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Improving Software Development Efficiency – How Diversity and Collective Intelligence Shape Agile Team Efficiency

Phil Diegmann
diegmann@wiso.uni-koeln.de

Christoph Rosenkranz
rosenkranz@wiso.uni-koeln.de

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Phil Diegmann
University of Cologne
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ABSTRACT

Information system development is largely dependent on social interaction and team work. Team composition, team processes, and behavior among, and agile practices used by team members play an important role for the success of information system development projects. Organizational psychology research found team diversity and collective intelligence to be important factors for team performance. In this research-in-progress paper, we propose a model and research design to investigate the effects of team diversity, collective intelligence, interpersonal relationships, and cognitive styles on team efficiency in agile software development. The proposed model combines recent research in the field of organizational psychology with agile information system research to provide a better understanding of the effects of team diversity, collective intelligence, and team efficiency.

Keywords

Agile Software Development, Diversity, Collective Intelligence, Interpersonal Relationships, Cognitive Styles, Efficiency, Team Composition, IS Development, IS Project Management

INTRODUCTION

Agile information system development (ISD) methods are increasingly popular in the industry (Conboy, 2009, Dybå and Dingsøyr, 2008, Fitzgerald, Hartnett and Conboy, 2006, Lee and Xia, 2010, Williams, 2012). With increasing diversity among agile ISD (henceforth AISD) teams and an increased need for team management, it has become important to understand the mechanisms of action in AISD teams (Berger and Beynon-Davies, 2009, Goh, Pan and Zuo, 2013, Lee and Xia, 2010, Persson, Mathiassen and Aaen, 2012, Sarker, Munson, Sarker and Chakraborty, 2009).

Team-level research in AISD, on the other hand, is scarce (Lee and Xia, 2010), although AISD is mostly conducted in teams and is quintessentially a team effort (Siau, Long and Ling, 2010, White and Leifer, 1986). Moreover, so far results are inconsistent. For example, some studies suggest that AISD methods work best for highly cohesive (non-diverse) teams (Cao, Mohan, Xu and Ramesh, 2009, Fruhling and de Vreede, 2006), and cohesiveness could be the main reason for successful ISD (Chin, 2003). Others find that diversity amplifies creativity and communication and therefore contributes to the success of AISD methods (Bear and Woolley, 2011, Lee and Xia, 2010, Phillips, Northcraft and Neale, 2006). This conflict between diversity and cohesion is acknowledged (e.g., McAvoy and Butler, 2009b), and it is pointed out that contradicting effects exist, especially on the efficiency of decision making.

Research on teams also has identified a "need to move beyond the simple diversity-affects-performance model in order to think in more complex ways about *how* and *under what conditions* a diversity of expertise in groups might promote or inhibit group effectiveness" (Van Der Vegt and Bunderson, 2005, p. 542). Similarly, researchers call for more empirical research on how diversity affects team performance in general (Van Der Vegt and Bunderson, 2005), in AISD (Lee and Xia, 2010), and on team-level effects in AISD (Conboy, 2009, Hong, Thong, Chasalow and Dhillon, 2011, Mangalaraj, Mahapatra and Nerur, 2009, McAvoy and Butler, 2009a, McAvoy, Nagle and Sammon, 2013).

In order to shed light on the diversity-performance debate, and to conceptualize this for the domain of AISD, we suggest to build on insights from recent studies on team work to propose a model answering the calls for further conceptualization and investigation. Contemporary studies find that collective intelligence (CI) of a team is an important explanation of a team's performance on a wide variety of tasks (Woolley, Chabris, Pentland, Hashmi and

Malone, 2010). Specifically, AISD teams are involved in very different phases over a project's lifecycle (i.e., planning, implementation, introduction, etc.), of which each demands different specializations and includes different kinds of tasks. Providing deeper insights into benefits and downsides of team-level effects in regard to different phases of the AISD lifecycle would benefit both research and practice. Further, research indicating both increases and decreases in team performance based on team composition (i.e., diversity and CI), giving recommendations on how to compose teams might reduce the number of failed projects and therefore might lead to a decrease in costs.

