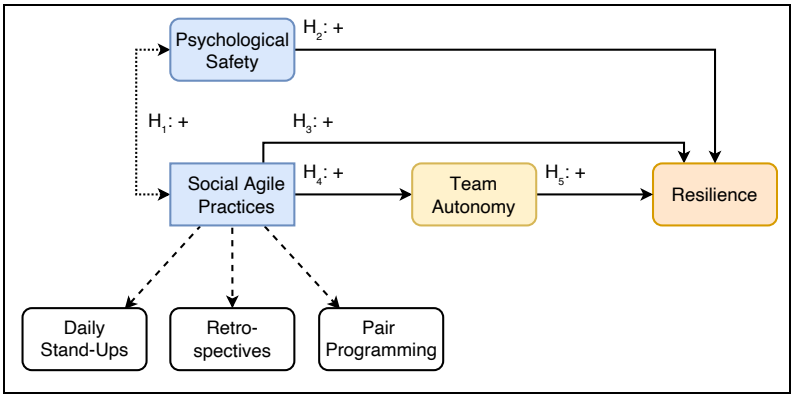

Figure 9-1. Research Model and Hypotheses

Independent variables in blue, mediators in yellow, dependent variables in orange. Dotted lines represent a covariance; first-order constructs have rounded corners.

9.4 Measurement and Data Collection

Comparing two models in this study, we reuse the existing data from our previous study (Hennel Under Review) to improve comparability. We collected data from one large, multinational consulting firm utilizing an online questionnaire. The target organization counts more than 500,000 employees worldwide. To be invited to participate in this study, projects had to be ISD projects and had to self-identify as following an agile approach, whereby no particular methodology was prescribed. Using a snowballing approach, we were able to recruit heads of divisions or teams who, in turn, recruited their team members as participants. In total, we collected 173 usable responses from 63 different teams across four countries and three continents. The data collection lasted from August 2020 to March 2021. A summary of the descriptive statistics of the final survey sample, including further detailed information about the individual respondents' characteristics, can be retrieved from Table 9-2

and Table 9-3. However, as this information was optional to participants, we received only 51 responses on the data listed in Table 9-2 and Table 9-3.

Using extant literature as a baseline, we followed Tripp et al. (2016) for agile practice usage. Because of our focus on *social* agile practices, we selected only those practices for measurement from the source, which have a social component (Hummel et al. 2015). Further, Lee and Xia (2010) were used as the item source for team autonomy. Finally, we combined items from multiple studies on psychological safety (Detert and Edmondson 2011; Edmondson 1999; Majchrzak and Jarvenpaa 2010; Pearsall and Ellis 2011; Schaubroeck et al. 2011) to generate a non-overlapping measurement for psychological safety.

To minimize biases such as social desirability bias (Nederhof 1985, p. 264), we followed best practices such as postulating neutral questions concerning social desirability as far as possible.

Individual Characteristics		
Education	University entrance qualification	2%
	Bachelor's degree	49%
	Master's degree or Diploma	39%
	Not specified	10%
Employment	Less than one year	11%
	1 to 5 years	58%
	5 to 10 years	22%
	10 to 15 years	18%
Age	20 to 25	18%
	25 to 30	25%
	30 to 40	33%
	40 to 50	8%
	Not specified	16%
Role	Architect	4%
	Business Analyst	6%
	Developer	37%
	Scrum Master	16%
	Tester	10%
	other	14%

Table 9-2. Individual Characteristics

Project Characteristics		
Setting	International	51%
	Domestic	46%
	Not specified	3%
Team Size	Less than 5	7%
	5 to 10	45%
	10 to 25	32%
	25 to 50	11%
	More than 50	5%
Co-Location	Complete co-location	16%
	(Some) distribution	44%
	Distribution and outsourcing	28%
	Not specified	12%

