

Making Software Teams Effective: How Agile Practices lead to Project Effectiveness through Socio-Psychological Mechanisms

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Abstract

This study uses an organizational psychology lens to gain a fundamental understanding of how Agile Practices positively influence socio-psychological mechanisms that lead to a successful project.

The theoretical framework of this study is based on a causal model of teamwork derived from innovation research with the major constructs of coordination capability and knowledge growth. We will investigate the impact of Agile Practices on these constructs through well-researched teamwork variables such as goal commitment and social support, and by the new constructs adaptivity and open communication. We will then determine the impact of these constructs on project performance. In addition, we will analyze the moderating effect of team autonomy on the relationship between coordination capability and project performance.

The quantitative field study will be conducted in Nov 2008 and targets a sample size of 60 agile projects.

Keywords: agile practices, teamwork, team performance, customer feedback, communication, social support, team autonomy

1 Introduction

In recent years, new software development methods have emerged under the label “agile methods”. Their purpose is to effectively integrate changing customer requirements and to emphasize the collaboration within the team. Software development methods are composed of several practices describing technical or organizational processes necessary for implementing a software project. Those practices which are specific to agile methodology are called ‘Agile Practices’ in this study.

Parallel to the market penetration of agile methods and their practices, scientific investigation of Agile Practices has also increased, although it has remained primarily within the software development field. In this field, a few empirical studies using a psychological perspective have emerged. They analyzed various positive effects of Agile Practices in projects:

Whitworth and Biddle (2007) studied social interactions in agile teams. Participant interviews in this study led to the conclusion that Agile Practices such as collective ownership, short it-

erations, pair programming and daily stand-up meetings increased perceived social support, cohesion and motivation in software development teams.

Law and Ho (2004) conducted a case study on social factors in an XP environment. They observed that co-location improved team communication, and that customer on-site and an iterative planning strategy led to increased customer satisfaction.

Robinson and Sharp (2005) used an ethnographic approach to analyze the social implications of the Agile Practices. They found that four Agile Practices - namely pair programming, test-first development, simple design, refactoring - all incorporated pairing. Pairing involves two technical developers sitting side-by-side to accomplish a task. According to the study, pairing can be described as an intensive but also potentially stressful form of conversation.

These psychological studies of Agile Practices dominantly used qualitative methods such as grounded theory or case studies. Therefore, it would be valuable to validate them using quantitative methods, which are less sensitive

to the verbal communication ability of the participants and more safeguarded against casual circumstances due to the larger sample size.

In contrast to the scarce coverage of psychological factors in software development research, there is an abundance of studies about such factors in the field of organizational psychology. Extensive study of teams in this field over the past few decades has identified important team performance factors such as goal setting, goal commitment, cohesion and social support. Investigating these team performance factors as mediators between Agile Practices and project effectiveness may unveil important socio-psychological mechanisms. Such findings could help to understand the complex relationships between Agile Practices and team performance.

Fundamental to the discussion of Agile Practices in software development research, the Agile Manifesto (Beck et al., 2001) highlights core principles shared by all agile methods and implemented by Agile Practices. Many software development studies investigate in detail the effectiveness of a particular Agile Practice, such as pair programming (Williams, Kessler, Cunningham, & Jeffries, 2000), and include the development of appropriate measurements and metrics. Building on these studies, research on Agile Practices will benefit from a comparison of Agile Practices in a representative selection. Only by such a comparison can Agile Practices be put into perspective, because their relative value against each other can be detected. Based on these considerations, the resulting research question hence is:

How do Agile Practices influence socio-psychological mechanisms which have a positive impact on project effectiveness?

The results may disconfirm the popularity of well-covered practices and may raise attention to previously neglected practices.

2 Theoretical Framework

Scholl (2005) developed a causal model of teamwork which provides an appropriate base for this study due to its focus on interaction and innovation, as well as its definition of the construct coordination capability: Four studies using Scholl's model have investigated various interaction aspects of teamwork and confirmed the model's predictions. Thus we can assume the model's general applicability to the analysis of teamwork. Scholl tested his model in a field study on innovation processes. Innovation processes are characterized by high degrees of novelty and uncertainty. These characteristics also describe the con-

text of agile projects. A major force leading to the development of agile methods was the inability of the preceding plan-driven methods to cope with high degrees of uncertainty and novelty invoked by frequently changing customer requirements. Furthermore, one of the major constructs in Scholl's model, coordination capability, is well applicable to the agile context. Coordination capability is defined as the "ability to execute complete decision making and implementation cycles". Iterations, the short development cycles which are a fundamental element of agile methods, are themselves essentially "complete decision making and implementation cycles". Coordination capability can therefore be recast in the agile context as the "ability to execute iterations". By applying Scholl's model in the agile context, confirmation of its previous findings could extend its validity to a new real-work context and thereby serve as a source of new insight in this context. The described verification goal regarding Scholl's model leads to the first hypothesis:

H 1 *Effectiveness of a software project is positively dependent on coordination capability and knowledge growth.*

A multitude of studies based on goal setting theory, as summarized by Locke and Latham (2002), has confirmed the mediating effect of goal commitment on performance, both at the individual and the group level. Social support can mediate this effect as shown by Aubé and Rousseau (2005). This study will investigate a new role of social support, as a direct influence on coordination capability. Coordination capability can be considered as a concrete form of performance, leading to the third hypothesis:

H 2 *Coordination capability is positively dependent on goal commitment and social support.*

The current study analyzes the impact of Agile Practices on team learning as knowledge growth through adaptive behavior and open communication. When the team receives customer feedback as a source of knowledge growth, it can respond adaptively by modifying the implemented and planned scope accordingly. An additional positive effect on knowledge growth can be expected if the team manages to establish open communication through an error-tolerant culture in which team members may communicate own mistakes and provide constructive criticism without fearing repression. The resulting second hypothesis is:

H 3 *Knowledge growth is positively dependent on adaptivity and open communication.*

Iteration planning is practiced in the prevalent agile methods as planning meeting in which all team members decide on scope of the current iteration by collectively setting effort estimations. This Agile Practice may have a decisive impact on goal commitment due to the empowerment effect.

The Agile Practices of iterative development and continuous integration & testing represent the fundamental building blocks of agile methodology. Their impact on the technical realization of software projects has been covered in many studies and does therefore not represent the center of attention in this study. In regards to team dynamics, their most valuable effect may consist in a fast rhythm providing focus of effort towards generating the iteration result which in turn represents feedback on the team performance. The above considerations can be transformed into the following hypothesis:

H 4 *Goal commitment is positively dependent on the Agile Practices of iteration planning, iterative development and continuous integration & testing.*

In his study, Scholl found a high correlation between willingness to cooperate and both coordination capability and knowledge growth. Willingness to cooperate should lead to more open communication and mutual social support. In agile contexts, open communication and social support may be directly proportional to the frequency of face-to-face contact such as through the Agile Practices of stand-up meetings. The resulting hypothesis hence is:

H 5 *Face-to-face communication established by stand-up meetings has a positive effect on social support and open communication.*

Apart from frequent face-to-face communication, we can expect a positive effect on open communication by the Agile Practice retrospectives. Retrospectives are internal lessons learned workshops in which a team reflects on areas of improvement on a regular basis. During the retrospective, team members are encouraged to provide constructive feedback to each other, and should follow up on the decided action points afterwards. If the team consistently follows this Agile Practice, we can expect to confirm the following hypothesis:

H 6 *Open communication is positively dependent on the Agile Practice retrospectives.*

Adaptivity, as mentioned above, is the behavior of a team to direct their efforts to the received customer feedback. Sources of customer

feedback are formal product demonstrations in the Agile Practice customer acceptance tests, and through informal communication channels as operationalized as customer access by Layman, Williams, and Cunningham (2006). Furthermore, the adaptation process also flows in the other direction, from the customer to the team: The customer in turn receives feedback from the team about the technical feasibility of his requirements and can thus adapt his requirements to these constraints. These reflections can be summarized in the following hypothesis:

H 7 *Adaptivity is positively dependent on the Agile Practices customer demonstrations and customer access.*

Despite all team efforts, a team might fail to deliver according to expectations due to factors which are located outside the team's circle of influence. These external factors may have a dominating destructive effect on the performance, or more specifically on coordination capability, because they decrease the team autonomy in decision making and implementation. Team autonomy may determine the extent of how much Agile Practices can influence teamwork. This effect is tested in the following hypothesis:

H 8 *Team autonomy is a positive moderator on the relationship between coordination capability and effectiveness.*

3 Method

Our sample is composed of software development projects applying Agile Practices consistently. The field study will be conducted through a web-based questionnaire completed by four team members of each project team.

This study postulates a model of several independent causal mechanisms of teamwork toward project performance through three subsequent causal levels. Multivariate statistics provides structural equation modeling (SEM) as the only method to define a model of this complexity, estimate its parameters, and to allow the calculation of model fit indexes to evaluate the stability of the estimated parameters.