Building on this, we propose a model that explicitly focuses on the social-behavioral aspect of AISD to explain "how the work is done" (Sawyer, Farber and Spillers, 1997, p. 47), as have done others in the IS discipline (e.g., Kautz, Madsen and Nørbjerg, 2007, Sawyer et al., 1997). While other research has seen technology and information systems as important, but only adjacent to team research (e.g., Kozlowski and Ilgen, 2006), we set our focus to ISD. This focus is not on technological aspects of ISD, such as specific programming frameworks, but rather on the specific tasks, phases, and features of ISD. Resulting from this model, guidance on how to manage team-level effects might be derived. To empirically evaluate our model, we plan to conduct a study among multiple organizations. In this research-in-progress paper, we argue for our model and present our research design.

The remainder of this paper is structured as follows. We give an overview about related work, targeting team effects and ISD. Next, we derive the proposed model and state corresponding propositions based upon previous literature. Finally, we give an outlook on the proposed research design being used for data collection and analysis.

RELATED WORK

Information Systems Development and Agile Approaches

IS are often developed in the form of projects (Hirschheim, Klein and Lyytinen, 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, Schmidt, Lyytinen and Keil, 2000).

The major problems of ISD projects are not so much technological as sociological in nature (DeMarco and Lister, 1987, p. 4). Coordination and communication between various stakeholders are necessary for successful implementation (Gallivan and Keil, 2003, Ko, Kirsch and King, 2005), and creating a shared understanding between involved stakeholders is deemed to be a major driver for ISD success (Gallivan and Keil, 2003, Tan, 1994).

In practice, approaches for developing IS range from sequential approaches (Royce, 1970) to more cyclic, iterative approaches (Boehm, 1988). The resulting AISD methodologies (Cao et al., 2009, 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 in the field of AISD methods has investigated mainly specific and individual or organizational phenomena, such as the use and effects of specific agile practices (APs) (Balijepally, Mahapatra, Nerur and Price, 2009, Holmqvist and Pessi, 2006, Maruping, Zhang and Venkatesh, 2009b), and effects regarding whole projects or organizations, such as the introduction of AISD methods to teams (Cao et al., 2009, Heeager, 2012, Hong et al., 2011, Kotlarsky, 2007, Mangalaraj et al., 2009).

As research thus covers the individual and organization-wide level of effects on AISD, team-level effects are covered less so, and existing results are contradictory. Team research has included technology as an influencing factor of team work (e.g., Kozlowski and Ilgen, 2006), but specific features of ISD have not been observed. Research found that cohesive teams are the optimal base for applying APs (Cao et al., 2009, 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 ISD. These inconsistencies are especially important for AISD, as AISD teams rely heavily on efficiency (to respond quickly to requirement changes and being flexible; Conboy, 2009) and problem solving ability (to complete complex, non-routine tasks; Lee and Xia, 2010).

At the same time, ISD projects are becoming more distributed and diverse (e.g., Persson et al., 2012, Ramesh, Mohan and Lan, 2012, Sarker et al., 2009, Sarker and Sarker, 2009). Research on AISD has started adapting diversity concepts, while calling for a better understanding of effects of diversity in ISD (Lee and Xia, 2010). Extant research applied theories of organizational psychology while being focused on IT use than on ISD (e.g., Gorecki, Berthon, DesAutels, Donnellan and Teigland, 2008, Nan, 2011, Wang and Hahn, 2015). While research on teams thus is not completely new to ISD research, team composition effects, such as diversity and collective intelligence (CI), have not been investigated by ISD research yet.

Team Work and Group Performance

Research on team work has focused mainly on outcomes of team performance, before shifting to mediation effects and more general speaking from input-process-output models to cyclic input-mediation-output-input models (for a comprehensive overview, see Ilgen, Hollenbeck, Johnson and Jundt, 2005). A notion of teams as complex, context-sensitive, and evolving systems has emerged (Ilgen et al., 2005, Kozlowski and Bell, 2003).

