Explaining How Agile Software Development Practices Moderate the Negative Effects of Faultlines in Teams

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Abstract

This research-in-progress aims at investigating what moderating effects use of Agile Software Development (ASD) methods and practices has on negative performance effects of faultlines, i.e. specific configurations of attributes in team members.

Based on literature in ASD and psychology, a model of the moderating effects of ASD practices is developed and is to be assessed using a global online study.

Since ASD practices shape team work and can be linked to known moderators of negative faultline effects, we expect to find moderating effects of ASD methods and practices on faultline effects.

Information on the prevalence and moderation of faultline effects in ASD teams will help with a more detailed understanding of how ASD practices work and the contingencies that can inhibit or support their effects.

Insights into group functioning in ASD settings will provide guidance on which ASD practices may be helpful in attenuating negative team dynamics.

Keywords agile software development, subgroups, faultlines, team dynamics.

1 Introduction

Agile software development (ASD) has been very impactful in computer science in the past years (Dyba and Dingsoyr 2009). One key aspect of ASD is its reliance on heterogeneous project teams (Lee and Xia 2010). This means team members differ in their characteristics—e.g. age, personality, or development skills—inexperienced vs. experienced programmer (Wiesche and Krcmar 2014). Organizations tend to design heterogeneous project teams since they are linked to many advantages such as an increase in efficiency and competitive advantage by leveraging creativity and flexible adaption to change (Lau and Murnighan 1998; Nerur and Balijepally 2007).

Despite such advantages, potential downsides to heterogeneity have also surfaced. Specifically, it may lead to social disintegration and a reduced ability to engage in creative processes (Nishii and Goncalo 2008). Based on combinations of members' diverse characteristics, a team may split into two or more smaller working groups called subgroups (Lau and Murnighan 1998). One example of subgroups are those due to geographical distance between team members (Polzer et al. 2006), which is directly related to extant research on distributed ASD (Persson et al. 2012; Ramesh et al. 2006).

The concept of faultlines is used often to identify such potential subgroups. Faultlines can be described as potential divides based on the compositional dynamics of attributes in members, e.g. differences in demographics, which can cause subgroups to form (Lau and Murnighan 1998). Such faultlines and subgroups may overturn the positive effects initially sought by the creation of heterogeneous teams and result in opposing groups that operate separately and thus can harm group dynamics (Lau and Murnighan 1998). The emergence of subgroups is not only based on faultlines but also on the context of the situation at hand (Lau and Murnighan 1998). Research has identified a number of specific factors that help in keeping faultlines at bay, thus inhibiting the emergence of subgroups, and the negative effects associated with them. Upon studying the possible remedies proposed in literature, a direct link to using ASD methods is palpable. ASD aims at delivering high-quality software and puts forth a number of people-related propositions to attain this aim, e.g. working together and communicating directly (Beck et al. 2001). A good working atmosphere is sought to enable a good flow of communication (Cockburn and Highsmith 2001). Knowledge on how team characteristics, e.g. faultlines, affect work outcomes can thus be considered of prime importance to ensure agile project success. Since ASD practices emphasize direct elaboration of information and call for constant reflexivity, they seem conceptionally close to proposed moderators of faultline effects. We intend to improve understanding of faultline effects in ASD teams by investigating the following research question: "What moderating effects does use of ASD methods have on negative effects of faultlines?" Building on previous literature in psychology and ASD research, this research-in-progress derives a model of how ASD practices moderate the effects of faultlines, which is to be evaluated in a survey study.

