AGILE OR FRAGILE? – THE DEPLETING EFFECTS OF AGILE METHODOLOGIES FOR SOFTWARE DEVELOPERS

Research in Progress

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Abstract

Despite the increasing diffusion of agile software development methodologies (ASDM) in firms, academic studies in this field – though rising in number – are largely missing out on the implications for the individual software developer. The application of agile methodologies in software development projects has significant impact on the individual developer's way of working. While some empirical research evaluated the advantages of ASDM for individuals, potential negative consequences for developers, who have to cope with multiple draining demands in their daily work, remains largely unexplored. Using resource depletion theory as a lens, we develop a research model to examine how the use of ASDM potentially decreases individual job satisfaction and increases turnover intention. We suggest that the effect is mediated by developers' level of depletion expressed by psychological strain. In addition, we aim to determine who is more or less affected by depletion in an agile context introducing the capacity for self-control as a moderator. To test our model, we plan to conduct a cross-sectional field survey among software developers working in agile teams. Drawing attention to underrepresented negative implications on an individual level, we want to contribute to a more balanced picture of ASDM use in theory and practice.

Keywords: Agile methodologies, software development, project organization, individual developer, resource depletion.

1 Introduction

Agile has grown to one of the buzzwords in business nowadays. Indeed, 71% of enterprises claim to use agile approaches (PMI, 2017). Rapidly changing business environments in the digital age resulted in the need for new work arrangements using agile practices and, thereby, leading to faster product delivery and better management of changes in priorities and requirements (VersionOne, 2017). Most prominent is the agile way of working still in software development (VersionOne, 2017), where it originally came from (Fowler and Highsmith, 2001). Agile software development (ASD) is significantly different from traditional plan-based concepts (Mahadevan et al., 2015; Schlauderer et al., 2015). Practices such as iterative delivery or continuous integration place new demands on developers. Whereas organizational and team level implications of the use of agile software development methodologies (ASDM), e.g. method adoption, success factors, or team communication, have attracted considerable research attention (e.g. Chow and Cao, 2008; Dingsøyr et al., 2012; Nerur et al., 2005; Wiedemann and Weeger, 2017), research on the consequences for the individual developer is scarce.

Exceptions are a few studies that examine the advantages of ASDM use concerning individual job satisfaction (e.g. Balijepally et al., 2009; Melnik and Maurer, 2006; Tripp et al., 2016) and empowerment (Tessem, 2014) of developers being part of ASD projects. In general, their results confirm the positive impact of ASDM use. However, most recently, an empirical study by Tripp et al. (2016) found only mixed support for the hypothesis that agile practices had an effect on individual satisfaction directly and via specific job characteristics. The findings suggest that a more precise examination of the individual implications of applying ASDM is needed. In particular, we believe that research investigating potential negative side effects of ASD can give further insights. The principles underlying ASDM, such as constantly embracing change or short iteration cycles, represent demands, which might have unwanted depleting implications for developers. Research does indeed acknowledge this potential. For example, Schlauderer et al. (2015) and Tripp et al. (2016) both mention that ASD is demanding and requires a high level of self-discipline from developers. Also, Balijepally et al. (2006) indicate that shared decision-making, continuous collaboration, and the diversity of skills in agile teams can create stress among developers. Studies targeted particularly towards explaining the effects of energy-draining, stressful demands in ASD and individual differences with regard to the intensity of the effect are still lacking, though.

The purpose of this research is to extend previous literature by shedding light on the potential negative effects of ASDM use on the individual developer. In particular, we are interested in the implications of ASDM use on job satisfaction and turnover intention of developers. We draw upon resource depletion theory (Baumeister et al., 1998; Muraven and Baumeister, 2000) in order to explain the effects of high demands (e.g. psychological strain) on individuals working in ASD teams. In addition, we intend to examine who can better cope with potential depletion due to the application of ASDM. We therefore apply the concept of self-control capacity, i.e. the individual ability to control one's behaviour or resisting temptations (Tangney et al., 2004). Overall, our examination of ASDM use yields the following research questions: *How does ASDM use lead to lower job satisfaction and higher turnover intention and how do individual differences in dispositional self-control affect these relationships?*

With this research, we aim to contribute to theory and practice in several ways. First, we make an initial step to investigate a potentially negative psychological impact of ASDM on developers. Hence, we add to previous ASDM research by painting a more balanced picture of ASDM use. Second, by integrating resource depletion theory, we introduce a new theory in ASD research that might explain why ASDM can have detrimental side effects on job satisfaction and turnover intention: ASDM may decrease job satisfaction and increase turnover intention as they might be draining for developers. We also follow the call of Dingsøyr et al. (2012) to embrace more theory-based approaches in the context of ASD. In addition, we expand the research from Tripp et al. (2016) and give a potential explanation for the mixed results the authors found. For practitioners, we would like to draw attention to the fact that applying ASDM may trigger unwanted negative consequences. The results might give a further explanation why ASDM still do not always reach the expectations hold upon them.