In organizational psychology, two concepts have emerged as important predictors of team performance in the last decade: diversity and CI. As regards the first, research over recent decades found contradictions (del Carmen Triana, Miller and Trzebiatowski, 2014, Hülsheger, Anderson and Salgado, 2009, Joshi and Roh, 2009, Milliken and Martins, 1996, Phillips et al., 2006, Post, 2012, Van Der Vegt and Bunderson, 2005). Some studies find a positive relation between diversity and team performance (see Bear and Woolley, 2011, Phillips et al., 2006, Van Der Vegt and Bunderson, 2005), but outlined a dependency on specific contextual circumstances, such as the competitive threat-level (del Carmen Triana et al., 2014), team identification, and climate (Van Der Vegt and Bunderson, 2005). Team identification and climate have been found to play an important role in generating positive effects from diversity (Van Der Vegt and Bunderson, 2005). Studies which identified a negative effect describe an overhead of communication and a risk for conflict (Ely and Thomas, 2001, Leonard, Levine and Joshi, 2004, MacMillan, Entin and Serfaty, 2004).

Scholars differentiate between deep-level (DLD; i.e., education, experiences, also known as job-relevant diversity) and surface-level diversity (SLD; i.e., ethnicity, age, also known as background diversity) (Aggarwal and Woolley, 2013, Hülsheger et al., 2009, Phillips et al., 2006). These two types act differently: while SLD highlights dissimilarities and encourages sharing of unique information (Phillips et al., 2006), DLD might lead to harmful conflict (Jehn, Northcraft and Neale, 1999) or facilitate team performance by providing different educational backgrounds and skillsets (Joshi and Roh, 2009).

In regard to CI (Woolley et al., 2010), the average intelligence of team members and the single highest intelligence correlate only weakly with CI, and cohesion, motivation, and satisfaction do not correlate. The two most important factors contributing to CI are social sensitivity and a balanced number of speaking turns per group member (Wooley et al 2010). These findings were replicated for face-to-face and online communication (Engel, Woolley, Jing, Chabris and Malone, 2014). Additional influencing factors of team performance have been identified by team research. For instance, mental models, which "allow people to predict and explain the behavior of the world around them" (Mathieu, Heffner, Goodwin, Salas and Cannon-Bowers, 2000, p. 274), and especially shared mental models, which allow teams to quickly adapt to changing situations because of knowledge about their team's members mental models (Cannon-Bowers, Salas and Converse, 1993).

Recent research in the ISD field has started to apply these findings. For example, the phenomenon of practical intelligence (PI), which is referred to as the "capability to resolve project related work problems [... and] is targeted at resolving unexpected and difficult situations that often cannot be resolved using established processes and frameworks" (Langer, Slaughter and Mukhopadhyay, 2014, p. 365), of project managers was found to be important for project performance (Langer et al., 2014). In the same study, project complexity and task or team familiarity were identified as moderators on the effect of project managers' PI on project performance.

While these phenomena have been investigated on their own and mainly in the context of general or occasional teams, ISD research has not put these theories together and evaluated these effects in the specific context of AISD teams, although AISD methods rely heavily on team work, composition, communication, and interpersonal relationships (Beck, Beedle, van Bennekum, Cockburn, Cunningham, Fowler, Grenning, Highsmith, Hunt, Jeffries, Kern, Marick, Martin, Mellor, Schwaber, Sutherland and Thomas, 2001, Lee and Xia, 2010, Maruping, Venkatesh and Agarwal, 2009a, Rosenkranz, Corvera Charaf and Holten, 2013, Sawyer, Guinan and Cooprider, 2010).

Research on team composition and performance has been mostly performed involving students in laboratory conditions, but to our knowledge no studies have empirically investigated effects of team diversity and CI specific to real-world AISD teams.