Table 9-3. Project Characteristics

9.5 Data Analysis and Hypothesis Testing

We estimated the research model using covariance-based (CB) structural equation modeling (SEM) in *R 4.1.0 dev-r80120* (R Core Team 2021) with the packages *lavaan 0.6-8* (Rosseel 2012), *semTools 0.5-4* (Jorgensen et al. 2021), and *metaSEM 1.2.5* (Cheung 2015). We adopted CB-SEM instead of alternative techniques such as partial least squares (PLS) SEM mainly for two reasons. First, CB-SEM is more potent in model validation since it can calculate the overall fit of a proposed model by comparing the proposed and observed covariance matrices (Hair 2009; Lowry and Gaskin 2014). Second, CB-SEM is more effective in validating models developed using a well-established theory. As our research model is deeply rooted in AISD and organizational psychology research, we deemed CB-SEM appropriate (Lowry and Gaskin 2014). Further, as it is likely that anonymous and self-administered questionnaires have less distortion, we distributed all questionnaires online, collected no personal information, and made sure that neither team leaders nor we could access raw or non-pseudonymized data.

To ensure that the results originated from a valid and reliable set of measurement instruments, we first conducted the following four analyses: (1) test for support of required internal validity and convergent and discriminant validity, (2) support for strong reliabilities, (3) test for multicollinearity, and (4) test for common method bias. Using these statistical methods allowed us to rely on proven state-of-the-art statistical methods, giving us the best possible insight into our data and reliable grounds for rejection or support of our hypotheses.

Our initial model shows extremely poor model fit. Only PNFI (.60 > .50) suggests a satisfactory fit. The GFI (.74 < .95), AGFI (.68 < .90), NFI (.67 < .90), NNFI (.73 < .90), CFI (.76 < .90), RMSEA (.10 > .05), SRMR (.13 > .08), RFI (.63 < .90), and IFI (.77 < .90) all suggest a poor fit (Brown 2015; Jackson et al. 2009). Further, pair programming shows a very low loading factor (.228) on social agile practices. We therefore omitted pair programming, five items from psychological safety, and one item from team autonomy. Details on the items are also given in Table 9-4, which also displays the wording for each item and key sources per construct. With this improved version of the model, we proceed our analysis.

For internal reliability, a composite reliability (CR) score of .700 or higher needs to be achieved (Hair et al. 2016). As can be seen in Table 9-5, all constructs exceed this threshold, aside from daily stand-ups, all constructs even exceed .800 but do not exceed .900, which could be interpreted as suboptimal as well. Convergent validity is supported by large (standardized) loadings for all constructs (see Table 9-4). While the original sources include more items per construct (e.g., for team autonomy), we removed those items during data analysis that did not load sufficiently.

Item	Wording	References	Factor	Construct
RTR_1	On a regular basis, our team reflects on previous work and looks for ways to improve team performance.	Tripp et al. (2016)	.890	Retrospective (RTR)
RTR_2	At the end of each work cycle, the team asks itself "what went well during the last work cycle."		.721	
RTR_3	At the end of each work cycle, the team asks itself "what could be improved during the next cycle."		.730	

Item	Wording	References	Factor	Construct
DSU_1	Our team has a short meeting every day to discuss what is going on with the project.	Tripp et al. (2016)	.553	Daily Stand-Ups (DSU)
DSU_2	Each day, all team members share with the team what they are working on.		.820	
DSU_3	The team discusses issues together daily.		.730	
TA_1	The project team was allowed to freely choose tools and technologies.	Lee and Xia (2010)	.582	Team Autonomy (TA)
TA_2	The project team had control over what they were supposed to accomplish.		.754	
TA_3	The project team was granted autonomy on how to handle user requirements changes.		.770	
TA_4 •	The project team was free to assign personnel to the project.		.538	
PS_1 *	Members of my team are able to bring up problems and tough issues.	Detert and Edmondson (2011); Edmondson (1999); Majchrzak and Jarvenpaa (2010); Pearsall and Ellis (2011); Schaubroeck et al. (2011)	.207	Psychological Safety (PS)
PS_2 *	It is safe to take a risk in my team.		.027	
PS_3 *	In my team, my unique skills are valued and utilized.		.307	
PS_4	It is difficult to ask other members of my team for help.		.828	
PS_5	If you make a mistake on this team, it is often held against you.		.773	
PS_6	In my team, it is not advisable to bring up problems and tough issues.		.759	
PS_7 *	If you make a mistake on this team, it is never held against you.		.101	
PS_8 *	No one on this team would deliberately act in a way that undermines my efforts.		.061	