In the following, we elaborate on the theoretical background of our research before we derive our hypotheses. We then go into detail about the current status of our study. Finally, we summarize the paper and give an outlook on our next steps.

2 Theoretical Background

2.1 Agile software development methodologies

The agile manifesto introduced twelve principles, which revolutionized the way of developing software (Fowler and Highsmith, 2001). It emphasizes welcoming requirement changes, short development cycles, as well as shared decision-making and continuous collaboration. Various methods embracing the agile manifesto emerged in the last two decades including Scrum, Extreme Programming (XP), feature-driven development, Kanban, or crystal methodologies (Dybå and Dingsøyr, 2008; Tripp and Armstrong, 2014). The raison d'être of these methodologies is their varying degree of adherence to the manifesto and their different focus (Dingsøyr et al., 2012). Among the most popular approaches are XP (Beck, 2000), which provides specific techniques for the development process itself, and Scrum (Schwaber and Beedle, 2002), which focusses more on project management and creative teamwork in solving complex problems (Barlow et al., 2011; Rigby et al., 2016).

Research on ASDM has developed since the articulation of the agile manifesto. Earlier scientific literature on ASD has often concentrated on XP, as it was very prevalent in the beginning of ASDM adoption (e.g. Baskerville et al., 2002; Maruping et al., 2009; Vidgen and Wang, 2009). More recent studies shift the focus to the application of Scrum practices, examining implementation challenges or the role of shared understanding (e.g. Baumgart et al., 2015; Hekkala et al., 2017; Hummel et al., 2016). In addition, the coexistence of ASDM and traditional plan-driven methods in hybrid software development approaches has lately received more attention by information systems (IS) researchers (e.g. Mahadevan et al., 2015; Ramesh et al., 2012; Schlauderer et al., 2015). Examining acceptance factors and changes in control, these studies shed light on the transitioning phase between traditional and ASD.

Besides the rising attention concerning Scrum or hybrid approaches, interest in agile team dynamics emerged in recent years putting more emphasis on the "people factor" of agile methods (Cockburn and Highsmith, 2001; for a comprehensive overview of agile team research have a look at Wiedemann and Weeger, 2017). Whereas trust and motivation have been studied a while ago (e.g. McHugh et al., 2011; Tessem and Maurer, 2007), a wider range of mechanisms and theories has been applied to the ASD context by now. Ghobadi and Mathiassen (2016) and Hummel et al. (2016), for example, investigated the installation of knowledge sharing and shared understanding within ASD teams. Hummel et al. (2015) identified a set of social ASD practices (e.g. daily stand-up meetings, a technique from Scrum), which influence the direct communication among team members positively. Drawing on decision process theory, Coyle et al. (2015) determined the important role of individual contribution behaviours on ASD decision-making. Furthermore, Baumgart et al. (2015) used the five factor model to analyse the effect and composition of personality traits within ASD teams.

With regard to the individual developer in agile teams, literature concentrates on developer job satisfaction and individual empowerment. Tessem (2014) studied empowerment among developers from agile and traditional software development teams. He found that it is present in both and determined differences in the way of achieving it. Concerning satisfaction, Balijepally et al. (2009) found that pair programming (a technique used in XP) is more satisfying than traditional sole programming is. Studies of Melnik and Maurer (2006) as well as Tessem and Maurer (2007) reached similar results for ASDM usage in general. Furthermore, Tripp et al. (2016) conducted a study based on the job characteristics model and found mixed support for the effect of ASDM use on developer job satisfaction. The authors were able to measure the use of ASDM, but only parts of the agile practices surveyed had an impact on satisfaction. These results give reasons to believe that additional constructs (e.g. stress or depletion) may play a role when examining the consequences of ASDM application on the developer (Tripp et al., 2016).