THEORY DEVELOPMENT

Figure 1 displays the constructs and relationships used for our model. Table 1 summarizes the constructs.

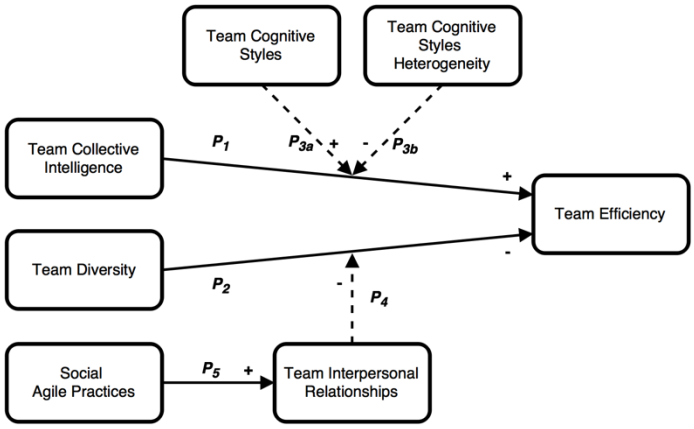

Figure 1. Proposed Research Model

Name	Definition	Based upon
Team Collective Intelligence (CI)	A group's general ability to perform a wide variety of tasks, as a property of the group itself, not of its members. CI is differentiated from the intelligence of individuals on a group level, as average and highest individual intelligence were weaker predictors or group performance and are only moderately correlated with CI.	Woolley et al. (2010), Engel et al. (2014)
Team Diversity	The differences among team members regarding visible (i.e., surface-level; e.g., race, age) and invisible (i.e., deep-level; e.g., experience, education) characteristics.	Phillips et al. (2006), Post (2012)
Team Cognitive Styles (CS)	The way an individual gathers, processes, and organizes information; typically differentiated into more analytical, process-driven and more connective, holistic thinking.	Allinson and Hayes (1996), Witkin and Goodenough (1981)
Team Cognitive Style Heterogeneity	Cognitive style heterogeneity relates to the diversity of CS of team members.	Allinson and Hayes (1996), Witkin and Goodenough (1981)
Team Efficiency	The ability of a team to complete a project in time and in budget, and to respond to user requirement changes and incorporate them with minimal time, cost, personnel, and resources.	Lee and Xia (2010), Van Der Vegt and Bunderson (2005)
Team Interpersonal Relationships (IRs)	Relationships and their associated behavior and norms in the workplace; manifestations are business associates (i.e., mere colleagues), business friends or personal friends.	Madsen and Matook (2010)
Social Agile Practices (SAPs)	APs entailing communication practices or practices aiming at exchanging knowledge and facilitating interpersonal interaction (e.g., daily scrums or pair programming).	Hummel et al. (2015)

Table 1. Constructs and Definitions

In the scope of this paper, team performance is represented by team efficiency. While more factors influence the overall performance measure, AISD is oriented on efficiency by delivering working software frequently and welcoming change during development (Beck et al., 2001). We did not add the artifact created by the ISD team into our model explicitly, as we are focusing on the social aspects of ISD.

Team efficiency describes the ability of a team to complete a project in time and budget, and respond to requirement changes and incorporate them with minimal time, cost, personnel, and resources (Lee and Xia, 2010, Van Der Vegt and Bunderson, 2005). Furthermore, efficiency in a turbulent and changing environment is linked to flexibility, "the ability […] to create change, or proactively, reactively, or inherently embrace change in a timely manner" (Conboy, 2009, p. 336). Therefore, efficiency is related to the frequency of inherited changes. A similar indicator for efficiency is bug severity, that is, the product of number of bugs and the hours needed to fix these bugs (Maruping et al., 2009a).

As pointed out, research has found that *team CI* as a factor describes a group's general ability to perform a variety of tasks (Engel et al., 2014, Woolley et al., 2010). Looking at the components on which CI is based (i.e., social sensitivity), we conclude that CI facilitates team efficiency.