2 Theoretical Background

2.1 Teams in Agile Software Development

Agile software development (ASD) has been very impactful in computer science in the past years (Dyba and Dingsoyr 2009) and use of ASD methods has been found to significantly improve project success (Serrador and Pinto 2015), which coincides with findings of overall maturing of IT markets (Pflügler et al. 2015). For the purpose of this research, ASD methods, e.g. Scrum, are defined to comprise a set of practices, e.g. daily stand-up meetings (Tripp et al. 2016). As has been stated before, a key aspect of ASD is its reliance on heterogeneous project teams (Lee and Xia 2010). In addition, a core ingredient of working in an agile manner is a focus on people aspects—as witnessed by the agile manifesto (Beck et al. 2001). Adding to these prescriptions of how things should be done, research has taken an interest in the mechanics of how ASD methods work on several levels and their effects on outcomes. As a notable example, previous research has investigated the interaction of using ASD methods and the concept of control to steer teamwork (Maruping et al. 2009). A recent study on coordinating expertise in software projects has found the decentralized structure typical of ASD well-suited for design tasks, but not as much for technical tasks (Kudaravalli et al. 2017). Lee and Xia (2010) have studied the effects of constituents of ASD practices on outcomes contingent on situational factors and have suggested relationships may take rather complex forms. As further examples, a framework integrating different levels of analysis in Scrum has been described (Kim 2007) and effects of Pair Programming have been investigated. It has been found to decrease defects in software (di Bella et al. 2013), a laboratory analysis has found an increase in satisfaction (Balijepally et al. 2009), and lastly meta-analytic analysis has found effects of Pair Programming to be contingent on situational factors, e.g. task complexity (Hannay et al.

2009). In a nutshell, extant evidence on the effects of ASD methods and practices suggests a set of complex interactions contingent on the situation at hand.

There are several key aspects of ASD that describe the special nature of ASD projects and consequently ASD team characteristics. ASD projects have been classified as complex adaptive systems (CAS): The overall functioning of the team cannot be explained by looking solely at its parts and is under constant evolution due to inputs and outputs. These dynamics call for constant exchange of information instead of preplanned procedures (Augustine et al. 2005). In ASD research, social aspects have been found to take a prominent role (Dyba and Dingsoyr 2009). "People issues" have been described as crucial aspects in ASD. These range from recruitment and training, over team design, to conflicts in teams (Conboy et al. 2011; Domino et al. 2003; Gren 2017). Findings from previous research on the effects of project failure highlight another contingency: on the one hand project failure can cause personal hardship for team members, while at the same time providing an opportunity to learn (Pflügler et al. 2016; Pflügler, Jäschke, et al. 2018). Research at an individual or dyadic level in ASD has also investigated the personality of developers and the effect of gender on team performance (Balijepally et al. 2006; Choi 2015). ASD teams are characterized as self-regulating (Cockburn and Highsmith 2001) with ASD principles promoting a strong focus on informal, face-to-face communication (Beck et al. 2001). Teams are meant to incorporate a culture of change and feedback (Williams and Cockburn 2003), which is also cast into practices such as stand-up meetings (Yu and Petter 2014). Given this number of wide-ranging prescriptions of how things should be done, it is not surprising agile development has been described as a culture (Whitworth 2008), which implies a link to the vast field of research on cultural issues. Recent research has found first descriptive evidence that ASD teams differ in terms of the prevalence and composition of subgroups compared to traditional development (Pflügler, Wiesche, et al. 2018), but has not investigated the underlying mechanisms.

2.2 Faultlines, Subgrouping, and Its Effects

Subgroups are seen as entities composed of members sharing a common relation based on their characteristics. This subset is part of a larger team—hence the term subgroup (Carton and Cummings 2012). Commonly used characteristics include sex, age, or job status (Lau and Murnighan 1998). Another potential faultline could be geographic distance (Polzer et al. 2006), e.g. a team could be split between the US and India. The resulting subgroups may be prone to conflicts in which each subgroup acts unitedly in opposition to the other group. Faultlines can also emerge in conjunction and add to each other (Lau and Murnighan 1998). An exemplary case is illustrated in figure 1, where geographic distance and differences in job role are aligned to create a divide between subgroups.

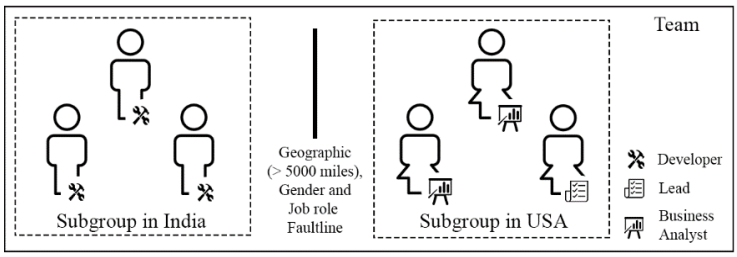

Figure 1: Exemplary Illustration of Subgroups and Faultlines.