2.2 Self-regulatory resource depletion

In the context of resource depletion theory, self-regulation refers to the act of exerting control over one's feelings, thoughts, or impulses and adapt behaviours based on various demands (Baumeister et al., 2006; Baumeister and Vohs, 2007). For example, regulating negative affect, resisting distractions, or coping with stress are demands, which require a great deal of control over oneself (Muraven and Baumeister, 2000). According to Muraven et al. (1998) and Baumeister et al. (1998), self-regulation relies on a limited resource, just like energy or strength, and is consistent across seemingly unrelated domains, such as controlling emotions, cognitive processing, or choice and volition. When this common inner resource is used up, one falls in a state of ego depletion, which describes a state of diminished availability of regulatory resources, or self-control strength (Baumeister et al., 2007; Muraven et al., 1998). Once depleted, subsequent tasks in need of self-regulation are less successful than they would be without prior depletion (Baumeister et al., 2006). Literature compares self-control strength usually with a muscle that gets exhausted when continuously exerted (Baumeister et al., 2007; Muraven and Baumeister, 2000). In particular, reacting frequently to self-regulation demands without a possibility of replenishing regulatory resources can lead to chronic depletion and to increased psychological strain (Muraven and Baumeister, 2000; Oaten and Cheng, 2005).

In the organizational environment, resource depletion theory has lately received increasing attention. Studies use this model in order to explain what consequences self-regulation demands, especially stress, at the workplace or in family life have on an organizational or individual level (Chan and Wan, 2012; Schmidt et al., 2012). Reina et al. (2017), for example, found that the depleting effect of family-to-work conflict of chief executive officers lowers their firms' performances. Furthermore, Mawritz et al. (2017) suggests that employees that show deviant behaviour deplete their supervisors' regulation resources and thereby trigger abusive supervision. In another study, executed by Uy et al. (2017), the authors were able to explain why surface acting has a negative impact on work engagement using the depletion mechanism. Very interestingly, Lanaj et al. (2016) found that the generally very positively noted act of helping others comes at the cost of depleted regulatory resources. In line with these studies, we believe that resource depletion theory has the potential to provide an explanation to mainly unintended negative effects in the ASD environment.

2.3 Self-control capacity

As we elaborated above, self-regulation relies on a finite pool of resources, which can be used up leading to depletion and a reduced ability to self-regulate. However, the pool can be of different sizes, meaning that some people have a larger amount of self-control resources to start from (Muraven and Baumeister, 2000). This self-control capacity is defined as a "dispositional, trait-like factor that operates as a protective resource when individuals face high demands of self-control" (Diestel et al., 2015, p. 816). When engaging in tasks involving self-regulation, such as focusing attention or complex problem-solving, individuals with high trait self-control will have more resources remaining afterwards, given the same circumstances (Hagger et al., 2010). Accordingly, people that are higher in trait self-control are less prone to interpersonal conflicts and more effective when resisting temptations or controlling their behaviour (Tangney et al., 2004). Evidence suggests that these benefits also hold true in work settings. Diestel et al. (2015), for example, found that self-control capacity enhances the sleep quality of employees and thereby alleviated the negative effect of emotional dissonance at the workplace on psychological strain. More general, Schmidt et al. (2012) determined that trait self-control attenuates the link between job-related self-regulation demands and employee strain and well-being.

3 Hypotheses Development

Resource depletion theory builds the theoretical basis for our research model as depicted in figure 1. By adopting this theory, we aim at explaining the implications of the draining demands of ASDM use on individual job outcomes. Accordingly, our research model sheds light on the effect of ASDM use on developers' level of psychological strain (H2), the effect of developers' strain on their individual

job satisfaction and turnover intention (H1a/H1b), the role of psychological strain in mediating the effect of ASDM use on satisfaction and turnover intention (H3), and the moderating role of self-control capacity on the effect of ASDM use on developer strain (H4).