P_1: *An increase in team CI has a positive effect on team efficiency.*

Cognitive styles (CS) are defined as the way an individual gathers, processes, and organizes information (Allinson and Hayes, 1996, Witkin and Goodenough, 1981). Different connotations exist; some researchers classify CS into analytical, procedural, thinking versus intuitive, declarative, thinking (Mello and Delise, 2015, Woolley, 2009). Similarly, research differentiates between sequential thinking as "a form of analytical thinking" (Post, 2012, p. 559) and connective thinking as "a form of holistic thinking" (Post, 2012, p. 559).

Building upon CS, teams may be process-focused or outcome-focused. Process-focused teams tend to emphasize specific tasks and individual actions, whereas outcome-focused teams tend to emphasize an a more abstract level (Woolley, 2009). Routine tasks might be executed more efficiently by process-focused teams, while outcome-focused teams might be more successful at more complex, creative tasks (Woolley, 2009). Moreover, heterogeneity in CS among team members has been found to have negative effects (Aggarwal and Woolley, 2013, Mello and Delise, 2015). Comparing CS to mental models, research found mental models to be depending on CS to be developed and shared, as CS influence and shape both form and content of the mental models (Riding and Rayner, 2000).

In sum, we argue that the benefits of CI are moderated by both, the matching between CS and the task at hand as well as the *CS heterogeneity* among team members.

P_{3a}: *Team cognitive styles moderate the positive effect of team CI on team efficiency. A homogeneous process-focus amplifies this effect, while a product-focus decreases this effect.*

P_{3b}: *A heterogeneous focus decreases the effect of team CI on team efficiency.*

As outlined in the related work section, research found that *team diversity*, especially diversity in experience, education, abilities, and professional background (i.e., DLD), does foster both conflict and a team's problem solving ability (Lee and Xia, 2010), and therefore diversity is a double-edged sword, providing possible benefits and possible pitfalls. While organizational psychology describes the effect of diversity on performance in general (efficiency and effectiveness) as an inverted U-shape (Van Der Vegt and Bunderson, 2005), we expect diversity to impact efficiency more linearly and negatively due to the overhead on communication.

P_2: *An increase in team diversity, that is, more DLD, leads to a decrease in team efficiency.*

It is also well-known that team climate factors, such as friendships and psychological safety, influence conflict repelling factors, such as helping behavior and norms (Madsen and Matook, 2010, Milliken and Martins, 1996, Post, 2012). Team climate and identification moderate the effect of diversity on performance (Van Der Vegt and Bunderson, 2005). As team research literature points out (e.g., Milliken and Martins, 1996), diversity might lead to an overhead in communication due to differences among team members. In teams that are more familiar, this

negative effect might be weaker or even repealed. Business friendships or personal friendships (Madsen and Matook, 2010) might have already dissolved the communication overhead and contribute to team climate and identification (see also Van Der Vegt and Bunderson, 2005).

Similarly, conflict among team members can be a necessity for effectiveness (Amason, 1996, Bradley, Anderson, Baur and Klotz, 2015, Jehn, 1995, Jehn, 1997, Jehn, Greer, Levine and Szulanski, 2008). Moreover, conflict can be differentiated into three types of disagreements: task conflict (about the content of the task), relationship conflict (on a personal level) (Jehn, 1995, Jehn et al., 2008), and process conflict, which is similar to task conflict, but more distinct: it describes disagreements about delegation and responsibility (Jehn, 1997, Jehn et al., 2008). According to research, only task conflict positively effects team performance, while other conflicts negatively affect task performance (Jehn, 1997).