Faultlines can explain the emergence of subgroups: The specific configuration of member characteristics in a team is seen to describe the likelihood of subgroups emerging and foreshadows their dynamics (Lau and Murnighan 1998). Previous studies have investigated faultlines based on diverse characteristics, e.g. personality, geography, or information (Polzer et al. 2006; Thatcher and Patel 2012). In the following, the main focus will be on geographic faultlines, e.g. the case illustrated in figure 1, and those due to demographic attributes as they have been originally described (Lau and Murnighan 1998). While faultlines exist based solely on the specific composition of team member attributes, they may not be perceived. Such faultlines have been called "dormant" and can become "active" as perceived subgroups following a triggering event (Jehn and Bezrukova 2010). In a meta-analytic review, both types have been found to negatively affect team outcomes with effects being more pronounced when faultlines are active (Thatcher and Patel 2012). While there is much research on the negative effects of faultlines and perceived subgroups, meta-analytic review has found some instances that have suggested faultlines may have positive effects if the context of subgroups and tasks is aligned (Thatcher and Patel 2012). This being said, the current study focuses on negative effects given their prime importance in research and potential to disrupt ASD projects.

With development and formation of faultlines described to differ based on contextual factors (Lau and Murnighan 1998), several mechanisms that moderate such effects have been proposed. Since they can be directly related to the principles of face-to-face communication and reflection put forth in the agile manifesto (Beck et al. 2001), in the following, direct elaboration of information and team reflexivity are described.

2.3 Moderators of Faultline Effects

Within team processes, extant research considers direct **elaboration of information** to be the main mechanism through which diversity drives performance (van Knippenberg et al. 2004). "Elaboration is defined as the exchange of information and perspectives [... and] the process of feeding back the results of [...] individual-level processing into the group" (van Knippenberg et al. 2004). In the organizational theory context of the definition proposed by van Knippenberg et al., the term information is closely related to individuals' actions and backgrounds, which implies some subjectivity. Direct channels for knowledge sharing are considered to deactivate faultlines by preventing task conflicts through supporting easy communication (van der Kamp et al. 2015). They enable constructive discussions and prevent misunderstandings that otherwise could trigger the emergence of subgroups. Face-to-face, i.e. direct, communication is established as a core principle in the agile manifesto (Beck et al. 2001) and agile methods have been found to improve communication (Pikkarainen et al. 2008).

Team reflexivity refers to how teams discuss task-related issues, processes, and reflect about group objectives and strategies (Schippers et al. 2003). Such a process allows team members to understand their specific project context in more detail, to identify and overcome information-sampling biases, and stimulates them to "look beyond" the perceived subgroups they may belong to (De Dreu 2007; Veltrop et al. 2015). In addition, teams create a shared understanding and a shared frame of reference (van Ginkel et al. 2009; Veltrop et al. 2015) that helps to reframe cognitive representations (Veltrop and Haan 2012). Reframing in turn provides insights to overcome intergroup bias and to omit conflicts (van der Kamp et al. 2015). A shared understanding of both team factors and task characteristics have been found to influence group outcomes and subsequently performance (Mathieu et al. 2000). On a theoretical level, reflexivity is one of the core principles acclaimed in the agile manifesto (Beck et al. 2001) and has been empirically found to increase team effectiveness in agile settings (Kakar 2017).

3 Research Model

Much existing research describes a negative relationship between faultlines and team performance. There are, however, factors that help in keeping faultlines at bay and thus to avoid negative effects. ASD methods exhibit a number of core principles that create a unique type of teamwork environment. As will be motivated in the following, these principles are likely to foster factors that have been identified as moderators of the effects of faultlines. This leads to the hypothesized interaction of constructs depicted in Figure 2, which will be detailed in this section and the subsequent method section.