Item	Wording	References	Factor	Construct
RES_1	This team can be characterized as resilient.	Chakravarty et al. (2013)	.587	Resilience (RES)
RES_2	The team always finds a way to make things work.		.714	
RES_3	The team has the ability to absorb shocks.		.694	
RES_4	The team builds capabilities to defend against a wide range of scenarios.		.812	
RES_5	The team is pliable in that we can adjust to abnormal conditions and then bounce right back when conditions come back to normal.		.785	

Table 9-4. Questionnaire Items and Factor Loadings

• Omitted item due to construct AVE below .500 and lowest loading marked in orange
** Omitted items due to loading factors below .500 marked grey*

As Table 9-5 shows, our model passes the test for discriminant validity based on the average variance extracted (AVE) value of a latent construct being larger than its squared correlation with any other latent construct in the model, and therefore convergent and discriminant validities can be confirmed. Given that the correlations of independent variables are below the recommended threshold of .600 (Grewal et al. 2004), we presume that multicollinearity is not a significant issue for the model or dataset (see Table 9-5).

Given that most of our data is based on self-reported survey data, we used two kinds of approaches to examine common method bias. First, we used procedural remedies to invoke an up-front research design to blunt common method bias (Podsakoff et al. 2003). We provided extensive instructions to participants to focus on the survey and remember their work. Further remedies include randomized items so that participants

would be less likely to detect underlying constructs, attention-trap questions, and inversely coded items. Second, we evaluated the correlations among constructs. The most important problem with common method bias is high correlations among constructs. Following Pavlou et al. (2007), the correlation matrix (see Table 9-5) indicates that all correlations were significantly below the recommended threshold of .900, which indicates that common method bias is not likely to be a severe threat in the model.

As regards the evaluation of the model fit, first, our model is significantly different from a baseline model ($\chi^2(122) = 182.21$, $p < .001$). However, due to the broad consensus that the χ^2 test should not be used as a central evaluation criterion (e.g., Brown 2015), we only report this test for completeness and transparency. Second, we report recommended model fit indices to assess model fit (Brown 2015; Jackson et al. 2009) (see Table 9-6). Our model surpasses all acceptance thresholds except GFI, AGFI, NFI, and RFI. However, our model misses the satisfactory levels of these criteria by only a margin each. We further agree with the recent arguments by Xia and Yang (2019) "[...] that surpassing a set of cutoff values should not serve as the only justification for the acceptance of a model, and it is more appropriate to consider RMSEA, CFI, and TLI as diagnostic tools for model improvement" (Xia and Yang 2019, p. 421). Fundamentally, we still need to explain whether other options exist to improve the model, why the options are or are not adopted, and the substantive scientific consequences of considering this model to be the final one (Xia and Yang 2019, p. 421). Following this, we argue for accepting this model, albeit being subject to evaluation by further studies; we see no direct

opportunities for improvement post hoc, but avenues for future studies as discussed in the "Discussion" section.

Construct	TA	RTR	DSU	PS	RES	CR	R^2
Team Autonomy (TA)	**.500**					.747	.189
Retrospective (RTR)	.367	**.615**				.826	.654
Daily Stand Ups (DSU)	.292	.520	**.504**			.748	.414
Psychological Safety (PS)	.047	.084	.067	**.620**		.830	
Resilience (RES)	.445	.366	.291	.364	**.522**	.844	.300

Table 9-5. Correlation Matrix

with Average Variance Extracted (AVE; bold), Composite Reliability (CR), and Explained Variance (R^2)