Applying these findings to the effects of diversity on both efficiency and problem solving ability, we argue that closer *team IRs* – that is, business associates, business friends, or personal friends (Madsen and Matook, 2010) – facilitate positive effects and mitigate negative effects, and might even turn negative effects positive, possibly resulting in an inverted U-shaped effect. Knowing one another well reduces the need for communication by creating a common understanding and trust, and establishes social norms and team identification. Less friendly interpersonal interactions "may account for the suboptimal performance outcomes of gender-diverse and ethnically diverse teams" (Joshi and Roh, 2009, p. 619). Research indicates that IRs in teams which are based on mutual trust establish an environment of psychological safety (Hülsheger et al., 2009), therefore the willingness to share unique information might be increased (Kearney, Gebert and Voelpel, 2009).

P_4: *Team IRs moderate the effect of team diversity on team efficiency. In more familiar teams, the negative effect of team diversity on team efficiency is weakened or even reversed.*

As regards AISD approaches, many different APs entail interpersonal exchange and communication, for example, daily scrum (Schwaber and Beedle, 2002), pair programming (Beck and Andres, 2004), or co-located office space (for a comprehensive overview, see Hummel, Rosenkranz and Holten, 2015). As many of these *social agile practices* (SAPs) moderate or target a friendly and supportive interaction by definition, they contribute to improved team IRs (Madsen and Matook, 2010).

P_5: *SAPs enforce team IRs. The more rigid and complete these practices are applied, the stronger IRs among team members are.*

PROPOSED RESEARCH DESIGN

We plan to evaluate our propositions using a survey-based panel design and collecting data in multiple organizations applying ISD methods, and a quantitative analysis using multivariate statistics.

Data will be collected at multiple points in time (start, middle, and end of sprints) by using questionnaires and, if possible, data from project management and issue tracking. As sprints should be similar to each other, measurements are comparable and give more evidence for causal relationships, for instance in regard to the moderating effect of evolving IRs.

As regards potential measurements for latent variables, extant literature already utilized questionnaires and provide tested indicators, as outlined in Table 2. Additional control variables are listed in Table 3.

Before distributing the survey among different companies, we plan to conduct a pre-test among a small amount of local companies with the possibility to conduct interviews while refining the questionnaire. In regard to comparability among different organizations, every organization or project is treated as an individual study. We further plan to utilize the back-translation technique (Brislin, 1970) to be able to reach out to more participants and to ensure adequately worded items.

Construct	Measurement Items
Team Collective Intelligence (CI)	Can be measured via social sensitivity and speaking turn taking (Engel et al., 2014, Woolley et al., 2010). While the later can be observed and asked for in questionnaires rather easily, the first one can be derived from the "reading the mind in the eyes" (RME)

	test (see supporting online material for Woolley et al., 2010). The RME test is well documented and can be included in questionnaires easily, as it exists of 36 pictures of eyes, displaying different emotions and state of minds, while the participant has to choose the best matching emotion from four different options. Therefore, we will measure self-reported speaking turn equality averaged over each team and the RME test.
Team Diversity	While SLD can be observed via items regarding ethnicity, age, and other demographic characteristics (Phillips et al., 2006), data regarding DLD can be approximated via items regarding education, religion, and political orientation (Phillips et al., 2006, Post, 2012). Educational diversity is reflected in ISD teams especially via professional specialization, such as domain-specific knowledge, experience in different programming languages, frameworks, or aspects of implementation (e.g., user-interface design, testing, and so forth). Therefore, we will measure DLD via education, experience, and professional specialization, as these are easy to measure and are less likely to offend participants in comparison to measurements regarding religion and political beliefs.
Team Cognitive Styles (CS)	CS has been observed in previous studies via different measures. For instance, Scott and Bruce (1995) propose a 25-item measurement, whereas Woolley (2009) utilized eight items, evenly distributed on process and outcome focus. To improve reliability and minimize biases, we will utilize both measurements.
Team Cognitive Style Heterogeneity	Builds upon the CS measurement, comparing the heterogeneity present among team members. Accordingly, CS heterogeneity will not be measured directly, but will be inferred from the CS measurements of all team members per team to represent the heterogeneity present in the team.
Team Efficiency	Adherence to schedule and budget are important parts of team efficiency and can be obtained via items in a questionnaire, or via data from project management and tracking tools. Similarly, response efficiency has been used in questionnaires before (Lee and Xia, 2010). Combining items to capture formal efficiency measures (i.e., adherence to schedule and budget) and measures regarding the ability to respond to requirement changes (i.e., response efficiency) makes up our proposed measurement for efficiency. We propose the latter to consist of bug severity and flexibility. The former has been defined as the product of number of bugs and the hours needed for resolving (Maruping et al., 2009a), while the latter can be defined as the number of implemented changes in a given time frame (Conboy, 2009). This data will be collected from project management and issue tracking tools. Therefore, we will ask for formal efficiency measures and the ability to respond to requirement changes as perceived by team members. Additionally, we will gather data about formal efficiency measures and the ability to respond to requirements changes from project management and issue tracking tools.
Team Interpersonal Relationships (IRs)	Observable characteristics (relationship norms, degree of communality, helping behavior, conversation, amount of depth and self-disclosure, trust, intimacy, need responses, and obligation) for different types of IRs are provided by extant literature (Madsen and Matook, 2010). Those will be asked for in a questionnaire to be able to characterize the IRs present in different teams.
Social Agile Practices (SAPs)	Regarding the usage of SAPs we will use already tested items to observe the usage of APs (Hummel et al., 2015). We will limit the items to those relevant to SAPs as identified by previous literature (Hummel et al., 2015). For each relevant SAPs we will therefore ask if and how regularly these APs were applied.