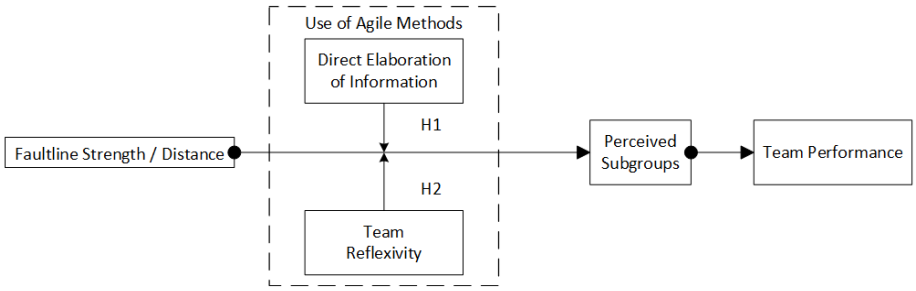

Figure 2. Hypothesized interaction of constructs. Source: Own figure.

3.1.1 Direct Elaboration of Information

A factor that is present in ASD methods and indicated as beneficial in mitigating negative effects of faultlines is direct elaboration of information, i.e. high levels of especially face-to-face communication. It has been described as a potential deactivator of faultlines and to decrease task conflict (van der Kamp et al. 2015). A longitudinal study of software teams has found direct communication and phone calls to benefit the development of team cognition, i.e. knowledge on team members' capabilities and a shared understanding of the task (He et al. 2007). Agile principles incorporate this mechanism since they prominently call for face-to-face communication over written documentation (Beck et al. 2001). Practices such as planning games, daily stand-ups, retrospectives, and pair programming all arguably

involve much direct communication. Moreover, ASD methods suggest that communication between both business people and developers should be on a daily basis and through informal communication as well (Hummel et al. 2013). ASD principles thus extend the call for face-to-face communication beyond developers working on implementation, which arguably bridges perceived differences in professional background. As another aspect, ASD usually takes place in collaborative workspaces and adds additional roles to the traditional software practitioner, which support and facilitate communication (Levy and Hazzan 2009). Previous research has found ASD practices to improve especially team-internal communication (Pikkarainen et al. 2008).

Drawing on previous research on the positive effects of face-to-face communication and the importance attributed to informal communication by ASD methodology leads to:

Hypothesis 1: Use of ASD methods moderates the negative relationship between faultlines and team performance through the direct elaboration of information.

3.1.2 Team Reflexivity

Team reflexivity, i.e. the extent to which teams discuss task-related issues, processes, and reflect about group objectives and strategies (Schippers et al. 2003), is described to help in extending members' frames of observation beyond their immediate environment (De Dreu 2007) as well as in creating a shared understanding—and thus in bridging faultlines (Veltrop et al. 2015).

A culture of change and feedback is one of the core values of ASD (Williams and Cockburn 2003). Agile practices—such as daily stand up-meetings, planning games, or sprint retrospectives—actively encourage team members to reflect on their performance and team behavior (Yu and Petter 2014). Use of ASD practices has been found to foster shared mental models in teams (Schmidt et al. 2014). In the context of the specific practice of pair programming this process is termed Pair Negotiation, Pair Review, and Pair Learning (Beck 2000). Programmers jointly approach a problem and reflect on each of their ideas. They commonly detect problems and learn from each other—thus increasing pair trust and enhancing the level of shared information.

ASD methodology emphasizes reflection and review of project performance by team members. Such team reflexivity is described in literature as an important ingredient to well-performing diverse teams. This assertion leads to:

Hypothesis 2: Use of ASD methods moderates the negative relationship between faultlines and team performance through team reflexivity.

4 Method

Having outlined its theoretical foundation, the hypothesized moderating effect of ASD methods on the effects of faultlines is to be tested empirically. An online survey will be distributed to ASD teams in different countries. Each team member will answer the survey individually, which allows for investigating within-team differences and individual effects. In addition, project leaders will be interviewed to gauge the dependent variable team performance. A total of 100 participants is sought, which is expected to surpass the required sample size given an expected medium effect size (Cohen 1992). Table 1 offers an overview of the sources of items for both independent and dependent variables.

Variable	**Scale Source**
Elaboration	(Homan et al. 2008)
Reflexivity	(Schippers et al. 2007; Shin 2014)
Use of ASD practices	(Tripp et al. 2016)
Perceived Subgroups	(Rico et al. 2012)
Conflict	(Li and Hambrick 2005)

Table 1. Constructs used in survey and sources.