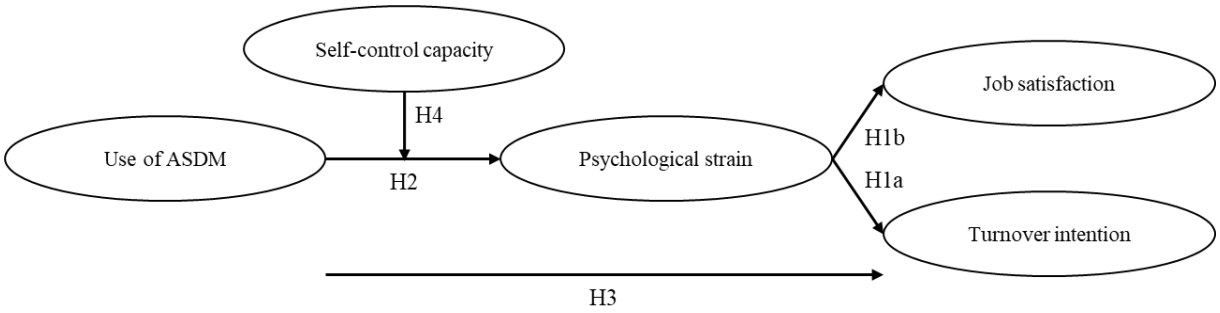

Figure 1. Research Model.

3.1 Effects of psychological strain at work

The relationship between psychological strain at the workplace, characterized by fatigue and a need to recover, and the individual job satisfaction and intention to change jobs has been studied widely among researchers (e.g. De Croon et al., 2004; Rutner et al., 2008; Sonnentag and Frese, 2003). In the context of ASDM use, we chose these two dependent variables for the following reasons. First, ASDM claim to create more satisfied employees (Highsmith, 2002). However, recent research has determined mixed results concerning this aspiration (Tripp et al., 2016). Second, we added turnover intention because of its high relevance from a practitioner's perspective in a digitized world. Firms are paying high wages to recruit and retain the best software developers (Bureau of Labor Statistics, 2018). Although firms also hire freelancers, who simultaneously work for multiple firms in the project-based context of software development, those developers working full-time for one company are most valuable. They have deep knowledge of the company-specific software and hardware or the firm's cutting-edge technologies. Keeping these can be key to a company's digital competitive advantage.

With regard to turnover intentions, De Croon et al. (2004) were able to demonstrate that psychological strain in terms of fatigue mediates the effect of stressful work on turnover. Moore (2000) and Rutner et al. (2008), additionally, show that work exhaustion due to high job demands in an IT context is positively related towards employee turnover intention. We follow these arguments, theorizing that strain stemming from the use of ASDM, as well, will positively affect the intention of developers to change the current position. In accordance with the above-mentioned project-based context, we will investigate turnover intention in terms of the willingness to change the project and the company. Furthermore, we add developer job satisfaction to our research model. In longitudinal as well as meta-analytic studies, researchers show that exhaustion negatively affects job satisfaction (Lee and Ashforth, 1996; Wolpin et al., 1991). Rutner et al. (2008), in addition, give evidence that work exhaustion produces lower job satisfaction within IT professionals in particular. In line with these studies, we propose that psychological strain in the context of ASDM use negatively affects developer job satisfaction.

Hypothesis 1a: Psychological strain positively influences developers' turnover intention (project/company).

Hypothesis 1b: Psychological strain negatively influences developers' job satisfaction.

3.2 Depleting demands in agile software development

Software development is inherently a complex activity and a cognitively demanding task (Balijepally et al., 2015; Maruping et al., 2009) that has the potential to provoke negative effects, e.g. psychological stress, within developers (Venkatesh et al., forthcoming; Windeler et al., 2017). In addition, ASD approaches add the notion of agility to software development (Lee and Xia, 2010). Agility in IS development is defined by Conboy (2009, p. 340) as "the continual readiness […] to rapidly or inherently

create change, proactively or reactively embrace change, and learn from change […]." Constant change of requirements, processes, and behavior, in general, requires mental and behavioral flexibility, a core construct of agility (Conboy, 2009). However, this flexibility to adapt behaviors and thoughts often means not to proceed in the normal and known way. This, in turn, requires self-regulation in order to be able to implement different approaches and break own habits (Muraven and Baumeister, 2000). The continual readiness to act, which the definition mentions, additionally, requires a high level of self-discipline from the developers (Schlauderer et al., 2015). Self-discipline is usually investigated in the same vein as self-regulation since the cognitive and affective control over oneself is underlying both (Hagger et al., 2010; So et al., 2016). Therefore, adding agility to software development methodologies implies adding mechanisms intensely demanding self-regulatory resources to a task, which is already characterized by a high level of cognitive processing.