A common drawback to using SEM requires a high sample size for the estimation. However, this precondition only applies if all indicator variables are included as parameters into the full model. In order to reduce the number of parameters, and to obtain more stable estimations, two different aggregation techniques will be used in the structural analysis: composite

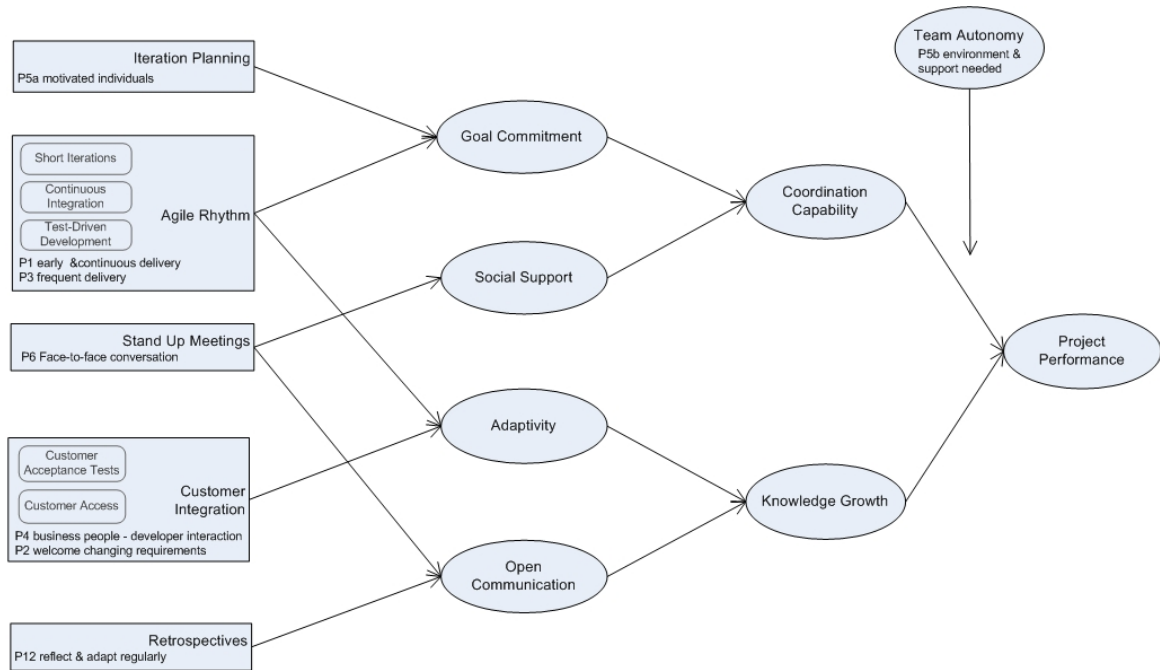


Figure 1: Causal Model of Agile Teamwork Effectiveness

scores (Ronald S. Landis & Tesluk, 2000) and item parceling (Little, Cunningham, & Shahar, 2002).

References

- Aubé, C., & Rousseau, V. (2005, September). Team goal commitment and team effectiveness - the role of task interdependence and supportive behaviors. *Group Dynamics: Theory, Research, and Practice*, 9(3), 189–204.
- Beck, K., Beedle, M., Bennekum, A. van, Cockburn, A., Cunningham, W., Fowler, M., et al. (2001, August). *Manifesto for agile software development*. Online. Available from <http://agilemanifesto.org>
- Law, A., & Ho, A. (2004). A study case: evolution of co-location and planning strategy. In *Proc. agile development conference* (pp. 56–62).
- Layman, L., Williams, L., & Cunningham, L. (2006, November). Motivations and measurements in an agile case study. *Journal of Systems Architecture: the EUROMICRO Journal*, 52(11), 654–667.
- Little, T. D., Cunningham, W. A., & Shahar, G. (2002). To parcel or not to parcel: Exploring the question, weighing the merits. *Structural equation modeling*, 9(2), 151–173.
- Locke, E. A., & Latham, G. P. (2002, September). Building a practically useful theory of goal setting and task motivation. *American Psychologist*, 57(9), 705–717.
- Robinson, H., & Sharp, H. (2005). The social side of technical practices. In H. Baumeister & M. Marchesi (Eds.), *Extreme programming and agile processes in software engineering* (Vol. 3556/2005, pp. 100–108). Springer Berlin / Heidelberg.
- Ronald S. Landis, D. J. B., & Tesluk, P. E. (2000, Apr). A comparison of approaches to forming composite measures in structural equation models. *Organizational Research Methods*, 3(2), 186–207.
- Scholl, W. (2005). Grundprobleme der Teamarbeit und ihre Bewältigung. Ein Kausalmodell (Basic problems of team work and their solution – a causal model). In M. Högl & H. Gemünden (Eds.), *Management von Teams. Theoretische Konzepte und empirische Befunde (Management of teams. Theoretical concepts and empirical results)* (3rd ed., pp. 33–66). Wiesbaden: Gabler.
- Whitworth, E., & Biddle, R. (2007). The social nature of agile teams. In *Proceedings agile 2007* (pp. 26–36).
- Williams, L., Kessler, R. R., Cunningham, W., & Jeffries, R. (2000). Strengthening the case for pair programming. *IEEE Software*, 19–25.