Table 2. Constructs and Measurement Items

We will choose the best fitting multivariate method for data analysis, depending on data access and availability (Gefen, Straub and Boudreau, 2000). While partial least squares (PLS) structural equation modeling (SEM) is able to work with lower sample sizes compared to covariance-based (CB) SEM (Chin and Newsted, 1999, Goodhue, Lewis and Thompson, 2012, Wolf, Harrington, Clark and Miller, 2013), CB-SEM is preferred for theory-testing (Hair, Ringle and Sarstedt, 2011). Both approaches would be applicable and the best fitting approach will be applied. According to G*Power (Faul, Erdfelder, Buchner and Lang, 2009, Faul, Erdfelder, Lang and Buchner, 2007), a sample size of 68 Teams is needed to achieve a power-level of 0.8. It is important to note that our sample size does not refer to individuals but to teams. Comparable studies aimed at a power 0f 0.8 with at least 60 (Engel et al., 2014) or 110 (Maruping et al., 2009a) teams. To gain access to enough teams to satisfy the sample size

requirements, we are currently in talks with a large consulting company. To reduce a possible sampling bias, we are targeting software development teams from companies of different sizes and industries.

Control Variable	**Measurement Items**
Customer Satisfaction	Adherence to budget Adherence to schedule Fulfilment of requirements If available, we will gather the same information in addition to the developer report directly from the customer.
Team Size	Number of team members
Project Duration	Actual duration of the project in months
Team Virtuality / Team Co-Location	Amount of work time spent remote / virtual compared to the amount of work time spent co-located.
Team Informality	Number of hierarchy levels in the team's organization
Team Autonomy	Extend to which teams and team members influence the decision making progress and monitor their progress.
Team Diversity (SLD)	SLD measurements (i.e. demographic characteristics of participants)

Table 3. Control Variables

We identified multiple risks associated with our current research design. As we are measuring efficiency, which is related to success, a social desirability bias is likely. Social desirability is the "tendency […] to deny socially undesirable traits and claim socially desirable ones, and the tendency to say things which place the speaker in a favourable light" (Nederhof, 1985, p. 264). To counter the effect of social desirability bias, we plan on implementing the recommendations made by Nederhof (1985), such as granting anonymity and an as neutral as possible wording. Measuring at different points in time is clearly adding complexity to our research design, but needed to add additional confidence in causal relationships. By conducting a repeated measurement design, we are able to control for evolving relationships within the team and to observe different kind of tasks.

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