With regard to the individual practices applied in ASD, Schlauderer et al. (2015), for example, found out that especially the daily stand-up meetings and the close collaboration required by developers while trying to stay focused on their tasks seems to be in need of a high level of self-discipline. Pair programming, in addition, calls for great understanding among agile team members (Balijepally et al., 2006). Also, there is a series of skills and backgrounds coming together in an agile team creating a potential cause of conflict (Trimmer et al., 2002). The resulting demanding interpersonal interactions were found by various studies to have a depleting impact on self-regulatory resources (e.g. Finkel et al., 2006; Lanaj et al., 2016). Moreover, the short cycle times as a central part of ASDM place additional pressure on agile team members to stay focused and resist distractions (Beck, 2000; Maruping et al., 2009) which, in turn, may increase developer fatigue and depletion (Zohar et al., 2003). To sum it up, we theorize that the use of ASDM has the potential to deplete developers' regulatory resources. In line with Diestel et al. (2015), we further argue that psychological strain is characterized by depletion. Hence, we hypothesize developers using ASDM are prone to psychological strain at work. This in turn decreases developer satisfaction and increases turnover intention.

Hypothesis 2: The extent of ASDM use positively influences the level of psychological strain of developers.

Hypothesis 3: Psychological strain within developers mediates the influence of ASDM use on job satisfaction and turnover intention.

3.3 Buffering depletion in agile software development

We theorize that a developer's self-control capacity can attenuate the effects of ASDM use on psychological strain. Developers in agile teams need to be flexible and open for changes, work closely together, and stay focused in order to deliver code constantly. All of these acts require self-regulatory resources. Those developers that have a greater ability to control their thoughts, behaviour, and attention can draw from a greater pool of self-control resources than those with less self-control capacity. They have more resources available to cope with the depleting demands they constantly face in agile teams. Thus, higher self-control capacity enables these developers to exert more draining tasks without getting depleted than those with less self-control capacity. They will find it easier to adapt to sudden changes in the development process and to focus on their task despite interruptions from the team or frequent meetings. After potential conflicts within the team, these developers will suffer less from depletion and still have the discipline to get themselves back to work. Existing research provides some evidence backing up our proposition. Literature identified dispositional self-control to be a higher order construct of the personality traits conscientiousness, agreeableness, and emotional stability (Olson, 2005; Tangney et al., 2004). These traits, conscientiousness and agreeableness in particular, have been determined as essential personality factors within successful ASD teams (Balijepally et al., 2006; Baumgart et al., 2015). Accordingly, we propose that developers, who score higher in these traits, or in self-control capacity, can deal better with the continuous demands of agile teams and practices.

Hypothesis 4: Self-control capacity negatively moderates the relationship between ASDM use and developers' psychological strain such that developers with higher self-control capacity experience lower psychological strain from ASDM use than developers with lower self-control capacity.

4 Outlook, Research Design, and Measurement

To test our research model, we aim to conduct a cross-sectional field survey among agile software development professionals. We intend to recruit our sample making use of a panel company that is specialized in conducting internet-based surveys and has access to a large community of software developers. We plan to measure ASDM use, psychological strain, and the outcome variables separately at three subsequent points in time to strengthen causal inferences and minimize common method effects.

Agile Techniques	**Definition**	**Categorization**
Iterative delivery - Iteration planning - Iteration reviews	The process of 1) planning and 2) delivering in an incremental manner. Specifically, the concept that delivery in small chunks provides the team with the ability to generate code and immediately receive feedback from the environment after each iteration.	Management techniques
Daily standup (Schwaber and Beedle, 2002)	A (usually) daily meeting in which all project members meet while standing to encourage brevity. In Scrum, the meeting involves asking and answering (1) What did I accomplish yesterday? (2) What will I do today? and (3) What obstacles are impeding my progress?	Management techniques
Retrospectives (Schwaber and Beedle, 2002)	A meeting held at the end of each iteration in which the team 1) critically reflects on the last iteration and 2) identifies and implements continuous improvement opportunities.	Management techniques
Short iterations (Schwaber, 2004)	In general, the iteration length is fix and should not exceed 30 days.	Management techniques
Unit testing (Beck, 2000)	Using dedicated test code that one can run (usually automatically) to test the effects of changes to the system. The team generally performs this testing before team members are allowed to check in code, which allows developers to be sure that they have not broken anything in the system.	Engineering techniques
Continuous integration (Beck, 2000; Duvall et al., 2007)	The process of systematically and regularly building and deploying the code to a test server.	Engineering techniques
Coding standards (Beck, 2000)	A set of established norms as to code-naming and consistency.	Engineering techniques
Refactoring (Fowler and Beck, 1999)	A commitment by the team to use practices that lead to removing redundancy, eliminating unused functionality, and refreshing obsolete designs.	Engineering techniques