Model Fit Index	Criterion	Value	Satisfaction
Goodness of Fit Index (GFI)	≥ .95	.90	**not** satisfactory *
Adjusted Goodness of Fit Index (AGFI)	≥.90	.85	**not** satisfactory *
Relative Fit Index (RFI)	≥.90	.86	**not** satisfactory *
Normed Fit Index (NFI)	≥ .90	.88	**not** satisfactory *
Non-Normed Fit Index (NNFI) / Tucker-Lewis Index	≥ .95	.95	satisfactory
Root Mean Square Error of Approximation (RMSEA)	≤ .06	.05	satisfactory
Standardized Root Mean Square Residual (SRMR)	<.08	.07	satisfactory
Comparative Fit Index (CFI)	≥ .90	.96	satisfactory
Incremental Fit Index (IFI)	≥ .90	.96	satisfactory
Parsimony-Adjusted Measures Index (PNFI)	≥ .50	.71	satisfactory

Table 9-6. Model Fit Indices, Thresholds, and Satisfaction

** still, we argue for accepting the model following Xia and Yang (2019)*

Details on the path weights and the hypotheses testing results are displayed in Figure 9-2. Regarding our hypotheses, hypothesis H_1 must be rejected due to non-significance. H_2 was found to be significant ($p \leq .001$) at .331, H_3 showed to be borderline significant ($p \leq .05$) at .290, and H_4 and H_5 were significant as well ($p \leq .01$) with coefficients of .435 and .276, respectively. As H_3 was significant, we found support for a partial mediation of the effect of social agile practices on resilience via team autonomy. We, therefore, conclude that while H_1 must be rejected, H_2 to H_5 are supported.

While team autonomy has a relatively low R^2 value of .189, daily stand-ups and retrospectives (i.e., our first-level constructs which form our second order construct social agile practices, which explains team autonomy) are

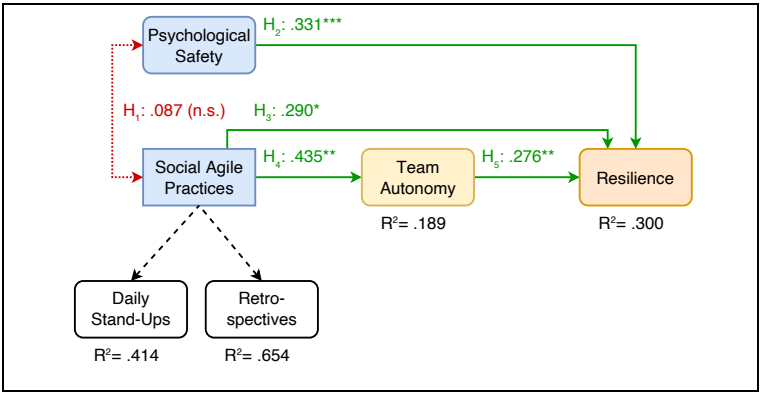

Figure 9-2. Results

Supported hypotheses printed in green, rejected hypotheses in red.
**: p ≤ .05; **: p ≤ .01; ***: p ≤ .001; (n.s.): p > .05*

just two of many factors explaining how a team gains autonomy. For instance, other agile practices (e.g., sprints and sprint planning meetings in which a team has considerable influence on which work packages are worked on next) certainly increase a team's autonomy. Similarly, control styles (Remus et al. 2019) and control modes (Kirsch 1997) significantly drive a team's autonomy. However, as these specific effects were only part of our research question, we see the moderate R^2 value of .300 for resilience as more important. Considering that resilience has many other possible influencing factors, accounting for roughly a third of the explanatory value is a significant outcome.

Regarding explanatory power (see Table 9-7), we see a small to very small effect size for the effect of psychological safety on resilience and a small effect size for the effect of social agile practices on resilience when mediated by team autonomy. Finally, we see a large effect size for the direct effect of social agile practices on resilience.

Path	Effect Size	References
SAP → TA → RES	.301 *small*	Cohen (1988) and Sawilowsky (2009)
SAP → RES	.728 *large*	
PS → RES	.170 *small to very small*	

Table 9-7. Effect Sizes

Comparing the this model, the psychological-safety-as-bystander model ("Model 1") to the previous, psychological-safety-as-moderation model ("Model 2"; (Hennel Under Review)), Model 1 shows a lower value for Akaike information criterion (AIC; Akaike 1974), Bayesian information criterion (BIC; Schwarz 1978), and the sample-size adjusted BIC (Sclove 1987) and should therefore be favored over Model 2. Details are shown in Table 9-8. We, therefore, conclude that psychological safety neither covariates with social agile practices, nor moderates the effects of social agile practices.