Perceived subgroups, which measures in how far participants perceive subgroups or see the team as one cohesive entity (Rico et al. 2012), has been included as a mediator since perceived subgroups in team members indicate activated as opposed to dormant faultlines (Jehn and Bezrukova 2010), which have been found to exert stronger effects on team outcomes (Thatcher and Patel 2012). With this design, we act on findings that faultline activation may be more relevant than the existence of dormant faultlines and that much research has not considered this distinction (Jehn and Bezrukova 2010).

Items of the independent construct *Elaboration* gauge the contribution and use of information among team members (Homan et al. 2008). *Team reflexivity* investigates to what extent teams learn from the past, reflect before and during tasks, and communicate problems (Schippers et al. 2003; Shin 2014). To examine the degree of use of agile methods, questions from research by Tripp et al. (2016) are included to gauge teams' use of ASD practices, namely visual tools, coordination and shared responsibility with business owners, daily stand-ups, and team reflection. In addition, questions on code formatting, continuous improvement, and pair programming are included. This allows us to determine the degree of agility of teams, i.e. whether ASD is at the core of their work or whether they have just adopted single practices. We deem teams agile if they employ at least three practices.

Conflict captures information on both task-related and personal conflicts in the team (Li and Hambrick 2005). Contingent on level and type, i.e. task- or relation-centered, conflict is described to either invigorate teams or to negatively affect their performance. Moderate task- and process-related conflict coupled with low relation conflict have been generally described to benefit team performance (Jehn and Mannix 2001), while relation-centered conflict has been found to negatively affect productivity in ASD teams (Gren 2017). Furthermore, task requirements are to be used as a control variable. ASD projects have been classified as complex adaptive systems (CAS), which calls for constant exchange of information instead of preplanned procedures (Augustine et al. 2005). Since the degree of routine work in tasks moderates the impact of diversity on performance (Pelled et al. 1999), task requirements may obscure the effects of ASD practices on faultline effects.

All constructs are operationalized on Likert scales with 5 points and in the cases of identity and agile practices with 7 points. Demographic data have been included to control for team size, team longevity, job level, and prior agile experience. Moreover, demographics will be used for calculating faultlines in teams based on strength and distance (Thatcher and Patel 2012). Analysis is to be carried out in the statistical software package SPSS. While validated items have been taken from extant research, factor analysis to ensure reliable and valid results is still to be carried out (Straub 1989).

5 Expected Contribution

This research is expected to make both research and practical contributions. For research, our results will provide an initial understanding of faultlines in ASD teams and thus offer a first insight into how prevalent a much-researched topic in group theory is in the context of ASD. This will enable linking group-theoretic results and ASD research and consequently will contribute to tackling the "people issues" described in ASD (Conboy et al. 2011). This research will add to previous work having found a complex relationship between agile outcomes and its antecedents (Lee and Xia 2010). By including task- and relation-based *conflict* as a control, results will also be helpful in gaining a more nuanced understanding of the role of conflict in ASD, which has been described as an issue (Balijepally et al. 2006; Domino et al. 2003; Gren 2017). Integrating such results and the current research can be a worthwhile research endeavour to uncover the chain of effects surrounding ASD functioning and culture.

To practitioners, insight into how teams function under an ASD regime is beneficial in deciding when to use which ASD practices and helps with forecasts of how ASD will turn out. In addition, practitioners will benefit from knowledge on the exact correlations of ASD methods and practices to faultlines and emerging subgroups, which will be helpful in tailoring use of ASD methods to the situation at hand. Well-founded use of ASD methods to keep subgroup dynamics at bay may thus go a long way in ensuring project success.

6 Conclusion

Part of ASD methodology is the intention of leveraging diversity in heterogeneous teams to achieve superior outcomes. Research in psychology and group theory does, however, outline potential negative effects of diversity in teams: so-called faultlines along characteristics of members and the subsequent emergence of subgroups have been found to negatively affect team performance. This being said, several moderators proposed by extant research can be related to core principles of ASD methods, which leads us to propose that ASD methods and practices moderate negative effects of faultlines. The proposed relation is to be investigated using an online survey study of agile teams. By achieving a more fine-grained understanding of the effects of ASD methods on team dynamics, findings are expected to offer both research and practical contributions.

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