Table 1. List of ASD practices considered in this research (adapted from Tripp et al. (2016))

For the questionnaire, all constructs will be measured using 7-point Likert scales ranging from "strongly disagree" to "strongly agree". The items are based on previous research. The items for measuring ASDM use will come from Tripp et al. (2016). We took their list of ASD practices and updated it with respect to current statistics on the most widely used ASD practices (table 1) (VersionOne, 2017). Accordingly, the questionnaire items from Tripp et al. (2016) will be adapted to the techniques presented in table 1. The construct of ASDM use will be modelled as an aggregate second-order construct consisting of the individual ASDM techniques (cf. Tripp et al., 2016). A sample item would be "The team discusses issues together daily". For completeness, we will add an "I don't know"-option.

We will measure the depletion effect, i.e. psychological strain, with five items from the scale proposed by Van Yperen and Hagedoorn (2003). A sample item is "Due to my job, I feel rather exhausted at the end of a working day". Self-control capacity will be assessed using Tangney et al.'s (2004) self-control capacity scale. Similar to Diestel et al. (2015), we intend to focus on the items referring to one's general tendency towards self-discipline as well as one's inclination to deliberate/nonimpulsive action. These constitute the core parts of dispositional self-control (Muraven and Baumeister, 2000). Hence, we will use a shortened scale with items like "People would say that I have iron self-discipline". The dependent variable developer satisfaction will be measured applying the 3-item-general-satisfaction-scale developed by McKnight et al. (1997) and used by Rutner et al. (2008). We plan to adapt it to measure general job satisfaction and satisfaction in the current ASD project. For measuring turnover intention, we will draw on items from Leiter et al. (2011). We will modify the scale to the extent that it provides information on company and project level.

We will also assess a range of control variables. Next to age and gender, we will control for negative affect since it can influence self-reports of stress and strain (Moore, 2000). Five items from the PANAS (Positive and Negative Affect Schedule) will be used (Watson et al., 1988). Experience with ASDM will also be added since continuous practice of tasks requiring self-regulation has been shown to enhance self-regulation abilities (Muraven, 2010). Thus, experience with agile practices might affect the level of psychological strain. We will also include team size and dispersion, since especially social ASD practices (Hummel et al., 2015) are designed for smaller, collocated teams. The number of team members and their location affects the degree of communication manageable by team members (Barlow et al., 2011; Misra et al., 2009). Developers of large teams applying ASDM are likely to become worn out by not being able to efficiently interact. Additionally, we will add items concerning time pressure from a scale used by Maruping et al. (2015) as short iterations and continuous integration might lead to high time pressure potentially stressing developers. We will also control for job control (items used from Jackson et al. (1993)) because according to the job strain model by Karasek (1979) low decision latitude combined with high job demands leads the high strain at work. Lastly, we will add organizational (and project) tenure to the list of control variables (Rutner et al., 2008).

We are currently conducting a pre-study with the aim to assess the proposed constructs and items. According to the results, we will re-evaluate and adapt, where necessary, the research model.

5 Conclusion

This research-in-progress paper is motivated by the need to examine the potential negative effects of ASDM use on individual developers in organizations. In the same vein, the results might explain why ASDM still do not reach the expectations hold upon them. So far, scientific work has concentrated its effort on the organizational or team level of ASDM application. The individual developer, in general, and the implications of ASD demands on an individual level, in particular, have not received much attention (Tripp et al., 2016). We aim to further close this research gap by making a step towards identifying potential negative psychological effects that ASDM use has on developers. Applying resource depletion theory not only follows the call of Dingsøyr et al. (2012) for more theory-based research in the to a large degree case-study based ASD research context but also opens up a new research path to study ASD. Researchers can take our model and conceptualization to take a more nuanced perspective on ASDM and develop new ideas including positive and negative effects, for example, concerning the outcomes on individual or team performance over time (Benlian, 2015) or software quality (Windeler et al., 2017). Dyadic studies that compare the consequences of ASDM from different stakeholder perspectives (e.g., developers vs. managers) may also provide novel insights (Benlian, 2013; Benlian and Haffke, 2016). We also hope to contribute to practice by pointing out who is particularly affected by depletion and who can cope well with the continuous, draining demands. Developers are among the most valuable employees in our digital world. The market for good developers is highly competitive. The results of our study might, therefore, give some guidance on how to be an attractive employer for agile developers.

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