Criterion	Model 1	Model 2	Favored Model
AIC	8,208.505	8,208.782	Model 1
BIC	8,394.549	8,401.132	Model 1
Sample-Size Adjusted BIC	8,207.722	8,207.972	Model 1

Table 9-8. Model Comparison

Model 1: Psychological Safety acts as "Bystander"
Model 2: Psychological Safety acts as Moderator

9.6 Discussion

Building upon previous research (i.e., especially Hennel Under Review; Hennel and Rosenkranz 2020), we motivated a research model, argued for our hypotheses, and have shown which we could support and which we had to reject based on an empirical investigation. While our initial model

could not be confirmed in the most critical aspects, we provide three main contributions to theory and practice.

First, our main contribution is falsifying a rival theory to extant research. On a purely argumentative basis, explaining the interaction between social agile practices, team resilience, and psychological safety via a covariation appears convincing and intuitive, as we already knew that a moderation was not involved (Hennel Under Review). However, with these results, we offer supporting evidence for a less direct relationship as stated by previous research (Hennel Under Review). This contributes to research by improving our understanding of the inner workings of AISD teams and solidifies the groundwork for research on AISD teams by ruling out a rival theory. Adding to this, the previous study found a small mediation effect and a large direct effect for SAPs on Resilience (Hennel Under Review). This in and of itself shows the importance of SAPs in this context. While this model still does not explain how SAPs and psychological safety interact, it offers a baseline model for future research to expand on and evaluate different interactions. For practitioners, this finding further stresses the importance of implementing retrospectives for reaping resiliency benefits, as pointed out previously (Hennel Under Review). Further, it offers an explanation why some teams might not show the expected resilience although practicing retrospectives: if the team in question has not the required autonomy to act on their insights gathered from retrospectives and daily stand-ups, it cannot realize the benefits.

Second, we have shown that this quantitative evidence — even with an updated, modified model and underlying assumptions — cannot support the previously assumed (Hennel and Rosenkranz 2020) relationship between psychological safety and social agile practices. As stated before

(Hennel Under Review), this finding also opens an avenue for future research: the differences between the qualitative indications for this relationship and the quantitative operationalization, measurement, and analysis are likely to hold new insights and reconcile the different findings, ultimately leading to improved understandings of inner AISD team workings and improving AISD practice implementations. This finding, therefore, indirectly contributes to research by providing the base for subsequent studies, investigating this discrepancy further, and reconciling apparently opposing findings.

The Transferability of our conclusions is limited as all findings are based on data gathered from one corporation. However, as the participants worked across different divisions, on different continents, in different teams, and different roles, we argue for a limited yet acceptable level of transferability. We, therefore, call for replication in different contexts. Further, as our data were collected via self-report questionnaires, it is possible to suffer from an increased effect of the social desirability bias. An overestimation of psychological safety is likely socially desirable. We tried to mitigate the influence of social desirability bias as laid out in the section "Measurement and Data Collection" and followed Nederhof (1985) to minimize the effect. Situational factors, such as mood or current time pressure, could also have influenced participant's responses, as psychological safety has an affective dimension to it. Future research could eliminate these concerns by replicating this study or conducting a longitudinal analysis. Finally, this data is reused but reinterpreted from a previous study (Hennel Under Review). However, as this study aims at clearing the possible interpretations of identified effects and the

underlying models overlap in large parts, we argue for this reuse to be ethically and methodologically acceptable.

9.7 Conclusion

This paper continued the research on social and psychological effects in AISD — a still sparsely research niche in AISD research. Through a quantitative field study, we shed light on the interaction of social agile practices, team autonomy, and psychological safety. More importantly, we have falsified a rival theory and have shown that psychological safety does not act as a moderator on effects stemming from social agile practices. The limitations of this study, as well as our contributions to research and practice, build a foundation for future research to extend our insight into how socio-technical effects are at play in AISD projects and, more precisely, explain the differences between qualitative and quantitative findings.

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